Popular Theology from Popular Scientists:
Assessing the Legacy of Eddington and Jeans as Apologists

Abstract

This thesis asserts and demonstrates that the current historical evaluation of the significance of Arthur Eddington and James Jeans is inadequate. Not only has their importance in the years between the two World Wars been forgotten, but their transitional role in the science and religion debate post-Darwin is now largely unrecognised. Both had a major influence on subsequent popular apologists and Eddington in particular influenced post war academic theologians as diverse as Thomas Torrance and Eric Mascall.

It is generally accepted that the apologetic writings of Eddington and Jeans were widely read and were adept at conveying their message. They have, however, been increasingly ignored by historians and theologians. This thesis argues that their work post-Darwin on the new physics of the early twentieth century was significant in steering the science and religion dialogue in the United Kingdom away from the more conflict-based approaches such as the beginnings of creationism in the United States. Further their deployment of metaphor, ability to engage in dialogue with the public through the press and the new technology of the wireless were innovative and left a legacy for apologetics and the science and religion dialogue.

By an examination of three key texts, a new account is given of the authors' importance and of the reactions of contemporary theologians, philosophers and scientists. Their work brought the latest science to bear on important areas of traditional theological debate in an accessible way and to a good apologetic end. The role of intuition and 'seeking' in relation to Eddington's writing shows a fresh Quaker-influenced approach to apologetics and the science and religion debate.

The widely-accepted role of Susan Stebbing in the post-war decline of Eddington and Jeans is examined and dismissed as simplistic. A new analysis of the reasons for their decline and neglect is made. Jeans and Eddington remind us that the importance of general cultural trends and contemporary events in the science and religion debate is often overlooked. The history of the reception of their apologetic work and the pattern of their continuing significance illustrate the connectedness of theology with current events.

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Unless otherwise stated, all italics are as in the original.

CHAPTER ONE

THEOLOGY, POPULARISATION AND APOLOGETICS

1.1 Introduction

The initial contention of this thesis is that the current evaluation of the historical significance of Sir Arthur Eddington and Sir James Jeans is inadequate and in need of a reappraisal. In the years between the two World Wars they were very well known and widely respected. They first came to British public attention as popularisers of 'the new physics' in a number of accessible books.

Such a reappraisal leads on to some important conclusions about their significance. These books helped move the general public on from a Victorian, mechanistic, deterministic and naïve view of science to a more nuanced understanding of physics from the sub-atomic world to the universe at large. Both physicists also played a role in changing the public understanding of the role of the brain in human perception in observation and cognition. Their popular apologetics presented two under-stated cases for Christian belief in an accessible way which addressed some key issues in modern physics. For all these reasons, their role in the history of the relationship between science and religion in the English-speaking world in the century following Charles Darwin is significant.

The influence was not just on the reading public but beyond, into academic theology and philosophy. In post Second World War Britain their influence declined somewhat, but the reasons for that decline are far more complex than are commonly stated. Their legacy will be re-examined and a new assessment of their significance in the dialogue of science and religion in general and Christian apologetics in particular will be given.

This thesis, therefore, is a study in the area of historical theology which deals with the developing relationship between science and theology and with the practice of apologetics. Eddington and Jeans' exposition of their individual but overlapping understandings of the new relationship made them *de facto* popular apologists even if of a somewhat modest and cautious nature.

This thesis additionally has implications for general church history as it deals with two significant authors who had a mass popular following from men and women in the pews in the

inter-war period. Their work had a substantial impact on church life. It has interest for the student of the history of theology as both authors were read by theologians and philosophers and students of these disciplines, and Eddington in particular, influenced some significant theologians in the post-Second World War period.

1.2 Reasons for Re-Examining the Significance of Eddington and Jeans

Eddington and Jeans were mathematical physicists and astronomers of a very high calibre. Eddington's contributions to twentieth-century astronomy and physics are very significant indeed and are widely noted. The observations he made during his 1919 eclipse expedition to Principe were pivotal in gaining acceptance for the work of Albert Einstein, although some have queried the validity of the conclusion drawn from this expedition.[1] Even if this argument is accepted, Eddington played a key role in the promulgation of relativity, both at an academic and a popular level.

Henry Norris Russell wrote in 1945, 'The death of Sir Arthur Eddington deprives astrophysics of its most distinguished representative.'[2] Subrahmanyan Chandrasekhar adopted this as the title for his essay *Eddington: The Most Distinguished Astrophysicist of his Time.*[3] Susan Stebbing, one of his most forthright critics, described Eddington as a 'mathematician as well as a physicist gifted beyond the common race of physical scientists'.[4] Roger Penrose writes of 'the outstanding astrophysicist Eddington'.[5] In *The Oxford Dictionary of Scientists* Eddington is described as 'the major British astronomer of the interwar period'.[6]

[1] Harry Collins and Trevor Pinch, *The Golem: What you should know about science* (Cambridge: Cambridge University Press, 2nd ed. 1998), Chapter Two *passim.* See also Jason M Rampelt, 'Arthur Stanley Eddington: Relativity and Dogma' in Nicolaas A Rupke (ed.), *Eminent Lives in Twentieth Century Science and Religion* (Frankfurt am Main: Peter Lang, 2nd ed. 2009), 146.
[2] Henry Norris Russell, 'Sir Arthur Eddington' *Astrophysics Journal* 101 (1945), 133.
[3] Subrahmanyan Chandrasekhar, *Eddington: The Most Distinguished Astrophysicist of his Time* (Cambridge: Cambridge University Press, 1983).
[4] L Susan Stebbing, *Philosophy and the Physicists* (London: Methuen, 1937), 279.
[5] Roger Penrose, *The Road to Reality: A Complete Guide to the Physical Universe* (London: BCA, 2004), 697.
[6] John Daintith and Derek Gjertsen, (eds.), *The Oxford Dictionary of Scientists* (Oxford: Oxford University Press, 1999), 152.

Before they both ventured into popular apologetics, Eddington and Jeans were skilful and successful scientific popularisers. Eddington had written *Stars and Atoms* and Jeans the best-selling *The Universe Around Us*. They highlighted the new understanding not only of astronomy but also of the nature of matter shown by quantum physics, relativity physics and contemporary accounts of atomic structure. In their books, articles and radio broadcasts they helped the general reading public understand the move away from the discarded Victorian materialistic, mechanistic and deterministic view of science. For this Stebbing praised their work: 'To have made this clear to the common reader is one great gain of the recent spectacular advances in physics and the popularisations of them.'[7] *The Matter Myth,* Paul Davies and John Gribbin's book of 1992, is subtitled *Dramatic Discoveries That Challenge Our Understanding of Physical Reality.*[8] Many of these dramatic discoveries described in the first chapter can be found in the writings of Eddington and Jeans from the inter-war years. The title of Davies and Gribbin's book illustrates that the debate on the nature of matter still continues.

Yet the popularity of Eddington and Jeans as Christian apologists from the late twenties through to the forties is not as widely known. Jeans was better known than Arthur Eddington by the general reading public in the thirties and forties. His books were less expensive and more accessible than Eddington's and as a result they sold in greater numbers. *The Universe Around Us* brought him fame as a popular writer on astronomy before he turned to popular apologetics.[9] His lasting influence, however, has not been as great as that of Eddington amongst those with an interest in the history of science or in the science and religion debate. He did not play the pivotal role that Eddington played in the establishment of Einstein's ideas through the Eclipse Expeditions of 1919. Jeans did have a role in the acceptance of relativity in Great Britain but, unlike Eddington, he did not write a popular or semi-popular book on the topic. Eddington's role in the eclipse expedition to Principe and the accompanying press publicity assured that his name is always associated with this key development in twentieth century physics.

The name of Eddington is still well known to those with an interest in the history of science or the science and religion debate. His contributions in the development of relativity theory and the internal constitution of the stars speak for themselves. If, however, you ask such a group of people about the significance of Eddington, those under fifty will generally mention two

[7] Stebbing, *Philosophy and the Physicists,* 268.
[8] Paul Davies and John Gribbin, *The Matter Myth: Dramatic Discoveries That Challenge Our Understanding of Physical Reality* (New York: Simon & Schuster, 1999).
[9] James Jeans, *The Universe Around Us* (Cambridge: Cambridge University Press, 1929).

issues: the failure of Eddington's book *Fundamental Theory* and his unsuccessful dispute with Subrahmanyan Chandrasekhar regarding the maximum size of a white dwarf star. In mentioning the former they are often influenced by Clive Kilmister's *Eddington's Search for a Fundamental Theory*[10] and, in the latter, Arthur Miller's popular *Empire of the Stars.*[11] His earlier successes are dwarfed by two of his later failures. Those over fifty are more likely to have read their books when at school or university and as a result are more likely to be positive. They might also point to Stebbing's *Philosophy and the Physicists* of 1937 as a key text which 'destroyed the reputation' of both scientists. This idea will be examined in this thesis. Their work, as has been said, was read by theologians and philosophers. Academic philosophers engaged with their work and discussed it in philosophical journals, not just in the popular press. This is in contrast to the comparative lack of interest that current philosophers take in the work of, for example, John Polkinghorne, or for that matter, Richard Dawkins and Stephen Hawking. Professional scientists for a generation or more were influenced by their work. Professor Neil Spurway has placed *The Nature of the Physical World* ahead of such classics as Charles Coulson's *Science and Christian Belief*[12] and Ian Barbour's *Issues in Science and Religion*[13] in personal significance and influence.

Their use of philosophical Idealism will be examined. Stebbing pointed out that most physicists of her time who had attempted to construct a philosophy upon the basis of their physical researches had ended by advocating some form of Idealism.[14] This new description of physical 'reality' was not the world depicted by nineteenth-century physics with its inappropriately simple models of atomic structure. This new view of the sub-atomic world partially explains their acceptance (along with that of some other physicists) of Idealism. All theology proceeds with a philosophical underpinning. Sometimes this is acknowledged, for example, John Macquarrie and existentialism; at other times it is not.

The discussion between Realism and Idealism still continues. Not all modern writers in the field of the science and religion debate accept Critical Realism. While some, such as John

[10] C W Kilmister, *Eddington's Search for a Fundamental Theory* (Cambridge: Cambridge University Press, 1994).
[11] Arthur I Miller, *Empire of the Stars* (London: Little, Brown, 2005).
[12] Charles Coulson, *Science and Christian Belief* (London: Oxford University Press, 1955).
[13] Ian G Barbour, *Issues in Science and Religion* (London: SCM, 1966).
[14] Stebbing, *Philosophy and the Physicists* (London: Methuen, 1937), 265-266.

Polkinghorne,[15] think that Idealism is a lost cause, others, such as Keith Ward, disagree.[16] The issue of Realism and Idealism will be discussed at length in chapter seven.

In the twenties and thirties Eddington and Jeans had popular acclaim, but many academics were critical of their work. It could be argued that if they had popular acclaim but academic censure, then any claims that a re-evaluation of their significance is needed is difficult to maintain. But a number of factors should be borne in mind. One factor is that some theologians valued Eddington's work, especially in the years after the Second World War. The second is that for others, Jeans' well-known books were a first introduction to the science and religion debate or cosmology.

Their major significance is that of popular apologists, not professional theologians, and they were very widely read, more widely than theologians, bishops or celebrity preachers. Their success as writers will be demonstrated. They were as popular and well known as apologists in the inter-war years as C S Lewis was during and after the Second World War.

Eddington and Jeans helped show to a general audience that the natural world described by the modern science of the early twentieth century was not the simple mechanical model of popular perception but a world of shadows and probabilities. Jeans' restatement of the Design Argument in a popular modern form will be examined, as will the contribution of both to the criticism of a too-simple form of determinism.

Their use of metaphors will be discussed. In their use of a telling metaphor they set a style for popular writing on science and religion. Metaphors are still needed in popular scientific exposition as has been seen in the use of the 'Margaret Thatcher metaphor' in relation to the Higgs boson and in the teaching of school science.[17] In using vivid metaphors they became popular with the general reading public but were criticised by academics.

Both Eddington and Jeans also helped the general public comprehend the role of human perception in our understanding of the universe, despite the fact that they were both mathematical physicists and astronomers. They helped general readers and some scientists

[15] John Polkinghorne, *One World* (London: SPCK, 1986), 21-22.
[16] Keith Ward, *More Than Matter: What Humans Really Are* (Oxford: Lion, 2010), *passim* and *A Philosopher Looks at the Gospels* (Oxford: Lion, 2011), 179 and 182.
[17] The Margaret Thatcher metaphor was devised by Professor David Miller of University College, London to explain the clustering of the field round a Higgs boson and how this generates the particle's mass http://www.prospectmagazine.co.uk/magazine/mass-metaphor-and-margaret-thatcher/

move away from a simplistic approach which down-played the role of the brain/mind. The more nuanced view which they and others put forward is now generally accepted.

Jeans was a very successful writer of popular apologetics. He argued persuasively that modern physics was not inimical to Christian faith. He asserted that there was evidence of mathematical design in the universe. Eddington was a significant, original thinker, influenced by Quaker thought on experience and the Inward Light. He had an intuitive approach to science which generally worked for him; his approach emphasised the role of intuition and seeking in both physical science and theology. Both made contributions to the debate on perception and were significant figures in the debate on the relationship between science and theology. For these reasons, a thorough reassessment of their work is worthwhile.

The reappraisal will be carried out by an examination of the primary sources and especially the three key texts, published in successive years: namely Eddington's 1928 *The Nature of the Physical World,*[18] his 1929 *Science and the Unseen World*[19] and Jeans' 1930 *The Mysterious Universe*.[20] This study will also involve a critique of their critics and in particular the critics' understanding of the nature of science.

The idea, first heard by the writer in sixth form science lessons that Stebbing's writings had, in Mary Warnock's term, 'debunked' the work of the two physicists and ended their influence, will be examined and itself debunked.[21]

1.3 The 'Eddington and Jeans' Phenomenon

One of the main reasons for suggesting the necessity of a reappraisal of the significance of the work of Eddington and Jeans as Christian apologists is that many people have forgotten how significant they were in the inter-war years, both in academic debate and popular readership.

Eddington and Jeans were two of the leading celebrity scientists of the 1930s. But they were not just stars of the printed press, the radio and the popular lecture circuit; they were important historically in the development of physics, astronomy, philosophy and the study of

[18] Arthur Eddington, *The Nature of the Physical World* (Cambridge: Cambridge University Press, 1928).
[19] Arthur Eddington, *Science and the Unseen World* (Cambridge: Cambridge University Press, 1929).
[20] James Jeans, *The Mysterious Universe* (Cambridge: Cambridge University Press, 1930).
[21] Mary Warnock, *Women Philosophers* (London: Dent, 1996), 94. See also John Habgood, *Varieties of Unbelief,* (London: Darton, Longman and Todd, 2000), 17.

the relationship between theology and science. They were established scientists of note. They were not like some modern scientific journalists and authors, in possession of a science degree or two, but without a significant career in science behind them. Their reputations commanded attention, if not always respect. In 1912 Eddington became Plumian Professor of Astronomy at Cambridge and Jeans became, after long service to the Royal Society, the first Professor of Astronomy at the Royal Institution in 1935, a largely honorary role. In this section an attempt will be made to describe how their names were often mentioned together, before in the next section discussing their influence.

While the names of Eddington and Jeans were linked together in the popular minds, in the scientific community they were often best known for their heated and bitter verbal battles at the Royal Astronomical Society. The following extract from a November 1926 tussle at the RAS indicates the flavour of these exchanges:

> May I conclude by assuring Prof. Eddington it would give me great pleasure if he could remove a long-standing source of friction between us by abstaining in future from making wild attacks on my work which he cannot substantiate, and by making the usual acknowledgements whenever he finds that my previous work is of use to him? I attach all the more importance to the second part of my request, because I find that some of the most fruitful ideas which I have introduced into astronomical physics – e.g., the annihilation of matter as a source of stellar energy, and the highly dissociated atoms and free electrons as the substance of the stars – are by now fairly generally attributed to Prof. Eddington.[22]

It has been suggested in the official *History of the Royal Astronomical Society* that the arguments between Eddington and Jeans at the Royal Astronomical Society were conducted 'on good personal terms' by the two protagonists.[23] The above disagreement sounds like a genuine argument. Eddington also famously battled with Subrahmanyan Chandrasekhar at the Royal Astronomical Society, but took the young astrophysicist to Lord's and Wimbledon. The evidence suggests no such warm friendship existed between Eddington and Jeans.

Nevertheless, Eddington and Jeans were commonly regarded as a pair. Stebbing's *Philosophy and the Physicists* and Bertrand Russell's *The Scientific Outlook* (1931) were both very much

[22] James Jeans, 'Diffuse Matter in Interstellar Space' *Observatory* 49, (1926), 333-335 quoted in I S Glass, *Revolutionaries of the Cosmos* (Oxford: Oxford University Press, 2006), 222.
[23] R J Tayler (ed.), *History of the Royal Astronomical Society* (Oxford: Blackwell, 1987), 29.

attacks concentrated on these two linked individuals.[24] Joseph McCabe's 1933 rewrite of *The Existence of God* was largely promoted by what he describes as the 'Eddington-Jeans utterances'.[25] C E M Joad's *Philosophical Aspects of Modern Science* of 1932 starts with a chapter on 'The Idealism of Professor Eddington' and then goes on to a chapter on 'The Idealism of Sir James Jeans' followed by one entitled 'Mr Russell's Neutral Stuff'.

The historian A J P Taylor links their two names thus:

> England remained Christian in morality, though not in faith. There was a vast appetite for unrevealed religion and for a vague religiosity, supplied by ingenious astronomers such as Sir Arthur Eddington and Sir James Jeans.[26]

C S Lewis in *Broadcast Talks* in 1942, known to later generations as the first section of *Mere Christianity,* wrote*:*

> Many of you no doubt have read Jeans or Eddington.[27]

Many had, as a section below will show. David Evans writes:

> Because the names of Eddington and Jeans were so often spoken together in the thirties, it might have been supposed that they were collaborators, but, if they ever were, only to a very minor degree, and essentially mostly critical opponents, with Jeans usually the aggressor.[28]

The evidence that Jeans was usually the aggressor is thin. Evans was a former student and continuing admirer of Eddington.

Evans correctly points out that the careers and receipt of honours of the two scientists followed very similar paths, apart from Jeans' decision to give up academic posts to concentrate on popular writing and scientific committee work.[29] Jeans was born in 1877, Eddington in 1882. Jeans arrived at Trinity College, Cambridge in 1896, Eddington in 1902. Jeans was Second Wrangler in 1898, Eddington was Senior Wrangler in 1904. Jeans was awarded the Smith's Prize in 1900, Eddington in 1907. Jeans was awarded a Trinity Fellowship

[24] Bertrand Russell, *The Scientific Outlook* (London: George Allen and Unwin*,* 1931).
[25] Joseph McCabe, *The Existence of God* (London: Watts, 1933), 146.
[26] A J P Taylor, *English History 1914-1945,* (Oxford: Oxford University Press, 1965), 169.
[27] C S Lewis, *Broadcast Talks* (London: The Centenary Press, 1942) 53 and *Mere Christianity,* (Glasgow: Collins, 1952), 54.
[28] David Evans, *The Eddington Enigma: A Personal Memoir* (Princeton: Xlibris, 1998), 95.
[29] Evans, *The Eddington Enigma,* 96.

in 1901, Eddington in 1907. Jeans became a Fellow of the Royal Society in 1906, Eddington in 1914. Jeans was awarded the Gold Medal of the Royal Astronomical Society in 1922, Eddington in 1924. Jeans was knighted in 1928, Eddington in 1930. Eddington was admitted to the Order of Merit in 1939, Jeans in 1940. Eddington died in 1944, Jeans in 1946. Jeans was thus both senior and in many ways superior to Eddington until Eddington became Plumian Professor of Astronomy in 1912.

Jeans' background was also more privileged than Eddington's. Edward Milne's record of Jeans' fellow schoolboys shows the heights to which some of them rose, indicating the high standing of the school and its contribution to the ranks of the great and the good in British society:

> Here he was a contemporary of D A Winstanley, the present Vice-master of Trinity; Lord Mountevans (Evans of the *Broke)*; Sir Cyril Norwood, President of St John's College; Oxford; Sir Herbert Creedy, formerly Permanent Under-Secretary of State for War; Sir William Elderton, formerly Chairman of the Equitable Assurance Society; Professor Major Greenwood; and M N Tod, Vice-Provost of Oriel.[30]

In *The Taylorian*, the magazine for the old boys and current pupils of Merchant Taylors' School, Jeans' arrival at Trinity is recorded by one of his fellow students in the 'Cambridge Letter'.[31] A similar letter is printed recording new arrivals and selection for the sports teams at Oxford. But there is no letter in the magazine from former pupils unfortunate enough to be attending Manchester or any of the other fledgling red-brick universities. In the same magazine, the first toast at the annual dinner of the Merchants Taylors' Company is recorded as 'Church and Queen'.[32] Jeans was not only senior to Eddington, but his social superior, having attended a very Anglican, prestigious public school rather than a minor Quaker private school.

The academic careers of Jeans and Eddington had many similarities despite the differences in their schooling. Their names were often linked together. For the general reading public they were two scientists who defended the Christian faith. For academics they were two physicists and rather poor amateur philosophers who attempted to use Idealism, by then an outmoded system of thought, to defend a Christian world view. To astronomers they were the two

[30] E A Milne, *Obituary Notices of Fellows of the Royal Society* 5, (Feb 1947), 574.
[31] *The Taylorian,* October 1896, 47.
[32] *The Taylorian,* October 1896, 194.

antagonists at the Royal Astronomical Society. Their approaches to 'scientific apologetics' were very different, as shall be seen.

At this point the importance of Jeans and Eddington being treated together should be noted. It is often the case in historical development that an individual becomes significant because they are a contemporary of others who share or disagree with their views. John Polkinghorne, Ian Barbour and Arthur Peacocke had a bigger effect on each other and perhaps a bigger impact as 'scientist-theologians' than they would have had without each other.[33] These partnerships, intentional or unintentional, need to be recognised in assessing impact.

1.4 Resources for the Study of Eddington and Jeans

The sources for the study of Arthur Eddington are more numerous than sources for the life of James Jeans. The Quakers have treasured the memory of Eddington, one of their most distinguished sons, and resources can be found in Quaker institutions which are not matched elsewhere for Jeans, although the Archives Room at Merchant Taylors' School does contain material which sheds some light on the school's reputation as a leading school for mathematics and its ethos at the time of Jeans. The Royal Institution Archives, where Jeans was Professor of Astronomy, does contain more material on Jeans than on Eddington.

The Royal Society Library was a useful source of obituary notices for both Eddington and Jeans from learned societies in Canada and the United States of America. It also contains reviews of their books published in the United States which are not readily available in other libraries. The archives here also contain drafts of some of Jeans' popular books and a range of correspondence from around the time when he became a Fellow.

The Royal Institution Archives contain records of the lectures and symposia with which they were involved. Both contributed to the Friday Evening Discourses for more than one series of lectures. In addition to the accounts of these talks in *The Proceedings of the Royal Institution*

[33] See, for example, Ian G Barbour, *Issues in Science and Religion* (London: SCM, 1966), John Polkinghorne, *One World* (London: SPCK, 1986) *Scientists as Theologians* (London: SPCK, 1996) and Arthur Peacocke, *Theology for a Scientific Age: Being and Becoming – Natural, Divine and Human* (London: SCM, 2 ed. 1996).

the Archives contain extensive press cuttings reporting these events and Jeans' Christmas Lecture of 1933, *Through Space and Time*.

The Library at Friends' House, London, is an excellent source of materials for the study of Arthur Eddington. The library contains a large range of journals such as *The Friends' Quarterly Examiner, The Journal of the Friends' Historical Society* and many no longer published journals from the time of Eddington. The library has a wide range of books by Rufus Jones, John William Graham and other major influences upon Eddington. The library has an archive of useful pamphlets including a set of the Arthur Stanley Eddington Memorial Lectures. Several of the books by Rufus Jones which were consulted here were not available in other libraries. The Woodbrooke Quaker Study Centre in Birmingham holds a smaller range of material but did contain a number of relevant pamphlets not found in the Library at Friends' House, London.

The Library at Lambeth Palace, London, contains a good range of books on twentieth century church and general history which proved useful at the start of the research. Dr Williams's Library in Gordon Square, London, has a good range of journals related to its specialism – "English Protestant nonconformity". Dr Williams's Library has a rich stock of books on twentieth century theology which were consulted.

The Sir Robert Ball Library of the Society for the History of Astronomy in Birmingham was a useful source of material and benefits from a very detailed catalogue of resources. This catalogue was helpful in tracking down books by authors which made substantial reference to Eddington or Jeans, not obvious from the title. The librarian there was particularly helpful.

The Library of the Royal Astronomical Society, Piccadilly, London, is a useful source of biographical information on astronomers which it sees as one of its specialisms. It is a very good source of astronomical journals containing over three thousand no longer published titles and three hundred current journals. It has a good selection of books on astronomy from the earlier part of the twentieth century. The Library contains a range of letters and postcards in Eddington's own hand. Most of these are connected with the administration of the Royal Astronomical Society including how the work of Einstein might be brought to Fellows' attention.

The Gladstone Library in North Wales has a twin focus of theology and literature. The library has a rich stock of British and foreign twentieth century theological books and shorter

theological tracts and pamphlets. It also has a rich stock of literary journals in a few of which the work of Eddington and Jeans was examined.

The Library at St John's College, Durham, and the main University Library in Durham were also consulted. The Library at Trinity College, Cambridge was visited. It had some papers relating to both Eddington and Jeans. The Hudson Memorial Library at St Albans Abbey was likewise consulted.

Regarding full length biographies there are three for Eddington. His first biography was published in 1957 and written by a former student, Vibert Douglas, the second by another former student David Evans in 1998 and the most recent and best by Matthew Stanley in 2007. Jeans' biography was published in 1952 by E A Milne, Professor of Mathematics at Oxford and a cosmologist. Both Jeans and Eddington featured in J G Crowther's *British Scientists of the Twentieth Century* (1952),[34] in A M Low's popular *They Made Our World* (1949),[35] and Eddington but not Jeans in Nicolaas Rupke's more recent *Eminent Lives in Twentieth Century Science and Religion* (2009).[36] Eddington has been the subject of Chandrasekhar's short *Eddington: The Most Distinguished Astrophysicist of his Time* (1983) and one by Bell Burnell[38] (1985) in an anthology of biographies of Quaker notables. Studies of Jeans have not appeared in either short book or full length book forms since Milne's work.

What is the reason for this disparity of treatment? Partly, as has already been noted, this is down to Eddington's role in the Principe Expedition and the fame generated for him in the wake of the Einstein legend, which has been the dominating story in twentieth century physics. Jeans, according to James Crowther,[39] played the key role in the acceptance of the quantum theory in Great Britain with his paper to the Physical Society of London, *Report on Radiation and the Quantum Theory,*[40] but this has not grabbed popular attention in the way that relativity theories have. The disparity of attention is also partly explained by the Quaker connection. The accounts of Eddington's life by Jocelyn Bell Burnell and Matthew Stanley rightly emphasise the Quaker element in his thinking and Bell Burnell's version was written explicitly because Eddington was a Quaker. Part of the difference may be that as a Cambridge

[34] J G Crowther, *British Scientists of the Twentieth Century* (London: Routledge & Kegan Paul, 1952).
[35] A M Low, *They Made Our World* (London: Scientific Book Club, 1949).
[36] Jason M Rampelt, 'Arthur Stanley Eddington: Relativity and Dogma' in Nicolaas A Rupke, (ed.), *Eminent Lives in Twentieth Century Science and Religion* (Frankfurt am Main: Peter Lang, 2nd ed. 2009).
[38] Jocelyn Bell Burnell, 'Arthur Stanley Eddington', *Living in the Light: Some Quaker Pioneers of the Twentieth Century,* vol. 2 (Pasadena: Quaker Publications, 1985).
[39] Crowther, *British Scientists,* 94.
[40] James Jeans, *Report on Radiation and the Quantum Theory* (London: Electrician Publishing, 1914).

professor, Eddington drew a larger flock of admiring followers than Jeans, the committee man. Jeans was a key player in British mathematics, physics and astronomy in the first half of the twentieth century in Britain and he deserves fuller attention.

The biographies vary in quality as would be expected. Vibert was a research student of Eddington's and her recent personal knowledge is evident in the book. Stanley's book is very well researched and contains a considered evaluation of Eddington's significance. Evans' book is worth reading even though Stanley is critical of it, describing it as 'a virtual paraphrase of the Vibert Douglas biography, with the addition of some interesting personal recollections.' [41] While Stanley's biography is far better researched, Evans does gives an account of how Eddington's scientific work has stood the test of time. In addition, his personal recollections are useful, not merely interesting or anecdotal, and give an account of Cambridge in the days when Eddington was a professor and Evans himself was a student. Finally, nationality plays a part. There are three book-length biographies of Eddington: by Vibert Douglas, a Canadian; by Stanley, an American; and by Evans, a Welshman. While Stanley's account is undoubtedly thoroughly researched, of the three biographies solely on Eddington, Evans understands better the social history of Britain and the class structures of England in the first half of the twentieth century, whereas Vibert Douglas writes with the benefit of comparatively recent personal knowledge. Stanley makes the mistake of describing Eddington's childhood as 'fairly poor'.[42] Clearly, after the death of his headmaster father, the family circumstances would have been reduced, but he went to a Quaker preparatory school and had a home tutor. His father was, before he died, the proprietor as well as the Headmaster of Stramongate School.[43] He was not poor. Evans does understand the nuances of the British class system and how this would impact upon their careers as students when arriving at Trinity:

> ... in hyper-class conscious Britain, it mattered that Jeans had been educated at the prestigious Merchant Taylors' School, while Eddington came from an obscure Quaker institution and a red-brick university.[44]

Evans' book is probably the weakest of the three but still adds depth for the serious student of Eddington.

[41] Matthew Stanley, *Practical Mystic* (Princeton: Princeton University Press, 2007), 249.
[42] Stanley, *Practical Mystic,* 23, possibly following J G Crowther *British Scientists of the Twentieth Century* (London: Routledge & Kegan Paul, 1952), 141.
[43] Chandrasekhar, *Eddington*, 2.
[44] Evans, *The Eddington Enigma,* 96.

In a few places, I have disagreed with Stanley on some minor points. It is, however, in my judgement, the best of the three biographies especially regarding the importance it places on Eddington's Quaker values. Vibert Douglas's work benefits from the close recent support she received from Eddington's colleagues, family and friends. Evans' biography is anecdotal in some parts, but like Vibert Douglas he was a former student of Eddington so the accounts help paint a portrait of the man. It does contain an evaluation of Eddington's continuing significance.

I benefited from a discussion with Matthew Stanley who shared his experience of finding resources for studying Eddington's life. He also made some helpful comments on resources for Jeans.

Milne's biography of Jeans will be shown to have a number of errors or easily questionable judgements. This is especially disappointing as it is the only full-length treatment of his life. The book was published two years after Milne's death and the Publishers' Note in the book indicates that 'his failing health made it impossible for him to give it his final revision'.[49] The book was revised by Jeans' friend S C Roberts of the Cambridge University Press, who was a biographer and an expert on the Sherlock Holmes stories rather than a scientist. Milne's ill health and Roberts' input may explain some of the errors in the book.

Peter Bowler's *Reconciling Science and Religion: The Debate in Early Twentieth-Century Britain* is rich in not only biographic information but also in bibliographic detail.[50] It was used extensively at the start of the work on Eddington and Jeans to provide references to primary sources but also throughout the study on other personalities involved.

The main biographical source on Charles Raven for Section 7.7 on twentieth century apologetics is F W Dillistone's biography *Charles Raven: Naturalist, Historian, Theologian.*[51] This biography is well written and contains none of the obvious errors found in Milne's biography of Jeans. It is four hundred and forty-eight pages long. Raven was an early feminist, a writer on Christian Socialism, like Eddington a pacifist, a Canon at Liverpool when the Cathedral was new, the Master of Christ's College, Cambridge, and Vice Chancellor of the University. As a result of this variety in Raven's life, the sections on his scientific work are comparatively short, focused in only a few chapters. In his *Religious Experience and Christian*

[49] Milne, Jeans, v.
[50] Peter J Bowler, *Reconciling Science and Religion: The Debate in Early Twentieth-Century Britain* (Chicago: University of Chicago Press, 2001).
[51] F W Dillistone, *Charles Raven: Naturalist, Historian, Theologian* (London: Hodder, 1975).

Faith, F W Dillistone compares the work and thought of five pairs of writers including Charles Raven and Julian Huxley.[52] This was informative, as was Raven's autobiographical *A Wanderer's Way*[53] and Bowler's *Reconciling Science and Religion*.[54] The main source on Chesterton is Ian Ker's authoritative biography, *G K Chesterton.* Bowler's study again was very useful.

A new annotated edition of *The Nature of the Physical World* was published in 2014 by H G Callaway, an American philosopher who studied and taught at Temple University, Philadelphia. It has notes which would be very helpful to the first-time reader. These explain the historical background, key people mentioned by Eddington and in some cases how the science has progressed. They also helpfully explain English idioms to American readers. There is in addition an extensive and more technical introduction, entitled 'A S Eddington, Physics and Philosophy'. This has five sections. After an introduction Eddington's career is outlined. Callaway then looks at four topics in *The Nature of the Physical World* where physics and philosophy overlap: the selective influence of mind; causation and indeterminacy; mysticism, mind and values; and, finally, the limits of structure. It is a very useful addition to the literature as the review in *Isis* indicates. The *Isis* review, however, takes to task Callaway for his interpretation of Eddington's philosophy of science. In addition, and more within the scope of this dissertation, John Stachel in his review suggests that keeping with the original pagination of the 1928 edition would have been better for new students of the work.[55]

1.5 The Publishing Success of Eddington and Jeans

Michael Whitworth, in his study of popular physics writing in the pre-Second World War years, suggests one key event led to the boom in popular physics publishing in the years that followed 1919.[57] This was the announcement in *The Times* that Eddington had, following the publication of Einstein's General Theory of Relativity, by his work at Principe, 'proved the

[52] F W Dillistone, *Religious Experience and Christian Faith* (London: SCM, 1981).
[53] Charles E Raven, *A Wanderer's Way,* (London: Martin Hopkinson, 1928).
[54] Bowler, *Reconciling Science and Religion*, 277-286.
[55] H G Callaway (ed.), *Arthur S Eddington* The Nature of the Physical World *Gifford Lectures of 1927: An Annotated Edition* (Newcastle: Cambridge Scholars Press, 2014), reviewed by John Stachel, *Isis* 107, no 1 (March 2016), 199-201.
[57] Michael Whitworth, 'The Clothbound Universe: Popular Physics Books, 1919-1939' *Publishing History* 40 (1996), 53-82.

theory'.[58] While there were attempts to condense the theory to one article, it became obvious, because of the complexity of the subject, that something longer was needed:

> ... and so the boom in popular-science books began. This boom continued throughout the 1920s, sustained by new developments in theories of the atom, and reached its zenith in 1930 with the publication of James Jeans's *The Mysterious Universe.*[59]

Although Whitworth does not make this point, according to this view, therefore, Eddington was there at the start and Jeans at its zenith.

Eddington's first book following the 1919 announcement was *Space Time and Gravitation* which was published by Cambridge University Press in May 1920.[60] The publishers considered it a 'non-technical' book rather than a 'best-seller'. Nevertheless, it sold well, with six impressions in fifteen years, totalling 7,000 copies. To give a comparison, Aldous Huxley's contemporary novels C*hrome Yellow* and *Those Barren Leaves* were both initially printed in runs of 2,000 books, followed by reprints of 1,000 copies. The art historian Clive Bell's book *Civilisation* was printed in a run of 1,500 copies followed by two reprints of 1,000. Whitworth sees the three most significant popular books of the period as A N Whitehead's *Science and the Modern World* of 1926, Eddington's *The Nature of the Physical World* of 1928 and Jeans' *The Mysterious Universe* of 1930. Whitworth says that *The Nature of the Physical World* 'lifted popular science to new heights'.[61] While Cambridge sold 21,020[62] copies of *Science and the Modern World* in Britain between 1926 and 1938, *The Nature of the Physical World* sold 26,159 copies in the Cambridge edition between 1928 and 1943, and 17,064 copies in the cheaper Everyman edition, from its appearance in 1938 up until 1943. In total it sold about 90,000 copies in his lifetime, just 10,000 short of his best-selling and not overtly religious *The Expanding Universe*.[63]

Space does not permit Whitehead and *Science and the Modern World* to be considered in this study. Additionally, Whitworth sees his book as distinct from the other two volumes in a number of ways. The first is in terms of sales. It was much less popular but, nevertheless, its

[58] Whitworth, 'The Clothbound Universe', 59.
[59] Whitworth, 'The Clothbound Universe', 53.
[60] A S Eddington, *Space Time and Gravitation: An Outline of the General Relativity Theory (*Cambridge: University Press, 1920).
[61] Whitworth, 'The Clothbound Universe', 65.
[62] All sales statistics from Michael Whitworth, 'The Clothbound Universe' or Jason M Rampelt, 'Arthur Stanley Eddington', 137.
[63] Arthur Eddington, *The Expanding Universe* (Cambridge: Cambridge University Press, 1933).

relative success after its publication in 1926 took Cambridge University Press by surprise. It was only with the publication and success of *The Nature of the Physical World* that the Press decided to advertise *Science and the Modern World* in more popular periodicals. The second is in terms of difficulty. He quotes Dorothy Emmett in the introduction to a 1985 reprint of *Science and the Modern World* in which she comments on the 'Jekyll and Hyde' character of the book.[64] Parts of it contain complex terminology and technical philosophy. Additionally, Whitehead was not an apologist, as Norman Pittenger points out.[65] Space again does not permit consideration of other significant writers of the inter-war period such as the physicist and populariser Oliver Lodge. The influence of Eddington and Jeans on Charles Coulson will be considered in chapter nine.

The success of *The Nature of the Physical World* was dwarfed by that of *The Mysterious Universe.* The Rede Lecture was delivered on 4 November 1930; the book was published on the following day, and by the end of December that year 70,000 copies had been sold in the UK. Whitworth says that the lucidity of Jeans' exposition was critical, but price, marketing and reviews were also crucially important. The work of Eddington and Jeans was translated into numerous languages and they were especially popular in the USA. They were quoted in the press, interviewed by leading journalists and asked to give radio talks and public lectures; Eddington, for example, gave the lecture at the prestigious Annual Dinner of the British Astronomical Association in April 1939, then a more intellectually significant organisation than now.[66] Their influence was further spread by clergy in pulpits and parish magazines who welcomed their writings.

By 1937 139,000 copies of *The Mysterious Universe* had been printed by Cambridge University Press and 56,195 copies were sold of *The Nature of the Physical World.* The more precise figure for the latter is explained by the fact that Eddington kept a very close record of his sales. The sales for *The Nature of the Physical World* kept well above a thousand per annum from its publication in late 1928 until 1934 when it was 1,147 copies, from where it fell to 857 in 1935, followed by 456 in 1936, 322 in 1937, 274 in 1938 and 179 in 1939. From 1938 onwards the Cambridge University Press edition was challenged by a cheaper Everyman Edition which sold 9,855 copies in that year and then between 1000 and 2000 copies until

[64] Dorothy Emmett, 'Foreword' A N Whitehead *Science and the Modern World* (London: Free Association Books, 1985), xv.
[65] Norman Pittenger, *Alfred North Whitehead* (London: Lutterworth, 1969), 38.
[66] *Journal of the British Astronomical Association* 123, (Oct 2013), 252.

1943 – the year before the death of Eddington and the final year of his records.[67] These sales were very significant for their time, as Whitworth has demonstrated.[68] To give further comparisons*, Essays and Reviews* published in 1860 sold 22,000 copies in two years according to Desmond and Moore, which is a greater figure, they point out, than *The Origin of Species* did in twenty years.[69] Jeans' *The Mysterious Universe* sold 70,000 copies in just the two months following its publication. These figures alone would make their work worthy of a reappraisal for the influence they had on popular theology, but they also influenced both succeeding popular apologists and academic theologians, as will be demonstrated. The figures above provide evidence for C S Lewis' statement that 'Many of you no doubt have read Jeans or Eddington.'[70]

The next chapter will examine the intellectual background at the start of the twentieth century when Eddington and Jeans were first students and then Fellows at Cambridge. It will start with an examination of British theology and the churches and then consider continental theology. The relationship of theology and science will then be discussed and finally the state of physics and astronomy. The aim of this is to set the two apologists against the intellectual background of the time, a process encouraged by John Brooke and Geoffrey Cantor.[71] Eddington and Jeans worked at a time of changing ideas and in the wake of the Darwinian controversy of the previous century.

[67] Rampelt, 'Arthur Stanley Eddington', 137.
[68] Whitworth, 'The Clothbound Universe', 53-82.
[69] Adrian Desmond and James Moore, *Darwin* (London: Michael Joseph, 1991), 500.
[70] Lewis, *Mere Christianity,* 54.
[71] John Brooke and Geoffrey Cantor, *Reconstructing Nature: The Engagement of Science and Religion* (Edinburgh: T&T Clark, 1998), 147.

CHAPTER TWO

THE PHYSICAL AND UNSEEN WORLDS AT THE START OF THE TWENTIETH CENTURY

2.1 British Christianity and Christian Theology at the Start of the Twentieth Century

Eddington and Jeans were born in the last quarter of the nineteenth century and were active writers in the first half of the twentieth century. This chapter will attempt to set them against the background of the theology and science of the period.

It is important to note that within the field of science and theology in the context of the English-speaking world, theology and religion are often used interchangeably in speaking of the relationship with science. When reporting the work of other scholars, an attempt will be made to use the terms that they use in their own work. In this thesis, however, theology will be understood as the attempt to give a rational account of the Christian faith, while religion will be understood more widely to include not only belief in God but the practice of the Christian faith. This study is concerned with Christian theology but it has some interest for other theists with a belief in a Creator.

This thesis is primarily about the theology contained within the three key texts mentioned in chapter one. But this is not a discussion of a corpus of academic work by a theologian written for other theologians of which the general public is largely unaware. It is a consideration of popular and semi-popular apologetic theology delivered first as public lectures and then published in accessible book form. It was widely read, as has been seen, and thus influenced the 'lived religion' of those outside of academic theology and the clerical hierarchy. Eddington will be shown to have a traditional Quaker distrust of theology and a high view of religious experience. While the views of Eddington and T H Huxley were not identical, Eddington's distinction has resonances with Huxley's low view of theology but higher view of religion.

The British Christianity into which Eddington and Jeans were born at the end of the Victorian era was very diverse, according to Owen Chadwick in his *Victorian Church.*[72] Tim Grass contends that during the closing years of the nineteenth century many churches changed in the emphasis of their theology and church life from preparation for the next life to enjoyment of this life and to establishing the kingdom of God on earth.[73]

The intellectual turmoil of late Victorian religion was caused not only by the publication of *The Origin of Species* in 1859 but by the growing influence of Biblical criticism and radical German theological scholarship. This made Christianity at the turn of the century a religion in transition. This theological flux was reflected in the favourite hymns of the time such as *Abide with me, Lead kindly light* and *Guide me, O thou great Redeemer* in which God is called upon from out of the darkness and believers are pictured as pilgrims in the valley of the shadow of death.

Chadwick argues that much late Victorian theology moved its emphasis away from the atonement to the incarnation and that theologians justified their activity by appealing not to external nature but to the inner evidence of religious and moral experience. This is significant to the discussion of the thought of Eddington.

The work of Eddington and Jeans focused mainly on the doctrines of creation and eschatology, but it also had a bearing on the concept of predestination. Their support for Idealism and their popularisation of the current understanding of atomic structure and associated issues had epistemological implications. One of the key claims of this thesis is that there are greater differences in the apologetic approach between the two writers than is commonly acknowledged. Jeans believed in the efficacy of the design argument. Eddington did not. Eddington strongly argued in favour of the Inner or Inward Light, a traditional Quaker theme re-emphasised by modern liberal Friends. Jeans was largely silent on the issue of religious experience.

Michael Ramsey, in his fascinating but almost devoid of reference to science, *From Gore to Temple,* summed up the theology of the leaders of the Church of England at the turn of the century thus:

[72] Owen Chadwick, *The Victorian Church: Part II 1860 - 1901* (London: Adam & Charles Black, 1970), 466.
[73] Tim Grass, *Modern Church History* (London: SCM, 2008), 261.

> It is almost a common place that a theology of Incarnation prevailed in Anglican divinity from the last decade of the reign of Queen Victoria until well into the new century. This was due in part to the prophetic teaching of Westcott upon the Incarnation and social progress, and in part to the dogmatic teaching of the *Lux Mundi* school.[74]

Ramsey sees the theology of the Anglican Church at the turn of the century as in a period of doctrinal reconstruction which began with the publication of *Lux Mundi: A Series of Studies in the Religion of the Incarnation* in 1889.[75] Ramsey views the writers as shaped by two main influences but downplays the commonly supposed influence of a third. Ramsey says that the Tractarian Movement and a common desire to grapple with current intellectual questions were key, but he disputes how much influence the Idealism of T H Green and others had on the *Lux Mundi* authors, saying that this had often been greatly exaggerated.

Linked with a change in emphasis in theology, there was a growing interest in mysticism during the last quarter of the century starting with the High Anglicans and then spreading to Roman Catholics. W R Inge's Bampton Lectures of 1899 *Christian Mysticism* gave form to this movement.[76] Chadwick sees the Keswick school of evangelicals as using language not too dissimilar from Catholic mysticism, especially when they talked about the indwelling of Christ in the believer. Eddington's approach to theology was shaped by the Quaker understanding of mysticism and his own love of nature. Despite the title *The Mysterious Universe* mysticism is not a major theme in Jeans' writing. He finds the size of the universe awe-inspiring, but does not argue simply from that to a designing God.

Chadwick concludes his monumental two-volume study with these words:

> Whether or not the citizens attended those churches or chapels, the Victorians preserved a country which was powerfully influenced by Christian ideas and continued to accept the Christian ethic as the highest known to man.[77]

The death of Queen Victoria, while the end of an era in one sense, was not a major turning point for religion or theology. The First World War, however, was such a watershed, not only in church life but also in academic theology and popular piety.[78] For Eddington, the First World

[74] Arthur Michel Ramsey, *From Gore to Temple* (London: Longmans, 1960), 16.
[75] Ramsey, *From Gore to Temple,* 2.
[76] William Ralph Inge, *Christian Mysticism* (London: Methuen, 1913).
[77] Chadwick, *The Victorian Church: Part II,* 472.
[78] Grass, *Modern Church History,* 259.

War was a significant time. He was a conscientious objector in the Quaker tradition and was involved in a long struggle to be free from the call to military service.[79] Jeans, a month short of thirty-seven at the outbreak of war and having suffered ill health as a student, was not called upon to serve in the military.

Diarmaid MacCulloch begins his chapter on the twentieth century with the heading 'A War That Killed Christendom'.[80] Grass writes that the catastrophic loss of life during the war ensured the return of the afterlife to centre-stage in British theology, but this was not a return to traditional views of the four last things. Instead, he says, there was a dramatic upsurge of interest in spiritualism as the bereaved sought for comfort concerning their loved ones, and prayer for the dead became more widely accepted.[81]

Grass dismisses the idea that the First World War dealt a death blow to liberal theology because it had no answers to the questions posed by the conflict between Christian nations. He argues that liberalism continued to flourish on the optimism around the founding of the League of Nations and was still not extinguished by the Second World War. Nevertheless, many did see liberal theology if not dead, as, to use Grass' term, 'bankrupt'.[82]

MacCulloch proposes a dichotomy which is at once true and misleading:

> By 1914, then, Western Christianity was caught between two extremes of proclamation: stark and selective affirmations of traditional beliefs and, at the other end of the spectrum, a denial of any authority or reality behind Christian truth-claims.[83]

If these are the two and only two extremes, then by definition all of the rest of Western Christianity must be 'caught between'. But it does suggest a polarised view which downplays the 'significant middle', not least in the Church of England.

[79] Stanley, *Practical Mystic,* 124. The account of Eddington's fight to be treated as a conscious objector is very well told in chapter four 'Pacifism' of *Practical Mystic.*
[80] Diarmaid MacCulloch, *A History of Christianity* (London: Allen Lane, 2009), 915.
[81] Grass, *Modern Church History,* 261.
[82] Grass, *Modern Church History,* 262.
[83] MacCulloch, *A History of Christianity,* 863.

2.2 European Theology and the Physical World in the Early Twentieth Century

While Jeans was discussing the Great Architect of the universe and Eddington the role of intuition in both science and religion, the issue of natural theology was a live concern in continental Europe, not least in the writings of Karl Barth and Emil Brunner. It is interesting to contrast Barth's later views with those expressed in *The Epistle to the Romans* on the following verses from Paul's first chapter:

> For what can be known about God is plain to them, because God has shown it to them. Ever since the creation of the world his eternal power and divine nature, invisible though they are, have been understood and seen through the things he has made.[84]

Barth writes on 'that which may be known of God is manifest unto them':

> The truth concerning the limiting and dissolving of men by the unknown God, which breaks forth in the resurrection, is a known truth... We know that God is He whom we do not know, and that our ignorance is precisely the problem and the source of our knowledge.[85]

On 'for the invisible things of God are clearly seen' he says:

> Plato in his wisdom recognized long ago that behind the visible there lies the invisible universe which is the Origin of all concrete things...The clear, honest eyes of the poet in the book of Job and of the Preacher Solomon had long ago rediscovered, mirrored in the world of appearance, the archetypal, unobservable, undiscoverable Majesty of God. The speech of God can always be heard out of the whirlwind.[86]

Barth's commentary is both rhetorical and nuanced. The tension between the known and the unknown God is thoroughly rehearsed. Clearly God can only be heard out of a whirlwind if God chooses first to speak but it is evidently not a statement of the impossibility of knowing

[84] Rom. 1.19-20a, NRSV.
[85] Karl Barth, *The Epistle to the Romans* 6th ed., trans. Edwyn Hoskyns (Oxford: Oxford University Press, 1968), 45-46.
[86] Barth, *The Epistle to the Romans,* 46.

God through nature. Even a pagan such as 'Plato in his wisdom' can recognise something of the truth of what lies behind nature.

A different message, however, is found in Barth's *Nein!* This was written in 1934 in response to Brunner's *Nature and Grace* of the same year. Both articles were translated into English in 1946 and published under the title *Natural Theology* with a preface by John Baillie of Edinburgh, but the articles themselves were well known before they were conveniently brought together in one English book.[87] Brunner's thesis is elegantly stated; it is measured and written from a profound depth of Calvin scholarship. It does, however, have a tone which Baillie described as common in German speaking theology but then unusual in theology written in English, namely a very open display of the *odium theologicum* which continues throughout *Nature and Grace* and also in Barth's reply, whose first chapter is entitled 'An Angry Introduction'.

Brunner says that from the doctrine of *sola gratia* and the position of the Bible as the sole ultimate standard of truth Barth draws a number of conclusions. Key amongst these are that since humans are sinners who can be saved only by grace, the image of God in which he has been made has been created is obliterated entirely and without remnant. Likewise, Brunner says Barth dismisses general revelation in nature, conscience and history relying for his theology only on the special revelation of God in Christ and the Bible.

On the *imago Deo* Brunner says that *formally*, the *imago* is not in the least touched. Whether sinful or not, humanity is responsible. *Materially*, the *imago* is completely lost; humans are sinners through and through and there is nothing human which is not defiled by sin. Holder sees a similarity between Irenaeus and Brunner in this distinction.[88] Brunner goes on to assert:

> Wherever God does anything, he leaves the imprint of his nature upon what he does. Therefore the creation of the world is at the same time a revelation, a self-communication of God. This statement is not pagan but fundamentally Christian. But nowhere does the Bible give any justification for the view that through the sin of man this perceptibility of God in his works is destroyed, although it is adversely affected.[89]

[87] Emil Brunner and Karl Barth, *Natural Theology trans*. Peter Fraenkel (London: Geoffrey Bles, 1946) all *italics* as in Fraenkel's translation.
[88] Rodney Holder, *The Heavens Declare: Natural Theology and the Legacy of Karl Barth* (Pasadena: Templeton Press, 2010), 30.
[89] Brunner and Barth, *Natural Theology,* 25.

Brunner talks of an *Anknüpfungspunkt* or 'point of contact' between human nature and divine grace; there is a dimension of human nature that enables humans to encounter their Creator. Brunner accuses Barth of refusing to follow St Paul on key passages in the first two chapters of Romans in his later theological writings 'for he himself would surely agree that the relevant passages in his *Epistle to the Romans* do not count here'.[90] This is an interesting stance to take on the level of theological significance of biblical commentaries.

Brunner concludes that in the long run the Church can bear the rejection of *theologia naturalis* as little as its misuse. It was the task of his theological generation to find the way back to a true *theologia naturalis.* He was convinced that it was to be found far away from Barth's negation and quite near Calvin's doctrine. 'If we had enquired from the master earlier, this dispute would not have arisen.'[91]

Barth's response was entitled merely *Nein!* The sub-title was *Answer to Emil Brunner.* Barth argues that there is nothing in human beings which establishes a point of contact with God. It is only through God's grace in divine revelation that men and women come into contact with God:

> When (roughly since 1929) Brunner suddenly began to proclaim openly "the other task of theology," the "point of contact," etc., I made it known that whatever might happen I could not and would not agree with this.[92]

Barth attacks what Brunner has said ridiculing his distinction between the formal *imago Deo* and the material *imago Deo.* He accuses him of abandoning the Reformation principles of *sola fide – sola gratia.* Barth writes:

> Brunner is of the opinion that his natural theology "adheres to the teaching of the reformation" and is "quite near Calvin's doctrine" and that conversely Calvin's doctrine is at least usually "more or less" the same as his own doctrine of the formal side of *imago Deo.*[93]

Barth then asserts that Brunner has failed to see Calvin in his historical context. In the introductory chapters of the *Institutes,* Calvin (along with other Reformers in their writings) was unaware of the full import of Thomist thought:

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[90] Brunner and Barth, *Natural Theology,* 61.
[91] Brunner and Barth, *Natural Theology,* 59-60.
[92] Brunner and Barth, *Natural Theology,* 71.
[93] Brunner and Barth, *Natural Theology,* 94-95.

> They remained essentially untouched by the great synthesis of St Thomas, which later gained such great influence. Hence they did not feel themselves called upon to clarify the problem of the *formal* relationship between reason with its interpretation of nature and history on the one hand and the absolute claims of revelation on the other...[94]

Barth appears to assert that if the Reformers did know more about the thought of Aquinas, they would have looked at this topic in more depth and would have approached this topic in the manner not of Brunner but Barth. It could be asserted that if Barth took seriously the passage in Romans chapter one quoted above, as he does in *The Epistle to the Romans,* rather than ignoring it as he does in *No!* then he might have ended with a position closer to that of Calvin and Brunner.

Barth decries Brunner (and possibly Calvin) for being insufficiently anti-Thomist but he also wants to assert that his position has the support of 'Every Roman Catholic theologian who knows his subject'.[95]

At the same time that Barth was re-writing his commentary on Romans and arguing with Brunner, Eddington was arguing that religious experience was key to Christian faith and Jeans was asserting that there was evidence of design, discoverable by all without special revelation, in the universe portrayed by modern physics. The approaches of the four scholars were quite different and there is no direct reference to Barth or Brunner in the popular books of Eddington and Jeans but there was a common interest in the topic of natural theology during the inter-war years in, at least, Britain, America and the German speaking areas of Europe. Both the argument between Barth and Brunner and the books of Jeans and Eddington in German translation kept the discussion of natural theology alive on both sides of the North Sea. The work of two of these scholars, Barth and Eddington, was brought together in a synthesis by Thomas Torrance as will be seen later.

[94] Brunner and Barth, *Natural Theology,* 101-102.
[95] Brunner and Barth, *Natural Theology,* 95.

2.3 The Relationship between Science and Theology at the Start of the Twentieth Century

The key issue for the relationship between science and theology in the late nineteenth century was the publication in 1859 of Charles Darwin's *The Origin of Species.* By 1900 Christian theology had largely come to terms with the ideas of this significant volume, partly by drawing on elements within its own thought which had either been forgotten or neglected. Eddington makes a point of not talking about evolution, saying his training was in the physical sciences, but evidently has no theological problem with the concept.[96] Likewise Jeans, who wrote the first chapter 'Cosmogony' of *Evolution in the Light of Modern Knowledge*.[97] In this he sets the scene, so to speak, for life to evolve by describing the process by which the earth was formed.

If *The Origin of Species* was the key scientific text of the second half of the nineteenth century, the key volume of theology for Anglicans at least was *Lux Mundi,* published in 1889. It has been seen that Ramsey viewed *Lux Mundi* as a work which set the theological agenda at the start of the twentieth century for Anglicans. In this volume the theory of evolution was accepted and welcomed as an ally. The following oft quoted passage from Aubrey Moore's chapter on 'The Christian Doctrine of God' illustrates this stance:

> The one absolutely impossible conception of God in the present day, is that which represents Him as an occasional visitor: science has pushed the deist's God farther and farther away, and at the moment when it seemed as if He would be thrust out altogether, Darwinism appeared, and under the disguise of a foe did the work of friend.[98]

Likewise, J R Illingworth in his essay on 'The Incarnation and Development' writes:

> Our creator will be known to have worked otherwise indeed than we thought, but in a way quite as conceivable and to the imagination more magnificent.[99]

According to Ramsey, for the writers of *Lux Mundi* the acceptance of Darwinism encouraged a theology of immanence, in a form similar to that found in the Greek Fathers. Ramsey

[96] Eddington, *Unseen World,* 14.
[97] Anon (ed.), *Evolution in the Light of Modern Knowledge: A Collective Work* (London: Blackie, 1925).
[98] Charles Gore (ed.), *Lux Mundi* (London: John Murray, 1889), 99.
[99] J R Illingworth in Gore (ed.), *Lux Mundi,* 195.

believed that the writers showed that historic orthodoxy and evolution were not opposed to each other. But Ramsey believed that some writers, notably John Illingworth, went beyond this and suggested an association between religion and civilisation and between progress and Incarnation which was ill founded. Ramsey argues that it is the doctrine of the atonement which guards the difference between what he describes as the true and false type of immanentism. On the viewpoint of John Illingworth, he concludes:

> Subsequent years made this optimism incredible, and brought back the plea that the Cross be given once again the central place which Illingworth deprecated.[100]

MacCulloch asserts that the fact that the Church of England was headed by Archbishop Frederick Temple, who had assumed evolution to be a basic truth, indicated its general acceptance at least within the heartland of the Anglican Communion.[101] He writes that many Protestant theologians had begun constructing a new natural theology which had seen evolution as a gradual unfolding of God's providential plan. He cites as an example James McCosh, the Ulster-born president of Princeton University appointed in 1868. At this university Jeans later lectured from 1904 to 1905. MacCulloch sums up the combined effect of Darwinism and German Biblical scholarship thus:

> Nevertheless, for many sensitive people, science and history between them had irretrievably shaken the basis of revealed religion... Evolution turns some of the human characteristics which seem most divine – moral fastidiousness, love – into products of self-interested evolution. It robs the world of moral or benevolent purpose, and even if God is taken as a first cause as the *Origin* still proclaimed, it is difficult to summon up enthusiasm for worshipping an axiom in physics.[102]

MacCulloch's book is commendably wide in scope but the last sentence is an example of contestable judgement to accompany the misleading tautology seen earlier in this chapter. For many Christians the advances in physics and astronomy caused no angst similar to that brought about by Darwinism, even though the ideas were as revolutionary. This may have been because astronomical advances did not bear so closely on the Christian doctrine of humanity as biological advances did. But few thought the advances meant that at church or chapel they were 'worshipping an axiom in physics'. MacCulloch's comment on 'revealed

[100] Ramsey, *From Gore to Temple,* 5. See also 38.
[101] MacCulloch, *A History of Christianity,* 858.
[102] MacCulloch, *A History of Christianity,* 860-861.

religion' above is interesting in the light of A J P Taylor's comment and David Livingstone's book *Darwin's Forgotten Defenders*.[103]

Taylor characterised the work of Eddington and Jeans as supplying to the public 'unrevealed religion and ... a vague religiosity'.[104] This is far too simplistic. Clearly Eddington and Jeans were not biblical scholars nor did they make large use of the Bible in their work, but they did argue that current science supported traditional Christian beliefs in a Creator and Sustainer of the world, two ideas not inimical to 'revealed religion'.

Livingstone has studied one group of Christians who very much believed in 'revealed religion' that is, traditional evangelicals. He found that a number of these found the theory of evolution to be compatible with biblical faith. Livingstone, a British scholar, in his *Darwin's Forgotten Defenders* concentrated mainly on American reactions to Darwin and noted two eminent supporters from the scientific and theological communities. The first was the biologist Asa Gray, who somewhat had the role in the USA that T H Huxley had in Britain of defending Darwin's work. Gray was a 'thoroughgoing Congregationalist evangelical' according to Livingstone.[105] The second was the theologian B B Warfield of Princeton. Livingstone writes on the Princeton evangelicals and Warfield himself thus:

> ... its faculty were in many ways the classical architects of modern conservative evangelicalism. ... Even Warfield, the exponent of a particularly stringent view of biblical inerrancy, was an open supporter of the evolutionary perspective.[106]

Livingstone is open to the challenge that he is selective in his use of examples:

> As I indicated at the outset of this book, it is not my purpose here to offer a complete portrait but rather to depict *a* tradition of evangelical scholarship that found the resources to meet the evolutionary challenge. Determining how representative the figures I have chosen to illustrate the case really were it is admittedly problematic, but I am confident in asserting that they were amongst the intellectual leaders of evangelical thought.[107]

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[103] David N Livingstone, *Darwin's Forgotten Defenders: The Encounter Between Evangelical Theology and Evolutionary Thought* (Edinburgh: Scottish Academic Press, 1987).
[104] Taylor, *English History 1914-1945,* 169.
[105] Livingstone, *Darwin's Forgotten Defenders,* xi.
[106] Livingstone, *Darwin's Forgotten Defenders,* xii.
[107] Livingstone, *Darwin's Forgotten Defenders,* 187.

He starts from the reasonable assertion that evolutionary thought is compatible with a traditional evangelical understanding of Christian belief; then reports that Warfield and likeminded theologians supported evolutionary thought and then asserts therefore they are 'the intellectual leaders of evangelical thought'. Nevertheless, Livingstone makes the case well that they were in the mainstream of conservative evangelical thought, not just liberal evangelical thought, and that their work was fundamental to modern evangelical scholarship. He rightly points out the extent of Warfield's influence and notes that even those who support a young earth creationist viewpoint often use a Warfieldian model of biblical inerrancy, while failing to acknowledge Warfield's own position on evolution.

Livingstone in *Putting Science in its Place* writes 'Science is not some eternal essence taking form in history; rather it is social practice grounded in concrete historical circumstances.'[108] In a more recent book, *Dealing with Darwin: Place, Politics, and Rhetoric in Religious Engagements with Evolution,* he broadens the scope of his study of the reception of Darwinism amongst Presbyterians of Scottish descent, both in Scotland and the diaspora. [109] He uses sources from Edinburgh, Belfast, Toronto, Colombia in South Carolina and Princeton. Here he ably demonstrates how local context is key in the shaping of responses to Darwinism in particular and in the science and religion debate in general – 'the shape of these encounters with Darwin redraws attention to the salience of *place* and *politics* in religious engagements with scientific claims.'[110] There is depth in the work of Livingstone and resonances with the findings of this study.

Some of those who relied on the William Paley type argument from biological design often had more problems than those who relied on 'revealed religion'. To use MacCulloch's term, advances in astronomy in late Victorian science were seen by some as explaining in more detail how the First Cause had caused the created order to exist. MacCulloch covers the topic of the relationship between science and theology at the start of the twentieth century but his scope is wide and his comments descriptive rather than evaluative. Grass has very little to say about science in an otherwise informative book. Philip Kennedy's book on twentieth century theologians lists some key dates in the development of science but his choice of events is often interesting. It does, however, set the work of theologians in the context of scientific

[108] David N Livingstone, *Putting Science in its Place: Geographies of Scientific Knowledge* (Chicago: University of Chicago Press, 2003) 180. *Italics* as in the original.
[109] David N Livingstone, *Dealing with Darwin: Place, Politics, and Rhetoric in Religious Engagements with Evolution* (Maryland, John Hopkins University Press, 2014).
[110] Livingstone, *Dealing with Darwin,* 198.

and cultural development. Chadwick gives the topic wide coverage, is evaluative as well as descriptive, but concentrates mainly on Darwin and biology.

For many, science was not a barrier to faith; for some, it was a spur to faith. Chadwick linking the nineteenth and twentieth centuries, puts it thus:

> ... we continue to find that old axiom or feeling, which Darwin seemed to have demolished in himself, that scientific study can lead upwards towards God. Faraday felt it; Kelvin never doubted it; the most eminent among Victorian medical men, from Sir James Paget to Sir Ronald Ross, were marked for their piety; and the long tradition from Sedgwick through Jeans and Eddington to Sir Alastair Hardy continued to be important.[111]

Chadwick suggests that scientists of the late nineteenth century were no more unsettled in their faith than barristers. But there was a change in view point amongst the general educated public who by 1900 had accepted the theory of evolution as compatible with Christian faith. While many Protestants had accepted Darwinism, Chadwick, in contradiction of David Livingstone, argues evangelicals remained conservative against doctrines of evolution or of the presence of fork-lore in Genesis.[112] The in-depth research of Livingstone is preferable to the more general work of Chadwick. Nevertheless, Chadwick's work is to be trusted more than MacCulloch's on detail. This is to be expected as Chadwick wrote two large volumes on the Victorian church in England whereas MacCulloch wrote one very large volume on the whole history of Christianity in all lands.

Two milestones in this acceptance of Darwinism are often noted. The first was the publication in 1872 by SPCK of T G Bonney's *A Manual of Geology* which supported an age of the earth much older than the date proposed by Archbishop Usher.[113] Darwin and modern geology were not wholly responsible for the change in the general view of the age of the earth or the interpretation of the book of Genesis. The advance of modern biblical studies played a major role in this process. By the time of the publication of the *Origin,* Usher's date of the creation was far from universally accepted amongst leaders of Christian thought. The second milestone was the burial of Charles Darwin in Westminster Abbey in 1882. The substantial biography of Darwin by Adrian Desmond and James Moore indicates the wide

[111] Chadwick, *The Victorian Church: Part II,* 6.
[112] Chadwick, *The Victorian Church: Part II,* 471.
[113] Chadwick, *The Victorian Church: Part II,* 28.

support for this move within the church, Parliament, the press and the nation.[114] The final chapter of this book describes the importance of this funeral not just for Darwin's memory but for T H Huxley's plans for a 'scientific priesthood'.[115]

With the acceptance of Darwinism came a rejection of the form of the design argument found in Archdeacon Paley:

> Unless they were Roman Catholics committed to a form of Thomism they slowly dropped natural theology, that is they ceased to argue towards the existence or qualities of God from a contemplation of nature.[116]

The old Paley style 'watch on the heath' argument from order in nature which points to a design and a Designer was no longer viable. Darwin's thesis of natural selection brought about by the struggle for survival acting upon random variations, in for example, the structure of the mammalian eye, could be explained without invoking special creation. Paley's design argument became irrelevant to any late Victorian theology that mattered, asserts Chadwick; the first shadow of the knowledge of God seemed to lie in the heart or the conscience, not in nature. While Eddington might not have used Chadwick's words, his position was not too far from the idea expressed by Chadwick. Jeans saw design in the structure of the universe and restated the design argument in a modified form.

In rejecting the idea of a sequence of special creations whereby God brought into existence each individual species fully formed and developed, Christians at the start of century looked rather to see God in the process. This was a view of God as not only as the creator but as the sustainer and not only as transcendent above and detached from his world but as immanent within the world and within its development. It is possible to believe in special creation and in God as sustainer but the acceptance of Darwinism increased interest in the concept of God as upholder and sustainer and the idea of Divine immanence:

> Nearly all the English theology of the later nineteenth century was 'immanentist'; talked as often of God within the world as of God above the world; dwelt more upon the incarnation of the word in Christ and less upon the atonement wrought by Christ; and (like Coleridge and Maurice) based its ultimate claim upon the

[114] Desmond and Moore, *Darwin,* Chapter 44.
[115] Desmond and Moore, *Darwin,* 665.
[116] Chadwick, *The Victorian Church: Part II,* 30.

> religious experiences of men. History contributed as much as science to this change of thought.[117]

Questioning people at that time no longer assumed a conflict between science and religion and if they had intellectual difficulties it was on textual criticism or the authority of the Bible. This may seem positive but linked with this was an idea that religion had abandoned any claims to speak with authority about the physical world. Changing thought since the publication of the *Origin* had led to a world view for many Christians that compartmentalised thought into two non-interacting categories of 'religion' and 'science' – a view bequeathed to the twentieth century but not held at the start of the nineteenth century.

Kennedy, in his book *Twentieth-Century Theologians* writes:

> No theologian writing before 1900 knew certainly that the universe is both expanding and much more than 10 billion years old.[118]

This is of course true, but neither did any astronomer, and the use of the words 'knew certainly' in connection with astrophysical theory is interesting. Nevertheless, Kennedy is right to point out the quite different conception of the physical universe which emerged as the twentieth century progressed. Eddington and Jeans worked at time of rapid change in physics and astronomy and at a time when the general public's interest shifted from evolution to show an equal interest in astronomy. It will be argued that the work of Eddington and Jeans was transitional in helping shift the debate around science and religion from being focused mainly on evolutionary biology towards these importance changes in physics and astronomy.

2.4 Physics and Astronomy at the Start of the Twentieth Century

The twentieth century was a time of significant advance for physics and astronomy across many fields. The branches of physics and astronomy which feature regularly in the popular and semi-popular works of Eddington and Jeans are detailed in the succeeding paragraphs. These areas are of significance for their apologetic writings.

[117] Chadwick, *The Victorian Church: Part II,* 31-32.
[118] Philip Kennedy, *Twentieth-Century Theologians* (London: I B Taurus, 2010), 2.

At the beginning of the twentieth century one of the key questions facing physics and astronomy was an issue which many physicists had forgotten by the end of the century. Put simply, what is the nature of the medium which carried the rays of light from the sun, or any other star, to the surface of the earth?

The ether (or aether) was the hypothetical invisible, universal and weightless medium postulated as necessary to support the propagation of electromagnetic radiation through otherwise empty space. The existence or not of the ether plays a role in the careers of Eddington and Jeans.

The existence of this ether was challenged as early as 1887 by the famous Michelson-Morley experiment. In this investigation these two American scientists attempted to measure the velocity of the earth through the ether. They did this by attempting to show that the speed of light measured in the direction of the earth's rotation was different from that at 90 degrees to the rotation of the earth. No such difference was found. One explanation of this phenomenon, or lack of phenomenon, the Lorentz-Fitzgerald contraction, was proposed in 1892 and played a role in the development in the role of Einstein's special theory of relativity and in the demise of the concept of the ether. Eddington played a prominent role in the acceptance of Einstein's work in the English-speaking world; Jeans played a less significant but not negligible role.

In 1897 J J Thompson, a Fellow of Trinity College, Cambridge conducted researches at the Cavendish Laboratory which led to him to postulate a new light atomic particle which Stoney later named the electron. This work led Rutherford, who had succeeded Thompson at the Cavendish, onto the study of the structure of the nucleus.

The nineteenth century had seen the development of the physics of electro-magnetism. Such significant names as Ampère, Ohm, Volta and Faraday had worked in this field but it was James Clerk Maxwell who gave these ideas the full mathematical expression in his equations of 1865. Maxwell calculated the speed of the propagation of these electromagnetic waves which turned out to be the same as the speed of light. These advances played a role in Einstein's work and in Eddington's Gifford Lectures.

The nineteenth century roots of the other significant development for the present study, quantum mechanics, are more diffuse and were less developed at the turn of the century but by 1927, according to Eddington, they had changed the nature of physics and, he jokingly

argued, made faith intellectually respectable again.[119] Helge Kragh sees the developments in relativity theory and quantum theory as the two main revolutions in twentieth century physical thought, but for Eddington and Jeans the not unlinked area of atomic structure was also significant.[120]

Professor John Charap in his semi-popular *Explaining the Universe* writes:

> ... the prevailing view in the community of physics [in 1900] was an optimistic acceptance that the progress of what we now call classical physics would continue, that the new discoveries would fit smoothly into the growing, coherent pattern of observation and theory which had been established with so much labor and ingenuity. Little did anyone foresee what was so soon to follow![121]

The foundations of the physics and astronomy of the nineteenth century had been laid in the earlier work of Sir Isaac Newton. This science, 'what we now call classical physics', was deterministic – it believed that if the position of an object was known and its speed and the forces acting upon it known, then its future was entirely predictable within the limits of the accuracy of the measurements made. This science was reductionist. It believed that all complex phenomena could be explained in terms of simpler, more general underlying laws. It was materialist, it saw matter as objectively existing real 'stuff' and had contempt for a world view which postulated non-objectively existing material, except for energy, when understood as a property of some objectively existing matter. It was also mechanistic; it tended to view the world as a giant complex machine. Whitehead described the physics of this age as dull.[122]

Kragh in his academic *The Quantum Generations* says that this received view outlined in the quotation from John Charap, in the paragraph above and in Whitehead's assessment is a myth, but that it has a foundation in truth, like most myths.[123]

Kragh does agree with Charap as seeing the notion of the ether as a key issue in science at the turn of the century. While late nineteenth century physics is often described as materialistic, a key concept in astronomy was this postulated ether, which according to some scientists, was

[119] Eddington, *Nature of the Physical World,* 350.
[120] Helge Kragh, *Quantum Generations: A History of Physics in the Twentieth Century* (Princeton: Princeton University Press, 1999), xiii.
[121] John M Charap, *Explaining the Universe: The New Age of Physics* (Princeton: Princeton University Press, 2002), 23.
[122] A N Whitehead, *Science and the Modern World* (Harmondsworth: Penguin, 1926), 123.
[123] Kragh, *Quantum Generations*, 3.

the fundamental substratum out of which matter was constructed. Is a universal, invisible and weightless medium really a materialistic conception?

In the next two chapters the formative influences upon Eddington and Jeans will be described and an outline of the key areas of theological interest will be attempted. While Evans is correct in saying that the careers went along similar tracks after their arrival at Trinity, their backgrounds were very different.[124] Both were shaped by the influence of their childhood and their experiences as young men. In order to set the foundations for the latter argument, there is a need to review in some detail the three key works, *The Nature of the Physical World, Science and the Unseen World* by Eddington of 1928 and 1929 respectively and Jeans' 1930 *The Mysterious Universe*. This process will give more than mere background, it will help in understanding both Eddington and Jeans in their own words and note their habit of using developing arguments. It is also necessary as both writers suffered from misrepresentation by both friends and critics.

[124] Evans, *The Eddington Enigma,* 96.

CHAPTER THREE

THE MOST DISTINGUISHED ASTROPHYSICIST OF HIS TIME

3.1 The Formation of a Quaker

In this chapter the influence of Eddington's Quaker upbringing will be described as well as a description of his early career. Eddington was not a physicist who happened to be a Quaker. The Society of Friends was integral to his thought both as an apologist and as a physicist.

Arthur Stanley Eddington was born in Kendal, Westmorland on 28 December 1882. After secondary education in Weston-super-Mare he went in 1898, a term short of his sixteenth birthday, to Dalton Hall at Owen's College, Manchester, which later became part of Manchester University. In the first year his studies were wide but in the next three years he concentrated on physics and mathematics. In 1902 he obtained a first class honours BSc in physics.

The Principal was John William Graham, who used his position at Dalton Hall to influence some of the brightest young Quaker students.[125] Graham wrote a pamphlet *The Meaning of Quakerism,* possibly while Eddington was at Dalton Hall.[126] In this, Quakerism was presented as a faith based on experiential and experimental knowledge of God.[127] The following passage from Graham is very much in line with the phraseology used by Eddington in *The Nature of the Physical World*:

> The appeal which will be made in this essay will be to religious experience, far more than to religious theory.[128]

[125] Stanley, *Practical Mystic,* 25.
[126] John William Graham, *The Meaning of Quakerism: An Address by John W Graham* (London: Headley Brothers, nd). The copy in the library at the Friends Meeting House, Euston Road, London has no date. Stanley believes it to be written in 1900 but internal evidence points to 1902 or later.
[127] Stanley, *Practical Mystic,* 26.
[128] Graham, *The Meaning of Quakerism,* 3.

Another Quaker emphasis is the rejection of creeds as documents to which Christians must assent. Graham refers to one of the key figures in early Quakerism, William Penn, who said that the New Testament was the only creed for members of The Society of Friends, a position which reserves liberty of interpretation to the reader. For Stanley certainly, the Inward Light is the key to understanding religion and religious experience. Dogma, creed and tradition are of no significance. Stanley on this point appears to hold a stronger line than Eddington did himself. Stanley's is undoubtedly a good study of Eddington but in places he does overstate his case. He does appear to hold a view which is more anti-theology than Eddington espoused. In this, as in most matters, Eddington is subtle and nuanced.[129] Stanley also underplays Eddington's insight that the microscopic is not always a good descriptor of the macroscopic.

Stanley's claim that Graham was probably the single most important influence on Eddington when he was a student while very likely is difficult to completely substantiate, but that he was a significant influence on *The Nature of the Physical World* does seem obvious from the following passage from *The Meaning of Quakerism:*

> No theological dogma has any binding force, unless it carries conviction. The revelation of God in science and history is our delight.[130]

3.2 The Renewal of the Centrality of the Inward Light in the British Society of Friends

The different theological strands of early twentieth century British Quakerism will now be explored. A few years before Eddington arrived at Owen's College there was a significant Quaker conference in the city of Manchester. The Society of Friends, then numbering about 17,000 people in England according to Graham, was no more homogeneous in its theological stance than any other church at the end of the nineteenth century.[131] It had been founded in the 1650s by George Fox and his followers in Northern England, which was still one of its areas of comparative strength. It was, at the end of the nineteenth century, perceived as inward looking, puritanical and reluctant to change. George Fox preached that Christians could know God directly through personal experience of the Inward Light (sometimes the Inner Light, the

[129] Stanley, *Practical Mystic,* 23-24.
[130] Graham, *The Meaning of Quakerism,* 45.
[131] Graham, *The Meaning of Quakerism,* 55.

form of the term more common in Eddington's time), which was a spark of the divine in all humans. He rejected the authority of any hierarchical church in favour of direct mystical experience.[132] After its turbulent beginnings, the Society of Friends went through a 'quietistic' phase when it was sedentary and anachronistic with a very great emphasis on personal experience of the Inward Light and disinterest in the outside world. In early Victorian Britain, many Quakers had become influenced by the evangelical movement. In America, the British-born Joseph Bevan Braithwaite was a leader of the evangelical party within Quakerism there, which included in their worship communion, baptism, hymns and revivalist-style meetings.

It was to the liberal trend in Quakerism that Eddington and Graham belonged. This was the dominant force behind the Manchester Conference and it wanted to establish a third way between the new evangelical Quakerism and the old paralysed quietism. Part of this liberal trend in Quakerism was the renewal of the classic Quaker doctrine of the Inward Light.

Graham was one of the speakers at the Conference. He called for the Inward Light and personal religious experience to be re-established as the foundation for Quakerism.[133] The text does not explain how varying understandings of the Inward Light can be reconciled, beyond an acknowledgement that multiple interpretations of scripture are acceptable and to be expected. John Punshon is a little more cautious about the role of individualism within Quakerism. Punshon sees it as right and proper that Quakers moved from the individualism of the early period in the life of the Friends to a position where decisions were and still are made corporately in meetings. He argues that the movement as a whole suffered from some over-enthusiastic early mavericks.[134]

Another key influence on British Friends, which grew out of the Manchester Conference, was the Friends' Summer School movement begun in 1897 by John Wilhelm Rowntree and George Cadbury. The Summer School was explicitly designed to help birth right Quakers learn how to bring their beliefs into the modern world. The Summer School was very similar both in format and in geography to that of the Keswick Convention founded by Canon Harford-Batesby in 1875.

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[132] Stanley, *Practical Mystic,* 26-27.
[133] *Report of the Proceedings of the Conference of the Members of the Society of Friends Held by Direction of the Yearly Meeting in Manchester from Eleventh to the Fifteenth of the Eleventh Month 1895* (London: Headley Bros, 1986), 241.
[134] John Punshon, *A Portrait in Grey: A short history of the Quakers* (London: Quaker Books, 2006), 90-97.

Eddington attended the Summer School in 1908 which was held in Kendal. There were around 300 people there. Two speakers especially impressed Eddington – Seebohm Rowntree on social issues and the American Rufus M Jones on mysticism.[135] Punshon states that Rufus Jones was 'one of the most influential Quakers of all time'.[136] Jones argued that theology was completely foreign to the primitive Church. The life of Jesus and the Apostles was based rather on religious experience.

Mysticism, according to Jones, was the type of religion which puts the emphasis on immediate awareness of relation with God, on direct and immediate consciousness of the Divine Presence.[137] Both Stanley and Jones see this lack of theology and creeds and a reliance on direct experience as a strength. Not all Quaker writers are so sure. Punshon again holds a contrary view. This refusal to engage in theological consideration, he says, is not wholly satisfactory, for it creates as many problems as it solves, particularly in the attempt to make sense of what the New Testament says about Jesus Christ.

The ideas of Jones meshed well with liberal Christianity outside The Society of Friends, as evangelical Quakers showed similarities with other evangelicals, but liberal Quakerism did have its own distinctive character. This traditional element of Quaker thought, the idea of the Inner or Inward Light, was reasserted and re-interpreted by both the Manchester Conference and the Summer School movement. This concept will now be examined in greater depth.

The Oxford Dictionary of the Christian Church sees the Inner Light as '… characteristic of, but not exclusive to, the Society of Friends.'[138] The importance of inner, subjective feelings and thought has been emphasized by groups other than Quakers. In Protestant thought there has been a split between those who distrust intuitions or inner emotions as not necessarily reflecting a believer's objective status before God, sometimes, but not always influenced by Calvinistic theology, such as the Princeton Presbyterian, B B Warfield; and those who value the inner feelings of the believer, sometimes, but not always influenced by Wesleyan or Arminian thought.[139] John Wesley's father, Samuel, is said to have asserted the importance of 'the inward witness' in his dying words .[140] Samuel Wesley, although a High Church Tory, was

[135] Stanley, *Practical Mystic, i37.*
[136] Punshon, *Portrait in Grey,* 237.
[137]Stanley, *Practical Mystic,* 37-38 quoting Rufus Jones, *Studies in Mystical Religion* (London: Macmillan, 1909), xv.
[138] F L Cross and E A Livingstone (eds.), *The Oxford Dictionary of the Christian Church* (Oxford: Oxford University Press, 3rd ed. 1997), 833.
[139] Roger E Olson, *A-Z of Evangelical Theology* (London: SCM, 2005), 137.
[140] Henry D Rack, *Reasonable Enthusiast: John Wesley and the Rise of Methodism* (London: Epworth, 3rd ed. 2002), 47.

influenced by his Puritan upbringing. He started his education at a Dissenting Academy before transferring to Exeter College, Oxford. When John Wesley described his own conversion he wrote 'my heart was strangely warmed'.[141] The 'Inner Light' was a common concept in English Puritanism, influenced though it was by Calvinism. The ideas of John Henry Newman on intuition and the illative sense will be considered later. The emphasis on the Inner or Inward Light or Witness was, indeed, key to Quaker faith, but not exclusive to it.

The concept of the Inner or Inward Light in Quaker thought can be seen as stemming from the theology of John's Gospel and especially the verse 'The true light, which enlightens everyone, was coming into the world' (Jn 1.9 NRSV).[142] A standard dictionary of Quaker beliefs and history *The A to Z of the Friends*[143] gives, in addition to that from the Prologue, another key text from John's Gospel 'I am the light of the world. Whoever follows me will never walk in darkness but have the light of life.' (Jn 8.12 NRSV)

George Fox was strongly influenced by the fourth Gospel and taught from the foundation of the Society of Friends that truth is primarily to be found in the inner voice of God speaking to the soul. According to Stephen Nichols, Fox originally taught that the Inner Light was the same as the voice of scripture, but over the years his opinion changed and he came to regard the on-going revelation of the Spirit as more important than the recorded revelation of the Word.[144] Nichols rightly argues that this led to growing eclipse of scripture as a basis for Quaker beliefs and to a subjective view of religion which equated religious truths with the individual's experience. Rex Ambler is a contemporary British Quaker who has written on this topic. He has gone back to Fox himself and 'translated' Fox's writings into modern English for contemporary Quakers and others. Of George Fox he writes:

> So his initial message was always the same: give up your dependence on doctrines, rituals, preachers and everything else that is external to you, and find the light that is within you because that will teach you all you need to know.[145]

The A to Z of the Friends goes on to describe the varieties of explanation of this concept down the years of Quaker history, concluding in the modern era where it identifies seven not entirely distinct emphases of interpretation. 'The Inner Light' has become a unifying phrase

[141] Quoted in Rack, *Reasonable Enthusiast,* 144.
[142] Cross and Livingstone eds., *The Oxford Dictionary of the Christian Church,* 833.
[143] Margery Post Abbott *et al., The A to Z of the Friends* (Maryland: Scarecrow Press, 2006), 157.
[144] S J Nichols, 'Inner Light' in Campbell Campbell-Jack and Gavin J McGrath eds. *New Dictionary of Christian Apologetics* (Leicester: IVP, 2006), 357.
[145] Rex Ambler, *Light to Live By: An exploration in Quaker spirituality* (London: Quaker Books, 2002), 7.

among Friends because of the multiple ways it can be interpreted.[146] This includes the modern liberal Quaker interpretation to which Eddington held. This emphasises the availability of the Inner Light to all humans, but downplays the importance of the atonement in relation to the action of this principle in the human soul.[147] While an ambiguous term can be a rallying point for unity, it does not make for theological precision.

3.3 The Development of a Physicist

While Graham was influential on Eddington's development as a Quaker, Arthur Schuster was the key person in his development as a physicist.[148] Schuster was a great believer in the importance of both applied mathematics and practical applications to modern science, but felt that the purpose of an educational institution was the training of scientific judgement.[149] Schuster emphasised the interdependence of the mathematics and physics. Each is weak without the other and there is interplay between the two as science advances. For Schuster there was no analytical, clinical method by which physics could be guided. Rather, a *Fingerspitzengefuhl* (literally 'finger tips feeling') was needed to grasp intuitively and sense what methods would be fruitful. Eddington would adopt this approach. For Schuster, science was a kind of doing, not a kind of knowledge. From Schuster, the German Jew turned Christian, educated not only in Frankfurt and Heidelberg but also in the French-speaking part of Switzerland and then in Britain, Eddington received a grounding in internationalism which would have accorded well with his Quaker belief in pacifism and a respect for the divine in all human beings.[150]

Eddington arrived at Trinity in the autumn of 1902. Although he was on a Natural Sciences scholarship he soon transferred to preparation for the rigorous Mathematical Tripos. This course at Cambridge had been for years the training ground for mathematicians and mathematical physicists and Trinity was viewed as the place in Cambridge for the ablest students. His private tutor was R A Herman. His lecturers included A N Whitehead, E W Barnes, the future Bishop of Birmingham, and E T Whitaker. According to Stanley, 'Neither

[146] Margery Post Abbott *et al., The A to Z of the Friends,* 156-158.
[147] Margery Post Abbott *et al., The A to Z of the Friends,* 158.
[148] Stanley, *Practical Mystic,* 29.
[149] Stanley, *Practical Mystic,* 30.
[150] Stanley, *Practical Mystic,* 29-33.

Whitehead nor Barnes had begun thinking seriously about religion yet and it is unlikely their work on this subject had much influence on Eddington.'[151] His biography shows that Barnes was ordained in May 1902, so that may not be the case.[152] According to John Barnes, his son and biographer, E W Barnes had a 'constant emphasis on mystical intuition as ultimately the only sure approach to knowledge of God' which could indicate an Anglican influence on Eddington, reinforcing his Quaker heritage.[153] In terms of his theological development, his time at Dalton Hall was more formative than his time at Cambridge.

After only two years of study at Cambridge, Eddington sat the Tripos. This was unusual but not unique. Eddington came out at the top of the list and was thus named Senior Wrangler, while Jeans was second Wrangler in 1898. Eddington took the advanced Part II examinations in 1905 and graduated BA. Eddington was uncertain which career path he should follow, until an offer was made from the Astronomer Royal, W M H Christie, for him to become the next Chief Assistant at the Royal Greenwich Observatory. Eddington was viewed as having both theoretical and practical experience, although he did put in a lot of practice with the transit circle at the Cambridge Observatory before taking up post in February 1906.[154]

The post at Greenwich was an excellent one. Eddington was regarded as a talented young man and he benefited fully from using some of the latest equipment and working with some of the key observers in England. In 1909 Eddington went to Malta to determine the longitude of the island. In 1912 he went to Brazil to observe a solar eclipse. The event was washed out by rain but, nevertheless, he contributed a paper to the Royal Astronomical Society describing what he would have done, namely, photograph the solar corona through different colour filters. Both expeditions were useful preparations for his 1919 trip to Principe when his observations were pivotal in gaining acceptance for the work of Einstein.[155]

Having already declined an opportunity to become Professor of Theoretical Physics at Manchester, Eddington accepted an offer to become Plumian Professor of Astronomy and Experimental Philosophy at Cambridge in 1913 following the death of George Darwin. He was only 31. In the following year he was also appointed Director of the Cambridge Observatory following the death of Sir Robert Ball. The Observatory was his home, as well as for his sister Winifred, until his death from stomach cancer in 1944. This summary of Eddington's life

[151] Stanley, *Practical Mystic,* 33.
[152] John Barnes, *Ahead of His Time: Bishop Barnes of Birmingham* (London: Collins, 1979), 48.
[153] Barnes, *Ahead of His Time,* 53.
[154] A Vibert Douglas, *The Life of Arthur Stanley Eddington* (London: Nelson, 1956), 11-14.
[155] Stanley, *Practical Mystic,* 35-36.

indicates the strong theoretical and practical preparation he had for his career in astronomy. It gave him a thorough grounding for his work as a popular apologist and it also indicates how his Quaker background fed into his later work.

3.4 Eddington the Populariser

In this section the work of Eddington as a populariser in general will be considered along with an overview of his significant academic essay 'The Domain of Physical Science'. Eddington was a successful author and broadcaster. His books sold very well, as has been said, and when they contained no reference to religion were generally well received. James Crowther, not the greatest fan of *The Nature of the Physical World*, described *Space Time and Gravitation* as 'brilliant' and *Stars and Atoms* as 'his best'.[156] Crowther's attitude to *The Nature of the Physical World* in his later *Six Great Astronomers* of 1962 is less critical than in *British Scientists* of 1952.[157] Einstein himself is said to have called Eddington's 1923 technical *The Mathematical Theory of Relativity* to be the best account of the topic written in any language.[158] This publishing success generated further income from popular lectures, radio broadcasts and work with the written press. Eddington contributed a chapter 'The Domain of Physical Science' to Joseph Needham's significant *Science Religion and Reality*[159] and to the not-so-important series of broadcast talks *Science and Religion.*[160] Eddington was seen, with Jeans, as one of the leading popular scientific apologists for Christianity, as the quotations from A J P Taylor and Lewis in chapter one illustrate, but before this Eddington, along with Jeans, was well regarded as a populariser of science without reference to religion.

Eddington was especially famous for bringing before the intelligent reading public Einstein's work on relativity. This can be seen in the writings of the popular crime author Dorothy L Sayers. In her short story 'Absolutely Elsewhere', Lord Peter Wimsey is accused of going 'all Eddington' when he starts talking of relativity and the speed of light.[161] The title of the short story is a reference to one of Eddington's significant diagrams in *The Nature of the Physical*

[156] Crowther, *British Scientists,* 175.
[157] J G Crowther, *Six Great Astronomers* (London: Hamish Hamilton, 1961).
[158] Ray Spangenburg and Diane Kit Moser, *Modern Science 1896-1945* (New York: Facts on File, 2004), 37.
[159] Joseph Needham, *Science Religion and Reality* (London: Sheldon, 1925).
[160] Julian Huxley, et al, *Science & Religion: A Symposium* (London: Gerald Howe, 1931).
[161] Dorothy L Sayers, *The Complete Stories* (New York: Perennial, 2002), 392.

World.[162] While *Space Time and Gravitation* is of no great significance for this discussion Rampelt argues convincingly that Eddington's 'love affair with the theory' rests upon the fact that Einstein's work described in this book 'showed that science does not rest on an immovable foundation outside of human experience.'[163]

Jeans was even more famous for his best-selling and accessible *The Universe Around Us,* but according to Whitworth, Eddington had a particular cache:

> As the man who proved the theory of relativity, Eddington was respected as a populariser.[164]

The use of the word 'proved' is, of course, questionable.

The *Nature of the Physical World* contains Eddington's most sustained account on how he sees the philosophical and theological implications of the new understanding of physics and was written three years after his significant essay 'The Domain of Physical Science'. Eddington's Swarthmore Lecture of 1929, *Science and the Unseen World,* is also significant. His later *New Pathways in Science* of 1935 brings little that is new to the debate apart from a chapter in which Eddington answers some of the critics of *Nature of the Physical World,* notably Stace. *The Philosophy of Physical Science* of 1939 is not a work of popular apologetics. Nevertheless, Braithwaite sees it as important in the development of the philosophy of science.[165] In addition, Thomas Torrance draws on it with considerable approval in his Hewitt Lectures of 1959. These were published eventually in 1969 as *Theological Science*.[166]

The essay 'The Domain of Physical Science' is just over twenty-nine pages long whereas *The Nature of the Physical World* is 361 pages long. Michael Whitworth writes of *Science Religion and Reality* thus:

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[162] Eddington, *Nature of the Physical World,* 48. This does indicate that Sayers did read the book as is also seen by her use of Eddington quotations in *The Mind of the Maker* (London, Methuen, 1941) 1, 15, 27, 35.
[163] Jason M Rampelt, 'Arthur Stanley Eddington', 129.
[164] Whitworth, 'The Clothbound Universe', 59.
[165] R B Braithwaite, 'An Empiricist's View of the Nature of Religious Belief,' The Ninth Arthur Stanley Memorial Lecture, reprinted in Volker Heine (ed.), *A S Eddington and the Unity of Knowledge: Scientist, Quaker & Philosopher* (Cambridge: Cambridge University Press, 2013), 101.
[166] Thomas F Torrance, *Theological Science* (London: Oxford University Press, 1969).

> Needham's work is important principally for Eddington's essay, 'The Domain of Physical Science', which latter formed part of *The Nature of the Physical World,* chapter XII.[167]

The Gifford Lectures and *The Nature of the Physical World,* built upon the ideas contained in 'The Domain of Physical Science' and developed them considerably. *Science Religion and Reality* is a volume of some substance. It has ten contributors including Arthur Balfour, Charles Singer, Joseph Needham, John Oman and Dean Inge. The essays are of a good length. Roy Hattersley[168] in his history of Britain between the World Wars notes its importance along with only one other volume of theology, *Essays Catholic and Critical*.[169] *Science Religion and Reality* is an academic volume*,* in contrast to the broadcast talks in *Science & Religion* of 1931 which has an equally illustrious set of contributors, but are shorter and more popular. Eddington's radio talk in this volume is printed as fourteen pages.

Joad sums up the chapter written by Eddington somewhat selectively, but brings out, nevertheless, one of the key points:

> In a famous essay in *Science Religion and Reality,* the substance of which appears again in *The Nature of the Physical World,* Prof Eddington emphasizes the cyclic method of physics. The entities with which the physicist deals are, he points out, ultimately definable in terms of each other.[170]

Little more will be said on 'The Domain of Physical Science' as so much is repeated in a slightly more accessible form in *The Nature of the Physical World* but one or two comments of Eddington's are worth noting. Eddington argues that science is not a superior form of knowledge when compared with everyday knowledge, nor is the former pedantic and the latter practical. Each has its place. Eddington sums up his argument thus:

> We cannot describe the difference without referring to a mind. The actuality of the world is a spiritual value. The physical world at some point (or indeed throughout) impinges on the spiritual world and derives its actuality solely from this contact.[171]

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[167] Whitworth, 'The Clothbound Universe', 62.
[168] Roy Hattersley, *Borrowed Time: The Story of Britain Between the Wars* (London: Little, Brown, 2007), 199.
[169] E G Selwyn (ed.), *Essays Catholic and Critical* (London: SPCK, 1926).
[170] C E M Joad, *Philosophical Aspects of Modern Science* (London: George Allen and Unwin, 1932), 23.
[171] Eddington, 'The Domain of Physical Science', 211.

The Idealism of Eddington will be considered in depth in a later section, but this passage gives a flavour of Eddington's thinking. Eddington's use of the words 'spiritual' and 'mystical' in his books could be described as both puzzling and vague. What, in the passage above, does 'The actuality of the world is a spiritual value' mean? The text does not provide the answer. Is Eddington asserting an Idealist understanding of reality? Does the physical world only exist because of its perception by a consciousness, Divine, human or animal, which is a 'spiritual' process?

Eddington writes that not all knowledge of the external world can be reduced to pointer readings:

> I venture to suggest that the division of the world into a material world and a spiritual world is superficial, and that the deep line of cleavage is between the metrical and the non-metrical aspects of the world.[172]

Eddington also quotes the German theoretical physicist and mathematician Professor Hermann Weyl on the nature of the four-dimensional world envisaged in relativity theory:

> 'It is a four-dimensional continuum which is neither time nor space. Only the consciousness that passes on in one portion of this world experiences the detached piece which comes to meet it and passes behind it as history, that is as a process that goes forward in time and space.' Here you see again the absolute necessity for a reference to consciousness. ... it is by their values for consciousness that we differentiate certain of these relations as *being* and others as *becoming*.[173]

Are Eddington and Weyl saying that those parts of the physical world which are perceived by consciousness have actual being while the rest have the potential to become so? This paragraph tends to support the explanation put forward above, but still leaves much ambiguity. Was there any influence of the ideas of Eddington and Weyl on being and becoming on the thought of Arthur Peacocke? In his substantial *Theology for a Scientific Age: Being and Becoming – Natural, Divine and Human* there is no reference to Eddington or Weyl.[174] In his biographical *From DNA to Dean* he likewise makes no reference.[175] It would

[172] Eddington, 'The Domain of Physical Science', 200.
[173] Eddington, 'Domain', 211, *italics* as in the original.
[174] Arthur Peacocke, *Theology for a Scientific Age: Being and Becoming – Natural, Divine and Human* (London: SCM, 2 ed. 1996).
[175] Arthur Peacocke, *From DNA to Dean: Reflections and Explorations* (Norwich, The Canterbury Press, 1996).

appear that there is no direct influence. Arthur Peacocke's daughter indicates than A N Whitehead is the major source of his thought in this area, though neither of these two books conclusively demonstrate this.[176]

Eddington, in the penultimate paragraph of 'The Domain of Physical Science', summarises his views on mind but at the end gives it a further twist:

> We have spelt mind with a small 'm,' for our values are human values; yet we trust there is even in us something that has value for the eternal. Perhaps the actuality of the world is not only in these little sparks from the divine mind which flicker for a few years and are gone, but in the Mind, the Logos. 'The same was in the beginning with God ... And Without Him was not anything made that was made.'[177]

This is unusual in the writings of Eddington. As a liberal Quaker he does not often quote from the Bible in this way and while he often quotes the classics or literature he generally merely alludes to scripture. It would appear that the Logos concept in the introduction to John's gospel strikes a chord with Eddington's liberal Quaker theology.

3.5 The Gifted Gifford Lecturer

In January to March 1927 Arthur Eddington gave the Gifford Lectures at the University of Edinburgh. They were published in 1928 as *The Nature of the Physical World* by Cambridge University Press at a cost of twelve shillings and six pence. The book was a major publishing success. According to Whitworth:

> *The Nature of the Physical World* lifted popular-science publishing to new heights.[178]

This was an extremely well purchased, if not always fully read book, comparable in significance to Stephen Hawking's *A Brief History of Time.*

[176] Private conversation with Jane Brooke.
[177] Eddington, 'Domain', 217.
[178] Whitworth, 'The Clothbound Universe', 65.

The *Preface* is short and contains little that is significant except for two statements. The first is:

> ... the idealistic tinge in my conception of the physical world arose out of mathematical researches on the relativity theory. In so far as I had any earlier philosophical views they were of an entirely different complexion.'[179]

The second is the understatement 'I have much to fear from the expert philosophical critic ...'[180] This is significant because he was completely accurate in this prediction.

The *Introduction* contains one of the most quoted and most criticised passages in the writings of Eddington:

> I have settled down to the task of writing these lectures and have drawn up my chairs to my two tables! Yes; there are duplicates of every object about me – two tables, two chairs, two pens.[181]

One of them, says Eddington, has been familiar to him from his earliest years. Above all it is '*substantial'.* Eddington goes on to contrast this with the table portrayed by modern physics:

> Table No. 2 is my scientific table. It is a more recent acquaintance and I do not feel so familiar with it... My scientific table is mostly emptiness.[182]

Sparsely scattered in that emptiness are numerous electrical charges rushing about with great speed; but their combined bulk amounts to less than a billionth of the bulk of the table itself. There is nothing '*substantial'* about the second table. It is nearly all empty space, space pervaded, it is true by fields of force, but, asserts Eddington, these are assigned to the category of 'influences' not of 'things'.[183]

Eddington had a particular writing style. His use of humour was often ironic. Stebbing missed this point as will be seen, but Bowler grasped it:

> The famous comparison between the real chair we sit upon and the physicist's chair made of insubstantial wave functions was not one of his better jokes.[184]

[179] Eddington, *Nature of the Physical World,* viii.
[180] Eddington, *Nature of the Physical World,* viii.
[181] Eddington, *Nature of the Physical World,* xi.
[182] Eddington, *Nature of the Physical World,* xi *italics* as in the original.
[183] Eddington, *Nature of the Physical World,* xii- xiii.
[184] Bowler, *Reconciling Science and Religion,* 103.

Eddington used examples of tables, desks and floorboards in his various books.

In his popular books and his semi-popular books such as *Space Time and Gravitation* published in 1920, he makes frequent use of quotations not only from scientists but also from philosophers, poets, novelists and Shakespeare. At least one of these has been recycled by a modern populariser of physics and astronomy:

> I could be bounded in a nutshell and count myself a king of infinite space.[185]

The quotation is found in Eddington's 1933 *The Expanding Universe* at the head of chapter two and again in Stephen Hawking's 2001 book this time at the head of chapter three and is alluded to in the title of the book *The Universe in a Nutshell.*[186] While Stephen Hawking acknowledges Shakespeare he does not acknowledge Eddington.

Eddington also deploys irony, humour and a range of illustrations and metaphors in his desire to convey his message to a popular audience. On occasion, this use of literary devices is picked upon by philosophers who expect a more precise use of language and greater consistency. A D Ritchie, in the first Arthur Stanley Eddington Memorial Lecture delivered in November 1947, argues that this style often led to misunderstandings:

> Eddington himself is not entirely free of blame for the misunderstandings. The very brilliance of his exposition and the felicity of his illustrations sometimes carried him further then he originally intended. He had, too, a somewhat mischievous sense of humour which delighted in making quite modest statements look like paradoxes.[187]

Eddington uses the technique of developing an argument in such a way that a statement at the beginning which may appear to be his view is actually contradicted at the end when the argument has developed. Joad is caught out by this stylistic device as is John Habgood.[188] Bertrand Russell makes this mistake with Jeans as will be seen in chapter six.

Eddington talks of physics as a world of shadows, a phrase used by Jeans in *The Mysterious Universe*.[189] For both of them the frank realisation that physical science is concerned with a

[185] William Shakespeare, *Hamlet,* Act 2 Scene 2.
[186] Eddington, *The Expanding Universe,* 29. Stephen Hawking, *The Universe in a Nutshell* (London: Bantam Press, 2001).
[187] A D Ritchie, *Reflections on the Philosophy of Sir Arthur Eddington,* 1.
[188] Joad, *Philosophical Aspects of Modern Science,* 113 and 291, John Habgood, *Varieties of Unbelief,* 17.
[189] Jeans, *The Mysterious Universe,* ix, 127, etc.

world of shadows is one of the most significant of modern scientific advances. This is a stark contrast with the very realistic concept of the nature of matter in late Victorian physics.

In the concluding paragraph of the Introduction he says that he proposes to discuss some of the results of modern study of the physical world which give most food for philosophic thought.

The first ten chapters cover much of what was outlined in the first sections of this thesis, with Eddington's self-professed 'idealistic tinge'.[190] The account is written in Eddington's normal manner. It is well constructed, lucid, bears the mark of having been first delivered orally, as Eddington acknowledges, and it contains his normal touches of gentle irony and humour. They describe 'The Downfall of Classical Physics' and include relativity, the new concept of relativistic time, the postulated heat death of the universe, the new understanding of gravitation, humanity's place in an enlarged (but not yet expanding) universe and quantum physics.

The judgements he makes on the significance of developments are individual and not always the received view. He sees the Rutherford model of the atom as more significant than the work of Einstein and Minkowski. Nevertheless, it is not this section of the book which caused controversy. Most of the philosophers and theologians who comment on his work concentrate on the last six chapters: 'World Building', 'Pointer Readings', 'Reality', 'Causation', 'Science and Mysticism' and the 'Conclusion'. Sections of these chapters will be considered elsewhere but here the final chapter and the conclusion will be discussed in some detail.

The final chapter of the book, 'Science and Mysticism', was part of the original Gifford Lectures as given in Edinburgh in 1927. As with Jeans' final chapter 'Into the Deep Waters' in *The Mysterious Universe,* and many semi-popular and popular science books since, it is the last chapter which generated the most criticism. 'Mysticism' for Eddington is not concerned with extreme experiences. It is the everyday common place experience of those who are religious. He is distrustful of the extravagances of some who use that term. He believes that a theologian might well show that 'the ecstatic mysticism of the anchorite is the vagary of a fevered body and not a transcendent revelation.'[191] He also uses the phrase 'more mystical' to describe the world portrayed by modern physics, as shall be seen.[192]

[190] Eddington, *Nature of the Physical World,* xvii.
[191] Eddington, *Nature of the Physical World,* 336.
[192] Eddington, *Nature of the Physical World,* 344.

Eddington starts the chapter with a statement of one of the commonly asserted notions of the modern science and religion debate, namely that scientific and, for example, poetic ways of understanding the world are complementary not contradictory views. The topic under discussion which illustrates this belief is the generation of waves by wind. He quotes from both Horace Lamb's *Hydrodynamics*, then the standard text on the subject (Lamb was one of his tutors at Owen's College) and from the Rupert Brooke sonnet:

> There are waters blown by changing winds to laughter
> And lit by the rich skies, all day. And after,
> Frost, with a gesture, stays the waves that dance
> And wandering loveliness. He leaves a white
> Unbroken glory, a gathering radiance,
> A width, a shining peace, under the night.[193]

Eddington defends the complementarity doctrine, although he does not use the term, by saying:

> Life would be stunted and narrow if we could feel no significance in the world around us beyond that which can be weighed and measured with the tools of the physicist or described by metrical symbols of the mathematician. [194]

Solid substance is no longer an idea in vogue in the world of the Rutherford atom and quantum theory. A table is not solid, neither is an atom, neither is a proton or an electron. The mind is a weaver of illusions, but perhaps in the mystical illusions of humanity there is an underlying reality. The mystical contact with nature gives an idea of the true relation of the world to ourselves – a relation not hinted at in a purely scientific analysis of its content. Eddington says he assumes that there is some kind of truth at the base of the illusion.

Eddington here develops an idea distinct from the standard complementarity doctrine. Poetry and nature mysticism are as valid as scientific discourse. The mystical 'illusion' does point to an underlying reality, but it is not distinct from the mystic:

> If I were to try to put into words the essential truth revealed in the mystic experience, it would be that our minds are not apart from the world; and the feelings that we have of gladness and melancholy and our yet deeper feelings are

[193] Rupert Brooke, The War Sonnets, IV The Dead.
[194] Eddington, *Nature of the Physical World,* 317.

> not of ourselves alone, but are glimpses of a reality transcending the narrow limits of our particular consciousness.[195]

He goes on to say that by introspection we may drag out the truth for external survey; but in the mystical feeling the truth is apprehended from within and is, as it should be, a part of ourselves. Eddington's emphasis on the essential unity of the knower's mind with the rest of the universe has a clear idealistic tinge. Eddington, in a key section, then makes a parallel between analysing humour and analysing the mystical experience. There is no point in dissecting a joke to get at its meaning: if you do attempt this process, you certainly will not laugh at the end. The real apprehension must come spontaneously, not introspectively. 'I think this is a not unfair analogy for our mystical feeling for Nature, and I would venture to apply it to our mystical experience of God.' [196]

He argues that for some people the divine presence is one of the most obvious things of experience. To this first person, another person without this experience must seem to be as a person without a sense of humour to someone who enjoys a joke. Eddington says that we may try to analyse religious experience as we may try to analyse humour, and construct a theology, but we should not forget that the theology is symbolic knowledge whereas the experience is intimate knowledge. Just as laughter cannot be compelled by the scientific exposition of the structure of a joke, so a philosophical discussion of the attributes of God is likely to miss the intimate response of the spirit which is the central point of the religious experience.

Here we see stated a key Eddington idea, drawn from his Quaker beliefs, the priority of religious experience over theology. It is prior both in chronology and importance. Eddington writes:

> In the mystic sense of the creation around us, in the expression of art, in a yearning towards God, the soul grows upward and finds the fulfilment of something implanted in its nature. The sanction for this development is within us, a striving born with our consciousness or an Inner Light proceeding from a power greater than ours.[197]

Science, he says, can scarcely question this sanction, for the pursuit of science springs from a striving which the mind is impelled to follow, a questioning that will not be suppressed.

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[195] Eddington, *Nature of the Physical World,* 321.
[196] Eddington, *Nature of the Physical World,* 322.
[197] Eddington, *Nature of the Physical World,* 327.

Whether in the intellectual pursuits of science or in the mystical pursuits of science, the light, he argues, beckons us ahead and the purpose surging in our nature responds.

Eddington returns to the waves 'waters blown by changing winds to laughter' and states that the waves do not intend to convey a mood of happiness, but they also had no intention of conveying colour, the impression of substance or of a geometrical form to the waves - the physical no less than the mystical significance of the scene is not there 'it is *here* – in the mind.'[198]

This is one of the strongest arguments that he mounts in defence of his Idealist or semi-Idealist understanding of physics - values, significance and scientific descriptions are placed into the physical world by human beings. He then moves on quickly to moral values and notes that we see the possibility of arbitrariness in this valuation and hanker after a higher standard that could be considered final and absolute. We could say there are no absolute values:

> Or there are absolute values; then we can only trust optimistically that our values are some pale reflection of those of the Absolute Valuer, or that we have insight into the mind of the Absolute from whence come those strivings and sanctions whose authority we usually forbear to question.[199]

Eddington then abruptly starts to draw some 'leading points' which need 'philosophic consideration' after admitting that he tried to make the outlook of the lectures as coherent as he could but he was not expecting finality.

> (1) The symbolic nature of the entities of physics is generally recognised; and the scheme of physics is now formulated in such a way as to make it almost self-evident that it is a partial aspect of something wider.
>
> (2) Strict causality is abandoned in the material world...
>
> (3) Recognising that the physical world is entirely abstract and without 'actuality' apart from its linkage to consciousness, we restore consciousness to the fundamental position...
>
> (4) The sanction for correlating a 'real' physical world to certain feelings of which we are conscious does not seem to differ in any essential respect from the sanction for correlating a spiritual domain to another side of our personality.[200]

[198] Eddington, *Nature of the Physical World,* 329 *italics* as in the original.
[199] Eddington, *Nature of the Physical World,* 331.
[200] Eddington, *Nature of the Physical World,* 331-332.

Eddington goes on to expound his form of intuitive, 'mystical religion' based not upon science or scientific methods but upon self-known experience. The starting-point of belief in mystical religion is a conviction of significance, the sanction of a striving in the consciousness. This strand in Eddington's thought will be considered in more detail later. Eddington argues that intuitive conviction of this kind has been the foundation of religion through all ages. This is clearly too simplistic and reflects a narrow study of religion.

It is important to note that Eddington is not saying in *The Nature of the Physical World* that the new physics shows that Christian belief is true: this is an intellectual sin of which Eddington is accused by Russell, but is not guilty, as shall be seen. The idea that physics is not competent to pass comment on religious experience is repeated by Eddington elsewhere:

> Physical science is by its own implication led to *recognise* a domain of experience beyond its frontiers, but not to *annex* it. All varieties of mysticism represent an escape from the closed world of physics into the open world beyond it and to which it points.[201]

Eddington argues for the primacy of spiritual experience over theology. Religious experience leads on to what would today be called the construction of a belief system. The prior experience for him is a valid form of data/knowing, and without the prior experience, religious belief cannot be truly held. Accordingly, the conviction which is postulated is that certain states of awareness in consciousness have at least equal significance with those which are called sensations and among these states of awareness: '... must be found the basis of experience from which a spiritual religion arises.'[202] Physics, says Eddington, cannot prove the truth of faith or much else:

> We cannot pretend to offer proofs. *Proof* is an idol before whom the pure mathematician tortures himself. In physics we are generally content to sacrifice before the lesser shrine of *Plausibility…* In science we sometimes have convictions as to the right solution of a problem which we cherish but cannot justify; we are influenced by some innate sense of the fitness of things.[203]

[201] Eddington in the preface to Alfred Allan Brockington, *Mysticism and Poetry on a Basis of Experience* (London: Chapman and Hall, 1934), ix, italics as in the original.
[202] Eddington, *Nature of the Physical World,* 334.
[203] Eddington, *Nature of the Physical World,* 337.

This section will be considered again later. Eddington points out that religious conviction is often described in somewhat analogous terms as a surrender; it is not to be enforced by argument on those who do not feel its claim in their own nature.

Eddington draws his argument together in a section headed *Mystical Religion.* His conclusion is clear and unambiguous but it is not as affirming of the Christian faith as some of those who quote from his work in support of Christianity might like:

> The idea of a universal Mind or Logos would be, I think, a fairly plausible inference from the present state of scientific theory; at least it is in harmony with it. But if so, all that our inquiry justifies us in asserting is a purely colourless pantheism.[204]

Science, he says, cannot tell whether the world-spirit is good or evil, and this argument for the existence of a God might equally be turned into an argument for the existence of a devil. Alongside this, Eddington's other comment that 'I repudiate the idea of proving the distinctive beliefs of religion either from the data of physical science or by the methods of physical science' should be kept in mind. Eddington follows the liberal Quaker idea that the source of authority for the believer is neither church nor creed nor scripture but the inner personal experience – the Inner Light or Inward Light. This is again classical Quakerism. It is very similar to Rex Ambler's summary of the teaching of George Fox.[205]

Eddington then turns to lay down a challenge which was taken up by Gordon Milburn in his *The Logic of Religious Thought: An Answer to Professor Eddington.*[206] Eddington asks if there is any system of inference from mystic experience comparable to the system by which science develops a knowledge of the outside world.

The final chapter concludes as the Introduction began with a description of woodwork. As with the start of 'The Domain of Physical Science' it concerns a scientist having difficulty entering a room because of his knowledge of the Rutherford model of the atom and modern planetary physics. This poses a problem for the physicist who may not be able to place his foot upon a no longer solid plank travelling at great speed around the sun.

> Verily, it is easier for a camel to pass through the eye of a needle than for a scientific man to pass through a door. And whether the door be barn door or

[204] Eddington, *Nature of the Physical World,* 338.
[205] Rex Ambler, *Light to Live By,* 7.
[206] R Gordon Milburn, *The Logic of Religious Thought: An Answer to Professor Eddington* (London: Williams & Norgate, 1929).

> church door it might be wiser that he should consent to be an ordinary man and walk in rather than wait till all the difficulties involved in a really scientific ingress are resolved.[207]

Eddington begins the 'Conclusion' by putting forward the hypothetical views of a well-meaning, 'matter of fact' scientist who does not believe in Eddington's portrait of modern science. Eddington confesses his own personal 'homesickness' for the 'handrails' of former scientific certainty:

> The physicist now regards his own external world in a way which I can only describe as more mystical, though not less exact and practical, than that which prevailed some years ago.[208]

The use of the word 'mystical' was again problematical. Eddington then goes into a discussion about the nature of the brain and its functioning and of the operation of the physical universe.

Eddington starts to wind up his argument and asserts that a besetting temptation of the scientific apologists for religion is to take some of its current expressions and after clearing away crudities of thought is to water down the meaning until little is left that could possibly be in opposition to science or to anything else. For him, from the side of physics, all that can be asserted of the spiritual world would be insufficient to justify the palest brand of theology.

Eddington says that the spiritual world as understood in any religion is by no means a colourless domain. He was unwilling to play the amateur theologian and examine this approach in detail. He argued that the attribution of religious colour to the domain must rest on inner conviction. This again reflects his Quaker roots. He goes on to argue that this inner conviction in religion is parallel to the unreasoning trust in reason which is the basis of mathematics, an innate sense of 'the fitness of things'[209] (his second use of this phrase, on which he does not elaborate, neither does Charles Coulson when he quotes it with approval[210]) that is at the base of physics as the irresistible sense of incongruity which is at the basis of the justification of a sense of humour.

Eddington then considers the view that science and religion belong to different realms of thought. Eddington states that they do have their own domains but there are frontier issues,

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[207] Eddington, *Nature of the Physical World,* 342.
[208] Eddington, *Nature of the Physical World,* 344.
[209] Eddington, *Nature of the Physical World,* 350.
[210] Charles Coulson, *Science and Christian Belief* (London: Oxford University Press, 1955), 115.

they are not, in Stephen Jay Gould's phrase, 'non-overlapping magisteria'.[211] He finishes by acknowledging that science will continue to change and things will look very different thirty years forwards just as they did thirty years previously. This too has implications for the relationship between science and faith:

> The religious reader may well be content that I have not offered him a God revealed by quantum theory, and therefore liable to be swept away by the next scientific revolution.[212]

One of the strengths of Eddington, as with Jeans, is that he does not overstate his case. Many popular apologists present too simple and too certain a conclusion for the general reader. Whether they do this out of genuine conviction or to simplify matters or to appeal to their own theological constituency is an interesting question. Eddington and Jeans are modest and cautious apologists.

3.6 A Quaker amongst Quakers

Science and the Unseen World was published in 1929 and this slim volume is the record of the Swarthmore Lecture of that year given on the evening before the Friend's Yearly Meeting at Friends House, Euston, London. This lecture series was started in 1908 following a resolution which the previous year had called for 'an annual lecture on some subject relating to the message and work of the Society of Friends.'[213] The preface states 'The name "Swarthmore" was chosen in memory of the home of Margaret Fox', wife of George Fox, and one of the Valiant Sixty early Quaker preachers and missionaries.[214]

A person not acquainted with Quaker theology (or lack of it) may at first consider much of the volume to be slight. But it is deeply imbedded in the Quaker tradition and the significance of

[211] Stephen Jay Gould, *Rock of Ages: Science and Religion in the Fullness of Life* (New York: Ballantine, 1999) see also Richard Dawkins, *The God Delusion* (London: Bantam, 2006), 77-85.
[212] Eddington, *Nature of the Physical World,* 353.
[213] Arthur Stanley Eddington, *Science and the Unseen World,* 5.
[214] Eddington, *Science and the Unseen World,* 5. Abbott et al, *The A to Z of the Friends,* 277 and Prof Jocelyn Bell-Burnell (private correspondence) prefer the spelling 'Swarthmoor' while *Science and the Unseen World* bears the spelling 'Swarthmore'.

the volume can only be seen in the light of a knowledge of this viewpoint. All of this volume is relevant to the current study. Arthur Ritchie makes the following point:

> Eddington, in this lecture, was speaking as a member of the Society of Friends to Friends and there was no risk of their misunderstanding him; but to a secular-minded audience his incautious use of the word 'mystical' for this last point might easily cause misunderstanding; for many the word 'mystical' suggests only 'mystification' and that means hocus-pocus.[215]

The book begins with a description of 'the beginning of the world' which is a mixture of contemporary science and allusion to the text of Genesis.[216] The view of Eddington on the Creation will be discussed in chapter six.

Eddington at the start of the second section asserts that science has 'blundered' in the past and will blunder again. Uncertainty, he says, is part of science as of religion:

> We seek the truth; but if some voice told us that a few years more would see the end of our journey, that the clouds of uncertainty would be dispersed, and that we should perceive the whole truth about the physical universe, the tidings would be by no means joyful. In science as in religion the truth shines ahead as a beacon showing us the path; we do not attain it; it is better far that we be permitted to seek.[217]

After having told his audience the creation story of modern science complete with biblical allusions, he then says that it is not irreligion but rather tidiness of mind that rebels against the idea of permeating scientific research with religious implication. He recalls that astronomers dislike being told that 'The heavens declare the glory of God.'[218] Eddington reminds his listeners of the story of Elijah in the wilderness[219]and the fact that the Lord was not in the great forces of nature 'Wind, earthquake, fire – meteorology, seismology, physics' but in the inner voice which said 'What doest thou here?'[220] This again is classical Quakerism. While the implicit rejection of the heavens declaring the glory of God would have appealed to Eddington's contemporary Karl Barth, the idea of the inner voice would have not.

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[215] A D Ritchie, *Reflections on the Philosophy of Sir Arthur Eddington,* 31.
[216] Eddington, *Unseen World,* 9.
[217] Eddington, *Unseen World,* 16.
[218] Ps. 19.1 KJV.
[219] 1 Kg. 19.
[220] Eddington, *Unseen World,* 18.

In Section III Eddington turns to the issue of human consciousness. He says that the crudely materialist view that the dance of atoms in the brain constitutes human thought is clearly out of step with modern physics. If you now ask a physicist what he has finally made out the aether (the spelling used in *Science and the Unseen World*) or the electron to be, the answer will not be a description in terms of billiard balls or fly-wheels; he will point instead to a number of symbols and a set of mathematical equations which they satisfy.

Here Jeans and Eddington are in partial agreement. The old mechanical model of physics and astronomy has passed away. Mathematics can give a very good description of reality (Jeans would say the best) but it has no direct, concrete, 'picture-able' equivalent for the non-mathematician which he or she can grasp. This decline of the old mechanical model has 'spiritual' implications:

> Perhaps the most essential change is that we are no longer tempted to condemn the spiritual aspects of our nature as illusory because of their lack of concreteness. We have travelled far from the standpoint which identifies the real with the concrete.[221]

Eddington's approach to Idealism in this book and in *The Nature of the Physical World* can be summed up in this sentence from *Science and the Unseen World:*

> Mind is the first and most direct thing in our experience; all else is remote inference.[222]

Eddington then turns to the issue of the supposed conflict between the scientific and religious outlooks. He develops a line of argument on religious experience which his Quaker audience would have appreciated. If religion is not an attitude towards experience, it is just a creed postulating an ineffable being who has no contact with humanity. Eddington argues that the scientists follow as great a light as the mystic because he or she seeks the truth. Eddington's language next becomes somewhat florid. He returns to more moderate language and to a key point in his theology:

> The desire for truth so prominent in the quest of science, a reaching out of the spirit from its isolation to something beyond, a response to beauty in nature and art, an Inner Light of conviction and guidance – are these as much a part of our

[221] Eddington, *Unseen World,* 20-21.
[222] Eddington, *Unseen World,* 24.

> being as our sensitivity to sense perceptions?... Study of the scientific world cannot prescribe the orientation of something which is excluded from the scientific world.[223]

As was noted by Arthur Ritchie and as has been seen in the examination of *The Nature of the Physical World,* Eddington used the word 'mystical' in a particular way. For him 'mystical' denoted what others would call the spiritual. He was dismissive of the hermit who starved him or herself into a 'mystical' experience. Mysticism was the experience of the person who listened to the Inner Light. It is in this context that he says that some would put the question 'Is the unseen world revealed by the mystical outlook a reality?' He says it is better to pose the question 'Are we, in pursuing the mystical outlook, facing the hard facts of experience?' Eddington concludes 'Surely we are.'[224]

Speaking directly to fellow Quakers he argues that the experience which comes to Quakers in silent worship meetings is one of the precious elements that make up the fullness of life, something which science cannot gainsay for this experience does not belong to the competence of a measuring-machine. While there may be some appeal in the simplicity and harmony of scientific laws it can apply neither to the world behind the symbols, nor to a sonnet, nor to the unseen world.

He then goes on to again quote Professor Weyl, as he did in *the Nature of the Physical World,* on the nature of the four-dimensional world envisaged in relativity theory and on being and becoming. Again the question can be asked, are Eddington and Weyl saying that those parts of the physical world which are perceived by a consciousness have actual being while the rest have the potential to become so? Here again there is support for that view, but it is not entirely clear what is meant. In this and a number of other passages *Science and the Unseen World* seems not as well written as *The Nature of the Physical World.*

Eddington asserts that it is best to put aside the question of whether God exists or not. He does this by analogy with the existence of the aether which, in 1929, he claims that half of his colleagues believe in it and half do not. Eddington later makes it clear that he does believe in a personal deity and this encouragement to set aside this key question of God's existence is best seen as part of his Quaker distrust of formal theology and belief in the supremacy of religious or mystical experience. Eddington suggests that most people have given no serious thought to

[223] Eddington, *Unseen World,* 27.
[224] Eddington, *Unseen World,* 28.

what it means to say that something exists. Those who have, such as his Trinity colleague John McTaggart, shed little light on the topic. We take the existence of our human friends for granted.

Eddington then explains that even the familiar apologetic device of invoking the existence of a deity to explain the existence of the material universe is not good enough as pantheism would do this. In *The Nature of the Physical World* he speaks well of the apprehension of the divine in nature or Nature but here he argues that religion does not depend on the substitution of the word 'God' for the word 'Nature.' It is interesting to speculate what Arthur Eddington would have made of the panentheism of Arthur Peacocke. Eddington was clearly not a pantheist. Would panentheism have appealed to him? Part of Peacock's motivation in his expression of panentheism in *Pathways from Science to God* appears to be the problem of suffering.[225] If Creation is costly to God as, Peacocke argues, if the natural world, with all its suffering, is panentheistically conceived of as 'in God', it follows that the evils of pain, suffering, death in the world are internal to God's own self. This may appeal to those who hold loosely onto the ideas of the Incarnation and Trinity, but adds nothing for those who hold a traditional view of the Incarnation where God in Christ suffers. Eddington only gives us a brief, rare and incomplete glimpses of what he thinks of Christ:

> The crucial point for us is not a conviction of the existence of a supreme God but a conviction of the revelation of a supreme God. I will not speak here of the revelation of a life that was lived nineteen hundred years ago, for that perhaps is more closely connected with the historical feeling which, equally with the scientific feeling, claims a place in most men's outlook. I confine myself to the revelation implied in the indwelling of the divine spirit in the mind of men.[226]

As a liberal Quaker, panentheism might have appealed to Eddington, but his writings point to his acceptance of the conventional idea of God as creating a universe apart from Godself. Eddington in his concept of the Incarnation certainly rested heavily on the Logos theology of John but it was fairly conventional by more recent standards. He would probably not have embraced panentheism.

[225] Arthur Peacocke, *Paths from Science towards God: The End of All Our Exploring* (Oxford: Oneworld, 2006).
[226] Eddington, *Unseen World,* 44-45.

Rampelt wisely comments that Eddington's infrequent use of religious language, compared with evangelical authors of this time for example, does not mean that there was a lack of religious fervour.[227]

Two points are worth commenting on from Eddington's quotation above. Eddington the liberal Quaker does not talk about the revelation in or of scripture but of the revelation of the life of Christ and of the indwelling divine spirit. Eddington's strand of Quakerism was a reaction to a growing evangelical movement within the Society of Friends and his omission of mention of scripture as revelation is significant. Secondly, Eddington the liberal Quaker and Idealist, talks of 'the indwelling of the divine spirit in the mind of men.' The lack of capitalisation of 'spirit' may or may not be significant – there are punctuation mistakes and McTaggart's name is misspelt in this book. Clearly George Allen and Unwin did not use their best proof-reader on this book.

Eddington then restates in summary two themes familiar to readers of *The Nature of the Physical World:* the inability of science to be the basis of religious belief, and a distrust of attempts at systematising our knowledge of the unseen world in dogmatic theology. The mystical apprehension of ultimate reality, and by this Eddington means an awareness of the Inner or Inward Light, should be sufficient for any believer who has had this experience. In this the 'mystic' is like the observer in astronomy who accepts the importance of what can be seen with the eyes. He or she recognises another faculty of consciousness, and accepts as significant the vistas of a world outside space and time that it reveals.

While Eddington is in sympathy with the criticism of systematic theologians and philosophers as too imprecise, he does not wish to press it too far as there are gradations of perceived coherence within the sciences and mathematics and pure mathematicians look down on what physicists consider as proof.

In the ninth and final section of the book Eddington looks directly at the history of the Society of Friends and the contribution of the group of people known as Seekers. These were men and women who left Anglican churches, especially the Puritan congregations. They believed that the spirit of the Antichrist ruled the churches and that God would appoint new apostles and prophets to lead the true believers. Many of them eventually entered the Society of Friends. Their influence upon Quakerism and the thought of Eddington will be explored later. As well as appealing to the Quaker temperament, the name also appeals to the scientific

[227] Jason M Rampelt, 'Arthur Stanley Eddington', 137.

temperament. Seeking is important as the findings of science are transitory and superseded by the findings of subsequent generations. He argues that one will understand the spirit neither of science nor of religion unless seeking is placed in the forefront.

Distrusting the settled once for all nature of the creeds, Eddington concludes that 'we' (presumably here he means Quakers) are repelled by that confident theological doctrine which has settled for all generations just how the spiritual world is worked.

> Religion for the conscientious seeker is not all a matter of doubt and self-questionings. There is a kind of sureness which is very different from cocksureness.[228]

Science and the Unseen World is the longest writing we have from Eddington that was aimed at a purely Quaker audience. The themes are familiar – the 'spiritual' or 'mystical' nature of modern scientific knowledge, the importance of seeking, the distrust of creeds and the priority of religious experience over formalised theology. The influence of the Society of Friends on his work is clear throughout his writing but here we see the most explicit references to Quaker history and thought, although some knowledge of Quaker approaches to Christianity is necessary to appreciate the nuances of Eddington's ideas. While Eddington was not a theologian, he was a regular attendee at Quaker worship and business meetings, a server on Quaker committees and reader of Quaker theology, both of classical Quakerism and the newly emerging liberal strand of Anglo-American Quakerism. This theological rooting, along with his intelligence, gave a real depth to his thought, especially as he talked of the theology of the natural world.

The influences upon Jeans and his work will now be examined. While Jeans was older than Eddington by five years, *The Mysterious Universe* was the last, and most successful in publishing terms, of the three key texts under discussion.

[228] Eddington, *Unseen World,* 55-56.

CHAPTER FOUR

THE MYSTERIOUS UNIVERSE OF JAMES JEANS

4.1 The Making of a Populariser

James Hopwood Jeans was born at Ormskirk, near Southport in Lancaster on 11 September 1877. He was the son of the parliamentary journalist William Tulloch Jeans of Elgin, Scotland. His mother was from Stockport. Edward Milne does not name her either in his biography or his Royal Society Obituary Notice, beyond saying that from her James Jeans obtained his middle name – Hopwood.[229] Census records show her to be Martha Ann Hopwood. His maternal grandfather from Stockport was called James Hopwood, so possibly it was not only his middle name that came from his mother's line, although James is a popular enough name in Scotland. The census records describe Martha as a shop assistant in 1861 and as a hosier in 1871. Her father is stated to be a provision dealer in 1861 and a patternmaker and grocer in 1871. No trade or profession is detailed for Martha's mother. William Jeans married Martha Hopwood in 1876. Clearly Jeans mother's family were not as well off as his father's, where, along with a long line of journalists, there were also newspaper owners. William Jeans was not, however, according to James Jeans at least, a financial success.[230] Jeans was no stranger by family background to making complex issues, such as politics and economics, understandable by the masses.

Milne tells us little of Jeans' denominational allegiance or theological position, saying only that Jeans' mother belonged to an evangelical family and that her great-great-great-grandfather had been an Independent minister in Cromwell's time at Marple in Cheshire.[231] He also writes that the Jeans' own home atmosphere was 'strictly Victorian, especially in relation to religious observance.'[232] Beyond that Milne says very little on Jeans' religious views or if he attended church except in his discussion of *The Mysterious Universe* where he states that he believed Jeans to be sincere in his view that a designing, mathematical Creator existed.[233]

[229] E A Milne, *Sir James Jeans: A Biography* (Cambridge: Cambridge University Press, 1952), 1.
[230] Alfred M Bingham, *The Tiffany Fortune* (Massachusetts: Abeel & Leet, 1996), 139.
[231] Milne, *Jeans,* 1.
[232] Milne, *Jeans,* 1.
[233] Milne, *Jeans,* 159.

What can be found from other sources? He attended an Anglican public school. He knew his Bible and the Thirty Nine Articles but that was not too unusual for a public school- and Cambridge-educated man.[234] He is buried in an Anglican churchyard in Surrey. Compared with Eddington there is a paucity of resources on his own theological position. He was critical of the church of the 'dark ages'[235] but also acknowledged the role some 'ecclesiastics'[236] such as Copernicus and Bruno played in the move away from an Aristotelian view.

Born in Lancashire, Jeans grew up in Brighton and London. He entered Merchant Taylors' School (then in the City of London before its move to its current home in Northwood, outer London), as a day boy in September 1890. He excelled at mathematics which was then a real strength of the school. He was a shy boy with little skill at games and was described by one of his teachers as a boy who never got up to mischief. He had a real skill at helping his friends with their mathematics homework, sometimes in return for help with his German homework. A number of his friends expressed surprise at his later fame as a popular expositor of science, as at school he could generally never see that anything needed explaining.[237]

Jeans went up to Trinity College, Cambridge in October 1896 at the age of nineteen to read Mathematics. His tutor was A W Verrall and his director of studies G T Walker. Other members of the college mathematics staff included James Glaisher, W W Rouse Ball, A N Whitehead, Robert Herman and Edmund Whittaker. Jeans and his contemporary G H Hardy were advised by Walker to take Part I after only one year rather than the customary two, which would give them longer on the more interesting and still developing mathematics studied in Part II.[238] This was a completely new development and viewed by some as slightly risky but Jeans was listed joint Second Wrangler and Hardy as Fourth. His work for Part II was interrupted by serious illness which placed him in a sanatorium; he took these papers in 1900 and was placed in the lower division of the first class. After this he was elected to an Isaac Newton studentship in optics and astronomy and won the Smith's Prize jointly with Hardy. Crowther says that he studied 'practical physics' in the Cavendish Laboratory in 1899-1900, a very interesting period

[234] On the Thirty-Nine Articles see, for example, James Jeans, *Physics and Philosophy,* 22, 209. On the Bible see, for example, *The Stars in Their Courses* (Cambridge: Cambridge University Press, 1947), 71, 82, 132.
[235] James Jeans, *The Growth of Physical Science* (Cambridge: Cambridge University Press, 1947), 72, 108.
[236] James Jeans, *The Astronomical Horizon* (Oxford: Oxford University Press, 1946).
[237] Milne, *Jeans,* 2-3.
[238] Milne, *Jeans*,4-5.

in physics and the life of the Cavendish following J J Thomson's work on the electron.[239] He was awarded the degree of MA in 1903. He held the position of University Lecturer in Mathematics for only one year from 1904 as he was appointed Professor of Applied Mathematics at Princeton, New Jersey in 1905. While there he finished and published his textbook on dynamics, *Theoretical Mechanics.* Jeans, in the short time he was in Princeton, helped establish the tradition of mathematical physics there by bring the two relevant departments together.[240]

It is interesting to speculate whether during his time Princeton he had any contact with the Theological Seminary there. The University and the Seminary are about a quarter of a mile apart.[241] The Seminary was a dominant force in American Presbyterianism and its influence was felt beyond that denomination into other strands of American Protestantism. The first professor appointed at Princeton Seminary, Archibald Alexander, wrote *Evidences of the Authenticity, Inspiration and Canonical Authority of the Holy Scriptures;* apologetics was a key element in the work of the institution until 1929 when the board of the Seminary was reorganised to the disadvantage of the conservatives.[242] As was seen in Chapter Two, B B Warfield, a traditional Calvinist who supported an intellectual approach to faith, was a friend of science and an advocate of a modified view of Darwinian evolution. He was a major force at Princeton in the first two decades of the last century. Did a contact with this theological institution with its tradition of apologetics and engaging with modern science inspire his later desire to defend the faith? It is difficult to find any direct evidence of a link but it is an interesting possibility.

Jeans returned to England in 1910 when he became Stokes Lecture in Mathematics at Cambridge. He held this position for only two years as he resigned from full-time, paid academic work but he did continue as an independent researcher.[243] He published forty-two scientific papers from the start of 1915 until 1928.

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[239] J G Crowther, *British Scientists of the Twentieth Century* (London: Routledge & Kegan Paul, 1952), 98.

[240] Princeton University Archives, Seeley G. Mudd Manuscript Library, 'The Princeton Mathematics Community in the 1930s' Transcript 29 (PMC29). https://www.princeton.edu/mudd/finding_aids/mathoral/pm02.htm

[241] I am grateful to Professor Russell Stannard for this detail.

[242] Archibald Alexander, *Evidences of the Authenticity, Inspiration and Canonical Authority of The Holy Scriptures* (Philadelphia: Presbyterian Board of Publication, 1836).

[243] This is the timescale given by Crowther, *British Scientists,* 104 and Milne, *James Jeans*, 17, both writing in 1952. Williamson writing Jeans' obituary in *The Journal of the Royal Astronomical Society of Canada* XLI (February 1947) 41, suggests he stayed in Cambridge until 1929, possibly because he continued to publish serious monographs. The former timescale is to be preferred.

Jeans was the first Professor of Astronomy at the Royal Institution from 1935 until ill health forced him to retire in 1946. This was largely an honorary position. The Royal Institution of Great Britain was founded in 1799. While ten chemical elements were discovered there its stated aim is 'diffusing science for the common purposes of life' and has a long tradition of popularisation.[244] He never returned to university work after 1912, partly as he did not need to earn a salary. In 1907 he married Charlotte Tiffany Mitchell, who was part of the wealthy Tiffany family of New York jewellers.[245] In 1934 Lady Charlotte Jeans died and in 1935 at the age of 58 he married the concert organist Suzanne Hock of Vienna. She was 24 at the time.[246] Like his first wife, she came from a wealthy family. His popular books sold well and this, along with two 'good' marriages and his own family money, gave him a secure financial position. Jeans filled his time with scientific committee work for the Royal Society, the Royal Astronomical Society and the Royal Institution and with the writing of a number of successful popular books. In 1923 he was made a Research Associate at the Mount Wilson Observatory near Pasadena in California, home of the 100 inch Hooker reflector telescope, for a time at the forefront of astronomical technology as it was the largest reflector in the world.

4.2 From Text Books to Best-Sellers

Before Jeans became a writer of popular and semi-popular books, he was a well-regarded writer of academic textbooks. Jeans published his first technical book in 1904 – *The Dynamical Theory of Gases*.[247] Crowther says that this book and his *The Mathematical Theory of Electricity and Magnetism* of 1908 were the standard textbooks of a generation of British students of mathematical physics.[248] Another five academic books appeared before *Astronomy and Cosmogony* in 1928. None of these first six books contains anything overtly theological. The key book for the purposes of this study is *The Mysterious Universe* which was published in 1930. Before this, Jeans had already moved away from writing academic texts to become a scientific populariser. Milne (for once accurate) compares Jeans to Edgar Wallace, the prolific detective novelist and creator of *King Kong*:

[244] Milne, *Jeans,* 78.
[245] Milne, *Jeans,* 17.
[246] Milne, *Jeans,* 78.
[247] James Jeans, *The Dynamical Theory of Gases* (Cambridge: Cambridge University Press, 1904).
[248] Crowther, *British Scientists,* 94.

> It was no idle compliment to Jeans that made people say he was the Edgar Wallace of astronomy, or to change "Have you read the mid-day Wallace, Sir?" into "Have you read the mid-day Jeans?" Jeans' writings added greatly to the interest of the ordinary man in astronomy, and increased the repute of astronomy the world over.[249]

Milne in his Royal Society obituary gives a false impression of sudden transformation in his writing:

> Jeans' last paper in the *Monthly Notices,* on "liquid stars", was published in 1928, and *Astronomy and Cosmogony* was also published in 1928. *The Universe Around Us* appeared in 1929. Thus suddenly did Jeans turn from original researcher to popular exposition.[250]

Milne is forgetting that in 1926 Jeans had already ventured into popular books with his semi-popular *Atomicity and Quanta,* which grew out of his Rouse Ball Lecture of the previous year. Crowther makes the same mistake, possibly drawing on Milne's obituary; the wording is similar.[251]

What turned the very bright school boy, who could seldom see any of the difficulties in maths or physics which his friends at school found, into the popular expositor, famed for his comprehensibility? It was not that he needed the money, a common reason for scientists to write a popular book which reads easily and sells well. Jeans, unlike Eddington, was a good extemporary lecturer. Eddington could deliver a brilliant lecture, but it had to be written before being read. Jeans had a natural fluency and could be amusing without rehearsal. Perhaps his short six years as a lecturer taught him the art of communication, even though his audiences were drawn from the bright young scholars at Cambridge and Princeton. Could it be said of Jeans as it was of the Cleric in *The Canterbury Tales, '*And he would gladly learn, and gladly teach'?[252] Was he simply someone who enjoyed explaining what he had learnt to as wide an audience as possible? In short, was it merely his personality type? Or was it the journalistic ability inherited from his predecessors?

Arthur Miller has another explanation. Miller's book on the tussle between Eddington and Chandrasekhar over black holes is semi-popular, well referenced in part, but with a high

[249] E A Milne, *Obituary Notices of Fellows of the Royal Society* 5, (Feb 1945), 585.
[250] E A Milne, *Obituary Notices of Fellows of the Royal Society* 5, (Feb 1945), 585.
[251] Crowther, *British Scientists,* 95.
[252] Geoffrey Chaucer, *The Canterbury Tales,* trans. Neville Coghill (Harmondsworth: Penguin, 1951), 27.

speculation quotient. He agrees that Jeans was a 'star lecturer at Trinity College' and tells that he was sought out by the president of Princeton, Woodrow Wilson, for a chair at a very good salary compared with that paid at Cambridge. He returned to Cambridge in 1910 when the holder of the Plumian Professorship of Astronomy, Sir George Darwin, was on his deathbed, believing that he was next in line. As a result of what Miller describes as Machiavellian internal politics, the chair went to Eddington instead, then merely a junior fellow – 'Disgusted with academia, Jeans resigned.'[253] This does not accord with the chronology given in Crowther where Jeans resigned in 1912 and Darwin did not die until 1913.[254] Crowther says Jeans was disappointed but feels Eddington's appointment was the right one. Jeans then retreated to his large house near Dorking, Cleveland Lodge where, according to Miller, he speculated about the universe and took to popular book writing. This section of Miller's book is unreferenced. Crowther's account explains the later tussles between Eddington and Jeans. Miller's suggestion that he turned to popular writing following a disappointment in preferment is plausible. This later hypothesis is not at odds with the idea that he naturally enjoyed teaching. A third possible reason will be suggested below. This third reason is, again, not incompatible with the previous two suggestions.

Jeans was an influential scientific communicator at home with books, newspapers and the radio. He was a very well-known figure in his day. A celebrity scientist before the term was invented; he was famous for his general popular writing prior to turning his hand to amateur theology and philosophy. After the publication of *The Universe Around Us* and *The Mysterious Universe* he was better known by the general reading public than Eddington, partly because these two books are easier to read than *The Nature of the Physical World.* Just as Eddington was mentioned in a Dorothy L Sayers crime story, Jeans too gets a mention in popular literature. The heroine in *Cold Comfort Farm* first published in 1932 is described thus when she makes a significant step forward:

> She felt like stout Cortez or Sir James Jeans on spotting yet another white dwarf.[255]

Astronomy and Cosmogony was his penultimate academic book before a gap of twelve years leading up to his final academic work *Introduction to the Kinetic Theory of Gases* in 1940.[256]

[253] Miller, *Empire,* 99.
[254] Crowther, *British Scientists,* 104.
[255] Stella Gibbons, *Cold Comfort Farm* (London: Penguin Classics, 2006), 120.
[256] James Jeans, *Introduction to the Kinetic Theory of Gases* (Cambridge: Cambridge University Press, 1940).

According to the bibliography in Milne's biography, Jeans' last academic paper was published in 1928 in *The Monthly Notices of the Royal Astronomical Society*.[257] *Astronomy and Cosmogony* does show an interest in matters theological and philosophical and for this reason it is significant for the current study. In 1928 at the time of publication, Jeans was Secretary of the Royal Society and Research Associate at Mount Wilson Observatory. *Astronomy and Cosmology* is a large format tome of 428 pages. The preface states Jeans' intention in writing the book. He says that he tries to explain and discuss all reasonable hypotheses then current. He hopes he has been fair and courteous to those whose views he cannot accept:

> My own personal contributions to the subject represent the outcome of twenty-five years of fairly continuous thought and work, and a considerable number of my results are published for the first time in this book.[258]

Jeans makes plain that this is not a neutral, introductory textbook but a personal summation of his view of the current state of astronomy, 'cosmic physics' and cosmogony.

One of Jeans' most successful academic books was *Problems of Cosmogony and Stellar Dynamics* published in 1919 to wide critical acclaim.[259] For Crowther it is undoubtedly his best book.[260] This book was the published form of his Adams Prize Essay of 1917. This book is not key to the present study, but it does play a role as a forerunner of *Astronomy and Cosmogony* and possibly in the development of Jeans as a popular writer. There was a big contrast in the reception of the two books. Milne's evaluation of the quality and importance of *Problems of Cosmogony and Stellar Dynamics* is high:

> We see a gifted mathematician marshalling his forces, surveying the field, uncovering the mistakes of his predecessors, devising new methods to make new attacks on intractable problems, and then turning aside from mathematical severities to make a grand synthesis of theory and observation.[261]

Of *Astronomy and Cosmogony* Milne says it that it scarcely competes with his earlier work in clarity or permanence.[262] Later on in the book he is slightly more upbeat, saying that the book

[257] James Jeans, 'Liquid Stars, a correction', *The Monthly Notices of the Royal Astronomical Society* 88, (1928), 393-395. This was a paper offering a correction to two papers on the same topic published in the same journal in 1927.
[258] Jeans, *Astronomy and Cosmogony,* ix-x.
[259] James Jeans, *Problems of Cosmogony and Stellar Dynamics* (Cambridge: Cambridge University Press, 1919).
[260] Crowther, *British Scientists,* 121.
[261] Milne, *Jeans,* 21.
[262] Milne, *Jeans,* 56.

is exciting and interesting throughout, but it cannot be regarded as a masterpiece of the quality of the Adams Prize Essay.[263]

Joseph McCabe quotes an unfavourable review comment on the book, taken from *Nature*:

> The personal views of the author pervade the book to such an extent that, besides being a work of science it must be considered a work of art.[264]

Crowther too describes the book as 'less satisfactory' than *Problems of Cosmogony and Stellar Dynamics* and repeats McCabe's criticism that Jeans' own views are too prominent.[265] Were the unfavourable reviews of this textbook an additional spur to Jeans to give up writing academic books and papers in 1928? This was, obviously, well after he was turned down for the Plumian chair which Eddington took up in 1913, but perhaps the poor reception of *Astronomy and Cosmogony* did play a part in his cessation of serious writing. Was he aware that he was no longer at the height of his powers as a mathematician? This was the view of Milne.[266] Jeans was 51 in September 1928 and other astronomers such as Bernard Lovell[267] and mathematical physicists such as John Polkinghorne[268] have considered a change of career around this point of life. Milne is not always the best analyst of Jeans' life and work but here his thesis is believable.

Astronomy and Cosmogony is a mixture of well written, accessible text with mathematics at undergraduate level. Jeans had expressed a hope that it would be accessible to non-mathematicians, but some chapters, notably that on 'The Configuration of Rotating Compressible Masses', are highly mathematical. The scientist most commonly referred to is Eddington, followed by Edwin Hubble, Ejnar Hertzsprung and Henry Norris Russell.

Jeans, as in his popular books, is careful to state the tentative nature of the science and the possibility of revision. When he reaches his conclusion he states what is known and what is still to be ascertained:

> If all matter were completely annihilated, the estimated present mass-density of radiation of 1.5×10^{-31} would produce a mass-density of radiation of 1.35×10^{-10}

[263] Milne, *Jeans,* 129.
[264] Joseph McCabe, *The Riddle of the Universe Today* (London: Watts, 1934), 190 quoting *Nature* 4 August 1928.
[265] Crowther *British Scientists,* 121.
[266] Milne, *Jeans,* 79.
[267] Bernard Lovell, *Astronomer by Chance* (London: Macmillan, 1990), 326.
[268] John Polkinghorne, *From Physicist to Priest* (London: SPCK, 2007), 71.

> ergs per cubic centimetre and this is the density of radiation at a temperature of 11.5 degrees absolute. But we cannot say how far this radiation may be diluted through invading parts of space in which no matter exists... We can estimate the future life of the present matter of the universe from the rate at which it is transforming itself into radiation, but we can only fix a lower limit to its past life... We have been able to form an estimate of the time during which the stars have existed as stars, but we cannot say for how long their electrons and protons have existed...[269]

On the last page of the conclusion which is a summary of his understanding of the current state of cosmology, he then turns very briefly to questions from philosophy and theology, saying that the cosmogonist has finished his task when he has described to the best of his ability the sequence of changes which constitute the history of the material universe. The picture which he draws, however, opens questions of the widest interest, not only to the scientist but to all of humanity.

Jeans then lists eight 'ultimate' questions:

> What is the significance of the vast processes it portrays? What is the meaning, if any there be intelligible to us, of the vast accumulations of matter which appear, on our present interpretation of space and time, to have been created only in order that they may destroy themselves? What is the relation of life to that universe, of which, if we are right, it can occupy only so small a corner? What, if any, is our relation to the remote nebulae, for surely there must be some more direct contact than that light can travel between us in a hundred million years? Do their colossal incomprehending masses come nearer to representing the main ultimate reality of the universe, or do we? Are we merely part of the same picture as they, or is it possible that we are part of the artist? Are they perchance only a dream, while we are brain-cells in the mind of the dreamer? Or is our importance measured solely by the fractions of space and time we occupy – space infinitely less than a speck of dust in a vast city, and a time less than one tick of a clock which has endured for ages and will tick on for ages to come?[270]

[269] Jeans, *Astronomy and Cosmogony,* 421.
[270] Jeans, *Astronomy and Cosmogony,* 422.

In these questions we can already see traces of the Idealism which becomes more obvious in *The Mysterious Universe.* It is interesting that in a scientific text Jeans is content to ponder so openly such non-scientific questions in very loose language; but such is the nature of final chapters. Jeans then writes a paragraph which is interesting in the light of his subsequent writing:

> It is not for the cosmogonist to attempt to suggest answers to these wide questions, or even to the more limited questions directly raised by the sequence of events which is his own special study.[271]

The cosmogonist, he argues, will be especially reluctant to attempt either, knowing how dimly most of the sequence of events can be seen, and how much of it cannot be seen at all. He can only end with a question; others may attempt an answer.

Eos: or the Wider Aspects of Cosmology was published as part of a successful popular series *To-day and To-morrow* by Kegan Paul in London.[272] This book is significant as it is his first truly popular book. It marks a key point in the shift in Jeans' writing from the academic to the popular. *Atomicity and Quanta* published in 1926, which was the written version of his Rouse Ball Lecture at Cambridge of May 1925, is best described as semi-popular. *Eos* was an expansion of his Trueman Wood Lecture delivered at the Royal Society of Arts in March 1928 and more accessible than *Atomicity and Quanta*. The books in the *To-day and To-morrow* series were written by 'some of the most distinguished English thinkers, scientists, philosophers, doctors, critics, and artists' according to an advertisement by the publishers.[273] The books cover a wide range of subjects. The series sold well at the standard price of two shillings and six pence and *Eos* was into its sixth impression by February 1931. Eos was the Greek goddess of dawn who opened the gates of heaven for the sun to rise.

The book is a summary of the current state of astronomy with an emphasis on humanity's place in the universe, humanity's brief existence on the planet (compared in a running metaphor to that of a three day old infant), the immensity of space and the future of the cosmos. In the section on the size of the universe he uses some helpful metaphors to convey the vital statistics of the size of the universe. Jeans makes comments on the destructive nature of the human race on earth and, as usual, on the tentative nature of science. He explicitly states that the cosmogony of 1928 should not be judged as a finished science or the solution

[271] Jeans, *Astronomy and Cosmogony,* 422.
[272] James Jeans, *Eos: or the Wider Aspects of Cosmogony* (London: Kegan Paul, 1928).
[273] Jeans, *Eos,* 89.

of a problem; it is rather the first confused groping of the infant mind trying to understand the world outside its cradle.

The sheer size of the universe is a theme that Jeans dwells upon in both *The Mysterious Universe* and *The Astronomical Horizon* and in *Eos* he devotes four pages to the topic. The main section of theological interest occurs, as is often the case with Jeans, at the end of the book, in the two final sections 'The Birth of the Planets' and 'Life and the Universe'.

In 'The Birth of the Planets' Jeans briefly outlines his views on planetary formation – that they occur because of the close approach of two stars causing long streamers of condensing gas which form into 'drops' which form into planets. A photograph of twin nebulae taken at Mount Wilson is shown and the suggestion is made that a similar process is under way there. 'It seems reasonably certain that the planets were formed in this way.'[274] As has been seen, this is not the current view of planetary formation.

While the term 'heat death of the universe' is not used, Jeans is somewhat pessimistic. So far as we can judge, he says, our part of the universe has lived the more eventful part of its life already. He then deploys one of his graphic metaphors saying that what we are witnessing is less the rising of the curtain before the play than the burning out of candle-ends on an empty stage on which the drama is already over. There is not time for many more planets to be born. This will be considered in greater depth later.

The section 'Life and the Universe' begins with a brief restatement of the contention that life probably only exists on planets. Jeans concludes that if planets are rare, on any scheme of current cosmogony, life must be limited to an exceedingly small corner of the universe.

Jeans then argues:

> But it does not at present look as though Nature had designed the universe primarily for life; the normal star and the normal nebula have nothing to do with life except making it impossible. Life is the end of a chain of by-products; it seems to be the accident, and torrential deluges of life-destroying radiation the essential.[275]

The argument put as simply as this confuses design with frequency of occurrence. To say that an object is designed to perform a function does not imply that it will perform its major

[274] Jeans, *Eos,* 82.
[275] Jeans, *Eos,* 86.

function all the time. The fact that planets are rare and the correct conditions of temperature and the right levels of radiation and gravity are rarer still, while stars are plentiful, abundant and regularly emit much life-stopping radiation, does not of itself prove that the universe is not designed for life. An alarm clock will only perform its major function for a few seconds in a 24 hour period and probably only for five days out of seven. But it is still designed for that purpose. On this metaphor, it is interesting to note that keeping time without sounding an alarm for the rest of the time is integral to its main function of sounding the alarm at six fifteen five days a week. Thus the evolution of the stars and the radiation produced, which may have a role in biological revolution, could be part of a design to produce life on a limited number of planets. Jeans, however, counsels against rushing to any theological conclusions on this topic - 'We must be beware … of hasty inference.'[276] This element in Jeans thought will be looked at in greater detail later.

Jeans then turns to another of his key beliefs – that scientific knowledge is in its infancy and that humans may be unable to grasp the whole complexity of the created universe. He gives his final sentence of the book a semi-Idealistic twist of not the greatest profundity, an approach which he takes up in *The Mysterious Universe.* This comment in *Eos* is very similar to his closing comments in *Astronomy and Cosmogony.*[277] Returning to his metaphor of the three-day old infant, signifying the new humanity in an old universe, he argues that mankind cannot be very confident of any interpretation it puts on a universe which it only discovered a minute or two ago. Mankind may be puzzled, distressed, and often irritated at the apparent meaninglessness and incomprehensibility of the world to which it has suddenly awoken. But it is still very young. Sooner or later the pieces of the puzzle must begin to fit together, although it may reasonably be doubted whether the whole picture can ever be comprehensible to one small, and apparently quite insignificant, part of the picture:

> And ever the old question obtrudes itself as to whether the infant has any means of knowing that it is not dreaming all the time. The picture it sees may merely be a creation of its own mind, in which nothing really exists except itself; the universe which we study with such care may be a dream, and we brain-cells in the mind of the dreamer.[278]

[276] Jeans, *Eos,* 86-87.
[277] Jeans, *Astronomy and Cosmogony,* 422.
[278] Jeans, *Eos,* 88.

Jeans' next book *The Universe Around Us* was one of the successes of scientific popularising in the inter-war years. Its success was comparable with *A Brief History of Time* in an era when the reading public was smaller and disposable incomes were not so great.[279] The significance of this book is not that it made a great contribution to the science and religion debate or that it established Jeans as a scientific apologist. It did neither. What it did do was to establish Jeans as one of the foremost scientific popularisers and so ensure the attention which *The Mysterious Universe* attracted the following year.

The Universe Around Us was published by Cambridge University Press with whom Jeans already worked on his academic books. The content of the last chapter of *Astronomy and Cosmogony* had been drawn to the attention of S C Roberts of Cambridge University Press and also the potential for Jeans to write a popular or semi-popular best seller. Roberts visited Jeans at his home in Dorking and suggested such a book. According to Roberts, Jeans decided to go with Cambridge University Press despite having had many offers from other publishers. Roberts' account of this in Milne's biography of Jeans ignores the fact that in 1928 Jeans had written *Eos* for Kegan Paul, possibly because the book was not yet published when the conversation took place. Part of the attraction with Cambridge University Press was the success Eddington had had with them with *The Nature of the Physical World* in 1928 and, according to Roberts, Jeans wished to maintain the 'friendly rivalry' with Eddington.[280] *The Universe Around Us* is an easier read than *The Nature of the Physical World.* It is a description of the current state of astronomy without the lengthy discussion of more difficult topics such as relativity, quantum theory and causation which can be found in *The Nature of the Physical World.*

The agreement was signed in April 1929 and the book was published in September of the same year. This quick progress for a book of almost 350 pages may be explained by the fact that some of the text already existed as lectures and radio talks but it was rewritten and does not appear disjointed. The text is well constructed, eminently readable and conveys the excitement of the unfolding understanding of the universe. It includes many full page plates of 'Nebulae' - galaxies in the now current parlance, a number of line diagrams and not too much mathematics.

The first edition of 7500 copies published in September was sold out in October. By the end of 1929 11,300 copies were sold following a reprint in November. The book was reprinted again

[279] Stephen Hawking, *A Brief History of Time* (London: Bantam Press, 1988).
[280] Milne, *Jeans,* ix.

in January 1930. The book was updated with a second edition published in October 1930 which included details of the 'new planet Pluto' the rotation of our galaxy, the 'apparent' expansion of the universe and other additions and improvements to the text.[281] By December 1930 40,000 copies had been sold in Britain and the United States. A third edition appeared in November 1933 which contained further writing on the development of the understanding of the nature the atom, notably on the neutron and the electron and at the other end of the scale further developments in the theory of the expanding universe.[282] By the third edition the book had expanded from 343 pages of text to 370 pages.

The Universe Around Us, as has been said, is not of major interest to the present study; but every now and then Jeans adds a comment of some significance. In the Introduction he questions why there is popular interest in astronomy and why professional astronomers spend 'arduous nights and still more arduous days'[283] studying remote parts of the universe:

> In part at least the answer would seem to be that many have begun to suspect that the astronomy of to-day, like that of Galileo, may have something to say on the enthralling question of the relation of human life to the universe in which it is placed, and on the beginnings, meaning and destiny of the human race.[284]

He then goes on to relate Bede's metaphor of the bird flying in one end of a hall of men feasting and out the other end and concludes that before he can understand himself, humanity must first understand the universe from which all their sense perceptions are drawn. He wishes to explore the universe, both in space and time, because he himself forms part of it and it forms part of him.

Jeans and Eddington agree on the idea that science does not provide at any given moment complete truth but moves forward to greater truth. Jeans sees science as advancing by providing a succession of approximations to the truth, each more accurate than the last, and each capable of endless degrees of higher accuracy. This section at least does suggest that Jeans has an 'ever advancing' concept of science rather than one in which science can, like the wandering planets, backtrack for a period. He does elsewhere present a more nuanced semi-Kuhnian view of scientific endeavour.[285] Jeans certainly has a concept of definite proof often

[281] *The Universe Around Us* (Cambridge: Cambridge University Press, 2nd ed. 1930), v.
[282] *The Universe Around Us* (Cambridge: Cambridge University Press, 3rd ed. 1933), vi.
[283] *Jeans, Universe Around Us,* 6.
[284] Jeans, *Universe Around Us,* 6.
[285] James Jeans, *Physics and Philosophy*, 1.

linked, but not here in the Introduction, to rigorous mathematics. He does not approve of the use of intuition in science saying that modern science, eschewing guessing severely, confines itself, except on very rare occasions, to ascertained facts and the inferences which follow unequivocally from them.

Here there is a real contrast, as shall be seen, with the approach of Eddington and a direct attack on Eddington's views. Jeans does believe there is some certainty in science and it can be found primarily in rigorous mathematics but also in observation; beyond this, Jeans argues that with the interpretation of observation the scientist moves away from certainty. Here he is unlike some later writers such as Hanson who emphasise the theory-laden nature of observation.[286] He takes observation as something objective (he does not use this term here) but states that with the interpretation of observations scientists are moving away from fact to hypothesis and worse, 'Here we leave the firm ground of ascertained fact, to enter the shadowy morasses of conjecture, hypothesis and speculation.' Again, stating the tentative nature of science he says that these questions are some of the most interesting in the whole of astronomy, to which it must be admitted that science has so far obtained only lamentably dusty answers.[287]

Astronomy as a science poses particular problems when it comes to arriving at definite conclusions and Jeans illustrates this admirably:

> Emden calculated in 1907 that the central temperature of a sun of this kind would be about 31,500,000 degrees. Later and more refined calculations by Eddington led to an almost identical temperature, but some still later calculations of my own give the substantially higher figure of 55,000,000 degrees. There is no need for the moment to discuss which of these figures is nearest the truth. Their diversity will indicate what kind of certainty attaches to all calculations of this type.[288]

In *The Universe Around Us* Jeans goes in for some self admittedly 'crude imagery' at times such as 'If we want a concrete picture of such a creation, we may think of the finger of God agitating the ether'[289] and at other points he discusses the idea of the design of the size of the universe within the framework of the new physics, but in a semi-anthropomorphic manner.

[286] Norwood R Hanson, *Patterns of Discovery* (Cambridge: Cambridge University Press, 1958) chapter 1 and Norwood R Hanson, *Perception and Discovery* (San Francisco: Freeman Cooper, 1969) chapter 9.
[287] Jeans, *Universe Around Us,* 275-276.
[288] Jeans, *Universe Around Us,* 281.
[289] Jeans, *Universe Around Us,* 328.

He outlines the various versions of thought regarding the beginning of the universe saying that Einstein's cosmology supposes that the size of the cosmos is determined by the amount of matter it contains. If it was decided, at the creation, to create a universe containing a certain amount of matter which was to obey certain natural laws, then space must at once have adjusted itself to the size suited for containing just this amount of matter and no more. Or, if the size of the universe and the natural laws were decided upon, the creation of a certain definite amount of matter became an inevitable necessity. De Sitter's universe is less simple, or at least allowed more freedom of choice in its creation. He concludes that after the laws of nature had been fixed, it was still possible to make a universe of any size, and to put any amount of matter, within limits, into it.

Jeans embarks on one of his wonderful metaphors to describe how thinly populated the universe is, saying that six specks of dust within the vastness of Waterloo Station (something many of his readers would have experienced) represent the spread of stars in space and concludes significantly:

> We live in a gossamer universe; pattern, plan and design are there in abundance, but solid substance is rare.[290]

Irritatingly Jeans does not go on to expand on the evidence for pattern, plan and design. This will be examined in greater detail later.

As in *Astronomy and Cosmology* Jeans has a section in *The Universe Around Us* in which he asserts that it is not the task of the astronomer to make philosophical or theological pronouncements based upon his work. Following these two disavowals it is surprising that he turned so quickly to write his next book, *The Mysterious Universe,* with a whole chapter devoted to the deep waters of this very speculation. In *The Universe Around Us* he writes:

> The astronomer must leave the problem at this stage. The message of astronomy is of obvious concern to philosophy, to religion and to humanity in general, but it is not the business of the astronomer to decode it. The observing astronomer watches and records the dots and dashes of the needle which delivers the message, the theoretical astronomer translates these into words – and according as they are found to form known consistent words or not, it is known whether he

[290] Jeans, *Universe Around Us,* 106.

has done his job well or ill – but it is for others to try to understand and explain the ultimate decoded meaning of the words he writes down.[291]

4.3 Into the Deep Waters

Jeans received a large amount of criticism about *The Mysterious Universe* and in particular the last chapter 'Into the Deep Waters' as Giovanni Macchia shows.[292] For this reason it is important to consider in some depth what it actually says. One of the key messages of the book is the same as that of *The Nature of the Physical World,* namely that the science of the early twentieth century is more open to the possibility of a religious interpretation to life. Beyond that Jeans' approach is quite different.

The Mysterious Universe was published in 1930 at a price of five shillings and is the most significant of all of Jeans' publication for the purpose of this study. While *The Universe Around Us* established him as a populariser, *The Mysterious Universe* gave him a widespread reputation as a defender of the Christian faith.

On 4 November 1930 Jeans gave the Rede Lecture at the University of Cambridge. *The Mysterious Universe* was a pre-prepared expansion of that lecture and was published the day after the lecture. Jeans had already had publishing success with *The Universe Around Us,* and *The Mysterious Universe* repeated this performance. Released in November, it was reprinted three times in the month and once more in December, with 70,000 copies sold in the final two months of 1930 and a further 50,000 copies in 1931. This was partly due to the publicity it had received in the press because of its controversial final chapter. In the Foreword Jeans outlines first the purpose and then the structure of the book:

> There is a widespread conviction that the new teachings of astronomy and physical science are destined to produce an immense change on our outlook on the universe as a whole, and on our views as to the significance of human life. The question at issue is ultimately one for philosophic discussion, but before the

[291] Jeans, *Universe Around Us,* 331.
[292] This is discussed in the next chapter. Giovanni Macchia 'J. Jeans' idealism about space and its influences on E.A. Milne at the dawn of modern cosmology', *Studies in History and Philosophy of Modern Physics,* 46 (2014) 303-315 and Michael H Whitworth *Einstein's Wake: Relativity, Metaphor and Modernist Literature* (Oxford: Oxford University Press, 2001) 50-57.

> philosophers have a right to speak, science ought first to be asked to tell all she can as to ascertained facts and provisional hypotheses. Then, and only then, may discussion legitimately pass into the realms of philosophy.[293]

Jeans then says that in the four main chapters of the book, 'The Dying Sun', 'The New World of Modern Physics', 'Matter and Radiation' and 'Relativity and the Ether' he outlines '... such scientific questions as seem to me to be of interest, and to provide useful material, for the discussion of the ultimate philosophical problem.'[294]

Chapter Five is the crucial area for the discussion of Jeans as an apologist. The whole argument of the chapter will be set forth here and a number of the key themes will be explored further in later chapters.

The question of whether or not Jeans set out in Chapter Five to defend the Christian faith, or even just a theistic position has been questioned. There is, as shall be seen, a certain air of tongue-in-cheek in his style and phraseology. Milne says 'There is no reason to suppose that this was not a genuine belief.' [295] But he says it in a way which suggests that at least some of Jeans' contemporaries did question it. A consideration of the final section of the book provides an answer in the positive to this question. A key issue is the query as to how far Jeans simplified his own views for publication. The texts of his books provide few clues.

Both Russell and McCabe in their comments in the books written in response to *The Mysterious Universe* clearly believe Jeans to be actively defending the Christian faith. Russell writes that the modern physicist approaches the established order apologetically. Previous scientists may have said harsh things but:

> "I am more humble, and do not claim to know anything that can controvert your dogmas." In return, the established order showers knighthoods and fortunes upon the men of science, who become more and more determined supporters of the injustice and obscurantism upon which our social system is based.[296]

McCabe, talking of Jeans and Eddington explicitly, writes:

> Religious writers and preachers all over Great Britain and America have for three years loudly assured their followers that these two masters of science have

[293] Jeans, *The Mysterious Universe,* vii.
[294] Jeans, *the Mysterious Universe,* vii-viii.
[295] Milne, *Jeans,* 159.
[296] Bertrand Russell, *The Scientific Outlook,* 103.

> admitted that there is mind or thought in the material universe and have taken this to be an acceptance of the design-argument.[297]

It would appear from the title of the chapter, the structure of the book and the reaction of contemporaries that Jeans was deliberately formulating an apologetic based upon a modified version of the design argument - namely that the mathematical orderliness of the universe points to a mathematically minded-designer or architect of all that is. His slightly tongue-in-cheek literary style, while straightforward in a way that Eddington was not, should be taken as the voice of the author who knows he is venturing into the fields of theology and philosophy in which he is not an expert, expecting that people would disagree.

Milne is inaccurate when he says Jeans 'did not give sufficient emphasis to the uncertainty which not only overhangs most scientific researches but is the very guarantee that further research is both possible and needed.'[298] The tentative nature of scientific knowledge was a recurring theme in Jeans' writing (and in Eddington's) as has been seen and will be further demonstrated.[299] Both authors acknowledged that the science, which had been mechanical and deterministic thirty years previously, could change again. Jeans writes:

> This [final] chapter merely contains the interpretations which I, a stranger in the realms of philosophical thought, feel inclined to place on the scientific facts and hypotheses discussed in the main part of the book. Many will disagree with it – it was written to this end.[300]

On the page between the Foreword and Chapter I there is an extensive quotation from Plato's *Republic* containing the parable of the prisoners chained in a cave with their back to the light, who only know the outside world by the shadows on the back walls of the cave.

The final chapter is thirty-five pages long and it starts with some uncontroversial physics about the speed of light and world-lines. Jeans proceeds to say that a single electron is best described in terms of three dimensions of space and one of time. Two electrons when they meet, however, are best described in six dimensions of space and one of time. To describe a meeting of three electrons, we need nine dimensions of space and one of time. Jeans argues that to be consistent involves saying that both the seven-dimensional and the four-dimensional constructions are as 'real' as each other. He points out that Schrödinger's system

[297] McCabe, *The Existence of God,* 145.
[298] Milne, *Obituary Notices of Fellows of the Royal Society* 5, (Feb 1945), 585.
[299] See Jeans, *Astronomy and Cosmogony,* 421, Jeans, *Eos,* 17-18 or Jeans, *Universe Around Us,* 281.
[300] Milne, *Jeans,* viii.

described here is not the only one and Heisenberg and Dirac have their own systems but he argues that '*all* the pictures' that science constructs 'are *mathematical* pictures.'[301]

He uses the word 'pictures' deliberately, saying that most scientists would agree that they are nothing but pictures or even 'fictions' because the outstanding achievement of twentieth century physics it was not the theory of relativity or quantum theory or even the dissection of the atom with the resultant discovery that things are not what they seem:

> … it is the general recognition that we are not yet in contact with ultimate reality. To speak in terms of Plato's well-known simile, we are still imprisoned in our cave, with our backs to the light, and can only watch the shadows on the wall.[302]

The best pictures, Jeans argues, are those presented in mathematical form. Jeans says that 'Nature's great book'[303] is written in a mathematical form, but not quite in the sense that Galileo meant. He does not say how his view is different from what Galileo had intended. He argues that only those who are mathematicians can understand modern science as it attempts to unravel the fundamental nature of reality. He agrees with Locke that the real essence of substances is for ever unknowable. We can only progress by discussing the laws which govern the changes of substances and thus produce the phenomena of the external world. These we can compare with abstract creations of the human mind.

Jeans, an accomplished pianist and organist, gives as an illustration the instance of a deaf engineer studying the action of a pianola. He or she might first try to interpret it as a machine, but would be baffled by the continuous reiteration of the intervals 1, 5, 8, 13 in the motions of its trackers. A deaf musician, although he could hear nothing, would immediately recognise this succession of numbers as the intervals of the common chord. He continues in a much reported phrase in the press at the time:

> In the same way, a scientific study of the action of the universe has suggested a conclusion which may be summed up, though very crudely and quite inadequately, because we have no language at our command except that derived from our terrestrial concepts and experiences, in the statement that the universe appears to have been designed by a pure mathematician.[304]

[301] Jeans, *Mysterious Universe,* 127. *Italics* are as in the original.
[302] Jeans, *The Mysterious Universe,* 127.
[303] Jeans, *The Mysterious Universe,* 127.
[304] Jeans, *The Mysterious Universe,* 132.

Jeans acknowledges that this is open to challenge on two grounds. As a mathematician he only sees nature through the mathematical blinkers he has fashioned for himself. But the success of mathematics in understanding the universe argues against this, and anthropomorphic, biological or engineering pictures are not successful. He concludes his refutation of the first objection with the much quoted:

> We have already considered with disfavour the possibility of the universe having been planned by a biologist or by an engineer; from the intrinsic evidence of his creation, the Great Architect of the Universe now begins to appear as a pure mathematician.[305]

The phrase 'the Great Architect of the Universe' is a reference to Voltaire who said, while discussing the design argument:

> If a watch proves the existence of a watchmaker but the universe does not prove the existence of a great Architect, then I consent to be called a fool.[306]

It would be no surprise if astronomers discovered the universe was, so to speak, 'designed by an applied mathematician' for the concepts of applied mathematics were specially designed to fit the workings of nature. If this were the case astronomers could be seen to be reading back into nature a God of their own creation. But from this follows another objection: there is no clear demarcation between pure and applied mathematics. Clearly some concepts, such as quantity, are borrowed from physical reality but Jeans asserts that if the more intricate concepts of pure mathematics have been transplanted from the workings of nature, they must have been buried very deep indeed within the human sub-conscious mind.

Jeans concludes in tentative language that:

> ... the universe is best pictured, although still very imperfectly and inadequately, as consisting of pure thought, the thought of what, for want of a better word, we might describe as the thought of a mathematical thinker.[307]

[305] Jeans, *The Mysterious Universe,* 134.
[306] Voltaire, unreferenced quotation in A J Hoover 'God, Arguments for the Existence of' in Walter A Elwell, (ed.), *Evangelical Dictionary of Theology,* (Basingstoke: Marshall Morgan and Scott, 1985), 449.
[307] Jeans, *The Mysterious Universe,* 136.

This passage will be considered further later in this thesis, as will the following quotation, but both are key to Jeans' developing argument and indicate from which school of Idealism Jeans mainly draws his ideas, namely from the tradition of Bishop Berkeley, whom Jeans quotes:

> All the choir of heaven and furniture of earth, in a word all those bodies which compose the mighty frame of the world, have not any substance without the mind... So long as they are not actually perceived by me, or do not exist in my mind, or that of any other created spirit, they must either have no existence at all, or else subsist in the mind of some Eternal Spirit.[308]

An objection to one construction of Idealism has been that if there is no one about in the quad of a college to observe the proverbial tree in the middle, how does it continue to exist? The Berkeleyan school answers that the tree subsists in the mind of God and Jeans introduces this idea which Eddington does not explicitly use in his *The Nature of the Physical World.* Jeans goes on to say:

> Modern science seems to lead, by a very different road, to a not altogether dissimilar conclusion... It does not matter whether objects "exist in my mind, or that of any other created spirit" or not; their objectivity arises from their subsisting "in the mind of some Eternal Spirit".[309]

Jeans insists that he is not trying to introduce a thoroughgoing Idealism at the expense of realism entirely. Jeans argues that objective realities do exist 'because certain things affect your consciousness and mine in the same way' but people have no right to assume we can label them either 'real' or 'ideal'. The true label he argues is 'mathematical'. Such a label does not imply anything as to what things are in their ultimate essence, but merely something as to how they behave.

Jeans goes on to say that the final description of a phenomenon is the mathematical description of it. He is not using the word 'final' in the sense of ultimate and perfect but the best possible description a human can give. Going beyond the mathematical formulae is a risk. The making of models or pictures to explain mathematical formulae and the phenomenon they describe, is not a step towards but a step away from reality for Jeans:

[308] Jeans, *The Mysterious Universe,* 137 unreferenced quotation.
[309] Jeans, *The Mysterious Universe,* 137.

> ... it is like making a graven image of a spirit... All the same, the mathematical physicist is still busy making graven images of the concepts of wave mechanics.[310]

Jeans finds the view that he describes as intellectually and personally satisfying. He says that the contact between human consciousness and the empty soap-bubble of space-time is similar to the contact between mind and the creation of mind – as in the reading of a book, or listening to music. The immensity of the Universe becomes a matter of satisfaction rather than awe; 'we are citizens of no mean city.'[311]

Jeans argues that if the universe is a universe of thought then the creation must have been an act of thought. The finiteness of time and space compel those who consider these matters to picture the creation as an act of thought; the determination of the constants such as the radius of the universe and the number of electrons it contained imply thought, whose richness, Jeans argues, is measured by the immensity of these quantities. Not all those who consider these matters come to this conclusion.

He agrees with Augustine, from whom the Latin quotation below is taken, and Plato in believing that time and space were created together, not space in time:

> Time and space, which form the setting for the thought, must have come into being as part of this act. Primitive cosmologies pictured a creator working in space and time, forging sun, moon and stars out of already existent raw material. Modern scientific theory compels us to think of the creator as working outside time and space, which are part of his creation, just as the artist is outside his canvas. "Non in tempore, sed cum tempore, finxit Deus mundum."[312]

Jeans, like Eddington, acknowledges that scientific views can change. Physics had changed since the late Victorian times. The river of knowledge having changed from flowing east to flowing west could change back to flowing east again. There is a wide spread measure of agreement which, he says, on the physical side of science approaches almost to unanimity, that the stream of knowledge is heading towards a non-mechanical reality; the universe begins to look more like a great thought than a great machine:

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[310] Jeans, *The Mysterious Universe,* 141.
[311] Jeans, *The Mysterious Universe,* 143.
[312] Jeans, *The Mysterious Universe,* 145, unattributed quotation from Augustine, *The City of God,* Book XI Chapter 6.

> Mind no longer appears as an accidental intruder into the realm of matter; we are beginning to suspect that we ought rather to hail it as the creator and governor of the realm of matter – not of course our individual minds, but the mind in which the atoms out of which our individual minds have grown to exist as thoughts.[313]

The passage above is very much an endorsement of Berkeley's position with a modern scientific presentation. Jeans continues:

> We discover that the universe shows evidence of a designing or controlling power that has something in common with our own individual minds ... for want of a better word, we describe as mathematical... we are not so much strangers or intruders in the universe as we at first thought.[314]

Clearly *The Mysterious Universe* is not a book of apologetics of the style that a professional theologian might write. Nevertheless, the title of the final chapter 'Into the Deep Waters', along with his Foreword, indicates not only that Jeans was aware of the attention that the chapter would draw, but also that it was an important part of his understanding of the universe as shown by modern science, which he would not flinch from putting forward. The final chapter on the evidence of a designing mind behind the world forms a unity with the first four chapters on the new physics as understood in 1930. Russell criticises this mix of science and apologetics:

> By prefacing his argument by a lot of difficult and recent physics, the eminent author manages to give it an air of profundity which it would not otherwise possess.[315]

A similar point is made from an opposite point of view by Giberson and Artigas in *Oracles of Science* where they criticise such authors as Richard Dawkins and Carl Sagan when they present philosophical and theological arguments in the final chapters of popular and semi-popular science books as if they derived from the science previously described.

> They are philosophical and theological claims cloaked in scientific rhetoric, presented on the concluding pages of highly literate books that masterly open science to broad audiences. But these grand now-here-is-the-point conclusions articulate the personal worldviews of the scientists making the claims, not the

[313] Jeans, *The Mysterious Universe,* 148.
[314] Jeans, *The Mysterious Universe,* 149.
[315] Russell, *Scientific Outlook,* 115.

> implications of the discussion that has preceded them, and certainly not the consensus of the scientific community.[316]

In both cases the reading public will inevitably, if not reasonably, look to the scientific reputation of the author as they assess the truth of their arguments.

One of the strengths of *The Mysterious Universe* is that it recognises the insufficiency of human language to explain both the mysterious universe as revealed by modern science and any reality which lies behind it. It does not present an over-simplified account of modern science and then proceed, QED, to the existence of God. While it is not as deep or as extensive as *The Nature of the Physical World* there is a developing argument towards a view for a designing, mathematician God.

Jeans' written style is different from Eddington's. Both are good masters of prose, but Jeans' style is more straightforward. As Eddington loved irony, you can never be sure how literally to take what he is saying. Eddington's wryly humorous approach to writing can also cause slight confusion at times. William McCrea says:

> The reader can never be quite sure when he is being invited to follow a serious argument, and when he is being – oh so delicately – conned.[317]

Jeans, in contrast, is generally more straightforward but he sometimes lacks depth. We do not, however, find Jeans rejecting the idea of a start to time and matter, as Eddington does even though he sees modern science pointing in that direction, merely because it offends his theology as it implies to him a discontinuity in the Creator. This will be discussed further in a later chapter. Jeans is awake to the criticism that he is making God in his own image, but argues that he is not projecting back mathematical concepts into the universe; there is evidence for a designing mind in the universe and that the designer appears to be familiar with the concepts of mathematics and to have employed them in the construction of the universe as shown by modern physics and astronomy. Jeans also was aware, as the quotation above shows, that the river of knowledge could change direction again. He was not attempting to put down a final, complete-and-standing-for-ever-argument for the existence of

[316] Karl Giberson and Mariano Artigas, *Oracles of Science* (New York: Oxford University Press, 2007), 11.

[317] Unreferenced quotation from William McCrea in Malcolm Longair, A*rthur Stanley Eddington* in Ed Peter Harman and Simon Mitton, *Cambridge Scientific Minds* (Cambridge: Cambridge University Press, 2002), 222.

God, but to state that, as a professional scientist, he believed that the current understanding of the universe pointed towards a designing God.

The first main criticism of *The Mysterious Universe* must be that it is too closely linked with an Idealist understanding of the world. While Jeans is not of that school of naïve Idealism which denies the substantiality of matter, his Idealism is open to criticism by professional philosophers in not being fully consistent or thoroughly thought through. The second main criticism is a criticism of the design argument or design arguments in general. A third criticism is that its use of language is too loose.[318] These criticisms will be considered at a later point. Nevertheless, the book had some strengths, and these will be considered later.

A number of themes run through Jeans' books and lectures, but there appears to be no substantial development in Jeans' ideas. In some books Jeans puts his ideas in a more elegant form than in others. Sometimes his statements on the Creator seem very anthropomorphic, despite his protestations. This is not surprising as Jeans was a scientist and not a professional theologian or philosopher. He was attempting to explain ideas in contemporary physics which were difficult to explain in everyday language. The language of mathematics was Jeans' language and the language of the new advances in physics and astronomy.

A key theme of Jeans was his assertion that the physics of the Victorian era appeared to be materialistic and relied heavily on mechanical models of the universe. These appeared to leave little space for a Creator and Sustainer of the cosmos. The physics of the early twentieth century was radically different. The theory of relativity and quantum theory had shown that the mechanical models of nineteenth century physics were grossly inadequate as representations of reality. In fact it was clear that ultimately reality was probably unknowable and certainly un-pictureable. Intuition or 'guessing' has no role in science. Observation has a crucial role in science but the interpretation of observations move us further away from exact knowledge. We must also be careful as we attempt to explain the mathematics because as we do so we do move further away from reality. For Jeans, mathematical descriptions of reality are the best.

Twentieth century physics, argued Jeans, was not mechanistic in its understanding of reality. The universe seemed to be more of a great thought than a giant mechanism. Jeans admitted

[318] Crowther, *British Scientists,* 130.

that the scene could shift and physics could return to its previous view, but he saw design in the universe and it was the design of a mathematical God.

The next chapter will consider some reactions to the writings of Eddington and Jeans, both in general, but also in particular to the three key texts which have been discussed in the last two chapters.

CHAPTER FIVE

TWO REACTIONS TO EDDINGTON AND JEANS

5.1 Introduction

The reactions of two authors, Bertrand Russell and Joseph McCabe, writing at the time will now be considered. The strengths of their arguments will be examined and their criticism critiqued. These are not the only authors who considered Eddington and Jeans. Joad and Inge will be considered in Chapter Seven. Bishop Barnes also in his *Scientific Theory and Religion*, for example, makes numerous and often favourable references to both Eddington and Jeans, but this is generally to support his own developing argument rather than to examine their views systematically as Joad, Inge and the two critics discussed below attempt.[319] From the 'anti' side of the debate, Chapman Cohen in his *God and the Universe* brings together articles from the journal *The Freethinker.*[320] His criticism of Eddington and Jeans is along similar lines to that of McCabe. It is interesting to note that neither Russell nor McCabe doubted that Jeans was writing popular Christian apologetics as some later authors did.

5.2 Bertrand Russell - Mathematician Turned Philosopher

In 1931 Bertrand Russell's *The Scientific Outlook* was published by George Allen and Unwin.[321] This was a book written with Eddington and Jeans very much in his sights. While other authors are mentioned, this is a book which is very much focused on these two. The same is true of the second edition of *The Existence of God* by Joseph McCabe but not so true of *God and the Astronomers* by Inge. Russell's focus is obvious in a letter he wrote to Stanley Unwin saying

[319] E W Barnes, *Scientific Theory and Religion* (Cambridge: Cambridge University Press, 1933).
[320] Chapman Cohen, *God and the Universe* (London: Pioneer Press, 3rd ed. 1946).
[321] Bertrand Russell, *The Scientific Outlook* (London: George Allen and Unwin, 1931).

that the point of the book was to pillory the 'hogwash in which Eddington and Jeans are causing the public to wallow'.[322] Ray Monk, Russell's biographer, writes:

> Having recently reviewed Jeans's *The Mysterious Universe,* Russell had become convinced that Jeans and Eddington, in arguing for the consistency of modern physics with religion, were motivated by ulterior political considerations. Making great play of the fact that both men were knighted (he refers repeatedly to "Sir Arthur" and "Sir James"), Russell portrays them as, consciously or unconsciously, undermining the threat previously posed by the scientific outlook to established religion, in reward for social distinction and honours.[323]

Monk quotes a section of *The Scientific Outlook* already referenced in this thesis, in which Russell attacks Eddington and Jeans for, in his view, claiming to know nothing which would disturb religious beliefs and adds that the establishment in return 'showers knighthoods and fortunes' upon the men of science, who become more and more determined supporters of social injustice.[324] Monk says the book shows Russell at his most irascible. The following two quotations, unused by Monk, support his thesis. Russell's contempt for theologians, bishops and the clergy, along with Jeans and Eddington, is evident throughout the book, but even while he is at his most sarcastic, he does make a telling comment or two:

> The statements of the scientists have as a rule been somewhat tentative and indefinite, but the theologians have seized upon them and extended them, while the newspapers in turn have reported the most sensational accounts of the theologians, so that the general public have gained the impression that physics confirms practically the whole of the book of Genesis.[325]

The comment on confirming 'the whole of the book of Genesis' is puerile but the first clause is significant. Both Jeans and Eddington are tentative, they do not attempt to suggest that the new physics proves the truth of Christianity. It is a contention of this thesis that this is one of their strengths and displays their intellectual honesty. It is also a contention of this thesis that they were misreported by some academics, notably Russell and also by Susan Stebbing as will be seen in later. The following quotation gives another example of Russell's irritability:

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[322] Ray Monk, *Bertrand Russell: The Ghost of Madness 1921-1970* (London: Vintage, 2001), 122.
[323] Monk, *Russell 1921-1970,* 122.
[324] Monk, *Russell 1921-1970,* 122 quoting Russell, *Scientific Outlook,* 103.
[325] Russell, *Scientific Outlook,* 105.

> I once knew an extremely learned and orthodox theologian who told me that as a result of long study he had come to understand everything except why God had created the world. I commend this puzzle to the attention of Sir James Jeans, and hope that he will comfort the theologians by dealing with it at not too distant a date.[326]

The book is peppered with such comments. Russell appears to have written the book in a state of high dudgeon, accusing Eddington and Jeans of anti-Bolshevism as well as seeking honours. In other books, Russell is more measured in his comments about Eddington and Jeans. In *The Scientific Outlook,* however, the tone is strongly sarcastic. Monk writes that the claim to have access to the subconscious motivations of Jeans and Eddington is 'bizarre', as is Russell's desire to blacken them by portraying them as lackeys of the established order. 'Neither had made any public pronouncements in favour of the established Church or of the capitalist system' says Monk. [327]

Eddington was, like Russell, a pacifist and a conscientious objector in the First World War. Eddington foresaw the dangers of modern nuclear warfare and spoke out against it. He was, as has been seen, a Quaker rather than Anglican, a fact which, in the interwar period, still placed him somewhat as an outsider. While Eddington was not as overtly political as Russell, they had much in common.

Jeans was politically different from Eddington. As has been seen, he came from a more privileged background, he had gone to Merchant Taylors' School, a grander public school than Eddington's private school, he married into money, twice. In the book *Living Philosophies* to which he contributed a chapter, he advocated eugenics, a position espoused by some on the left as well as on the right in the 1930s.[328] More significantly, Jeans spoke against socialism in this book, which does rather indicate a position in favour of capitalism. It does appear that Jeans was on the right politically and Monk is not quite accurate.

Russell had in the year of the publication of *The Scientific Outlook* become the third Earl Russell, which makes his comments on the knighthoods of Eddington and Jeans even more interesting.

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[326] Russell, *Scientific Outlook,* 118.
[327] Monk, *Russell 1921-1970,* 122.
[328] Albert Einstein, *et al, Living Philosophies* (Cleveland: World Publishing, 1930), 110- 112.

In considering the reasons for these verbal attacks, it is as difficult to claim to have access to the subconscious motivations of Russell as it is for Russell to have access to those of Eddington and Jeans. Monk suggests that Russell might have believed that Eddington and Jeans had been pressed into the reactionary forces of society. Did the aristocratic Russell have contempt for those who had earned their titles? Dora Russell testified to Russell's family pride in his title and connections.[329] Did the fact that Russell was seventh in the list of the mathematical Tripos at Cambridge in the year Eddington was senior Wrangler still rankle? Was it a grudge because Eddington through his contacts at Cambridge managed to avoid being fined as a conscientious objector, as he was deemed to be conducting essential scientific work which would benefit the nation, while Russell himself ended up in paying the then not inconsiderable sum of £100? To apply Ockham's razor, the simplest explanation may be that he was an unhappy man. It was a difficult time in Russell's life; he felt his marriage, his work as a mathematical logician and as a political activist had all ended in failure. Whatever his motivation, Russell's attack was severe.

In his chapter on 'Scientific Metaphysics' Russell examines the ideas of Eddington as contained in *The Nature of the Physical World.* The substance of the chapter first appeared in *The Nation* in April of 1931. There is a passing reference to Jeans and a footnote comment on Millikan, whom Russell thinks is a contrast to Eddington in that Millikan writes of 'a God who works through law'.[330]

Russell sums up his own position on Realism/Idealism thus:

> In metaphysics my own creed is short and simple. I think the external world may be an illusion, but if it exists, it consists of events, short, small and haphazard. Order, unity, and continuity are human inventions just as truly as are catalogues and encyclopaedias.[331]

Joad describes Russell as writing 'Neutral Stuff'; Russell describes it as neutral monism.[332] This contrasts with the Idealism of Eddington and Jeans and Joad's own Realism. On the new understanding of matter, Russell says that the dualism of mind and matter is out of date: matter has become more like mind and mind has become more like matter. 'One is led to

[329] Monk, *Russell 1921-1970,* 120-121.
[330] Russell, *Scientific Outlook,* 100 quoting Robert Millikan, *Science and Religion* (New Haven, Yale University Press, 1929), 39.
[331] Russell, *Scientific Outlook,* 132.
[332] Joad, *Philosophical Aspects,* 83.

suppose that what really exists is something intermediate between the billiard-balls of old-fashioned materialism and the soul of old fashioned psychology.'[333] Just as Eddington said that his Idealism sprang from his science so did Russell's approach to the Realism/Idealism debate.

In his chapter on 'Science and Religion' after a brief introduction, Russell looks at four key issues: free will, Jeans' mathematician God, God as Creator and evolutionary theology. What is noticeable is that Russell concedes that, while Jeans and Eddington are the leaders amongst the popular and semi-popular scientific writers who are prepared to defend the faith, they are not the only ones:

> In recent times, the bulk of eminent physicists and a number of eminent biologists have made pronouncements stating that recent advances in science have disproved the older materialism, and have tended to re-establish the truths of religion.[334]

It is interesting to note that then as now, more physicists seemed positively disposed to a religious interpretation of life than did biologists. Russell says that human free will was a doctrine traditionally defended by Catholic theologians, while believing that natural law operated in the non-human universe. Under the influence of Newton, the alliance between natural law and theology became very close. In the last hundred years, he asserts, this link has been watered down with only some of the fundamentalists and a few Catholic theologians maintaining the old tradition. All the other religious apologists are engaged in blunting the edge of logic, 'appealing to the heart instead of the head, maintaining that our feelings can demonstrate the falsity of a conclusion to which our reason has been driven.'[335]

This is obviously a direct attack upon Eddington's defence of the role of intuition in both science and theology. He then attacks Eddington's ideas in Chapter XIV 'Causation' in *The Nature of the Physical World.* Russell makes a firm case against free will based partly on philosophical considerations and partly on Pavlov's dogs, which he thinks have proved the case in psychology. After an examination of Jeans' pure mathematician God, which shall be considered later, Russell turns to the idea of God as Creator. The thought of Eddington and Jeans on the Creation and Russell's response to this will be considered later.

[333] Russell, *Scientific Outlook,* 132.
[334] Russell, *Scientific Outlook,* 105.
[335] Russell, *Scientific Outlook,* 106.

Another of the four sections of the chapter 'Science and Religion' was on Jeans' description of 'the Great Architect of the Universe' as a pure mathematician.[336] As he opens his argument, Russell totally misrepresents Eddington's position and over-simplifies Jeans':

> Sir Arthur Eddington deduces religion from the fact that atoms do not obey the laws of mathematics. Sir James Jeans deduces it from the fact that they do. Both these arguments have been accepted with equal enthusiasm by the theologians, who hold, apparently, that the demand for consistency belongs to cold reason and must not interfere with our deeper religious feelings.[337]

This is a gross simplification. Eddington's argument is, as we have seen, that the old deterministic and materialistic physics of the Victorian era has been replaced by relativity, quantum mechanics and the Rutherford atom. They do not 'obey' the old deterministic laws or understanding of nineteenth century physics. Jeans argues that there is evidence for design in the created order and the Great Architect of the Universe appears to be a pure mathematician: in this sense atoms obey laws. Russell, the author of *The Principles of Mathematics* and with A N Whitehead of the *Principia Mathematica* says that he has a preference for this type of pure mathematician God rather than the one who is conceived after the analogy of big business, no doubt, he says, because he prefers thinking to doing. He suggests a treatise should be written dealing with the influence of muscle tone upon theology. The man whose muscles are taut believes in a God of action, while the man whose muscles are relaxed believes in a God of thought and contemplation.

Russell goes on to record Jeans' surprise in *The Mysterious Universe* at the size of the universe compared with the earth, which Jeans presumes is the only part where there is life. Jeans says that it seems incredible that the universe can have been designed primarily to produce life like our own: had it been so, surely we might have expected to find a better proportion between the magnitude of the mechanism and the amount of the product.[338] One of the strengths of Jeans is that he is prepared to state facts which could be viewed unfavourably from an apologetic point of view. For Jeans, the size of the universe and the unimportance of life is a bit of a shock, at 'first glance at least'.[339] Russell like Joad and John Habgood on Eddington

[336] Jeans, *The Mysterious Universe,* 134.
[337] Russell, *Scientific Outlook,* 112.
[338] Jeans, *The Mysterious Universe,* 5-6, quoted in Russell, *Scientific Outlook,* 113-114.
[339] Jeans, *The Mysterious Universe,* 6.

sometimes misses out on a developing argument. Jeans goes on to conclude at the end of *The Mysterious Universe* that humanity is not a stranger or intruder in this vast cosmos.

Russell then returns to the attack and he is very journalistic in his criticisms. Joad, it will be seen, gives a more thorough and sober analysis of Jeans' thought. Russell writes:

> The argument is, of course, not set out with the formal precision which Sir James would demand in a subject not involving his emotions. Apart from all detail, he has been guilty of a fundamental fallacy in confusing the realms of pure and applied mathematics.[340]

Jeans explains in *The Mysterious Universe* that he is not using the term 'pure mathematics' in a narrow sense, but Russell goes off on this tack for a considerable time.[341] Russell argues that what a physicist asserts when he uses mathematics is something totally different from what the pure mathematician means. He then asserts falsely that Jeans argues that the world must have been created by a mathematician for the pleasure of seeing these laws in operation. Jeans merely says that there is evidence of design in the universe and the designer appears to be a pure mathematician. Russell thinks that the mathematical character of modern physics is not a fact about the world, but merely a tribute to the skill of the physicist.

This short section raises a number of issues which unfortunately Jeans does not address in *The Mysterious Universe*. It is also important to remember that Jeans does have a somewhat 'tongue-in-check' style of popular writing. Clearly a mathematical description of, say, a petrol engine does not imply that its designer was a mathematician. The fact that the whole universe does obey mathematical laws is a point worthy of comment. It implies that 'the Great Architect of the Universe', to use Jeans' phrase, has made a universe which is open to examination by mathematics and the operation of which can be predicted by mathematical techniques. This cannot be taken for granted, but it is a precondition for scientific study. If Jeans had made a longer, more detailed and more academic case on how the Great Architect of the Universe was a pure mathematician he may wished to have developed his Idealism to explain how human mathematics might be a reflection of the Divine mathematician. Russell then sums up his objections with the statement:

[340] Russell, *Scientific Outlook,* 116.
[341] Jeans, *The Mysterious Universe,* 138.

> ... if God were as pure a pure mathematician as His knightly champion supposes, He would have no wish to give a gross external existence to his thoughts.[342]

This is a classic case of an atheist stating that a supposedly non-existent Deity must be in his own image and a restatement of a very old belief that matter is evil.

Russell and Eddington had much in common. They studied together and had very similar views on the evils of war. In Russell's *The Analysis of Matter,* published in 1927 there are frequent respectful references to the work of Eddington, even where they disagree on the science.[343] Only Russell's collaborator Whitehead is mentioned more frequently. By the time of *The Scientific Outlook,* matters have changed completely: the most likely explanation, supported by Russell's letter to Stanley Unwin, is that Russell considers in writing *The Nature of the Physical* Eddington has turned from a mathematician and scientist to a Christian apologist and that Russell cannot accept this 'hogwash'. *The Scientific Outlook* is amusing, stimulating, makes some telling points but is in many places grossly inaccurate. Joad, it will be seen later is accurate in his criticism but far from amusing or stimulating.

5.3 Joseph McCabe - Friar Turned Sceptic

Joseph McCabe was a Catholic Friar before he left his Order and his church to become one of the leading figures with the Rationalist Press Association, one of its most prolific writers and, according to Ronald Numbers, a skilled debater.[344] Peter Bowler argues that the RPA founded by C A Watts in the late nineteenth century reflected a traditional middle-class ideology, opposed to religion, often agnostic, but in favour of traditional moral values.[345] The rival Secular Society was more aligned to atheism and in favour of a reformed, freer morality. McCabe was a supporter of the German naturalist Ernst Haeckel, famous for the no longer generally held view that an embryo recapitulates the historic evolution of its species. Haeckel also advocated a monism, arguing for a totally materialistic view of life as a unity. Haeckel was a proponent of Social Darwinism. His most famous popular book in English was *The Riddle of the Universe,* which was translated by McCabe. In McCabe's autobiography *Twelve Years in a*

[342] Russell, *Scientific Outlook,* 117.
[343] Bertrand Russell, *The Analysis of Matter* (London: Kegan Paul, 1927).
[344] Ronald L Numbers, *Creationism: From Scientific Creationism to Intelligent Design* (Massachusetts: Harvard University Press, 2nd ed. 2006), 163.
[345] Bowler, *Reconciling Science and Religion*, 349.

Monastery he said that he had the good fortune, on leaving the Church, to come under the genial influence of Sir Leslie Stephen, and had endeavoured to write in the mood of 'good-natured contempt,' which the critic recommended to him.[346]

In his writing the contempt is often, along with the writings of certain modern apologists for atheism, more obvious than the good-nature. As well as writing on Christianity, biology, psychology, science in general, history and philosophy, he translated Haeckel from the German and Voltaire from the French. He has one biography - *A Rebel to His Last Breath* - which is virtually a rationalist hagiography, published by a New Zealand writer which makes the briefest of mentions of the second edition of *The Existence of God* saying that it was rewritten twenty years after its first publication with attention given to 'the theistic speculations of Sir James Jeans and Sir Arthur Eddington.'[347] He is worthy of further study as he was a vocal figure in the debate between science and religion in the first half of the twentieth century.

The Existence of God was first published in The Inquirers Library series in 1913. The revised edition appeared in 1933 and was published in a popular edition by C A Watts and Co of London: the publishing arm of the RPA. Bowler writes:

> It was this second edition that dismissed the "Jeans-Eddington outbreak" as a total misrepresentation of science and insisted that only the older generation of scientists still took religion seriously.[348]

In 1934 McCabe's *The Riddle of the Universe Today* was published which included an attack on the ideas and Idealism of Eddington and Jeans and, in parody of the title of Inge's book, has a whole chapter devoted to them – 'God and Two Astronomers'.[349] But McCabe's most significant book for this study is this second edition of *The Existence of God* published in 1933. He begins the chapter 'The Last Stages of Theism' which was written for the second edition, with a refutation of the idea that leading modern scientists were now more favourably disposed to religion. These are only the old men of science 'Jeans, Thomson, MacBride, Eddington, Haldane, Osborn, Millikan, Pupin, Lloyd Morgan' who are clinging to their old beliefs while 'our brilliant new generation of scientific workers' who are unnamed, are no

[346] Joseph McCabe, *Twelve Years in a Monastery* (London: Watts, 1930), v.
[347] Bill Cooke, *A Rebel to His Last Breath* (New York: Prometheus, 2001), 71.
[348] Bowler, *Reconciling Science and Religion,* 50.
[349] McCabe, *The Riddle of the Universe Today,* 190.

longer theists.[350] Any support from biologists comes from a discredited Vitalism. Turning to the physical sciences, McCabe writes:

> Generally, however, the change is said to be that the new physics has discredited the mechanical conception of nineteenth-century science. Sir Arthur Eddington is largely responsible for this.[351]

McCabe goes on to argue that Eddington, as an astronomer, was unlikely to know that the materialists of the last century, whom he describes as building entirely on these mechanical conceptions, were not referring to physical ideas at all. Their 'mechanical theory' was a theory that the living organism is a chemical machine, and the whole progress of physiology has confirmed this. He cites Chalmers Mitchell as having demonstrated this.[352]

This is a partial reading of the history of science which does not take account of the mechanistic image of the physical universe common in the astronomy and physics of the nineteenth century, not just in biochemistry as McCabe asserts. Bowler, who writes 'I am not myself a religious person', summed up the Victorian background to early twentieth century science, before 'the new physics', as a scientific naturalism which implied a rigid determination of all events, including mental events, by natural laws.[353] While the old physics did not subscribe to a simple billiard ball model of nature, 'it did hold that the only way of understanding the world was to treat it as a mechanism.'[354]

McCabe has praise for Eddington 'a man of so fine a character' but thinks that Eddington misunderstood nineteenth century physics. He writes:

> It seems to many physicists incongruous to speak of an abandonment of mechanical principles when one of the most important sections of physics to-day is the study of wave mechanics.[355]

Here McCabe, more at home with biology, is mistaking a name for a description. Wave mechanics is the name given to the formulation of quantum theory by the Austrian Erwin Schrödinger. While it could be regarded as more classical than early quantum theory of the atom developed by Bohr, it dismisses the particle altogether, substituting for it waves alone.

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[350] McCabe, *The Existence of God*, 142.
[351] McCabe, *The Existence of God,* 143.
[352] McCabe, *The Existence of God,* 143.
[353] Bowler, *Reconciling,* xii.
[354] Bowler, *Reconciling,* 15-16.
[355] McCabe, *The Existence of God,* 144.

While the title involves the word 'mechanics' it is far from a Victorian understanding of physics**.**

McCabe then attacks the Idealism of Eddington and Jeans arguing that the average man-or-woman- in-the-pew was not aware of their denial of an objective universe. They would be shocked if their spiritual leaders acquainted them with this fact. He goes on to say that it seems a pity that the man-and-woman-in-the-pew were not clearly informed from the start that it meant, not that there is mind in a material universe, but that the material universe exists only in the human mind. This is a misrepresentation. Neither Eddington nor Jeans believed that the material universe exists only in the human mind or any other. Their Idealism, while far from fully formed, was not that simple.

McCabe goes on to assert that the most popular expressions of 'the new hope' were encouraged by phrases in the works of Jeans and Eddington and that the new discoveries have shattered 'the materialistic science of the nineteenth century' and thus cleared the field for the theistic interpretation.[356] Neither argued that the situation was as simple as that.

McCabe then makes two linked objections to the work of Jeans and Eddington. Firstly, the statement that a large number of men of science were materialists in the last century and very few are today is false. Eddington and Jeans do not make this claim in their books. They do say that the old materialist understanding of the universe is no longer credible in the light of modern physics. His second objection is that Haeckel and Büchner are maligned as neither based their theories on the existence of 'the hard, impenetrable atom' as the final unit of matter. This is odd as neither man is named or alluded to in works published by Jeans or Eddington during or before 1933, the date of the publication of the second edition of *The Existence of God*. Eddington is not saying 'they said atoms were the smallest unit; now we know they are not', he was saying that the notion of the atom since Rutherford's work has undergone a re-conceptualisation. It is not the solid 'real' thing previously imagined, but might be better described as electrical charges in a lot of empty space. McCabe concludes his discussion of Jeans and Eddington in *The Existence of God* with the following:

> In short, this entire claim that theism has entered upon a new and more hopeful phase because of changes in either science or philosophy is based upon crude interpretations of the personal opinions of two or three scientific men who, the general public would be surprised to know reject the magnificent story of the

[356] McCabe, *The Existence of God,* 146.

> evolution of the stars, planets, and life, put together by twenty other sciences... Physics is one of fifty branches of science. All the others deal with atomic matter just as they did in the nineteenth century.[357]

This gives an indication of the McCabe style of 'good-natured contempt', which is not above exaggeration and misinformation. Jeans and Eddington do not reject the work of other scientists and they did accept evolutionary biology. What McCabe appears to be referring to is their belief in a form of Idealism, and the associated views about the role of mind or thought in our perception of reality. Whether physics is one of five or fifty branches is a question for the taxonomy of science, but clearly its role is fundamental in understanding other branches of science and it is the key science for understanding atomic matter.

Joad produced minutely argued and scrupulously fair criticisms of the writings of Jeans and Eddington. McCabe's writing is neither reasonable nor accurate nor too far removed from the worst polemic, even though at the end of *The Existence of God* he calls for an end to 'mutual vituperation'. In *The Riddle of the Universe To-day* McCabe's arguments are even less structured than in *The Existence of God* and it appears to be unedited journalism at its worst.

As has been said, Chapter XI of *The Riddle of the Universe To-day* called 'God and Two Astronomers' is a parody of the title of Inge's book. By the end of the chapter McCabe has changed his mind about Inge's book and writes that it really ought to be called *God and One Astronomer*, for it is built entirely upon Jeans' theory of the end of the material universe.[358] This is not accurate. Eddington receives somewhat more mention than Jeans in Inge's book as will be seen when this book is examined in greater depth. Inge's book is the expanded text of the Warburton Lectures delivered in Lincoln's Inn Chapel from 1931 to 1933. The expansion involves a preface and introductory chapter followed by the six lectures. While Inge does discuss at length his own form of Christian Platonism and much of the book is an attack on the notion of progress and pantheism, astronomy and the ideas of Jeans and Eddington do lie at the heart of it.

McCabe begins 'God and Two Astronomers' with an unfavourable review comment taken from *Nature of* 4 August 1928 of Jeans' academic *Astronomy and Cosmology* of 1928, as has already been seen. McCabe then returns to familiar ground, namely that while Jeans and Eddington were being quoted 'all over England and America' no one was aware of their

[357] McCabe, *The Existence of God,* 150.
[358] McCabe, *Riddle Today,* 206.

Idealism. The works of the two distinguished astronomers 'were forced on the public by the exemplary co-operation of Press and pulpit' and all the world learned to smile at the mechanical conceptions of Victorian men of science. He then returns to the theme that no one pointed out to the public that these two leading authorities on the material universe and the new interpretation of it 'did not believe in the objective existence of anything.'[359] This is, as has been seen, inaccurate. After only a page of discussion on this topic he declares that he had seen enough of the absurdities of an Idealist philosophy. He then turns to Eddington's *Science and the Unseen World* starting with another comment on Eddington's good character and then writes that he 'repudiates the idea that astronomy furnishes evidence for the existence of God' while scientists who 'do not know astronomy (Millikan, Pupin, Thomson, etc) assure the public that the heavens do declare the glory of God; but what precisely does it all mean if the heavens are only an idea in the divine mind?' [360] This is a good example of polemical selective quotation. Eddington is not denying the validity of the Psalmist's declaration, as can be seen in the paragraph to which McCabe is alluding:

> It is so rubbed into us with implications far beyond the simple poetic thought awakened by the splendour of the star-clad sky.[361]

Eddington makes no use of the design argument and denies that science can prove the existence of God. McCabe then restates another theme in *The Existence of God,* that Eddington and Jeans are the two leaders of a very small band of older scientists who maintain that there is a difference between the physics of the 1930s and that of the late Victorian era. This is in clear contradiction with Russell's view above regarding 'the bulk of eminent physicists and a number of eminent biologists'.[362]

The rest of *The Riddle of the Universe To-day* goes over much the same ground as *The Existence of God.* McCabe's style is often vituperative, frequently misrepresents the arguments of Eddington and Jeans, is not well structured and sometimes his background as a biologist shows in his comments on physics and astronomy. McCabe was a popular author in his time but his work did not have the impact of Russell, partly due to his lack of an academic post. A few of his works are currently available as reprints but he has nothing comparable with the reissue of *The Scientific Outlook,* complete with a preface by David Papineau, which

[359] McCabe, *Riddle Today,* 191.
[360] McCabe, *Riddle Today,* 192 quoting *Unseen World,* 17.
[361] Eddington, *Unseen World,* 17.
[362] Bertrand Russell, *The Scientific Outlook*, 105.

appeared in 2009.[363] McCabe's criticisms were widely read but were less well argued and evidenced than those of Joad or Inge or even Russell.

5.4 Two Critics of Eddington and Jeans

The writings of Bertrand Russell and Joseph McCabe display a profound dislike for the three key texts which are the main sources of the thought of Eddington and Jeans for the purposes of this dissertation. Their comments are not balanced and objective and they display a partial reading of the texts. Russell's claim to have knowledge of what motivated the two astronomers is bizarre, but he does reasonably point out that some supporters read more into their work than was there. There seems to be no evidence that Eddington or Jeans wrote for political reasons or to secure further honours. Russell is still read and the book has been reissued, but *The Scientific Outlook* is not one of his best argued. McCabe's work has many inaccuracies and questionable judgements. It is journalism not scholarship. His work was widely read at the time and helped build on the critical comments from 'free thinkers' but it has not had a lasting influence.

In the next section the work of Eddington and Jeans will be examined as it relates to four key areas of theological discussion. The work of their critics and supporters will again be examined.

[363] Bertrand Russell, *The Scientific Outlook* with a preface by David Papineau (London: Routledge Classics, 2009).

CHAPTER SIX

THEOLOGY ENCOUNTERS THE NEW PHYSICS

6.1 Introduction

In this chapter the thought of Eddington and Jeans will be explored as it relates to some traditional theological ideas, namely: the creation and end of the universe; free will and the design argument. These were issues which were commented upon by reviewers and book writers. In addition, from the writings of Eddington alone, the classic Quaker emphasis on the Inner Light and intuition which did not receive as much attention, apart from sideswipes from Russell, will also be explored. It is crucial to an understanding of his work.

6.2 Eddington and Jeans on the Creation and End of the Universe

In this section the views of Eddington and Jeans on the Creation and Eschaton will be examined along with the responses of Russell and Inge. There are two aims in doing so. The first is to describe the encounter between the new physics and theology. The second is to illustrate one problem in writing scientific apologetics (and many other disciplines admittedly): that of timing. A position that seems, to the writer at least, credible can in the space of a few years of scientific advance look unwise or naïve.

The chapter in *The Nature of the Physical World* which best sums up Eddington's view on the creation of the universe is, ironically, the chapter entitled 'The Running Down of the Universe'. Eddington in 1928 had grave difficulties with the then emerging view depicting the universe as expanding, the view that would later be dubbed the 'big bang' by Fred Hoyle, one of Eddington's former pupils.[364] Eddington outlines two of the difficulties as he saw them:

[364] Fred Hoyle coined the term in a BBC Third Programme broadcast lecture in February 1950: see Jane Gregory, *Fred Hoyle's Universe* (Oxford: Oxford University Press, 2005), 47. The term 'big bang', in lower case, can be found in the published version of the lectures, Fred Hoyle, *The Nature of the Universe* (London: Blackwell, 1950), 102.

> But the difficulty of an infinite past is appalling. It is inconceivable that we are the heirs of an infinite time of preparation; it is not less inconceivable that there was once a moment with no moment preceding it.[365]

One of the strengths of Eddington and Jeans as apologists is that they do not overstate their case and they do not rush to judgement based on the latest, transitory theory in the physical sciences. Eddington writes that both scientists and theologians will reject as somewhat crude the naïve theological doctrine which is found, he says, in every textbook of thermodynamics, namely that some billions of years ago God wound up the material universe and has left it to chance ever since. Eddington asserts that this should be regarded as a working hypothesis of thermodynamics rather than its declaration of faith. It is one of those conclusions from which he saw no logical escape – but nevertheless he found it incredible:

> As a scientist I simply do not believe that the present order of things started off with a bang; unscientifically I feel equally unwilling to accept the implied discontinuity in the Divine nature. But I can make no suggestion to evade the deadlock.[366]

Russell in *The Scientific Outlook* rounds on these comments of Eddington, chastising him for not being sufficiently orthodox and criticising, perfectly reasonably, his selectivity of which scientific findings he will believe. Russell accuses him of not inferring a definite act of creation by a Creator because he does not like the idea. For once Russell is being fair to Eddington. He does give, in full, over a page of Eddington in quotation including the final sentence above which shows how Eddington is struggling with the issue. Russell continues:

> This illustrates the fact that the theological conclusions drawn by scientists from their science are only such as pleases them, and not such as their appetite for orthodoxy is insufficient to swallow, although the argument would warrant them.[367]

Russell said that there is far more to be said for the view that the universe had a beginning in time at some not infinitely remote period, than there is for any of the other theological conclusions drawn by scientists such as Eddington and Jeans. This criticism of Eddington is well made. Is there a theological motive in Eddington's rejection of a definite time to creation?

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[365] Eddington, *Nature of the Physical World,* 83.
[366] Eddington, *Nature of the Physical World,* 84-85.
[367] Russell, *Scientific Outlook,* 122.

Does it sound too much like the Creation story of Genesis chapter one for the liberal Quaker Eddington? Did he view it as giving ammunition to a more biblical understanding of the creation as favoured by the evangelical Quakers of Britain and America? Matthew Stanley indicates that for many liberal Quakers the rise of evangelical influence within the Society of Friends was viewed with apprehension.[368] The idea that Eddington rejected the concept of the expanding universe because it found favour with evangelicals is a credible explanation of Eddington's initial response.

Russell goes on to assert, reasonably, that while there was a time at which the universe was created, that does not mean that there is necessarily a Creator. Russell accepts provisionally that the world was made at some remote but unknown date. He asks if this indicates that the world was made by a Creator and answers himself - 'Certainly not, if we are to adhere to the strict canons of valid scientific inference.'[369] There is no reason whatever why the universe should not have begun spontaneously, says Russell, except that it seems odd that it should be so; but there is no law of nature to the effect that things which seem odd to us must not happen. There is, however, little expectation of spontaneous generation within the canons of science. Russell does not tell us what 'the canons of valid scientific inference' are, but does go on to argue as follows:

> To infer a Creator is to infer a cause, and causal inferences are only admissible in science when they proceed from observed causal laws. Creation out of nothing has not been observed. There is, therefore, no better reason to suppose that the world was caused by a Creator than to suppose that it was uncaused; either equally contradicts the causal laws that we observe.[370]

Anthony Kenny has described the problems for an atheist adhering to the Big Bang theory:

> According to the Big Bang Theory, the whole matter of the universe began at a particular time in the remote past. A proponent of such a theory, at least if he is an atheist, must believe that the matter of the universe came from nothing and by nothing.[371]

[368] Stanley, *Practical Mystic,* 18.
[369] Russell, *Scientific Outlook,* 122.
[370] Russell, *Scientific Outlook,* 122-123.
[371] Anthony Kenny, *The Five Ways: St Thomas Aquinas' Proofs of God's Existence* (London: Routledge, 1969), 66.

Lawrence Krauss has suggested an answer to the position outlined by Kenny.[372] Krauss argues that 'the very distinction between something and nothing has begun to disappear'[373] and that 'the case that *our* universe arose from nothing seems by far the most compelling intellectual alternative' with the idea of God described as a rather facile semantic solution. [374]

What Russell is arguing, namely that a creation by God and a material universe uncaused are equally plausible or implausible, is completely in line with what Eddington is putting forward in *The Nature of the Physical World.* For Eddington the science of the early twentieth century held no problems for those who have an inner experience of the truth of religion but equally neither the data of science nor the methods of science could prove the truth of religion or the existence of a Creator.

Nevertheless, the statement 'There is, therefore, no better reason to suppose that the world was caused by a Creator than to suppose that it was uncaused' does not necessarily follow from 'Creation out of nothing has not been observed.' The main problem with Russell's argument is his use of the word 'law'. He states that 'either equally contradicts the causal laws that we observe'. Scientists do not observe laws. Observations may form part of the process which leads to the formulation of scientific laws. Further observations may lead to the refinement or the discarding of a law, but scientists do not observe laws, they construct or formulate laws. Peter Bussey rejects this view, holding a view closer to Russell.[375] Russell then turns to the idea that a Creator and Sustainer of the universe may provide comfort for believers:

> Nor is there, so far as I can see, any particular comfort to be derived from the hypothesis that the world was made by a Creator. Whether it was, or whether it was not, it is what it is... In like manner, I see no comfort to be derived from the supposition that this very unpleasing universe was manufactured of set purpose.[376]

Russell says that some people, among whom he explicitly does not include Eddington, derive comfort from the thought that if God made the world, God may wind it up again when it has

[372] Lawrence M Krauss, *A Universe from Nothing: Why there is something rather than nothing* (London: Simon & Schuster, 2012).
[373] Krauss, *A Universe from Nothing,* 182-183.
[374] Krauss, *A Universe from Nothing,* 183-184.
[375] Peter J Bussey, 'Beyond Materialism: from the Medieval Scholars to Quantum Physics' *Science and Christian Belief,* 16 (2003) 161-162.
[376] Russell, *Scientific Outlook,* 123.

completely run down. Russell concludes his section criticising the idea of God as Creator by returning to the idea that the new physics has replaced or dethroned the old materialism:

> ... every scientist who had a tincture of philosophy was ready to admit that the hard little lumps [in the old model of the atom] were no more than a technical device. In that sense materialism is dead, but in another and more important sense it is more alive than it ever was.[377]

Russell is at his best in pointing out the weakness in Eddington's use of philosophy and his rejection in *The Nature of the Physical World* of an expanding universe. Russell does not make the best case for a materialism risen from the dead and while Bussey may agree with Russell on the status of scientific laws determining nature's behaviour, to say that causal laws are 'observed' is far too loose a use language for a philosopher.

One question of perennial interest is the place of humanity in the Creation. The reading public then and now want to know if we are alone in the universe. In Chapter VII of *The Nature of the Physical World* 'Man's Place in the Universe' Eddington discusses the formation of planetary systems. He outlines Laplace's nebular theory but opts for Jeans' more recent theory which suggests a close approach of another sun drew out the planets from the then larger sun. Astrophysicists have returned to a theory closer to that of Laplace. Eddington uses his discussion of the science to state his position on whether *homo sapiens* are the only form of life created by God in the Universe. The then current science led him to believe that solar systems were a freak and that double stars with no planets were more common. He thought that one in a million stars had a planetary system. He did not see every star as 'a likely minister to life.'[378] But, he says, we know the prodigality of Nature, with many acorns scattered per oak grown:

> If indeed she has no grander aim than to provide a home for her greatest experiment, Man, it would be just like her to scatter a million stars whereof one might haply achieve her purpose.[379]

It is important to note the 'If indeed'. Eddington does not hold a simple view of humanity as the king and queen of creation or as this earth as the sole place where intelligent life might be found:

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[377] Russell, *Scientific Outlook,* 125.
[378] Eddington, *The Nature of the Physical World,* 177.
[379] Eddington, *The Nature of the Physical World,* 178.

> I do not think that the whole purpose of the Creation has been staked on the one planet where we live; and in the long run we cannot dream ourselves the only race that has been or will be gifted the mystery of consciousness. But I feel inclined to claim that *at the present time* our race is supreme; and not one of the profusion of stars in their myriad clusters looks down on scenes comparable to those which are passing beneath the rays of the sun.[380]

It is clear that C S Lewis held a similar view.[381] We know that Lewis had read Eddington and Jeans. Did such passages as the one above help shape his view? In Lewis' essay 'The Seeing Eye' a very similar position is put forward. This is taken up in novel form in the Ransom or Cosmic Trilogy. The influence of Eddington and Jeans upon Lewis is discussed at greater length in chapter ten.

As was said at the beginning of this section, timing is key when it comes to writing popular scientific apologetics. In this Jeans was at an advantage with the publication of *The Mysterious Universe* in 1930 over Eddington's *The Nature of the Physical World* which was published in 1928 and *Science and the Unseen World* which was published in 1929. In *Science and the Unseen World* Eddington again looks at the creation in some depth but still has not accepted the notion of an expanding universe. He begins with an account of the creation which is a mixture of contemporary science and allusion to the text of Genesis chapter one:

> Looking back through the long past we picture the beginning of the world – a primeval chaos which time has fashioned into the world that we know. Its vastness appals the mind; space boundless though not infinite, according to the strange doctrine of science. The world was without form and almost void... In the beginning was vastness, solitude and the deepest night. Darkness was upon the face of the deep, for as yet there was no light.[382]

In 1929 Edwin Hubble announced what became known as Hubble's Law. He had measured the velocities of eighteen galaxies and discovered that these velocities increased in proportion to their distance from the earth. This was the first observational evidence of an expanding universe, although theoretical cosmological models had been put forward in which expansion was a component by the Dutchman de Sitter in 1917, the Russian Friedmann in 1922 and the

[380] Eddington, *The Nature of the Physical World,* 178 *italics* as in the original.
[381] See Lewis' essay The Seeing Eye' in C S Lewis, *Christian Reflections*, ed. Walter Hooper (New York: Ballantine, 1986), 233-237 and *The Cosmic Trilogy* (London: Bodley Head 1990).
[382] Eddington, *Unseen World,* 9.

Belgian priest Lemaitre (another former pupil of Eddington) in 1927. Eddington's account in *Science and the Unseen World* was thus, as in *The Nature of the Physical World* a pre-Hubble's Law, pre-expanding universe description. Eddington describes in *Science and the Unseen World,* the aggregation of particles into 'island universes' what we would now call galaxies. The process, as then understood, said that first star clusters and then individual stars formed. Eddington then explains again the next key event in the development of the universe saying that a star journeying through space casually overtook the Sun, not colliding with it, but approaching so close as to raise a great tidal wave. By this disturbance, jets of matter spurted out from the sun and then condensed into small globes – the planets. This is the view espoused by Jeans in his Adams Prize Essay. As has been said, it is not the view now held. This section in *Science and the Unseen World* also contains the significant statement:

> Thus the design of the first stage of evolution seems to have been that matter should ordinarily be endowed with intense heat. Cool matter appears to be an afterthought.[383]

The concept of design found in the writings of Jeans will be considered further at a later stage. This is one of the rare occurrences of the word in the writings of Eddington and he does not expand on the statement. Eddington along with Jeans believes that while planetary systems are not unique to our solar system, they are very rare. He then gives an outline of evolution leading to the arrival of *homo sapiens* in the physical world. When the formation of island universes, star clusters, stars and planets have been described, Eddington takes up his usual stance with regard to biological evolution saying that the story of evolution here passes into the domain of the biological sciences for which he cannot speak. He was not ready to take sides 'in the controversy between the Mechanists and the Vitalists.'[384]

The current science seen in this section is deftly delivered. It shows Eddington's profound understanding of the science involved and how to deliver a difficult topic to an audience of non-scientists. Eddington is happy to admit to a lack of complete knowledge. The following passage, talking of island universes, illustrates both this willingness and also the deftness of exposition:

[383] Eddington, *Unseen World,* 12.
[384] Eddington, *Unseen World,* 14.

> They acquired rotation (we do not yet understand how) which bulged them into flattened form and made them wreathe themselves into flattened spirals.[385]

Eddington shows no hesitation in describing and affirming the current account of the creation, as described by modern physics, nor with using the words of Genesis 1 in the same passage. Eddington suggests that some may say that 'the scientific epic of creation' is more to the glory of God than the biblical account but that it is not right to permeate scientific research with religious implication. There is possibly a contradiction between his approach at the start of the book and this last statement of his.

We do see his interest in numbers - which became a feature of his later books - emerging. 'Nature' is personified, but it is done in Eddington's traditional tongue-in-cheek manner. Eddington is also clear that religion does not depend on the substitution of the word 'God' for the word 'Nature'. It is worth quoting one section on the place of humanity as it will become relevant when the response of Stebbing is discussed:

> Looking back over the geological record it would seem that Nature made nearly every possible mistake before she reached her greatest achievement Man – or perhaps some would say her worst mistake of all.[386]

It is interesting that Russell, a mathematician and philosopher, accepts an expanding universe theory of creation in *The Scientific Outlook* published in 1931, whereas Eddington, an astronomer, was in 1928 still saying, 'As a scientist I simply do not believe that the present order of things started off with a bang.'[387] Hubble's law was published in 1929. According to Helge Kragh it was in 1930 that the expanding universe became generally accepted.[388] Kragh seems to mean here that it became widely accepted in the scientific community, rather than amongst the general public. He sees the comments of Eddington at a Royal Astronomical Society in January 1930 as a significant part of this process. Eddington's semi-popular book of 1933 *The Expanding Universe* helped spread these ideas amongst the reading public. Here he accepts that the observational and theoretical evidence is pointing to an expanding universe. Kragh admits in the Preface that the view that the expanding universe is only 'tentatively held'[389] but talking of the work of the observers Eddington writes:

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[385] Eddington, *Unseen World,* 10.
[386] Eddington, *Unseen World,* 15.
[387] Eddington, *Nature of the Physical World,* 85.
[388] Kragh, *Quantum Generation,* 397.
[389] Helge Kragh, *Cosmology and Controversy* (Princeton: Princeton University Press, 1996), 21.

> Their picture is the picture of an *expanding universe*. The super-system of the galaxies is dispersing as a puff of smoke disperses.[390]

The generally accepted scientific view of the universe before the new thinking of the early twentieth century was of a static universe. *The Scientific Outlook* was published in 1931 and refers to *The Nature of the Physical World* and *The Mysterious Universe* but interestingly not to *Science and the Unseen World. The Scientific Outlook* was published before Eddington changed his mind on the issue as demonstrated in *The Expanding Universe.*

Jeans, writing in late 1930, had no problem with the idea of a creation followed by an expanding universe. He like Eddington has a chapter devoted to the winding down of the universe – 'The Dying Sun'. In the concluding chapter Jeans agues from entropy to a creation in time:

> It [entropy] is still increasing rapidly, and so must have had a beginning; there must have been what we may describe as a "creation" at a time not infinitely remote.[391]

Jeans' form of Idealism emphasises 'thought' (as opposed to 'mind') and he sees the creation as an act of thought. According to Jeans the finiteness of space and time compels this conclusion. Jeans sees this as extending to the setting of the constants of the physical universe. Jeans, following Plato and Augustine, sees the creation of matter as taking place with the creation of time.

Jeans is sometimes portrayed as the first to put forward the idea of the Steady State Theory or Continuous Creation. Fred Hoyle believes him to be an underrated astronomer in general and to have made a significant contribution in this area in particular.[392] A closer reading of the relevant section in *Astronomy and Cosmogony,* the text often cited by those putting forward this view, shows that his 'conjecture' that 'matter is being continuously created' indicates that this is how it appears to observers in this universe. What he conjectures is that the centre of nebulae (i.e. galaxies) are points at which 'matter is poured into our universe from some other, and entirely extraneous, spatial dimension'.[393] He could therefore also be claimed as a pioneer of the multiverse conception. A more sober assessment is that he was working at the

[390] Eddington, *The Expanding Universe,* 13 *italics* as in the original.
[391] Jeans, *The Mysterious Universe,* 147.
[392] Fred Hoyle, *Home is Where the Wind Blows* (Mill Valley, University Science Books, 1994), 419. Hoyle's continuing opposition to the Big Bang thesis is clear in this autobiography.
[393] Jeans, *Astronomy and Cosmogony,* 360.

boundary of astronomy and producing an informed speculation on the basis of the then available evidence. In *The Mysterious Universe,* Jeans is putting forward the idea of an expanding universe.

Jeans' thought on the creation will be examined in further detail in the section on the design argument.

Inge (who will be considered in greater detail in the next chapter) picked up on another aspect of the writings of both Eddington and Jeans in his 1934 book *God and the Astronomers*, this time very much with approval.

> The astronomers tell us as a certain fact – Eddington says it is the most certain truth of science - that the whole universe is steadily and irrevocably running down like a clock. The inevitable end, says Jeans, is annihilation – annihilation of life, of consciousness, of memory, even of the elements of matter itself.[394]

The doctrine of progress, says Inge, even a Law of Progress according to Spencer, was followed by many including, very cautiously, Darwin. Then he groups Hegel, 'the new Italian Idealists Croce and Gentile', Bergson, Professor Alexander and Wildon Carr, he says that for all these writers, God is bound up with God's creation. The world is as necessary to God as God is to the world. God is realising Godself in the historical process.

For these writers, God's fortune was entangled with that of the Cosmos, which is merely the externalisation of Godself. But, says Inge, all this time these men knew that this hope of progress was illusory for it was understood even then that the cosmos is dying and will fade away to nothing. Why did these men of science and philosophy not face this issue? He argues that they were so obsessed with what was really the lay religion of the time – the this-world religion, which by its illusory optimism had almost displaced the blessed hope of everlasting life taught by Christianity – that they could not believe that their law of never-ending progress was a dream.

> And yet, if Jeans and Eddington are right, this emerging, evolving God is no God at all, for surely a God under sentence of death is no God. Modern pantheism is built on sand, if it seeks to find a support in the natural sciences...

[394] Inge, *God and the Astronomers,* 8.

> Is science itself driving us back to the traditional Christian doctrine that God created the world out of nothing at a certain date?[395]

Neither Eddington nor Jeans come to any conclusion on the issue of whether or not creation was *ex nihilo,* while it was a key aspect of Christian belief for Inge. Fergusson in *The Cosmos and the Creation* argues that while the doctrine of the creation out of nothing 'is not taught in Scripture'[396] it was accepted 'almost immediately and unanimously.'[397] Inge continues that the acceptance of the Law of Entropy seems to drive us back to the traditional belief in an external Creator, who made a world which had a beginning in time and will have an end in time. Inge describes this as an astonishing *volte face* from the ideas of the nineteenth century, and yet, he says, the Law in question was pretty well known long before Eddington and Jeans began to write.

There can be no denying that Inge is using the latest science to bolster his own theological position. But he is accurately portraying it and he is widely enough read not merely to be using just the popular and semi-popular works of Jeans and Eddington to make his point. He is also critical of their use of Idealism; he does not accept all their views blithely.

While the picture of the fate of the universe has been refined and developed since the time of Jeans and Eddington, Inge's conclusion still stands. The scientific understanding of the future of all creation does not support the picture of unending progress of the human race in a forever habitable universe:

> The new astronomy forbids us to find an infinite purpose in our universe. Here again we seem to be returning to the religious beliefs in which we were brought up, abandoning the romantic apocalyptism of the last century.[398]

Inge defends his use, as an Anglican, of the work of Jesuit 'new Thomist' writers in a way that would be unnecessary today, saying that Christian Platonism has been strong in the English church, possibly as it is congenial to the English mind. He feels this understanding of the

[395] Inge, *God and the Astronomers,* 9-10.
[396] David A S Fergusson, *The Cosmos and the Creator* (London: SPCK, 1998) 23. Against this view see 2 Macc 7.28, Jn 1.3, Col 1.15-20 and Paul D Murray and David Wilkinson 'The significance of the theology of creation within the Christian tradition: systematic considerations', Chapter Two of Christopher Southgate, (ed.), *God, Humanity and the Cosmos: A Companion to the Science-Religion Debate* (Edinburgh: T & T Clark, 3rd ed. 2011).
[397] Fergusson, *The Cosmos and the Creator,* 31.
[398] Inge, *God and the Astronomers,* 12.

Christian faith is not only congenial to the English mind but very suitable to the current needs in defending the faith.

Inge was a Christian theologian who was positive about science. He sees it as having a reforming role in the life of the church. It purges human ideas of their own importance. It rebukes humans for exalting themselves above the animals. We are not the crown and roof of all.

> God is revealing Himself to our age mainly through the book of nature, fresh pages of which are opening before us nearly every year. I have no doubt this knowledge is given to us for a purpose. Science has been called, by Baron von Hugel, the *purgatory* of religion. The study of nature, he means, purifies our ideas about God and reality.[399]

It is interesting to see the contrast between his views on science and his views on modernist philosophy. Inge's own position on Realism and Idealism is not too far from Critical Realism: 'The world that we live in is real, though our pictures of it are very unlike the reality.'[400]

Inge then goes into a long discussion of the religious and philosophical significance of the second law of thermodynamics, largely without any reference to Eddington or Jeans. Modern science seems to point to a universe which is not eternal; we cannot look to this world for abiding joy or satisfaction. But Inge sees science as supporting traditional Christian theism, which postulates a Creator independent of his Creation, a creation which was made at a point in time and will end at a point in time. While entropy is unlike some physical laws in being non-reversible, it is accepted to be a key plank of modern physics and astronomy:

> There are some men of science who frankly admit that they see no way out of the impasse. Eddington, in his justly popular book, *The Nature of the Physical World* says that the Second Law of Thermodynamics 'holds the supreme position among the laws of nature.' 'If your theory is against this law I can give you no hope; there is nothing for it (your theory) but to collapse in deepest humiliation.'[401]

[399] Inge, *God and the Astronomers,* 15.
[400] Inge, *God and the Astronomers,* 16.
[401] Inge, *God and the Astronomers,* 33 quoting Eddington, *The Nature of the Physical World*, 77.

C S Lewis in his 'The Weight of Glory' sermon also the uses the second law of thermodynamics in a similar defence of Christian orthodoxy.[402] Eddington says the second law of thermodynamics points either to a date at which the contents of the universe were created in a state of high organisation, or at which pre-existing entities were endowed with energies which they have since been squandering.

Both Eddington and Jeans bring the latest science to bear upon two traditional areas of theological study. Eddington is reluctant to accept the idea of an expanding universe but then, when he believes there to be sufficient evidence, he not only embraces the idea but he popularises the view he once rejected.

Christian apologetics is written at a particular point in time. One of the consequences of this is that what is written at one point can become outdated or superseded. Eddington was wise enough to change his mind on the expanding universe. This was not, however, the case with what came to be known as the Chandrasekhar Limit, as the next section will show.

Both Eddington and Jeans are also wise enough to declare that they are writing about developing science and acknowledge that their views may change. Both authors are of the view that science and theology overlap and are happy to see them interact. They were both explicitly aware of their own lack of philosophical and theological training and of the opprobrium they would face as amateurs in other people's disciplines and for popularising their own field of expertise but nevertheless they felt it was important to initiate a discussion in some of the areas where both theology and science have a contribution to make. Their conclusions on the Creation and the end of the universe were not the last word but their willingness to discuss such issues was surely justifiable.

The popularity of Jeans and Eddington in the years leading up to the Second World War had an effect on both the science and religion debate and on apologetics. Their emphasis on astronomy and physics moved the debate in Britain away from evolutionary biology and on to the physical sciences and the creation of the universe. The readability of both Jeans and Eddington meant that they attracted attention from the man and woman in the pew, the regular churchgoer, but also the man and woman on the Clapham omnibus, the non-churchgoer. The impact of Jeans and Eddington and the depth of Eddington meant that their work was considered by professors of philosophy, deans of cathedrals, young scientists and

[402] C S Lewis, 'The Weight of Glory' in C S Lewis, *They Asked for a Paper* (London: Geoffrey Bles, 1962), 201.

future church leaders. Their consideration of the expanding universe model in cosmology gave the basis for Christian theologians and scientists to engage with what later became described as big bang cosmology. Milne, Jeans' biographer, wrote one such book, *Modern Cosmology and the Christian Idea of God*, in which he acknowledges his debt to Eddington from the first pages but strives to take the debate forward.[403] Pius XII in an address to the Pontifical Academy of Sciences in November 1951 entitled 'The Proof for the Existence of God in the Light of Modern Natural Science' used various aspects of recent science including Hubble's work on an expanding universe to support traditional Catholic belief.[404] More recently David Wilkinson has written on this topic.[405]

The issue of the heat death of the universe was raised by Eddington and Jeans and then taken up by Inge. This will be discussed in a later section. This is an issue for theology and perhaps it has been neglected by theologians, apart from Polkinghorne and Wilkinson.[406]

6.3 The Role of Intuition and Seeking in Religion and Science

Eddington's view on intuition and experience in religious belief drawing on some of the key sections in *The Nature of the Physical World* will now be examined.[407] The Quaker understanding of the Inner or Inward Light and Quaker belief in the priority of religious experience over theology were part of Eddington's spiritual inheritance. To this Eddington brought two further elements which were not exclusively Quaker. The first was a form of nature mysticism which saw the natural world as a place where one might spontaneously experience mystical feelings. This was clearly linked with Eddington's love of the countryside and appreciation of the natural world. Richard Dawkins has an interesting view on this, 'A quasi-mystical response to nature and the universe is common amongst scientists and rationalists. It has no connection with supernatural belief.'[408] While a love of nature is not exclusively Quaker, Cantor has pointed out that it was an element within the tradition of the

[403] E A Milne, *Modern Cosmology and the Christian Idea of God* (Oxford: Clarendon, 1952), 1-2.
[404] https://www.ewtn.com/library/PAPALDOC/P12EXIST.HTM see especially paragraphs 36 and 44.
[405]David Wilkinson, 'The revival of natural theology in contemporary cosmology', *Science and Christian Belief,* 2 (October 1990) 2, 95-115, *God, the Big Bang and Stephen Hawking* (Crowborough: Monarch, 2nd ed. 1996), *The Message of Creation* (Leicester: IVP, 2002).
[406] John Polkinghorne, *The God of Hope and the End of the World* (London, SPCK, 2002) David Wilkinson, *Christian Eschatology and the Physical Universe* (London: T&T Clark, 2010).
[407] Eddington, *The Nature of the Physical World* (Cambridge: Cambridge University Press, 1928).
[408] Richard Dawkins, *The God Delusion,* 32.

Society of Friends from the beginning. George Fox would often go with his Bible into the orchards or a field, seeing this as a better method of communion with God than attending church.[409]

The second element was Eddington's commitment to philosophical Idealism which he claimed developed out of his mathematical researches into relativity theory. As has been seen before, Eddington emphasises the essential unity of the human mind with the rest of the universe. The mind is not separate from the physical world but an integral part of it. He goes on to argue that to dissect a joke may be a learned process which will expose the inner workings of any alleged joke, but will banish its laughableness, for the real apprehension must come spontaneously, not introspectively, as must our mystical feeling for nature and our mystical experience of God.[410]

Eddington draws a distinction between symbolic knowledge and intimate knowledge. Mathematics, physics and theology are examples of symbolic knowledge; religious experience is an example of intimate knowledge. This definition is clearly influenced by his Quaker background with its assertion that religious experience is key and apostolic, as Rufus Jones was arguing, whereas the attempt to refine points of doctrine was seen as not necessary and at times positively dangerous. Quakers often view themselves as returning to a more apostolic understanding of and practice of Christianity than the mainstream churches.

The Apostle Paul is portrayed in the New Testament, in the Pauline epistles and by the author of Acts, as having undergone a number of significant religious experiences. Nevertheless, neither Jones, Eddington nor Stanley mentions the fact that the apostle Paul was clearly theologising when he wrote the Epistle to the Romans. Both experience and theology have a place in Christian belief. Eddington thinks that religious experience is key to believing and that theology is secondary, whereas Jones and Stanley are yet more negative about theological study.[411] Eddington views theology thus:

> We may try to analyse the experience as we analyse humour, and construct a theology, or it may be an atheistic philosophy, which shall put into scientific form what is to be inferred about it. But let us not forget that the theology is symbolic knowledge whereas the experience is intimate knowledge. And as laughter cannot

[409] Geoffrey Cantor, *Quakers, Jews and Science: Religious Responses to Modernity and the Sciences in Britain, 1650 – 1900* (Oxford: Oxford University Press, 2005), 230.
[410] Eddington, *The Nature of the Physical World,* 322.
[411] Stanley, *Practical Mystic,* 37.

> be compelled by the scientific exposition of the structure of a joke, so a philosophic discussion of the attributes of God (or an impersonal substitute) is likely to miss the intimate response of the spirit which is the central point of the religious experience.[412]

Along with the term 'The Inner Light', another key concept within Quakerism, is 'seeking'. The terms 'seeking' and 'Seekers' have a long history going beyond the foundation of the Society of Friends and are always closely linked with the idea of the Inner Light. The Seekers were a loose grouping of defectors from Anglican churches in the early seventeenth century, especially from Puritan congregations, who believed that the established church and other churches were ruled by the spirit of Antichrist. They were also known as the Waiters as they waited for the kingdom of God to be revealed. The Seekers did not attempt, or did not think it possible, to hasten its arrival, unlike some Anabaptists.[413] Some of the Waiters or Seekers shunned all religious meetings but others gathered for religious discussion, prayer, scripture reading and 'waiting upon the Lord in silence'. They had no religious leaders and did not administer the sacraments. The similarities with Quaker practice are obvious. By 1650 many of the Seekers had become disillusioned and George Fox found many early converts amongst these groups.

The term 'seeking' was thus in the Quaker lexicon from the foundation of The Religious Society of Friends and was linked with the concept of the Inner Light and the general Quaker distrust of theology. As the Inner Light was essential to real religion and truth was primarily to be found in the inner voice of God speaking to the soul rather than the attempt of men and women to formulate a precise creed or theology, seeking or striving rather than certainty was the key element of faith. Loukes argues that this Quaker theme is the extreme statement of the Reformation: that true religion consists not in certainty but in search.[414]

This idea of seeking and striving, tinged by Idealism, has already been noted in *The Nature of the Physical World* in chapter three above.[415] One has to strive in both science and religion as certainty is not available. As has been seen, Eddington believed science cannot prove the claims of religion, but modern physics provides no problems for believers who have religious experience or intuitive conviction. For Eddington, the starting-point of belief in mystical religion is a conviction of significance. Eddington said that this must be emphasised because

[412] Eddington, *The Nature of the Physical World,* 326.
[413] Cross and Livingstone (eds.), *The Oxford Dictionary of the Christian Church,* 1479.
[414] Harold Loukes, *The Quaker Contribution* (London: SCM, 1965), 15.
[415] Eddington, *The Nature of the Physical World,* 327-328.

appeal to intuitive conviction of this kind has been the foundation of religion through all ages and he did not wish to give the impression that he had now found something new and more scientific to substitute. This assertion is questionable as for many believers intuitive conviction plays a small or non-existent part in their religious life which may well be founded upon family or ethnic tradition or a belief in following religious authority.

One must seek and strive because proof is not possible in science, or religion, as shall be shortly seen:

> We cannot pretend to offer proofs. *Proof* is an idol before whom the pure mathematician tortures himself. In physics we are generally content to sacrifice before the lesser shrine of *Plausibility…* In science we sometimes have convictions as to the right solution of a problem which we cherish but cannot justify; we are influenced by some innate sense of the fitness of things.[416]

Eddington does not explain what he means by 'the fitness of things' nor elaborate on this any further although he uses the phrase again in the conclusion. Towards the end of *The Nature of the Physical World* Eddington embarks upon a summary of what modern physics might, tentatively, point towards:

> The idea of a universal Mind or Logos would be, I think, a fairly plausible inference from the present state of scientific theory; at least it is in harmony with it. But if so, all that our inquiry justifies us in asserting is a purely colourless pantheism. Science cannot tell whether the world-spirit is good or evil, and its halting argument for the existence of a God might equally be turned into an argument for the existence of a devil.[417]

This is an idea repeated later by Coulson in his John Calvin McNair Lectures. For Coulson 'the act of reflection' on nature 'has only got us as far as pantheism.'[418] Eddington and Jeans are both aware of the tentative nature of science. While they both see the physics of the early twentieth century as open to the possibility of Christian faith, they acknowledge that as Jeans said, the river of knowledge which once followed west (towards a crudely mechanical view of nature) and in the early twentieth century followed east (towards a non-mechanical view of the world) could again flow west.[419] Eddington believed that a besetting temptation of the

[416] Eddington, *The Nature of the Physical World,* 337.
[417] Eddington, *The Nature of the Physical World,* 338.
[418] Charles Coulson, *Science and Christian Belief* (London: Oxford University Press, 1955), 103.
[419] Jeans, *The Mysterious Universe,* 147.

scientific apologist for religion is to take some of its current expressions and after clearing away crudities of thought, to water down the meaning until little is left that could possibly be in opposition to science or to anything else. What the then current physics can show would be insufficient to justify the palest brand of theology that is not too emaciated to have any practical influence on man or woman's outlook. Eddington said he was unwilling to play the amateur theologian, and examine this approach in detail, but asserted that the attribution of religious colour to the religious domain must rest on inner conviction.

While it is in *The Nature of the Physical World* that the ideas of intuition and seeking are most thoroughly discussed, the ideas are found in others of Eddington's works, most notably in his Swarthmore Lecture *Science and the Unseen World* of 1929 in a passage already quoted.[420]

From the point of view of Eddington and Jeans, modern physics held no horrors for the believer. For Eddington, but not for Jeans, it was the Inner Light and seeking that provided both conviction and colour to religious faith. Eddington clearly saw a role for intuition in science, unlike Jeans. Eddington saw similarities in the knowing in both disciplines. Jeans relied on a mathematically rigorous approach to physics and astronomy. Following the British tradition of celestial mechanics, he believed in a mathematical model of truth in which valid knowledge came from rigorous deductions based on certain premises, as is shown by the following quotation from *Problems of Cosmology and Stellar Dynamics*:

> The main object of the essay is to build a framework of absolute mathematical truth; … When a firm theoretical framework has been constructed, it seemed permissible and proper to try to fit the facts of observational astronomy into their places.[421]

Eddington, no less a mathematician, did not share this approach, as we have seen in the quotation above on '*Proof', 'Plausibility'* and 'the fitness of things.'[422]

In *Science and the Unseen World* Eddington returns to the theme of the different methodologies of physics and mathematics, but starts from a discussion of theology and says that the physicist unhappy with the lack of coherence and the indefiniteness of theological theories, will probably be displeased with the theories of biology and psychology. They also fail to come up to his standard of methodology. But yet, he argues, knowledge grows in all

[420] Eddington, *Unseen World,* 47-48.
[421] Jeans, *Problems of Cosmology and Stellar Dynamics,* iv.
[422] Eddington, *The Nature of the Physical World,* 337.

these branches. Wherever a way opens for the scientist or other scholar, he or she is impelled to seek using the methods that can be devised for that particular opening.

In Eddington's work on stellar structure this methodology took the form of a somewhat speculative approach to science. Stanley says that Eddington's methodology was very different from Jeans' methodology.[423] Eddington rarely followed the custom of first defending his assumptions, instead he rapidly moved beyond what he could prove and merely attempted to advance the theory. The theory's value was in its ability to provide understanding and lead to further work rather than in its deductive relationship to established facts.

Evans, a former student and a clear admirer of Eddington, writes thus:

> The most glorious of all Eddington's achievements are his contributions to the theory of stellar structure, epitomised by his great work *The Internal Constitution of the Stars*, first published by the Cambridge University Press in 1926. Although seven decades have passed, this book is still worth reading ... Eddington had a wonderful physical intuition and relied on it, not only in his descriptive writings, but also in leaps of argument in his researches. For most of his life, it stood him in good stead, but as we shall see, was to lead him astray later.[424]

Interestingly, while James Crowther in one chapter argues that Jeans was unfit to be described as a theoretical physicist 'of the very first rank' because he lacked 'physical insight'[425] in the next chapter he describes Eddington's speculative approach to science using his physical insight as 'ultimately his vice'.[426]

Stanley agrees with Evans on Eddington's work on stellar structure as an example of the successful use of intuition and seeking in his science. He sees seeking as the value which was the foundation on which Eddington built his astrophysics, particularly his investigations into the then-intractable problems of stellar interiors. His success in addressing these problems was based on his willingness and ability to forgo scientific certainty in favour of opportunities for further progress. Developing his theory of stellar structure was an exercise in contesting the local boundaries of scientific validity. It was a concrete manifestation of the Quaker values he carried with him. 'Just as Quakers argued that the import of the spiritual life was not in

[423] Stanley, *Practical Mystic,* 53.
[424] David Evans, *The Eddington Enigma*, 95.
[425] Crowther, *British Scientists,* 112.
[426] Crowther, *British Scientists,* 152, see also 156.

dogma or final truth, Eddington was comfortable with a scientific method that functioned without certainty'.[427]

Dawkins has asserted that science is certain, resting only on provable assumptions while theology is speculative and based on wish fulfilment.[428] Stanley, a Harvard astronomy graduate, describes Eddington's pioneering work on the Cepheid variable stars, noting the use of non-provable assumption. An important factor in Eddington's derivation of the period of stellar oscillation was the ratio of specific heats, which could not be known without more information on the specific composition of the stellar interior:

> Eddington escaped this trap by assuming his theory was, for the moment, correct. He then used the known period of Delta Cephei (the second Cepheid variable to be discovered) and calculated the hypothetical value of its ratio of specific heats. This value, of course, was perched on a rather precarious structure of assumptions and guesses. But *it worked…*[429]

Eddington, Stanley points out, made no claims as to the final truth of his work:

> The inexactitude of the approach was not a problem, because its purpose was only to hold long enough to use trial and errors to get a result that could be compared with results.[430]

Glass, in his study of eight leading astrophysicists, also sees Eddington as a scientist whose intuition led him in the right direction, but gives a different example than that supplied by Stanley of such insight.[431] Glass, Senior Astronomer at the Cape Observatory, details how Eddington was one of the first to assess the significance of the Hertzsprung-Russell diagram. This diagram was drawn up independently by the Dane Ejnar Hertzsprung in 1911 and the American Henry Norris Russell of Princeton in 1913 and plots the absolute magnitude or brightness of stars against their spectral type. His interest in the HR diagram was to help him further in such works as *The Internal Constitution of the Stars* of 1926. Glass writes:

> It is rather typical of his perspicuity that he was one of the first people to have recognised its importance.

[427] Stanley, *Practical Mystic,* 47.
[428] Richard Dawkins, *The God Delusion,* 19, 77, 83, 89, 90-99, etc.
[429] Stanley, *Practical Mystic,* 59 *italics* as in the original.
[430] Stanley, *Practical Mystic,* 59.
[431] Glass, *Revolutionaries of the Cosmos*, 205.

> Eddington was to become famous for his "physical intuition", the faculty that enabled Galileo to cast aside ancient ways of thought and see what factors were the truly important ones when making theories about the behaviour of matter.[432]

Glass then examines Eddington's work on spiral nebulae, one name given to what are now called galaxies. It was then unclear whether these were internal or external to our galaxy and Eddington assumed correctly that they were external. It would be wrong to believe that Eddington had every detail correct – he placed the sun near to the galactic centre; but he was, as Glass said, perspicacious. Curiously Eddington draws the reader's attention to the fact that globular clusters are not evenly distributed, the detail from which Shapley soon afterwards used to give the current view of the sun as occupying a place in one of the spiral arms. Nevertheless, this example, although not quoted by Stanley, does back up Stanley's thesis on Eddington's use of intuition - that ideas should be pursued if they took the argument forward. Is, however, Eddington's statement 'its consequences are so helpful as to suggest a distinct probability of its truth' a reliable guide in either science or theology?[433] If 'helpful' means taking the theory forward, that is a defendable position. If 'helpful' means an idea which fits in with existing doctrine or theory, that may, or may not, be useful.

Eddington's famous physical intuition did not always serve him well. As John Hedley Brooke has rightly pointed out '... we must not assume that moments of inspiration have an intrinsic capacity to yield the truth.'[434] Evans details how Eddington's intuition or inspiration led him astray in his debate with Subrahmanyan Chandrasekhar, the young Indian scientist. Chandrasekhar calculated that a white dwarf star could not be more than approximately 1.44 times as massive as the sun without collapsing in on itself. Eddington, who along with Fowler, Stoner at Leeds and Anderson at Dorpat had been involved with the study of white dwarf stars, rigorously opposed this idea. His arguments were not so much mathematical as a belief or intuition that stars should not behave in this way. Evans records Eddington's comments at a debate at the Royal Astronomical Association meeting on 11 January 1935:

> Dr Chandrasekhar has got this result before, but he has rubbed it in in his last paper; and when discussing it with him, I felt driven to the conclusion that this was almost a *reductio ad absurdum* of the relativistic degeneracy formula. Various

[432] Glass, *Revolutionaries of the Cosmos,* 205.
[433] Glass, *Revolutionaries of the Cosmos,* 206 quoting Arthur Eddington *Stellar Movements and the Structure of the Universe* (Cambridge: Cambridge University Press, 1914) no page number given.
[434] John Hedley Brooke, 'Inspiration in Science and Religion: Historical Perspectives' in Michael Fuller (ed.), *Inspiration in Science and Religion* (Newcastle: Cambridge Scholars Press, 2012), 7.

> accidents may intervene to save the star, but I want more protection than that. I think there should be a law of Nature to prevent a star from behaving in this absurd way.[435]

Rampelt points out that Eddington had briefly discussed this possibility in his *Stars and Atoms* 'but only hypothetically and threw it away as a total absurdity.'[436] The current overwhelming opinion in astronomy is that Chandrasekhar was correct and Eddington was wrong. The thesis that a white dwarf star can be no larger than approximately 1.44 solar masses is an accepted part of astrophysics and is known as the Chandrasekhar Limit. Evans argues that Eddington was essentially an inspirational thinker, who could often see his goal with certainty before he knew how to reach it. Eddington thought he knew in his bones how things ought to be. His intuition had previously stood him in good stead, and now he sought to refute his critic not by calculation, but by mere rhetoric. Clearly if this is a case of intuition, intuition is not an infallible guide to truth in science.

It is interesting to note the words used to describe Eddington's insight.[437] Was it intuition: 'knowledge or perception not gained by reasoning and intelligence; instinctive knowledge or insight'? Eddington had intelligence and reasoning power in abundance. Of course, an intelligent and educated person can have flashes of inspiration but do we have in Eddington's intuition or insight a case of chance favouring the well-prepared mind?

Was it instinct? The proverbial duck takes to water because of an inherited ability or skill without which the species would fail to thrive. There is something wonderful in this ability, and it is 'not gained by reasoning and intelligence'. It is not, however, a flash of inspiration on behalf of the ducklings. Eddington clearly had an able father (and probably an able mother, though the social mores of her generation make it difficult to assess this from such a distance in time) but while he may have been genetically favoured, he certainly studied and worked hard. How much instinct is involved?

Was it perspicuity: 'The quality of being acutely perceptive or discerning'? Or was it simply judgement – 'the faculty of being able to make critical decisions and achieve a balanced viewpoint, discernment.'

Eddington's own words are interesting:

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[435] Evans, *The Eddington Phenomena,* 144.
[436] Jason M Rampelt, 'Arthur Stanley Eddington: Relativity and Dogma', 148.
[437] All definitions are from *Collins English Dictionary,* (London: Collins, 1976).

> It is a matter for the judgement of the investigator, which of the natural properties shall be retained in his ideal problem, and which shall be cast aside as unimportant details; he is seldom able to give a strict proof that the things he neglects are unessential, but by a kind of instinct or by gradual experience he decides (sometimes erroneously it may be) how far his representation is sufficient. [438]

Is he saying that instinct develops with experience? If he is right, then it is a form of developing judgement rather than a flash of inspiration.

There are some similarities with John Henry Newman's thought set forth in his *Grammar of Assent* but also some significant differences.[439] Both Eddington and Newman emphasised personal participation and experience. Eddington emphasized intuition and the Inner Light. Newman emphasised the function of conscience in the knowledge of God and of judgement:

> This power of judging about truth and error in concrete matters, I call the Illative Sense.[440]

This is described by *The Oxford Dictionary of the Christian Church* as 'the faculty of judging from given facts by processes outside the limits of strict logic, in reaching religious certitude.'[441] In a paper 'Assent and Intuition' Newman gives a fuller definition:

> Absolute or simple assent is my recognition of the truth of a thought on its own account, and independently of everything else, as far as I can determine about myself, and whether it actually admits of proof or no; that is, it is assent to what I see to be self-evident.[442]

Chadwick says that Newman coined the expression the Illative Sense to describe the act of assent in the mind based upon a body of grounds in their totality, even though the mind is not aware of all the grounds and may well be resting on half-inarticulate experience along with reasoned argument.[443] Chadwick also argues that no one has taken the phrase the Illative Sense into their own theory. Christopher Friel points out that Bernard Lonergan did in fact

[438] Eddington, *Stellar Movements and the Structure of the Universe,* 201.
[439] John Henry Newman, *The Grammar of Assent* (London: Burns and Oates, 1870).
[440] Newman, *The Grammar of Assent,* 346.
[441] Cross and Livingstone (eds.), *The Oxford Dictionary of the Christian Church*, 1142.
[442] John Henry Newman 'Assent and Intuition' in (ed.), J Derek Holmes, *The Theological Papers of John Henry Newman on Faith and Certainty* (Oxford: Clarendon Press, 1976), 64.
[443] Owen Chadwick, *Newman* (Oxford: Oxford University Press, 1983), 36.

make such a use of Newman in his work.[444] Newman believed that the right moral attitudes foster the right intellectual attitudes. Chadwick then asserts:

> … when Newman wrote of certitude, he did not mean certain knowledge. He meant the conviction in a man's mind that he has certain knowledge.[445]

Eddington believed that certitude was impossible in both science and theology.

Michael Polanyi developed an argument for the role of experience and skill in his 1958 book *Personal Knowledge*.[446] Polanyi argues that personal judgement plays a role in science. It is not a super-objective process by which truth always emerges from the end of an investigation. Polkinghorne likewise writes:

> The simple account of science sees its activity as the operation of a methodological threshing machine in which the flail of experiment separates the grain of truth from the chaff of error. You turn the theoretico-experimental handle and out comes certain knowledge. [447]

If this were the case, why are not all scientists equally talented and successful? How would the committees which award Fellowships of the Royal Society and Nobel prizes differentiate when they come to award prizes? Polkinghorne argues that the consideration of actual scientific practice reveals a more subtle activity in which the judgements of the participants are more critically involved. Polanyi, like Eddington, rejected the idea of scientific objectivity in favour of a view of knowledge in which the 'knower' is more involved.

While this view of Polanyi is closer to Eddington's stance than to Dawkins', there are some significant differences. In *Personal Knowledge* Polanyi links Eddington, Freud and Lysenko as purveyors of novel conceptions in science.[448] But interestingly Eddington is not seen in the book as a fellow advocate, along with Polanyi, of a view of science which sees it as providing knowledge which is not permanent or absolute but personal, a link that was made with approval by Thomas Torrance in *Theological Science.* Torrance admired both Eddington's and Polanyi's works.[449] Rather Eddington is viewed by Polanyi as someone who advanced ideas in

[444] Christopher Friel, 'Faith and Feeling in Lonergan', *Australian E-Journal of Theology,*20, (Aug 2013), 2.
[445] Chadwick, *Newman,* 36.
[446] Michael Polanyi, *Personal Knowledge* (London: RKP, 1958).
[447] John Polkinghorne, *One World,* 10.
[448] Polanyi, *Personal Knowledge,* 151.
[449] Thomas F Torrance, *Theological Science,* 93.

his physical science which proved to be false. These positions are clearly not opposed; indeed the personal experience of being mistaken in science could lead to a realistically low view of the permanence of scientific theories. But Polanyi uses Eddington's later numerological explorations rather than his earlier successes in cosmology and stellar structure as his examples. Polanyi only refers to Eddington's posthumously published *Fundamental Theory.* This was the least successful of Eddington's works: a judgement, with which even his supporters such as Evans[450] and Kilmister[451] would not wholly disagree. Barrow and Tipler are more frank in their disapproval.[452] Polanyi seems blinded to Eddington's early contributions to physics and astronomy by the recently published *Fundamental Theory.* It is interesting to speculate on whether Eddington's reputation would not have been higher if his sister had, on his death, burnt not only many of his personal papers, but also the unfinished manuscript of *Fundamental Theory.* As has been alluded to before, *Fundamental Theory* probably did more to damage Eddington's intellectual reputation than the work of Russell, McCabe, Stebbing or any other of his critics. Polanyi could be viewed as a successor of Eddington in acknowledging the personal element in science, theology and philosophy but it is on his last book that Polanyi dwells.

For Eddington his intuitive approach to science and theology had links with his philosophical Idealism. But Jeans was as much of an Idealist as Eddington yet he spurned any suggestion that intuition had a role to play in science. Their Idealism will be considered in some depth in the next chapter. While many saw them as a pair there were significant differences and their approaches to intuition was one area where they differed. Even when they differed their joint 'mass' gave them an impact in Great Britain which steered the British science and religion debate away from evolutionary biology and on to issues of cosmogony and astronomy.

It is clear that two points may be drawn from this short section of the study. Firstly, Eddington's belief in the validity of intuition as a source of knowledge was influenced by his Quaker understanding of the importance of seeking and the Inner Light. Secondly, it proved a successful technique for Eddington in some of his work, such as on the internal constitution of the stars and on the spiral nebulae, but not in others, such as on what is now called the Chandrasekhar Limit. That intuition may sometimes help in the move towards truth was part

[450] Evans, *The Eddington Enigma,* chapter 12 *passim.*
[451] C W Kilmister, *Eddington's Search for a Fundamental Theory, passim.*
[452] John D Barrow and Frank J Tipler, *The Anthropic Cosmological Principle* (Oxford: Oxford University Press, 1986), 227-228.

of Eddington's Quaker belief; clearly in his science at least, it was not always on its own a sufficient guide to the truth.

6.4 The Design Argument

Some key points in the history of the design argument will be outlined very briefly to show the context in which Jeans put forward his modified, non-biological, non-teleological, mathematical form of the argument.[453]

The design argument has a long and varied history. It might be more realistic to describe *the* design argument as a family of arguments from the structure of the physical world to the existence of a designing deity. Thomas McPherson describes these associated arguments not as a family, but as 'a nest of arguments'.[454] Some forms of the argument rest upon alleged design, others upon the orderly structure of the world, some upon its intrinsic beauty while a number concentrate on the *telos,* the end or culmination to which the world is claimed to be ordered.

The phrase 'the argument from design' is queried by McPherson as it assumes its own conclusion. According to McPherson it might be better described as '… an argument *from* order *to* design; that is, an argument that will show that the order exhibited in the universe is of the kind called design.'[455]

While the design argument is an attempt to prove the existence of a Deity without invoking revelation, nevertheless, some proponents of the design argument have looked to biblical texts for support. One of the most obvious is the first creation story in Genesis. Here, according to Bray, 'the different parts of creation serve a purpose in the overall plan of God's universe.'[456] This orderliness is an essential component in the design argument. Another key text is Psalm 19, which was frequently quoted at Eddington. Here the heavens and the daily passage of the sun are said to 'declare the glory of God'. In the New Testament, Romans 1.19-

[453] For a fuller account of the history of the design argument, see Brooke and Cantor *Reconstructing Nature* chapters five to seven.
[454] Thomas McPherson, *The Argument from Design* (London: Macmillan, 1972), 6.
[455] McPherson, *The Argument from Design,* 9.
[456] G L Bray, 'Teleological Argument' in Campbell Campbell-Jack and Gavin J McGrath (eds.), *New Dictionary of Christian Apologetics,* 686.

20 is frequently referred to by proponents of the design argument to give scriptural authority to the idea that something may be learned of the existence and attributes of the deity by an examination of the physical world. Here not only the existence of God but his eternal power and divine nature are said to be made manifest by the things God has made.

Thomas Aquinas in the thirteenth century famously produced 'five ways' of proving the existence of God. His fifth way was the design argument. Aquinas was one of the scholars who put forward the idea of design to an end: 'Providence is concerned with the direction of things to an end.'[457] Aquinas' thought is obviously to be understood in the light of his respect for and reshaping of Aristotelian thought in the service of theology. Aristotle had a four-fold taxonomy of causes: material causes; efficient causes; formal causes and, significantly, final causes – what things are for ultimately. This was a form of explanation in terms of a goal or end. For Aquinas, nature acts in a good and orderly way not just because of a material cause (what a thing is made of) or an efficient cause (what produces something) but towards an end. The passage below is worth quoting at length because it shows how Aquinas' form of the design argument is teleological, unlike Jeans'. Aquinas' view is not just that the universe is orderly or beautiful but that it functions towards an end in a way which cannot be put down to pure chance. Talking of the view put forward by Empedocles and others that nature works by chance, he asserts:

> This explanation, of course, is absurd, for those things that happened by chance, happen only rarely; we know from experience, however, that harmony and usefulness are found in nature either at all times or at least for the most part. This cannot be the result of mere chance; it must be because an end is intended. What lacks intellect or knowledge, however, cannot tend directly toward an end. It can do this only if someone else's knowledge has established an end for it and directs it to that end. Consequently, since natural things have no knowledge, there must be some previously existing intelligence directing them to an end, like an archer who gives a definite motion to an arrow so that it will wing its way to a determined end... Consequently, the world is ruled by the providence of that intellect which gives this order to nature.[458]

[457] Brian Davies, *Philosophy of Religion* (Oxford, Oxford University Press, 2000), 251.
[458] Thomas Aquinas from *De Veritate* trans. Robert W Mulligan (New York: Henry Regnery, 1952) quoted in Davies, *Philosophy of Religion,* 251-252.

With the rise of modern science, the Aristotelian view of the world lost its power over Western thought but the design argument did not. It became especially popular in England from the seventeenth century onwards and was used by scientific apologists such as Boyle and Newton. Boyle used the famous watch or clock analogy before Paley in his 1663 book *The Usefulness of Experimental Natural Philosophy* in which he describes the cathedral clock at Strasbourg with its several parts each arranged to perform a specific task 'for which it was contrived, as regularly and uniformly as if it knew and were concerned to do its duty.'[459]

Writing around the turn of the eighteenth and nineteenth centuries, Paley was a great influence upon English theology. His accessible style and his use of non-technical language made much of his work open to non-theologians. His popularisation of the watch metaphor in his *Natural Theology* of 1802 has given many people the impression that he coined the idea. Charles Darwin read Paley with enthusiasm. Aileen Fyfe quotes his comment in his *Autobiography* that reading Paley's *Evidences* and his *Moral Philosophy* 'was the only part of the Academical Course which, as I then felt and as I still believe, was of the least use to me in the education of my mind.'[461] Adrian Desmond and James Moore assert that for a while at least he accepted its conclusions.[462] In a letter to John Lubbock the banker and naturalist in 1859 he writes 'I do not think I hardly ever admired a book more than Paley's *Natural Theology.*'[463] This was a key text for Darwin, but in later life he changed his mind on the topic.[464]

Even Dawkins in his refutation of the biological version of the design argument, *The Blind Watchmaker,* acknowledges Paley's contribution, before refuting it, asserting that '… it is wrong, gloriously and utterly wrong.'[465] Darwin himself was undecided on the question of order, design and a possible Designer:

> My theology is a simple muddle: I cannot look at the Universe as the result of blind chance, yet I can see no evidence of beneficent design.[466]

[459] Davies, *Philosophy of Religion,* 248.
[461] Aileen Fyfe, 'The Reception of William Paley's *Natural Theology* in the University of Cambridge' BJHS, 1997, Vol 30, 321.
[462] Desmond and Moore, *Darwin,* 77-79.
[463] Charles Darwin in Francis Darwin, (ed.), *The Life and Letters of Charles Darwin* (London: John Murray, 1988) Vol 2, 219.
[464] Desmond and Moore, *Darwin,* 90 and see 449-450 for his later disavowal of Paley.
[465] Richard Dawkins, *The Blind Watchmaker* (London: Longman, 1986), 5.
[466] Charles Darwin, letter to Joseph Hooker, 12 July 1870. http://www.darwinproject.ac.uk/correspondance-volume-18. (23 February 2011).

Darwin is commonly seen to have destroyed a simple form of the design argument as it related to the complexity in such organs as the mammalian eye or brain. Thomas Huxley wrote in 1864 that 'Teleology, as commonly understood had received its deathblow at Mr Darwin's hands'.[467] John Hedley Brooke[468] has asserted that in *Science and the Hebrew Tradition*, published in 1896 a year after his death, Huxley argues that Darwinism in itself does not wholly demolish the design argument.[469] This can be also be seen in Huxley's account of the reception of Darwin's theory, found in *The Life and Letters of Charles Darwin.* Huxley's article was written in 1887. Here Huxley says that evolution is 'the most formidable opponent of all the commoner and courser forms of Teleology.' But, he goes on to argue, there is a wider teleology which is not harmed. Design could have been incorporated in the 'molecules of which the primitive nebulosity of the universe was composed.'[470] Charles Raven draws attention to this passage in his Gifford Lectures and to similar comments by Asa Gray.[471]

Bernard Lightman, in a well-argued article, draws attention to the complexities of the issue of Huxley's approach to Christian theology as opposed to religion and the associated issue of Huxley's attitude to the Anglican intellectual establishment.[472] Lightman tells of an anonymous article 'Science and "Church Policy"', published in the journal *The Reader* in 1864. Lightman states that the author of the article was Huxley. The author says that there was certainly a potential conflict between science and theology but that there was no potential conflict between religion and science for:

> Religion has her unshakeable throne in those deeps of man's nature which lie around and below the intellect, but not in it. But Theology is a simple branch of Science or it is nought…[473]

Huxley in this article on the reception of the *Origin* goes on to say that the 'doctrine of Evolution is neither Anti-theistic nor Theistic.' It has, he says, as much to do with religion as

[467] Thomas H Huxley, 'Criticisms on *The Origin of Species*' [1864] in *Collected Essays by T H Huxley* Vol 2 (New York: Appleton, 1893).
[468] John Hedley Brooke, Christians in Science lecture, 'The Design Argument in the History of Natural Theology', London, 30 October 2010.
[469] Thomas H Huxley, *Science and Hebrew Tradition* (New York: Appleton, 1896).
[470] T H Huxley 'On the Reception of the *Origin of Species*' in Francis Darwin, (ed.), *The Life and Letters of Charles Darwin,* Vol 2, 201.
[471] Charles E Raven, *Natural Religion and Christian Theology: The Gifford Lectures 1951-1952,* Vol 2, 135.
[472] Bernard Lightman, 'Victorian Sciences and Religions: Discordant Harmonies', *Osiris* 16 (2001), 343-366.
[473] Lightman, 'Victorian Sciences and Religions', 345 quoting Anon., 'Science and "Church Policy"', *The Reader* 4 (31 December 1867) 821.

the first book of Euclid.[474] In his *Victorian Popularizers of Science* Lightman records Huxley's success as a populariser, including the praise of Darwin for his accessible books on evolution.[475] For Huxley, religion, as with poetry and art, belonged to the realm of feeling and ethics, whereas science belongs to the realm of intellect. Religion should not be identified with the realm of theology which belonged, as with science, to the world of intellect and could be proved wrong. Huxley saw himself as a man of 'profound religious tendency capable of fanaticism but tempered by no less profound theological scepticism.'[476] While not identical, there are similarities with Eddington's distrust of theology and view that religious experience was primary. Huxley had read of this distinction in the writings of Carlyle and Goethe.[477] Linked with his distrust of theology was his distrust of the Church of England. Huxley saw the Church of England as a privileged and repressive institution, a position he shared with many non-conformists of the time. He wished to achieve freedom for professional science outside the control of the Anglican elite. Lightman sees one of the sources of this distrust as coming from Huxley's time as a struggling young doctor. Huxley was apprenticed to a doctor as a teenager and obtained his qualification from the University of London. Although he was elected to the Royal Society in 1851 and obtained its Royal Medal in 1852, he initially had difficulties in obtaining posts and was passed over for less well-qualified Oxbridge graduates with Anglican establishment connections.[478]

Jonathan Topham in his chapter 'Science, Religion and the History of the Book' in *Science and Religion: New Historical Perspectives* looks at the *Bridgewater Treatises* – popular science and religion texts from a previous generation. His study of these influential booklets led to the conclusion that:

> … readers found them valuable for a range of reasons which were typically neither theological nor evangelistic. Many of them used in popular education, for instance, did so because they provided an accessible, authoritative, and above all religiously and politically 'safe' account of the latest findings in the several sciences.[479]

[474] Huxley, *The Life and Letters of Charles Darwin,* Vol 2, 202.
[475] Bernard Lightman, *Victorian Popularizers of Science: Designing Nature for New Audiences* (Chicago: University of Chicago Pres, 2010), 354.
[476] Lightman, 'Victorian Sciences and Religions', 347.
[477] Lightman, 'Victorian Sciences and Religions', 348.
[478] Lightman, *Victorian Popularizers of Science,* 358.
[479] Jonathan R Topham, 'Science, Religion and the History of the Book' in Thomas Dixon, Geoffrey Cantor and Stephen Pumfrey (eds.), *Science and Religion: New Historical Perspectives* (Cambridge: Cambridge University Press, 2011), 223.

Topham argues that it is important for a nuanced understanding of such books to study not just the authors and their books but also the readers of the books and how the readers used the books.[480] He also calls for an investigation of the motivations of authors and publishers in this field of writing on science and religion.[481] Applying this to Eddington and Jeans will be attempted in the conclusion.

As has been described in Chapter One, the work of Jeans and Eddington was produced in a period where the debates following the publication of *The Origin of Species* had, along with other factors, notably the rise of modern biblical criticism, changed much theology from the form seen in 1850.

There are three key elements in Jeans' construction of a modified design argument.

The first element can be stated very briefly. It is based on astronomy not biology. Jeans, despite the widespread decline in belief in a simple form of biological design following the work of Darwin, chose to reassert a cosmological form of the design argument after Darwin had supposedly destroyed it from its zenith of influence under Paley. Both Eddington and Jeans had no problem with evolutionary biology but both feel it is not their place to comment on it as physical scientists.

The second key element in Jeans' interpretation of the design argument is that it is not teleological. He does not appear to agree with Aquinas' view that 'Providence is concerned with the direction of things to an end.'[482] Jeans' emphasis is on design in the universe as it is, rather than the supposedly goal-directed behaviour of parts of the universe or the whole universe. McPherson rightly states that the common description of 'the argument from design or teleological argument' is not helpful as 'clearly there is a difference between the notion of design and that of end.'[483]

What is the reason for Jeans' emphasis on present structure rather than end? It is interesting to consider but difficult to formulate an answer from the thin basis of Jeans' published work. Jeans, as a cosmologist in the first half of the last century, has the pessimism about the future of the created order that was common amongst scientists of the time. While he does not

[480] Topham, 'Science, religion and the history of the book', 228.
[481] Topham, 'Science, religion and the history of the book', 233.
[482] Davies, *Philosophy of Religion,* 251.
[483] McPherson, *The Argument from Design,* 6.

dwell on the 'heat death of the universe' in *The Mysterious Universe* or *Eos,* he is not optimistic about the future of the cosmos:

> So far as we can judge, our part of the universe has lived the more eventful part of its life already; what we are witnessing is less the rising of the curtain before the play than the burning out of candle-ends on an empty stage on which the drama is already over.[484]

Jeans focuses on the current design of the cosmos not on any end to which the universe is heading. The explanation of Jeans' pessimism probably lies in the science of the time. The science of the 1920s had a more pessimistic tone than current cosmology when it came to the formation of planets. The successful search for extrasolar planets of the last twenty years and the recognition that stars are still being formed has created an optimism on the future of intelligent life in the universe which Jeans did not share. He wrote 'There is not time for many more planets to be formed.'[485] Jeans' understanding of the physical universe was based on early twentieth century theories (such as cosmogony) which drew upon modern technology (such as the Mount Wilson telescope). The theories of the time gave no ground for easy optimism about the fate of the cosmos.

Did Jeans merely not find Aquinas' emphasis on ends unhelpful, based as it was upon discarded Aristotelian ideas on the four causes? Milne says that Jeans distrusted Greek philosophy.[486] This is another statement of Milne for which clear evidence can be found to contradict his thesis. Jeans regularly quoted Plato and generally with approval. In *The Mysterious Universe,* Plato is quoted four times and every time with distinct approval. Jeans, who spent a year in the Classical Sixth at Merchant Taylors' before transferring to study mathematics seems, on a study of his work, to be quite fond of Plato. Russell rightly, if somewhat simplistically, says that Jeans' God is Platonic .[487] Aristotle is quoted less frequently and often with disapproval because of his belief in a static earth, an idea which long held sway because of his influence on the medieval church. Jeans begins his most famous book with Plato's well known simile of the cave and in the final chapter concludes that modern physics suggests that we are not yet in touch with ultimate reality, we can only see, in the words of Plato's metaphor, the shadows of the images on the walls of the cave. A better description of

[484] Jeans, *Eos,* 84-85.
[485] Jeans, *Eos,* 85.
[486] Milne, *James Jeans*, 54.
[487] Bertrand Russell, *The Scientific Outlook*, 113.

Jeans' view is that he distrusts Aristotle but respects Plato. Keith Ward has commented interestingly on Plato and modern science:

> In a sense modern science has, in a strange and unexpected way, returned to a form of Platonism. An important part of Platonism says the senses provide only appearances, whereas reality is purely intelligible and knowable, if at all, only by mind. Platonism, it seems, has returned in triumph, now guided and tested by observation and measurement.[488]

Jeans in a number of his books expresses surprise at the size of the creation. He is puzzled that so little of the universe is inhabitable – 'But it does not at present look as though Nature had designed the universe primarily for life'.[489] It is important not to miss the word 'primarily' in that sentence. As has been seen, Jeans correctly counsels against drawing too hasty a theological conclusion from this scientific data:

> There is a temptation to base wide-ranging inferences on the fact that the universe is apparently antagonistic to life. Other quite different inferences might be based on the fact of our earth being singularly well adapted to life. We shall, I think, do well to avoid both.[490]

Jeans then goes on to deploy one of his better metaphors which uses the natural world to make this theological point:

> Each oak in the forest produces many thousands of acorns, of which only one succeeds in germinating and becoming an oak. The successful acorn, contemplating myriads of acorns crushed, rotten, or dead on the ground, might argue that the forest is inimical to growth of oaks, or might reason that nothing but the intervention of a special providence could account for its success in the face of so many failures. We must be beware of both types of hasty inference.[491]

Jeans is advising against drawing an easy theological conclusion from a scientific description. This is in line with Jeans' views on science where he draws a sharp distinction between the ratios, the mathematical rigour, the observations and the interpretation the scientist puts

[488] Keith Ward, *Pascal's Fire: Scientific Faith and Religious Understanding* (Oxford: Oneworld, 2006), 99.
[489] Jeans, *Eos,* 86.
[490] Jeans, *Eos,* 87.
[491] Jeans, *Eos,* 87.

upon them. 'Here we leave the firm ground of ascertained fact, to enter the shadowy morasses of conjecture, hypothesis and speculation'.[492] Observations, pointer readings and mathematical descriptions are more secure than the interpretations we put upon them, and scientists, and others, should be careful of their interpretations of the physical data.

Jeans asserts that there is design in the universe, but it is only in *The Mysterious Universe* that this is dwelt upon at length. In *The Universe Around Us* he discusses the relative advantages for a designing Deity of the Einstein and de Sitter cosmologies. Later in the book he writes, as has been seen, 'We live in a gossamer universe; pattern, plan and design are there in abundance', but he does not go on to explain what the evidence for this design is or draw any inferences from the abundant evidence for design.[493]

The third key element in Jeans' modified design argument is that this design is clearly mathematical. He argued that a study of the universe suggests that it was designed by a mathematical God, but the person studying the universe must understand the language of mathematics to discern this. As has been seen, a deaf engineer studying a pianola would totally miss the significance of the intervals 1, 5, 8, 13 in the motions of the trackers. A deaf musician would interpret these to be the intervals of the common chord. Likewise, a mathematician sees mathematical order in the design of the cosmos and draws the conclusion, noted before:

> We have already considered with disfavour the possibility of the universe having been planned by a biologist or by an engineer; from the intrinsic evidence of his creation, the Great Architect of the Universe now begins to appear as a pure mathematician.[494]

This idea has precedents. Isaac Newton wrote to Richard Bentley, Master of Trinity College, Cambridge, arguing that 'to compare and adjust all these Things [the solar system] together, in so great a Variety of Bodies, argues that the Cause to be not blind and fortuitous, but very well skilled in mechanicks and geometry.'[495]

[492] Jeans, *The Universe Around Us*, 275.
[493] Jeans, *The Universe Around Us,* 106.
[494] Jeans, *The Mysterious Universe,* 134.
[495] Isaac Newton, *Four Letters from Sir Isaac Newton to Doctor Bentley Containing Some Arguments in Proof of a Deity* (Michigan: Gale Eco, 2010), 7-8.

Keith Ward points out that in Hume's *Dialogues Concerning Natural Religion* this position is advanced by Philo, if not by Hume himself.[496] J C A Gaskin in his Introduction to the Oxford edition of *The Dialogues* cautions against an easy identification of Philo with Hume, not least because it is not entirely clear from which position Philo is arguing.[497] He considers this a strength of Hume. Hume leaves us thinking rather than accepting a point of view on his authority.[498] Ward's summary of Hume's speech by Philo is that the universe shows a unity of cause and 'principles of mathematical elegance and order which are astonishing in their complexity and harmony'.[499] Ward later concludes that 'It is thus not implausible to take the orderedness of the world under physical laws as a sign of a purposive constitution of nature.'[500] A reading of *The Dialogues,* however, supports Gaskin's position on the subtlety of Philo's approach.

> If we see a house, CLEANTHES, we conclude, with the greatest certainty, that it had an architect or builder; because this is precisely that species of effect, which we have experienced to proceed from that species of effect. But surely you will not affirm, that the universe bears such a resemblance to a house, that we can with the same certainty infer a similar cause, or that the analogy is here entire and perfect.[501]

Philo is reluctant to rest too much on an argument starting from an ordered universe, then proceeding using metaphors or analogies with the construction of buildings, cities and ships to a designed universe saying it would be 'requisite that we had experience of the origin of worlds' before concluding too much. [502]

A more recent statement on mathematical design comes from Paul Dirac, who while an atheist when young, appeared to be more agnostic as he grew older. His use of the term God is somewhat ironic but his argument is pure Jeans:

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[496] Keith Ward, *Rational Theology and the Creativity of God* (Oxford, Basil Blackwell, 1982), 100 referring to David Hume's *Dialogues Concerning Natural Religion,* Part XI. See also Diana Townsend, 'Can mathematics contribute to the study of Christian Spirituality' (MA Thesis, University of Winchester, 2012), 2.
[497] David Hume, *Dialogues* and *Natural History of Religion,* ed. J C A Gaskin (Oxford: Oxford University Press, 1993), xxiii.
[498] Hume, *Dialogues,* xxiv.
[499] Ward, *Rational Theology and the Creativity of God,* 100.
[500] Ward, *Rational Theology and the Creativity of God,* 101-102.
[501] Hume, *Dialogues,* 46.
[502] Hume, *Dialogues,* 51-52.

> It seems to be one of the fundamental features of nature that fundamental physical laws are described in terms of a mathematical theory of great beauty and power, needing quite a high standard of mathematics for one to understand it. One could perhaps describe the situation by saying that God is a mathematician of a very high order, and He used very advanced mathematics in constructing the universe.[503]

Jeans' ideas on design have an idealistic tinge to them, as did Eddington's views on intuition. Jeans said that while nineteenth century science saw the universe as a giant machine, from twentieth century science, according to Jeans, one might infer that the universe is more of a giant thought and the thought was that of a Pure Mathematician. While both were Idealists, Jeans did not approve of the use of intuition and Eddington did not support the design argument. These two areas where theology met physics were areas of disagreement between the two men.

In line with Plato, Augustine and Aquinas, Jeans views, as has already been seen, the design of the Creation as taking place outside time and space. He said that primitive cosmologies pictured a creator working in space and time, forging sun, moon and stars out of already existent raw material. Modern scientific theory, Jeans says, gives us a view of the creator as working outside time and space, which are part of his creation, just as the artist is outside his canvas. Jeans then quotes, as we have seen, Augustine in support of modern cosmogony: 'Non in tempore, sed cum tempore, finxit Deus mundum.'[504]

The penultimate paragraph of *The Mysterious Universe* brings together the ideas of design, Idealism and mathematics in a typical Jeansian synthesis:

> We discover that the universe shows evidence of a designing or controlling power that has something in common with our own individual minds ... for want of a better word, we describe as mathematical... we are not so much strangers or intruders in the universe as we at first thought. Those inert atoms in the primaeval slime which first began to foreshadow the attributes of life were putting

[503] Farmelo, *The Strangest Man,* 377 quoting Paul Dirac 'The Evolution of the Physicists Picture of Nature, *Scientific American*, May 1963 Vol 208, No 5, 53.
[504] Jeans, *The Mysterious Universe,* 145 unattributed quotation from Augustine, *The City of God,* Book XI, Chapter 6.

> themselves more, and not less, in accord with the fundamental nature of the universe.[505]

It is interesting to contrast Jeans' statement with Sigmund Freud's 1917 somewhat self-serving summary of the supposedly bleak situation of modern man and women now that they realise they are in a hostile and indifferent universe without a God. John Durant paraphrases it thus:

> Sigmund Freud once argued that what he termed "the universal narcissism of men, their self-love" had suffered "three severe blows from the researches of science." These blows had been administered by Copernicus, who had revealed that the earth is not the centre of the universe; by Darwin, who had demonstrated that "man is not a being different from animals or superior to them"; and of course by Freud himself, who had shown *"that the ego is not master in its own house."*[506]

Jeans does not explicitly use 'fine-tuning' arguments, although they had already been used by some writers, as Russell's attempted refutation of such arguments in his 1927 booklet *Why I Am Not a Christian* indicates.[507]

The reactions to Jeans' modified design argument set forth in *The Mysterious Universe* were mixed.[508] Jeans realised that his lecture and book were open to the accusation of making God in his own image and within days of the lecture and publication of his book, exactly these points were made in a letter to *The Times* by Dr H B Heywood:

> When man was confronted with mysteries too deep for him, "he created God in his own image." The great mind of Sir James has travelled very far, but has at last reached the too-deep mystery and has created God in the image of a mathematician.[509]

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[505] Jeans, *The Mysterious Universe,* 149.
[506] John Durant, *Darwinism and Divinity* (Oxford: Blackwell, 1986), 1 quoting Sigmund Freud, *The Standard Edition of the Complete Psychological Works of Sigmund Freud* (London: Hogarth, 1973), Vol 17, 140-143.
[507] Bertrand Russell, *Why I Am Not a Christian: And other essays on religion and related subjects* (London: Routledge, 1996), 7.
[508] For a summary of press reaction see Bowler, *Reconciling Science and Religion,* 112-113.
[509] H B Heywood, *The Times,* 12 November 1930, 19.

Another correspondent, Sir William Schooling, queried whether the Great Architect of the Universe was a pure mathematician:

> May I, with due deference to a great thinker, question the inference that because the universe can be best described in mathematical terms it is the thought, or design, of a mathematician?[510]

Not all reaction was hostile. The influential Alban Goodier SJ, formerly the Roman Catholic Archbishop of Bombay, approved of Jeans' lecture and described him as 'a great man' in the course of a lecture at Kings College, London. [511]

Another aspect of his book which drew criticism was Jeans' understanding of Idealism. Jeans asserts that:

> If the universe is a universe of thought, then the creation must have been an act of thought. Indeed the finiteness of time and space compel us, of themselves, to picture the creation as an act of thought; the determination of the constants such as the radius of the universe and the number of electrons it contained imply thought, whose richness is measured by the immensity of these quantities.[512]

Jeans pictures the Great Architect of the Universe as a mathematician who selects the physical constants of the Creation as part of the very act of design. Milne, writing twenty years later, is not so sure:

> God is not free to design the law of gravitation as He pleases, any more than He is free to let the sum of the angles of a plain triangle add up to something different from 180^{o}. With God all things are not possible.[513]

One of Jeans' general defenders was the cosmologist Fred Hoyle. Clearly Hoyle approved of Jeans' contributions to the Steady State debate.[514] But his appreciation of him went beyond that to include support for his use of the design argument. Hoyle's description of Jeans as making 'the first modern statement on religion' is an example of a too simplistic statement

[510] William Schooling, *The Times,* 10 November 1930, 15.
[511] Alban Goodier, *The Times,* 6 Nov 1930, 11.
[512] Jeans, *The Mysterious Universe,* 144.
[513] Milne, *Modern Cosmology,* 85.
[514] Fred Hoyle, *Home is Where the Wind Blows* (Mill Valley, University Science Books, 1994), 419. Hoyle's continuing opposition to the Big Bang thesis is clear in this autobiography.

made by a scientist with no theological training.[515] Nevertheless, his other comments are interesting. Hoyle was clearly a fan of *The Mysterious Universe*:

> In my school days, there had been a big fuss about this book, especially among philosophers and religious believers. In the end, they mostly decided, to suit their peace of mind, that the book was a nut without a kernel. I never did take this view, and to this day I don't.[516]

Hoyle is wrong in saying *The Mysterious Universe* was disturbing to the peace of mind of religious believers. Objections to the book were made by many philosophers. Many theologians and clerics welcomed the book generally but did criticise some of the steps in Jeans' argument, his half-formed Idealism or his over-reliance on metaphors rather than its general thrust that modern physical science was not inimical to religious faith.

Hoyle was not opposed to Jeans' comments on the Great Architect of the Universe and brings together in an interesting way Eddington's intuition and Jeans' mathematical God. He writes:

> An example of the kind of idea Eddington was given to throwing out in his lectures was that a person imbued with adequate perception could guess the laws of physics without needing to experiment or observe the Universe at all.[517]

Hoyle says that Eddington knew full well that this had never happened but it was the kind of remark which made students think about Eddington's lectures long after they had left them. Hoyle argues that the classical laws of electromagnetism could not have been intuited in the form formulated by Maxwell but, as the subject developed, the mathematical structure of the later form of the theory is so inevitable that it could have been intuited and the same, he says, is true of special relativity. Hoyle makes an argument for saying that by 1949-1950 the theoretical and mathematical physicists overtook the experimentalists as the scientists at the forefront of research and development of physics. He concludes:

> Eddington was wrong, in a direct sense, and yet he could be said to be right indirectly. Without the experiments of 1947, it would have remained difficult to find the correct electrodynamic theory. But, with the correct route discovered, the insight of the human brain was little short of miraculous. The example adds spice

[515] Hoyle, *Home is Where the Wind Blows,* 414.
[516] Hoyle, *Home is Where the Wind Blows,* 216.
[517] Hoyle, *Home is Where the Wind Blows,* 238-239.

> to James Jeans's concept of God as a mathematician. It can at least be said that Jeans's view has more merit than what was said against it...[518]

Hoyle believes that Jeans' contribution to physics and astronomy is undervalued and that *The Mysterious Universe* was a much better book than many of its scientific, philosophical or theological critics at the time gave it credit for. Did Hoyle's change of mind on the existence of a Creator have something to do with the respect he had for Jeans' idea of the mathematical God? Hoyle's conclusion after his work on nucleosynthesis that a 'superintellect has monkeyed with the physics' is not too far from Jeans' mathematical designing God.[519]

In 1983 Hoyle's popular book *The Intelligent Universe* was published.[520] In this book he argues that the odds are too long for life to have evolved on earth by a random process. He argues that the universe is too small and too short-lived for this to be likely, but scientists were reluctant to admit this because it had religious connotations. In this he deploys his famous Boeing 747 metaphor. The popular idea that life can develop from a primeval soup, first into amino acids and then into more complex chains of amino acids such as enzymes, has stuck in the mind of the public. But it is very unlikely says Hoyle; as unlikely as a whirlwind passing through a junkyard containing all the parts necessary for a 747 and producing a ready-to-fly aircraft. He cites Francis Crick as agreeing with him. He concludes that 'Genes from outside the Earth are needed to drive the evolutionary process.'[521] But, having made that case, he still argues that even if you extend this to the Universe at large there is still a '... vast unlikelihood that life, even on a cosmic scale, arose from non-living matter.' He talks of an intelligence guiding evolution and asks if this intelligence is remote or close enough to contact. He asserts that humanity seems to have an instinct to build first temples and cathedrals and now large telescopes to establish a relationship with something outside this world.

Hoyle also points to the balances between oxygen and carbon being suitable for the development of carbon-based life and whether or not these balances are accidental. He is scornful of the approach of the anthropic principle which he says enjoins humanity to acknowledge that if it were not for these 'remarkable physical and chemical coincidences' we would not be here to remark on them.[522] He asserts that this approach implies that we should

[518] Hoyle, *Home is Where the Wind Blows,* 241.
[519] Fred Hoyle, 'The Universe: Past and Present Reflections' *Engineering and Science,* November 1981, 8.
[520] Fred Hoyle, *The Intelligent Universe* (London: Michael Joseph, 1983).
[521] Hoyle, *The Intelligent Universe,* 242.
[522] Hoyle, *The Intelligent Universe,* 220.

not probe these coincidences further, no matter how rich the world is in these anthropic balances. Hoyle concludes with a form of pantheism, 'So it is with the Universe, in which the controlling intelligence exists by the virtue of the support the Universe gives it.'[523]

The Intelligent Universe does not have the subtlety of *The Nature of the Physical World.* The final chapter is far from convincing. Throughout the book Hoyle shows himself to not have the depth of his former teacher Eddington. His pantheism is simply stated in the sentence above and he does not unpack this in any way or offer any support for this position. While his 747 metaphor is lucid and accessible it is merely asserted rather than explained or justified.

In conclusion it may be said that Jeans' use of the design argument is not simple and while he appears to have read Plato, Voltaire and possibly Paley on the subject, his ideas are driven by the science of his time. He does not write apologetics in the same manner as Paley. He describes the science but does not attempt to persuade his readers that all is for the best in the best designed of all possible worlds. But he does see design in the universe described by current science. He does not say that all the evidence points to the existence of a designing Deity, but rather he expresses surprise at some of the design details of the cosmos and wonders why it is the way it is. The final paragraph of *The Mysterious Universe* is not a summing up of all that has gone before (that occurs in the penultimate paragraph) but an admission that, while the current science points in that direction, he yet may be wrong. Jeans' account of the support of modern mathematical physics for the design argument is interesting and was no doubt welcomed by those who were already favourably disposed to the design argument. The book was very popular but its brevity, which amounted in parts to superficiality, must have left many intelligent men and women asking for more, although it did encourage some people to further study. On the positive side, it was lucid, an interesting read and understated, as Jeans was a modest and cautious apologist. Jeans was significant in taking the design argument which from Paley to Darwin rested largely on biological design and placing it firmly in the realm of astronomy. Jeans paved the way for new attention to the design argument in the late twentieth century, he possibly was an influence on Paul Davies.[524] He clearly had an influence on Hoyle, but Jeans was no pantheist, describing the creator as separate from his creation as an artist is from his canvas.

Jeans' use of the design argument, while briefly expressed, is certainly interesting, but it suffers the fault of any use of the design argument. It may be consonant with the existence of

[523] Hoyle, *The Intelligent Universe,* 248.
[524] Paul Davies, *The Mind of God* (London: Simon & Schuster, 1992), 140, 151, 202-203, 226.

God, but in no way does it prove it. The universe is best described in mathematical terms but that does not in itself indicate that there is necessarily a mathematical Great Architect of it all.

6.5 Eddington and Determinism

The Society of Friends was born during the seventeenth century in England. It had its roots in Puritanism. Calvinism was a major theological force at the time of its birth. While many Puritans were Calvinists, not all were. The Quakers have normally held views which eschew the doctrine of predestination, be it Augustinian or Calvinistic in formulation. They have also rejected the Presbyterian form of church government which often, but not always, went with Calvinism. The seventeenth century was a time of complex political and religious turmoil in England. The Religious Society of Friends was one of the more unusual products of the societal and religious changes of the period. Punshon puts this more graphically:

> The Presbyterians, the Congregationalists (or Independents) and the Baptists were its legitimate offspring, its love-child was the Society of Friends.[525]

George Fox with his emphasis on such biblical texts as 'The true light, which enlightens everyone, was coming into the world',[526] saw both the Gospel message and God's Spirit as being for all people, not just the elect of Calvinism, nor even just those who responded in faith to the Christian message as in Arminian or similar forms of Christianity. He cast the net very wide indeed:

> Christ has enlightened every man that comes into the world ... God, who made all, pours out of his Spirit upon all men and women in the world ... whites and blacks, Moors and Turks and Indians, Christians, Jews and Gentiles, that all with the Spirit of God might know God and the things of God, and serve and worship him in his Spirit and Truth, that he has given them.[527]

One of the key theologians of the Society of Friends (though some would describe that phrase as an oxymoron) was Robert Barclay, a Scottish Friend, a contemporary of George Fox, and

[525] Punshon, *Portrait in Grey,* 18.
[526] Jn 1.9 NRSV.
[527] Abbott, *et al*, *The A to Z of the Friends,* 83.

unlike many early Quakers, a gentleman scholar. Barclay had studied both in his native land and at the Scots College in Paris. He rejected the Calvinism of his own country and wrote his seminal *Apology* using the sequence of the *Westminster Shorter Confession.* In this, his emphasis was upon the universal availability of salvation:

> The angel who declared the birth and coming of Christ to the shepherds said not that his news was for a few... but "...to all the people."[528]

One of Eddington's predecessors as a Swarthmore lecturer was the Quaker Sylvanus Thompson who was the author of a variety of textbooks in the fields of electrical theory, magnetism and optics, some of which were used by Eddington when he was at Owen's College, Manchester. While having the normal regard for physical law of a physicist, he thought it dangerous to think that

> ... the whole world was ruled by fate, by fixed and determinate necessity, affording no scope for free-will or for the operation of moral forces. Such a view would reduce the universe to a mere mechanism and remove all moral responsibility from man; a view to be sternly repelled.[529]

All of this tends to suggest that Eddington, as a liberal Quaker, probably had a prior theological commitment to a belief in free will, even though as a mathematical physicist trained at the end of the reign of classical physics he might have felt compelled towards determinism.

The advances in quantum theory in the early part of the century were seen by Eddington to undermine the determinism of classical Newtonian physics. Eddington's chapter 'The Domain of Physical Science' in Joseph Needham's *Science Religion and Reality* published in 1925 contains no mention of Indeterminacy, which is unsurprising, as Werner Heisenberg did not publish his Principle of Indeterminacy until the summer of 1927. But the idea that quantum theory would end determinism in physics can be found before this date in the writings of Max Born and others.

Eddington asserts that his decision to hurl a piece of paper into the bin tomorrow because he is unsatisfied with the quality of his writing is evidence of an act of mental volition leading to movement in the physical world. He believes that this is not predictable or predetermined in the way that an eclipse of the moon is predictable. He continues, displaying characteristic

[528] Robert Barclay, *Apology* (Glasgow: R. Barclay Murdoch and J Menzies, 1886), 83, Proposition 5.vi.
[529] Sylvanus Thompson, *The Quest for Truth* (London: George Allen and Unwin, 1915), 48-49.

humour, questioning if the motion of the editor's pencil 'to grammatically amend the split infinitive in this sentence' simply is the automatic response under physical laws of a complicated configuration of electrons to the external stimulus of what is written on the paper. He says that such an extravagant hypothesis might conceivably appeal to the crude materialist who supposes that the world of electrons is the fundamental reality.[530]

Eddington then asserts that the 'laws of physics' do not limit the freedom of will, which most people perceive that they have. He quotes Professor Weyl of Zurich 'The freedom of action in this world is no more restricted by the rigorous laws of field physics than it is by the laws of Euclidean geometry according to the usual view.' [531]

His approach is not as direct as it is three years later, but he is clear that the landscape in physics is changing. He saw quantum theory, even more than the relativity theory, as the remarkable development of the last twenty years, constituting an 'amazing breach with the traditional type of physical theory.'[532]

Eddington's Gifford Lectures were given in January to March 1927 at the University of Edinburgh. They were published in November 1928 as *The Nature of the Physical World*. This gave Eddington only time for a 'hurried examination of the far-reaching consequences of this principle',[533] namely Heisenberg's Principle of Indeterminacy, as he reworked the lectures into the book. As a consequence this chapter is not one of the best written in the book, nonetheless, the message was clear enough.

The first extended paragraph of the chapter on 'Causation' was as delivered in the lecture in early 1927. It starts with a statement of the view of traditional classical, Newtonian physics:

> In the old conflict between freewill and predestination it has seemed hereto that physics comes down heavily on the side of predestination.[534]

Eddington goes on to quote his fellow mathematician, astronomer and would-be philosopher, Omar Khayyam, who was born in eleventh century Persia and wrote within an Islamic deterministic, predestinarian tradition. Eddington quotes Khayyam again at slightly further length in his Mathematical Association lecture. In *The Nature of the Physical World* we have:

[530] Eddington, 'The Domain of Physical Science', 214.
[531] Hermann Weyl quoted in Eddington, 'The Domain of Physical Science', 215 no page reference given.
[532] Eddington, 'The Domain of Physical Science', 215.
[533] Eddington, *The Nature of the Physical World,* 294.
[534] Eddington, *The Nature of the Physical World,* 293.

> Yea, the first Morning of Creation wrote
> What the Last Dawn of Reckoning shall read[535]

Eddington then shows suitable modesty as an Englishman discussing predestination in Scotland where the topic has caused great theological passion in the past. He declares that, like many other people, he cannot believe that life is completely determined but he had not been able to form a satisfactory conception of any kind of law or causal sequence which was other than deterministic. Despite the fact that others such as Einstein may dislike it, Eddington argues, things have changed and the old certainties of nineteenth century science have disappeared and on the scientific side a new situation has arisen. It is a consequence of the advent of the quantum theory that '*physics is no longer pledged to a scheme of deterministic law'*[536]. Determinism, he says, has dropped out altogether in the latest formulations of theoretical physics and it is at least open to doubt whether it will ever be brought back again.

Eddington includes a comment from a course of lectures given to commemorate the bi-centenary of the death of Newton given by, amongst others, Einstein, who said:

> It is only in the quantum theory that Newton's differential method becomes inadequate, and indeed strict causality fails us. But the last word has not yet been said. May the spirit of Newton's method give us the power to restore unison between physical reality and the profoundest characteristic of Newton's teaching, strict causality.[537]

Notwithstanding Einstein's view, Eddington asserts that, since the Gifford Lectures, the growing acceptance of the Principle of Indeterminacy has meant that the opposition of some physicists to determinism, brought about by earlier explorations in quantum theory, has hardened. Einstein is well known as a person critical of quantum mechanics. He was also, as the quote above shows, a determinist. He did not like the indeterminism at the heart of quantum theory and frequently used the divine name as part of his justification, but it is important to remember that Einstein did not believe in the personal God of traditional Judaism and Christianity. Abraham Pais, possibly Einstein's most critically respected biographer, writes:

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[535] Eddington, *The Nature of the Physical World,* 293.
[536] Eddington, *The Nature of the Physical World,* 294, *italics* as in the original.
[537] Albert Einstein reported in *Nature,* (26 March 1927), 467 quoted in Eddington *The Nature of the Physical World,* 293.

> Everyone familiar with modern physics knows that Einstein's attitude regarding quantum mechanics was one of scepticism. No biographer of him fails to mention his saying that God does not throw dice. He was indeed given to such utterances (as I know from experience), and stronger ones, such as 'It seems hard to look in God's cards. But I cannot for a moment believe that He plays dice and makes use of "telepathic" means (as the current quantum theory alleges He does.)'[538]

Max Born corresponded for some time with Einstein on the implications of quantum theory but did not agree with him. The following extract was written by Born before Heisenberg's pronouncements of 1927:

> I myself am inclined to renounce determinism in the atomic world, but that is a philosophical question for which physical arguments alone do not set standards.[539]

In writing to Born, Einstein puts his opposition to indeterminacy in an interesting way, reminiscent almost of Eddington's Quaker belief in the Inner Light or Witness:

> Quantum mechanics is very impressive. But an inner voice tells me that it is not yet the real thing. The theory produces a good deal but hardly brings us closer to the secret of the Old One. I am in all events convinced that *He* does not play dice.[540]

Not all physicists agreed with Born. What would Dawkins make of Einstein's 'inner voice'? Is this objective science? Schrödinger held similar views to Einstein and told Born that if he had foreseen the consequences of his theories he might not have published his papers.[541] Eddington outlines his position thus:

> The future is a combination of the causal influences of the past together with unpredictable elements – unpredictable not merely because it is impracticable to obtain the data of prediction, but because no data connected causally with our

[538] Abraham Pais, *Subtle is the Lord: The Science and Life of Albert Einstein* (Oxford: Oxford University Press, 1982), 440 quoting a letter from Einstein to C Lanzos 12 March 1942.
[539] Pais, *Albert Einstein,* 442 quoting Max Born *Zeitschrift für Physik* 38, (1926), 303.
[540] Pais *Albert Einstein,* 443 quoting a letter from Einstein to Born 4 December 1926.
[541] Pais, *Albert Einstein,* 443.

> experience exist... Meanwhile we may note that science thereby withdraws its moral opposition to freewill.[542]

He says that those who maintain a deterministic theory of mental activity must do so as the outcome of their study of the mind itself and not with any idea that they are thereby making it more conformable with our experimental knowledge of the laws of inorganic nature.

Eddington then goes into some detail on what the new ideas in quantum physics might be. He uses a metaphor to explain what they might mean in terms of statistical averages saying that human life is proverbially uncertain but few things are more certain than the solvency of a life insurance company. The average law is so trustworthy that it may be considered predestined that half the children now born will survive the age of *x* years:

> But that does not tell us whether the span of young A. McB. is already written in the book of fate, or whether there is still time to alter it by teaching him not to run in front of motor buses. The eclipse of 1999 is as safe as the balance of a life insurance company; the next quantum jump of an atom is as uncertain as your life and mine.[543]

Eddington might be interested to note that while the eclipse was seen in Cornwall in 1999, insurance companies have become insolvent, but not because their actuarial tables were at fault. Care needs to be taken with metaphors in scientific popularisation, as will be seen. He asserts that the nature of the quantum theory is statistical:

> Thus in the structure of the world as formulated in the new quantum theory it is predetermined that of 500 atoms now in State 3, approximately 400 will go on to State 1 and 100 to State 2 – in so far as anything subject to chance fluctuations can be said to be predetermined... But there are no marks distinguishing the 100 from the 400.[544]

Eddington may have been one of the first Christian writers to point the general public to this new concept of the nature of reality. He says that we might for illustration make a comparison with the doctrine of predestination. That theological doctrine has up to this point seemed to

[542] Eddington, *The Nature of the Physical World,* 294-295.
[543] Eddington, *The Nature of the Physical World,* 300.
[544] Eddington, *The Nature of the Physical World,* 301.

blend harmoniously with the predetermination of the material universe, but that is no longer the case.

Eddington goes onto another of his occasional unwarranted leaps in argument by asserting that a rather serious consequence of dropping causality in the external world is that it leaves no clear distinction between the 'Natural' and the 'Supernatural'. Eddington's argument runs as follows. In his chapter on gravitation in *The Nature of the Physical World* Eddington wrote comparing the invisible agent invented to account for the tug of gravitation to a 'demon'.[545] This, asserts Eddington, has all the explanatory force of a 'savage' who attributes all of the processes and objects in the natural world which he cannot understand to a demon. The Newtonian physicist had a defence: his demon Gravitation acted according to fixed causal laws and was therefore not to be compared to the capricious demon of the savage. Eddington explains well the weakness of Newton's position and how Einstein's theory is an improvement. Newton, in his defence, speaks frequently of his lack of understanding on gravity thus:

> You sometimes speak of gravity as essential and inherent to matter. Pray do not ascribe that notion to me; for the cause of gravity is what I do not pretend to know, and therefore would take more time to consider of it...
>
> Gravity must be caused by some agent acting constantly according to certain laws; but whether this agent be material or immaterial I have left to the consideration of my readers.[546]

Newton was again very clear on his own ignorance at the end of the *Principia:*

> I have not yet been able to determine from the phenomena the cause of these properties of gravitation, and I do not invent hypotheses. It is sufficient that gravitation exists, that it is capable of explaining all motions of heavenly bodies and of the sea.[547]

There is a great weakness in any scientific explanation which postulates a not fully understood, material or immaterial agency or substance. At the extreme, some such notions would fail Popper's test of being a theory which could be falsified and thus, according to Popper at least, could not be scientific theories. At Newton's time, gravity was so described

[545] Eddington, *The Nature of the Physical World,* 309 referring back to pages 117-118.
[546] Newton, *Letters to Bentley* quoted in Eddington, *The Nature of the Physical World,* 111.
[547] Hermann Weyl, *The Open World* (New Haven: Yale University Press, 1932), 36.

and was far from fully understood. In the early part of Eddington's career, the ether was a theory which could be so described. At the time of writing this thesis, theories of dark matter and dark energy are likewise not fully developed. Whether dark matter and dark energy will in one hundred years be an abandoned theory like the ether theory or developed and improved as the basis for further science, like Newton's theory of gravity, is an interesting question.

Eddington argues that this, not fully understood, material or immaterial agency, gravity, has the same explanatory sophistication as a literal demon, unless the demon Gravitation acts consistently. As Newtonian physics had a rigidly deterministic understanding of the world, then all was fine. But modern physics show that it there is no determinism at the atomic level, so the distinction between the savage's literal demon and the not fully understood, material or immaterial agency melts away. As there is now no longer any distinction between a supernatural explanation 'a demon' and a supposedly naturalistic description 'the Newton description of gravity', then there is no distinction between the natural and the supernatural.

A number of objections to this can be voiced. Firstly the Newtonian conception of gravitation works very well in most physical conditions, except those involving very massive objects, very small objects or very fast moving objects. Secondly, Eddington is using an explanatory metaphor as the starting point for argument forward rather than returning to the object of the metaphor. This process may not be the best way forward in such circumstances. Thirdly and most significantly, Eddington elsewhere acknowledges that science is not a static form of knowledge which gives fully complete and precise knowledge of the physical universe, so to say that the unexplained mechanism of gravity in Newton's conception is on par with the demon of a primitive animist in terms of explanatory sophistication is to overstate his case. Is this one of the cases which McCrea referred to where the audience is being 'gently conned'? At the forefront of scientific development there are always areas of theory which are underdetermined and explanations which are not fully formed.

Eddington sums up his view on this topic in 1928 thus: 'We on the other hand have concluded that there is no strict causal behaviour anywhere.'[548] H G Callaway writing in the introduction to his annotated edition of *The Nature of the Physical World,* says:

[548] Eddington, *The Nature of the Physical World,* 309-310.

> Eddington is not convinced of this "iron determinism," of the "primary laws." He is partly telling the story of nineteenth-century Newtonian physics – and this rigid determinism belongs to that story.[549]

Hyman Levy of Imperial College in a section on which he takes to task Eddington and Jeans on determinism and other topics records a comment from radio broadcast of March 1930 where Eddington is yet more sure '… we cannot find a particle of evidence in favour of determinism.'[550] Jeans, he notices, is not quite as assertive: 'Science has no longer any arguments to bring against our innate conviction of Free Will.[551]

To return to Eddington's starting point on the non-distinction between the 'Natural' and the 'Supernatural', he is surely overstating the case. While from a point of view which regards the whole universe working in its customary manner according to the descriptions of natural law as upheld by the loving purposes of a Creator God, the distinction between natural and supernatural is not always a helpful one. Nevertheless, Eddington's statement that there is no distinction between the natural and the supernatural was one that others found hard to accept.

Eddington believed firmly in the freedom of the human mind and spirit. In *The Nature of the Physical World* he argues that the mind had been 'emancipated' by the new science and that the perception of most humans that they have free will was not mistaken: 'I think we may now feel quite satisfied that the volition is genuine.'[552]

In 1932, four years after the publication of *The Nature of the Physical World* and five years after his Gifford Lectures, Eddington gave his Presidential Address to the Mathematical Association. In this he asserted again that the death of determinism in physics has implications beyond science:

> Some writers are incredulous and cannot be persuaded that determinism has really been eliminated. Some think it is only a domestic change in physics, having no reactions on general philosophic thought.[553]

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[549] H G Callaway (ed.), *Arthur S Eddington* The Nature of the Physical World *Gifford Lectures of 1927: An Annotated Edition,* xxxiii.
[550] H Levy, *The Universe of Science* (London: Watts, 2nd ed. 1947) 111.
[551] Levy, *The Universe of Science,* 115 an unreferenced quotation from Jeans.
[552] Eddington, *The Nature of the Physical World,* 311.
[553] Arthur Eddington, 'The Decline of Determinism', *Mathematical Gazette* 16, (May 1932), 141.

In one of the few mentions Eddington makes of the miraculous, he records 'Some imagine that it is a justification for miracles.'[554] He does not expand on this statement. Eddington goes on to define the scope of his lecture:

> In this address, I shall deal mainly with the physical universe, and say very little about mental determinism and free will. That might well be left to those who are more accustomed to arguing about such questions if only they could be awakened to the new situation which has arisen on the physical side. At present I can see little sign of such an awakening.[555]

Eddington is yet more resolute than he was in 1928 that determinism is dead in physics. Batten argues that by 1935, in *New Pathways in Science,* Eddington was not so optimistic.[556] A reading of the whole chapter, or indeed just the next sentence, 'But I think this is sufficient to justify a reorientation of our attitude to the problem' indicates that Eddington is nuanced as ever. Other sciences and intellectual disciplines may have in the past looked to physics to supply a rationale for determinism, but they may do so no longer. It may be that from within other disciplines, there is evidence of determinism, but for the physicists, they no longer hold the position, occupied for so long, of chief advocate for determinism. Others, philosophers, psychologists, theologians may have found indications of determinism in some other way.

Russell took Eddington's ideas in Chapter XIV 'Causation' in *The Nature of the Physical World* to task in *The Scientific Outlook.* This was published after the publication of 'The Domain of Physical Science' and *The Nature of Physical World* but before Eddington gave his Presidential Address to the Mathematical Association in 1932.

> One of the most remarkable developments in religious apologetics in recent times is the attempt to rescue free will in man by means of ignorance as to the behaviour of atoms.[557]

Russell states that the Principle of Indeterminacy was introduced into physics in 1927 by Heisenberg and the term has been seized upon by clergymen as something capable of giving

[554] Eddington, 'Presidential Address' 141.
[555] Eddington, 'Presidential Address' 141.
[556] Alan H Batten, 'What Eddington Did *Not* Say' *Isis,* 94 (2003) 656- 659 referring to Eddington, *New Pathways in Science*, 87.
[557] Russell, *The Scientific Outlook,* 107.

them an escape from the thraldom of mathematical laws. Russell found it surprising that Eddington should countenance this use of the principle.

Russell could not see any connection with the question of free will. For him the principle did nothing whatever to show that the course of nature is not determined. Russell states that the Principle of Indeterminacy has to do with measurement and not with causation. Measurement at the sub-atomic level is a physical process which has a physical effect on what is measured. He believes Eddington is making too much out of the then current inadequacy of physical law and theory. The problem is a temporary one which will be resolved. Regarding the current problems:

> It shows merely that the old space-time apparatus is not quite adequate to the needs of modern physics ... modern quantum mechanics has made it evident that a more fundamental reconstruction is necessary.[558]

Three points arise from Russell's argument here. This first is his use of the word 'determine' in this last quotation. Physical laws describe rather than determine the course of nature. Laws are verbal formulations which are human constructions with only a descriptive status. Southgate writing on this topic, gives a range of views, including:

> ... laws that seem deterministic do not have ontological status - they do not determine reality, but are only descriptions of regularities, or approximations to reality.[559]

The second is that the difficulties in the interpretation of quantum mechanics still exist. No fresh consensus has developed amongst the community of physicists as to how it relates to Newtonian physics or relativity. The old determinism has not been reinstated. It may be that Russell's 'fundamental reconstruction' of space and time will be installed, but there are currently no signs of this. Physicists still argue that the world shown by quantum mechanics is one which is not deterministic and closed. Osborn writes:

[558] Russell, *The Scientific Outlook,* 109.
[559] Christopher Southgate 'A test case: divine action' in Christopher Southgate (ed.), *God, Humanity and the Cosmos,* 281.

> Determinism has given way to an emphasis on *probabilities*. We simply do not have access to enough information to make deterministic predictions. And this is widely held to be a feature of the world rather than an observational limitation.[560]

The third point is that Russell is exaggerating what Eddington claims from quantum mechanics. Eddington is insistent on the limits of science, as has been seen, he repudiates the idea of proving the distinctive beliefs of religion either from the data or by the methods of physical science.[561] At the end of *The Nature of Physical World,* Eddington explicitly mentions quantum theory in his summary of his position saying that the religious reader may well be content that he has not offered him a God revealed by quantum theory and therefore liable to be swept away by the next scientific revolution.

Eddington's approach is more nuanced. He agrees with the first statement in the quotation below which opens Russell's chapter on 'Science and Religion' but he does not go as far as the second statement, namely that recent advances in science have disproved the older materialism, and have tended to re-establish the truths of religion.[562] Eddington implies, flippantly, that the decline of materialistic determinism has certainly made religious belief intellectually tenable, but neither 'the data of physical science or the methods of physical science' can prove religious faith. Yet Russell portrays Eddington as doing exactly that:

> It is very rash to erect a theological super-structure upon a piece of ignorance which may be only momentary.[563]

This has not proved to be a temporary ignorance. It is interesting to wonder whether Russell would have changed his stance after eighty years of quantum uncertainty.

In his influential *The Social Function of Science* the Marxist J D Bernal was likewise not impressed:

> The very indeterminacy of quantum mechanics is made an argument for human free will. In this way, modern science is made an ally of ancient religion, and even a substitute for it. Through the works of Jeans, Eddington, Whitehead and J S

[560] Lawrence Osborn, 'Theology and the New Physics', in Christopher Southgate (ed.), *God, Humanity and the Cosmos,* 142.
[561] Eddington, *The Nature of the Physical World,* 333.
[562] Russell, *The Scientific Outlook,* 105.
[563] Russell, *The Scientific Outlook,* 111.

> Haldane, assisted by the Bishop of Birmingham and Dean Inge, a new scientific mythical religion is being built up…[564]

Inge was not one of the churchmen who uncritically accepted the work of Eddington and Jeans. In fact in *God and the Astronomers* of 1933 he rejected one key plank of their thought, criticising those who take refuge in Berkeleyan idealism as an escape from certain apparently insoluble problems in their own subjects. Science, he argued, can never be independent of the realism with which it starts, and therefore can never become purely mathematical.[565] He was sceptical about the claims of the new science to prove indeterminism:

> I have ... taken no firm line about determinism and free will. This terrible problem arises in connection with the new belief in "indeterminacy," which is, I suppose, a mathematical demand. I do not think that a belief in real chance follows... The notion that "anything may happen" seems to me to threaten the foundation of science.[566]

Inge, while accepting Eddington's description of the change in mathematical physics, was unconvinced that this has much to say on determinism in the real world. It is interesting to see that Inge, the classicist and theologian, was concerned about the foundations of science. He admitted in this book that he was not equipped by his training to make pronouncements in the area of science. It is likely that Eddington, who asserted, with tongue in cheek, that belief became possible for the intelligent person after the publication of the Principle of Indeterminacy, would agree with Inge in stating that the foundations of science were shaken by this change in understanding of causation, but this was a good process and helped science advance.

Does the fact that scientists cannot tell when an individual atom of carbon 14 will decay to carbon 12 tell theologians anything about predestination? Does the principle of indeterminism have any bearing on theology? Does that fact that both the position and velocity of an electron cannot be known at the same time or a physicist or chemist cannot know when an electron will decay from one energy level to another have anything to tell about human free will? Can microscopic events tell us anything relevant about questions in philosophy or theology?

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[564] J D Bernal, *The Social Function of Science* (London: Routledge, 1939), 4.
[565] Inge, *God and the Astronomers,* viii.
[566] Inge, *God and the Astronomers,* ix-x.

Gribbin, in his popular *In Search of Schrödinger's Cat,* answers very definitely in the positive:

> It really does seem that these changes occur entirely by chance, on a statistical basis, and that already begins to raise fundamental philosophical questions.[567]

Stephen Hawking, who often uses the word God in the same way as Einstein, writes:

> Even God is bound by the uncertainty principle and cannot know the position and velocity; He can only know the wave function.[568]

While the implications of these researches in mathematical physics can be portrayed in such a way as to exaggerate their importance, it must be recalled that one of the claims of late Victorian mechanistic materialism was that large scale events are determined by small scale events. If there is a fundamental randomness at the heart of matter, it is difficult to say that the physics of the very small points to a rigid determinism in medium sized objects such as humans and planets. While statistical probabilities can be calculated, determinism no longer is the standard view of the physicist. The universe shown by science is now one which is open, not one which is closed. This does not prove an Arminian understanding of election, but it is congruent with such an approach. It has been seen that Eddington is a cautious apologist. In his famous section on the Principle of Indeterminacy he picks his words carefully, even if his tongue is firmly in his cheek:

> It will perhaps be said that the conclusion to be drawn from these arguments from modern science, is that religion first became possible for a reasonable scientific man about the year 1927… If our expectation should prove well founded that 1927 has seen the final overthrow of strict causality by Heisenberg, Bohr, Born and others, the year will certainly rank as one of the greatest epochs in the development of scientific philosophy.[569]

Batten has written an interesting article on this passage following on from mentions of the above in books by John Hedley Brooke, Peter Bowler and Max Jammer.[570] Batten suggests that Eddington was not saying 'this' (it is unclear what 'this' refers to here but presumably he

[567] John Gribbin, *In Search of Schrödinger's Cat* (London: Black Swan, 1984), 6.
[568] Hawking, *The Universe in a Nutshell,* 107.
[569] Eddington, *The Nature of the Physical World,* 350.
[570] Batten, 'What Eddington Did *Not* Say' 657 referring to Bowler, *Reconciling Science and Religion,* 36, 108; John Hedley Brooke, *Science and Religion: Some Historical Perspectives,* (Cambridge: Cambridge University Press, 1991), 327; Max Jammer, *Einstein and Religion: Physics and Theology* (Princeton: Princeton University Press, 1999), 230 and Peter J Bowler, *Reconciling Science and Religion: The Debate in Early Twentieth-Century Britain* (Chicago: University of Chicago Press, 2001), 36.

refers to a simple interpretation of 1927 as the key year of change) but that he was anticipating possible objections to his argument.[571] Batten's judgement here is suspect again. A more likely interpretation was that Eddington was using ironic humour. This is consistent with his general style and this assertion is supported by Eddington's playful sentence on the same page - 'Certain common activities (e.g. falling in love) are, I fancy, still forbidden to him.' 'Him' here being the aforementioned reasonable scientific man.

For Eddington, religion 'becomes' intellectually respectable because the prevailing science shows that the universe is not closed and mechanical, but it is not proved by these advances because religion cannot be proved by the methods or data of science. Additionally, Eddington, an Arminian Quaker by background, is now content that the Inner Light which led him to believe in human free will is not overruled by the deterministic physics of late Victorian science.

6.6 Conclusion

The popular nature of the three key texts from Eddington and Jeans has already been demonstrated. Their work brought new ideas in science to bear upon key Christian beliefs and their reach went beyond the generally reading public to academics in many fields and to church leaders. Their writings were not the last word on the topics discussed in this chapter but they were frequently the writers who bought these topics before both the popular and the non-astronomical academic audience. It has been noted that McCabe suggested that Inge's *God and the Astronomers* should be renamed *God and Two Astronomers* such was their influence upon Inge. While there is some hyperbole in McCabe's polemical point, it is not a total exaggeration.

As a result of this large impact they moved the debate in Great Britain on from an over-emphasis on evolutionary biology to the physical sciences and astronomy in particular. This is a key legacy. Their discussion of an expanding universe (for Eddington this came not in one of the key texts but in *The Expanding Universe*) opened the way for Christian theologians and scientists to consider the theological issues surrounding what later came to be known as the Big Bang. Their discussion on the end of the universe, taken up by Inge as it was, has been in the main neglected as were Eddington's views on intuition. Eddington's comments on

[571] Batten, 'What Eddington Did *Not* Say', 657.

determinism helped moved the debate on that topic away from a rigid determinism in physics, although this understanding of the implications of modern physics is not always understood. Jeans' comments on design were significant, paving the way for this idea to flourish in the 1970s onwards in cosmology.

CHAPTER SEVEN

IDEALISM AND TWO PHYSICISTS

7.1 Introduction

In chapter six a description was given of the positive contribution that Eddington and Jeans made in bringing to more general attention the new developments in physics which had a bearing upon theology. Their role in this widening of knowledge was very important indeed. In chapter seven, by contrast, their rather amateur and inconsistent use of philosophical Idealism will be examined. The work of the two popular apologists cannot be understood without a consideration of their use of Idealism. They became attracted to Idealism just as many professional philosophers and theologians were discarding this approach.

There will first be a consideration of the place of philosophical Idealism in Great Britain at the start of the twentieth century and then its influence on the writings of Eddington and Jeans. After this the reaction of two writers to the Idealism of Jeans and Eddington will be examined. The first is the philosopher C E M Joad, Reader at Birkbeck College, London. The second is the theologian W R Inge, Dean of St Paul's.

7.2 Idealism with a Scientific Tinge or Science with an Idealistic Tinge?

One of the major criticisms of the work of Eddington and Jeans is that, while it conveyed, as accurately as was reasonably possible in popular or semi-popular books, the findings of modern science, their work lacked philosophical rigour. Eddington writes in the 'Preface' to *The Nature of the Physical World*:

> My principal aim has been to show that these scientific developments provide new material for the philosopher.[572]

[572] Eddington, *The Nature of the Physical World,* viii.

This is of course a worthy aim. The developments in physics and astronomy were, indeed, philosophically and theologically significant, contributing to the debates on determinism, epistemology, creation and eschatology. The role of Eddington and Jeans in drawing the attention of the reading and listening public to both the advances in sciences and their implications was crucial.

Eddington briefly touches on his conversion experience to Idealism:

> I would like to recall that the idealistic tinge in my conception of the physical world arose out of mathematical researches on the relativity theory. In so far as I had any earlier philosophical views, they were of an entirely different complexion.[573]

Eddington's approach, as has been seen, bears more than a tinge of Idealism, and the same can be said for Jeans. Their approach, while not the naïve Idealism castigated by Dr Samuel Johnson, was very much in the Idealist tradition, with a scientific tinge. Eddington argues that as our conception of matter must shed its conception of substantiality, so too must our conception of existence shed its 'halo' before it can be admitted into physical science. Clearly the two are linked. If an electron is not like a solid little planet circling a solid nucleus but is best described in terms of probability, and if the whole physical world is shadowy rather than concrete, then necessarily the conception of the mode of the existence of the material world is not quite as it was formerly envisaged. Eddington is not over-concerned with words such as existence and reality; he was not simply asserting that modern physics showed that Idealism was true, but rather asserting the validity of both the spiritual and the scientific approaches as routes to the truth:

> All I would claim is that those who in the search for truth start from self-consciousness as a seat of self-knowledge with interests and responsibilities not confined to the material plane, are just as much facing the hard facts of experiment as those who start from consciousness as a device for reading the indications of spectroscopes and micrometers.[574]

Eddington was very accurate when he prophesied that he had much to fear from the expert philosophic critic. In order to see the philosophical context in which Eddington and Jeans were writing, it is essential to investigate the importance of Idealism at the start of the twentieth

[573] Eddington, *The Nature of the Physical World,* viii.
[574] Eddington, *The Nature of the Physical World,* 288-289.

century in Britain. Timothy Gouldstone in his study of Anglican Idealism in the nineteenth century defines Idealism thus:

> Put at its simplest, idealism is a broad term for a philosophical movement that defines ultimate reality as mental or 'spiritual' rather than physical; the mind and spiritual values are more fundamental than material ones.[575]

It might be better to say that it is a closely associated family of ideas rather than 'a philosophical movement.' Blackburn indicates some of the major varieties of Idealism, including Transcendental Idealism, Absolute Idealism and Immaterialism.[576] Idealism is not a single philosophical movement.

Forms of Idealism have been espoused by a number of philosophers since the time of Berkeley including Kant, Schelling and Hegel in Germany, and in England T H Green, Benjamin Jowett, F H Bradley, and Eddington's contemporary at Trinity College, Cambridge, John McTaggart. While their views were linked by the belief that the ultimate reality or Ultimate Reality was not material, their views were not identical, as Bernard Reardon points out:

> The term Idealism is an elastic one. In its widest sense it denotes the view that the mind and spiritual values are more fundamental than material ones. As such, it is opposed to naturalism which explains the mind and spiritual values in terms of material things and processes.[577]

It is interesting to speculate on the influence of McTaggart and Eddington upon each other. Eddington makes one reference to him in his books, in *Science and the Unseen World,* in which he doubts that McTaggart's *magnum opus, The Nature of Existence* sheds much light on the nature of existence.[578] McTaggart was both tutor and friend to Bertrand Russell and G E Moore. He influenced the young Russell towards Idealism and was its chief proponent in Cambridge when Moore and Russell were later leading the Realist rebellion.

Influenced by the German philosophers, Idealism become popular in British intellectual circles in Victorian times. Reardon gives three reasons for this. Firstly it was the doctrine of all the leading lights in the philosophical firmament such as Hegel and Green. Secondly, at this time,

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[575] Timothy Maxwell Gouldstone, *The Rise and Decline of Anglican Idealism in the Nineteenth Century* (Basingstoke: Palgrave Macmillan, 2005), 25.
[576] Simon Blackburn, *The Oxford Dictionary of Philosophy* (Oxford: Oxford University Press, 1994), 184.
[577] Bernard M G Reardon *From Coleridge to Gore: A Century of Religious Thought in Britain* (London: Longman, 1971), 117.
[578] Arthur Stanley Eddington, *Science and the Unseen World* (London: Allen and Unwin, 1929), 43.

British education at university level involved a staple diet of classics, and Plato was the philosopher *par excellence.* It was a short step from Plato's doctrine of the Forms to Hegel's Absolute Idealism. Hegel possibly had the edge on Plato for the late Victorians, as his view was more dynamic and seemed better to harmonise with evolution. Finally, Idealism seemed to present a spiritual bulwark against the rising tides of materialism and secularism. It seemed to offer a rational basis for Christianity when some theologians became embarrassed by its historical claims.

On this last point there is some scholarly agreement. Gouldstone says that 'Hegelianism', or at least some revision of it, appeared to offer a lifeline to theologically-minded academics and clergy worried by the rise of more materialistic traditions such as the prevailing Utilitarianism of J S Mill.

Embracing idealism also provided a means by which those who could not accept Christian doctrines for scientific or moral reasons could retain a coherent moral outlook based on a broad theism which grounded morality in the structure of the cosmos rather than the inventiveness of mankind.[579]

F M Turner agrees that Idealism represented an outlook that emphasised metaphysical questions in philosophy, historicist analysis of the past and significantly:

> … the spiritual character of the world, the active powers of the human mind, intuitionism, subjective religiosity, the responsibility of individuals for undertaking moral choice and action, the relative or even absolute importance of communities and communal institutions over individual action or rights, and the shallowness of any mode of reductionist thought.[580]

Clearly not all of these themes were found in every Idealist writer or thinker. Jeans, for example, was not a supporter of intuitionism, although Eddington was. T H Green influenced many with his social thought, but many Christian leaders so shaped did not agree with Idealist metaphysics.

F M Turner goes on to say that the spirituality inherent in late nineteenth century philosophical Idealism provided to university-educated men, by then recruited across a broad

[579] Gouldstone *Anglican Idealism,* 25.
[580] F M Turner 'The Triumph of Idealism in Victorian Classical Studies' in *Contesting Cultural Authority – Essays in Victorian Intellectual Life* (Cambridge: Cambridge University Press, 1993), 322.

spectrum of religious beliefs and social backgrounds, a bulwark against radical individualistic politics, religious scepticism, reductionist empiricism and scientific naturalism.[581]

Clement Webb asserts that Idealism:

> ... claimed to be in a position to affirm that the great doctrines of Christianity, of manhood taken into God, of life won by the losing of it in death, and the like, were true not indeed as the record or the anticipation of events miraculous and supernatural in a far distant past or in a remote future quite unlike the present, but rather as a statement of the inner significance of man in every age, of the whole history of civilisation itself.[582]

Adrian Hastings agrees with Gouldstone, Turner and Webb that Idealism appeared as a friend but argues that 'Here was a friend as dangerous as many enemies'.[583] Idealism appeared as an ally but philosophically undermined Christianity as a religion centred on the person of Christ. Remove this particularity and one is left with something which looks less and less like Christianity.

Gouldstone and Reardon give different dates for the start of the decline of Idealism in Britain. Reardon dates it to the early years of the twentieth century.[584] Gouldstone views the decline of Idealism as having started earlier in the last decade of the nineteenth century and quotes Edward Caird, Jowett's successor at Balliol, to that effect.[585] Earlier in the chapter, however, he quotes Willis with approval who says that from roughly 1875 to 1915, Hegelian thought dominated the professional study of philosophy in Britain.[586] Hastings said that reverence for Hegel was lessening with the turn of the century and crashed with the First World War.[587]

Alan Sell is critical of the close relationship between Idealism and Christian theology because in his view the attempt to express Christian thought through the medium of Idealism fails at certain critical points.[588] Along with Ramsey,[589] Sell identifies the doctrine of redemption as

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[581] F M Turner 'The Triumph of Idealism in Victorian Classical Studies', 350.
[582] C C J Webb *A Study of Religious Thought in England from 1850* (Oxford: Clarendon Press, 1933), 102.
[583]Adrian Hastings, *A History of English Christianity* (London: Collins, 1987), 229.
[584] Reardon, *From Coleridge to Gore,* 124.
[585] Gouldstone, *Anglican Idealism,* 38 quoting a letter of Edward Caird written in 1892.
[586] Gouldstone, *Anglican Idealism,*26 quoting K Willis 'The Introduction and Critical Reception of Hegelian Thought in Britain 1830 – 1900', *Victorian Studies* 32, (1988), 86.
[587] Hastings, *English Christianity*, 229.
[588] Alan P F Sell, *Philosophical Idealism and Christian Belief* (Cardiff: University of Wales Press, 1995), 5.
[589] Ramsey, *From Gore to Temple,* 9.

one of these key points; some Idealists believing there was no need for redemption. In this Sell and Ramsey are accurate as far as a traditional understanding of Christian theology is concerned. Sell believes that the influence of Idealism continued both in theology and philosophy past the beginning of the twentieth century, citing C A Campbell's Gifford Lectures of 1957 as an example of the continuing influence of what he describes as Broad Church Idealism.[590]

Ramsey cautions against an approach which suggests a wholesale or uncritical adoption of Idealism by many theologians in the late nineteenth and early twentieth century. While some of the authors of *Lux Mundi* of 1889, such as Henry Scott Holland, were influenced by Green on the unity of the sacred and secular, he diverged from Idealism in his explanation of the doctrine of redemption. John Illingworth was very sympathetic to Idealism; others amongst the contributors were not.[591] Even at the height of its popularity, the influence of Idealism was not universal.

What was the cause of the decline of the Influence of Idealism? Reardon, Sell and Gouldstone all state that vigorous attacks on Idealism from new movements within philosophy were the main cause. Reardon singles out the British philosophers, G E Moore and Bertrand Russell, and, from Denmark Søren Kierkegaard. Reardon writes:

> The big difficulty about Idealism is its lack of proof. The Idealist philosophers talk on and on at enormous length. But what they say seems not only contrary to common sense but indemonstrable. It is one thing to build up a system of ideas; it is something else entirely to show that they are true.[592]

In summary, Idealism had been a very potent force in British intellectual life. Its influence was still strong when Jeans and Eddington were students but by the time the three key texts were published from 1928 to 1930, it was well past its zenith of influence. The influence of Idealism on first Eddington and then Jeans will now be considered in some detail.

[590] Sell, *Philosophical Idealism and Christian Belief,* 3-4.
[591] Ramsey, *From Gore to Temple,* 10.
[592] Reardon, *From Coleridge to Gore,* 124.

7.3 Idealism in Eddington

Eddington's views on Idealism are briefly stated in his chapter 'The Domain of Physical Science' in Needham's *Science Religion and Reality*, then given a fuller, more detailed expression in *The Nature of the Physical World* and a fully Quaker statement in *Science and the Unseen World.*

In 'The Domain of Physical Science' Eddington sums up his position thus:

> Our thesis has been that the recent tendencies of scientific thought lead to the belief that mind is a greater instrument than was formerly recognised in prescribing the nature and laws of the external world as studied in physical science.[593]

The whole of *The Nature of the Physical World* has an Idealistic tinge, but the chapter that touches on the issue of Idealism most directly is Chapter XIII 'Reality'. This is not a straight philosophical discussion of Realism and Idealism but an account of what physicists then thought 'Reality' to be which leads into a discussion of the philosophical implications of these ideas. Eddington argues that for a long time, possibly back to our tree-based ancestors, we have confused the *concrete* and the *real*. 'For this reason the scientific world often shocks us by its appearance of unreality.' [594] But modern science has shown a world which is verging on the unreal. He did not wish to push this argument too far, but Eddington argued that physicists were no longer tempted to take up the attitude that everything which lacks concreteness is thereby self-condemned.

It is this leap from saying that modern science shows a world which is less concrete and real than the world of billiard ball atoms of nineteenth century science to saying that 'reality is spiritual', however warily it is said, which brought the close attention of his critics. Eddington does not insist on the use of the term 'spiritual world' but his vague use of this term and 'mind-stuff' did not please his expert philosophic critics.

Eddington says that the split between scientific matters and non-scientific matters is not a split between the concrete and the transcendental, but a split between the metrical and the non-metrical. Eddington goes on:

[593] Eddington, 'The Domain of Physical Science', 217.
[594] Eddington, *The Nature of the Physical World,* 274 Eddington's italics.

> To put the matter crudely – the stuff of the world is mind-stuff. As is often the way with crude statements, I shall have to explain that by "mind" I do not exactly here mean mind and by "stuff" I do not at all mean stuff.[595]

While this is the type of phrase which brings an ironic smile to the audience at a public lecture it is also the sort of sentence which brings down the ire of critics. Bussey has recently supported Eddington's position saying that '… Eddington's proposal seems to me real. There is a universal category of the mental.'[596]

Part of Eddington's case for Idealism is built on his understanding of the psychology of perception. As will be seen in the section on Joad, Eddington was closer to the now generally accepted view in psychology on this matter than his critics. He acknowledges his debt in his theories of perception to the mathematician and philosopher W K Clifford of University College, London.[597] William Clifford was trained in mathematics at King's College, London and Trinity College, Cambridge. He was the first to use the expression 'mind-stuff'. Clifford's views were not identical with those of Eddington, but could be described as Idealist Monism.

Eddington goes on to quote Russell with approval.[598] Russell, it should be remembered, studied mathematics at Cambridge at exactly the same time as Eddington. At least on the psychology of perception, they were agreed. It is from this understanding of the psychology of perception linked with the Quaker emphasis on experience that springs one of Eddington's most quoted expressions of his Idealist stance:

> It is difficult for the matter-of-fact physicist to accept the view that the substratum of everything is of mental character. But no one can deny that mind is the first and most direct thing in our experience, and all else is remote inference – either intuitive or deliberate.[599]

Many matter-of-fact physicists did not accept that the substratum of the world was mental. Eddington goes on to make his apologetic aim more obvious:

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[595] Eddington, *The Nature of the Physical World,* 276.
[596] Peter J Bussey, 'Beyond Materialism: from the Medieval Scholars to Quantum Physics' *Science and Christian Belief,* 16 (2003) 175, 177.
[597] Eddington, *The Nature of the Physical World,* 278 quoting W K Clifford 1875, no reference given.
[598] Eddington, *The Nature of the Physical World,* 281 quoting Bertrand Russell, *The Analysis of Matter,* 320.
[599] Eddington, *The Nature of the Physical World,* 281.

> This view of the relation of the material to the spiritual world perhaps relieves to some extent a tension between science and religion.[600]

But Eddington rejects a simple 'god of the gaps' solution saying that physical science had seemed to occupy a domain of reality which is self–sufficient, pursuing its course independently of and indifferent to that which a voice within us asserts to be a higher reality. He said that if scientists were to repent and admit that it was necessary to include among the agents controlling the stars and the electrons 'an omnipresent spirit to whom we trace the sacred things of consciousness, would there not be even graver apprehension?'[601]

Nevertheless, Eddington has a tendency to jump from the acceptance of physicists that the billiard ball picture of atomic structure is inadequate, and must be replaced by a far less concrete understanding of the nature of the physical world, to say that the substratum of the world is mental. Yet his statement that 'mind is the first and most direct thing in our experience' was significant. While not uncontested it may, nevertheless, be regarded as a statement of the obvious or alternatively as too simple without an adequate definition of what the mind might be.[602] This statement, however, when linked with the growing understanding of the role of the mind/brain in constructing the perception of the physical world, was for many a comparatively new insight into the way the world is. Previously, most physicists and much of the public, saw the world as not only objectively existing but also viewed perception as a very straightforward process. Science was a process by which clever men and women discovered facts about a complicated but real world which they put together into a picture of a difficult-to-understand but, nevertheless, straightforwardly existing concrete reality. Eddington's and Jeans' contribution was to point out that reality was less concrete and more shadowy than previously thought; that the brain played a crucial role in the construction of this view of reality, and because, *inter alia,* of the shadowy nature of physical reality and the nature of the mind/brain, science was a picture of reality which was subject to revision rather than the final truth.

Eddington was adamant that while modern physics had no problems for the Christian believer who had an experience of the Inner Light or intuitive religious experience, nevertheless, neither the methods of science nor the data of science could prove religious belief. Even the

[600] Eddington, *The Nature of the Physical World,* 281.
[601] Eddington, *The Nature of the Physical World,* 281-282.
[602] C E M Joad, *Philosophical Aspects,* 39-44.

crudest anthropomorphic images of the deity were better than that approach which attempted to apply mathematical descriptions to the divine:

> It is in this background, that our own mental consciousness lies; and here, if anywhere, we may find a Power greater than but akin to consciousness… So that the crudest anthropomorphic image of a spiritual deity can scarcely be as wide of the truth as one conceived in terms of metrical equations.[603]

Arthur Ritchie rightly makes an interesting parallel between the background of Eddington, imbibed at Dalton Hall, and that of Kant:

> For all the difference between eighteenth-century East Prussia and twentieth-century England, there is a strong resemblance between the religious faith of the Pietists in which Kant was nurtured and which influenced his thinking very strongly, and the faith of the Society of Friends, which influenced the thinking of Eddington.[604]

As will be later seen, Joad sees similarities between Kant's and Eddington's approach to Idealism.

7.4 Idealism in Jeans

Jeans' Idealism is first vaguely hinted at in *Astronomy and Cosmogony* in a passage already quoted in chapter four of this thesis. This was a scientific text but at the end Jeans lists eight 'ultimate' questions, one of which was 'Are they perchance only a dream, while we are brain-cells in the mind of the dreamer?[605] This is not a very precise phrase for a serious scientific book.

Jeans' *The Mysterious Universe* begins with Plato's figure of the prisoners chained in a cave who can see nothing but the shadows of images on a wall. It then goes on in four mainly uncontroversial chapters to describe the nature of the world as described by modern physics and astronomy. In the fifth chapter Jeans starts to draw some conclusions from this science.

[603] Eddington, *The Nature of the Physical World,* 282.
[604] A D Ritchie, *Reflections on the Philosophy of Sir Arthur Eddington* (Cambridge: Cambridge University Press, 1948), 3.
[605] Jeans, *Astronomy and Cosmogony,* 422.

Jeans writes, if the meeting of two electrons is best described by six dimensions of space and one of time and the meeting of three electrons by nine dimensions of space and one of time then in what sense do these nine dimensions of space exist? He quotes Schrödinger thus:

> It merely is an adequate mathematical description of what happens. It may be that also in the case of a single [electron], the wave-motion must not be taken to "exist" in *too* literal a sense, although the configuration-space happens to coincide with ordinary space in this particular case.[606]

Jeans' Idealism, like that of Eddington, starts from a recognition that the view of physics in 1930 shows a material world that is different from the conceptions of physicists from fifty years before. Jeans' Idealism is expressed in a different way from that of Eddington. His expression of Idealism owes much to Berkeley, as has been seen. For Jeans the universe is best pictured, with qualification, as consisting of pure thought. Jeans argues that by the road of modern physics he has come to the same conclusion as Bishop Berkeley that when it comes to material items 'their objectivity arises from their subsisting "in the mind of some Eternal Spirit."'[607] Jeans' style is interesting. He likes the sound of a grand phrase but it is not always clear what he means when he ventures into the realms of philosophy. He was a good expositor of science but the final sentence below indicates an ill-defined Idealist Theism:

> Mind no longer appears as an accidental intruder into the realm of matter; we are beginning to suspect that we ought rather to hail it as the creator and governor of the realm of matter – not of course our individual minds, but the mind in which the atoms out of which our individual minds have grown to exist as thoughts.[608]

It is this imprecise use of language in general and an imprecise use of Idealism in particular which attracted the criticism of philosophers and possibly caused the neglect of theologians. But such phrases were often quoted by popularisers, such as Edward Woods, Bishop of Croydon, in his 1934 book *What is This Christianity?*[609] Woods saw himself as a 'middle-man' between the scholars and 'those who inhabit rather more humble intellectual levels'.[610] Woods quotes this section from Jeans with obvious approval.[611] Thomas Nagel, the American anti-reductionist and atheist philosopher in *Mind and Cosmos: Why the Materialist Neo-*

[606] Jeans, *The Mysterious Universe,* 121.
[607] Jeans, *The Mysterious Universe,* 137.
[608] Jeans, *The Mysterious Universe,* 148.
[609] Edward S Woods, *What is This Christianity?* (London: Hodder and Stoughton, 1934).
[610] Woods, *What is This Christianity?* Ix.
[611] Woods, *What is This Christianity?* 46.

Darwinian Conception of Nature Is Almost Certainly False, has recently written something similar to Jeans, but makes no reference to him or his work. Is Jeans an unacknowledged influence on Nagel?

> Mind, as a development of life, must be included as the most recent stage of this long cosmological history, and its appearance, I believe, casts its shadow back over the entire process and the constituents and principles on which the process depends.[612]

7.5 C E M Joad – The Precise Realist Critic

In the next two sections, two significant critics of Jeans and Eddington will be considered. Both were influential and their criticisms of Jeans and Eddington were largely reasonable and balanced. Both could clearly see the philosophical weaknesses in the writings of the two scientists. The first was a philosopher, the second a theologian. Neither of them was wholly opposed to what the two astronomers were saying, but they did not hold back on their criticisms of the imprecise use of Idealism.

Cyril Joad at the time of writing *The Philosophical Aspects of Modern Science* was Reader in Philosophy at Birkbeck College, the University of London. He studied at Balliol College, Oxford, where he obtained a First in *Literae Humaniores* and in Greats. From Oxford he went to work for the Civil Service where he stayed until he became Head of the Philosophy Department at Birkbeck College. He was a Fabian socialist. Joad was, along with Russell and Eddington, a pacifist. He was the leading speaker for the motion 'That this house will in no circumstances fight for its King and Country' at the famous meeting of the Oxford Union Debating Society in 1933.[613]

Joad's *The Philosophical Aspects of Modern Science* appeared in 1932 and thus after the three key books for this study, and after Russell's response to Eddington and Jeans *The Scientific Outlook* of 1931. Unlike Russell's work, *The Philosophical Aspects of Modern Science* is a considered and balanced assessment of the work of Jeans and Eddington and acknowledges

[612] Thomas Nagel, *Mind and Cosmos: Why the Materialist Neo-Darwinian Conception of Nature Is Almost Certainly False* (New York: Oxford University Press, 2012), 8.
[613] Ruth L Saw, 'Cyril Edwin Mitchinson Joad, *The Compact Edition of the Dictionary of National Biography* (Oxford: Oxford University Press, 1975), *v*ol. 2, 2722.

the importance for philosophy of modern science. It looks in Chapter One at 'The Idealism of Professor Eddington' and the following chapter at 'The Idealism of Sir James Jeans' followed by (with a certain lack of rigour in description) 'Mr Russell's Neutral Stuff'.

In the 'Introduction' Joad writes that it is often said that current developments in physical science have no bearing upon philosophical problems, and that the metaphysician may ignore them as lying outside his province. Joad disagrees with this saying the work of Eddington and Jeans has important bearings upon metaphysical problems.

Joad gives a detailed, fair and balanced account of the views of the two. Nevertheless, there are some weaknesses in his argument. His lack of scientific training is sometimes evident. In one case he confuses stress in human muscles with stress at the atomic level. His own language is at times not always well chosen. For example:

> And I suggest that Professor Eddington does from time to time attribute to scientific objects an independent existence in the external world, because the process of world building which he imputes to the mind of the ordinary man positively requires some such conception.[614]

The term 'scientific objects' is a term reminiscent of the writings of thirteen-year-old science students. There are objects and there are everyday descriptions of those objects and scientific descriptions of those objects. There are 'scientific objects' such as test tubes and voltmeters, but Eddington is not arguing that these have any different existence in the real world than tables or chairs. Joad is accurate in saying that at some stages Eddington appears to believe in a real, independently existing external world and at others he does not. His assertion that there is a necessity for there to be existing entities in order to construct a world picture is, while contested, not unreasonable. Nevertheless, his commitment to common-sense Realism does sometimes lead him down the wrong track. He dislikes Eddington's and Jeans' conception of mind as constructing a picture of the external world from messages travelling along the nerve fibres into the brain, and the theory of knowledge in which it issues.

While the Idealism of Eddington and Jeans may be open to objection, so is the naïve Realism of Joad. A critical Realist approach asserts that knowledge of an external world can be advanced through observation, but also perceives that we must take into account the way prior knowledge and opinion shape our observations and that our knowledge of the world is

[614] Joad, *Philosophical Aspects,* 36.

often obtained at second hand and needs to be interpreted. Joad may have considered Eddington's understanding of the way the mind constructs reality untenable; it is, nevertheless, the standard view of modern neuroscience, according to Jamie Ward:

> Students who are new to cognitive neuroscience might believe that the eyes do the seeing and the brain merely interprets the image on the retina. This is far from the truth. Although the eyes play an undeniably crucial role in vision, the brain is involved in actively constructing a visual representation of the world that is not a literal representation of the pattern falling on the eyes... In fact the brain is biased to perceive objects when there is not necessarily an object there.[615]

Jamie Ward is not here denying the existence of an external world, but he is asserting the role of the mind in constructing its picture of the external world, even to the point that it can perceive objects which are not actually there.

Joad continues in direct contradiction of Eddington:

> Is it, however, in any sense true, as Professor Eddington asserts, that my mind knows itself as "the first and most direct thing in my experience"? I should answer that it is not true in any sense. Certainly I do not, in the brief and uncertain glimpses I do get of my own mind, observe it weaving secondary qualities out of messages reaching the brain, and then projecting them into the external world, which is one of the things which, on Professor Eddington's theory of world building is what my mind is constantly doing.[616]

Ward shows the Kanizsa illusion, a system of geometric shapes which was first described by the Italian psychologist Gaetano Kanizsa in 1955.[617] In this illusion a white triangle is perceived, although none is drawn. The non-existent triangle also appears to be whiter than the background, which it is not. Similar examples of illusion are the Ehrenstein illusion and the line drawing that either appears to be a beautiful young woman with a feathered hat or an old hag. All of these examples from current but basic psychology suggest that the brain plays a part in constructing the world view of the human observer. In this, if in nothing else, Eddington was correct. While Eddington's use of Idealism was not skilful, his insistence on the role of the mind in constructing our understanding of the world was significant.

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[615] Jamie Ward, *The Student's Guide to Cognitive Neuroscience,* (Hove: Psychology Press, 2006), 102.
[616] Joad, *Philosophical Aspects,* 39-40.
[617] Ward, *Cognitive Neuroscience,* 103.

These are two cases of Joad's weaknesses, a third on Jeans will be described below. His strength was in analysing Eddington and Jeans' use of Idealism and he comes to the same conclusion as Susan Stebbing several years later:

> Scientists, indeed, and especially physicists have shown in recent years an increasing disposition to enter the domain of philosophy; regrettably, I cannot help thinking, for the metaphysical interpretations which they have been led to place upon their results cannot but have seemed to the philosophers somewhat elementary. In particular the physicists have been making a belated discovery of the uses of idealism. [618]

Joad asserts that these modern scientific Idealists believe that the process of 'discovery' modifies the object or process they are discovering and may, indeed, be partially constructed by the mind of the scientist. This has led scientists to place greater emphasis on the role played by the mind. Joad asserts that such naïve Idealism would have had support from many philosophers until the then recent past.

Joad declares himself a common-sense Realist and agrees with Gouldstone that the two British scourges of Idealism were indeed Russell and Moore. Joad, while a Realist (Russell by 1932 was no longer so) is, however, happy to agree with Eddington and Jeans on a number of points. Russell seemed determined to paint the two as scientists who had sold out to the establishment in return for honours. Joad, however, agreed that a marked change had characterised the attitude of modern scientists, and the science of the 1930s was no longer inclined to dismiss the deliverances of the moral and religious consciousness as necessarily illusory. Joad could, nevertheless, employ sarcasm against ideas of which he did not approve:

> "Where science has progressed the farthest, the mind has regained from nature that which it put into nature." So Professor Eddington, who seems to conceive of the scientist as one who fares through the utmost confines of the universe to discover himself.[619]

Joad sees Eddington, Jeans and Sir Oliver Lodge as the leading Idealist scientists in Britain. While Eddington, Jeans and Russell get a chapter devoted to them in the main part of the book, Lodge does not. He is only mentioned again towards the end of book, when Joad rhetorically asks how is this world to be conceived? Joad says as mind-stuff, according to

[618] Joad, *Philosophical Aspects,* 10-11.
[619] Joad, *Philosophical Aspects,* 15.

Professor Eddington; as a mathematician's mind, according to Sir James Jeans; or as an immaterial ether according to Sir Oliver Lodge. Two issues arise from this section.

Firstly, why is Lodge not given more serious consideration? While Lodge's work in science on radio waves was not as significant as Eddington's, it was possibly nearly as important as Jeans' labours within physics and astronomy. Was it that Lodge's dabbling in Spiritualism had put him beyond the pale?

Secondly, while it has been seen that Eddington did value the role of intuition in both science and religion, Joad is incorrect in implying that Jeans valued highly the intuitive faculty. Jeans was quite clear that it had no role in his view of the way science advanced. Joad also points out that both Planck and Einstein hold similar views on the Idealist nature of the universe. He quotes an *Observer* interview of Max Planck by the journalist and science writer J W N Sullivan. In this Max Planck states that 'Consciousness, I regard as fundamental. I regard matter as derivative from consciousness.'[620]

Joad argues that while he agrees with some of the views of Eddington and Jeans he believes that the reaction against materialism and mechanism has gone too far. Joad then sets out his personal creed, he is not a simple reductionist:

> I should hold then that the researches of the scientist are, equally with the perceptions of the plain man, the moral consciousness of a good man, the sensitivity of the artist, the religious experience of the mystic, revelatory of reality. Epistemologically they stand on equal terms.[621]

Clearly there are some points of agreement between Eddington and Joad and, equally clearly, Joad is not a close ally of Russell in his outright opposition to all that Eddington and Jeans have to say in *The Nature of the Physical World* and *The Mysterious Universe.* Joad was later accused of an 'escape to mysticism' by the Labour politician Aneurin Bevan.[622]

Joad writes that Eddington's work had a high impact; he has undoubtedly been largely responsible for the current belief that modern physics favours an Idealist interpretation of the universe as a whole. Joad explains that these views are set forward in *The Nature of the Physical World* and *Science and the Unseen World* and that a lot of the contents of these

[620] J W N Sullivan interview with Max Planck, 25 January 1931, no reference given, quoted in Joad, *Philosophical Aspects,* 16.
[621] Joad, *Philosophical Aspects,* 16-17.
[622] Nicklaus Thomas-Symonds, *Nye: The Political Life of Aneurin Bevan* (London: I B Tauris, 2015), 99.

books are actually philosophy not science, so he feels less diffident in criticising the work. They are in fact interpretations of the conclusions of science not science itself. He then says he will summarise very briefly the main features of Eddington's work and then criticise it. The very brief summary is thirteen pages long. The summary is fair, unlike Russell's, but what Joad says Eddington is arguing in his philosophical passages may not be everyone's perception of Eddington's case. This has much more to do with Eddington's lack of precision than Joad's unfairness.

At the end of his thirteen-page summary Joad gives a one-page summary of this summary and then analyses Eddington's various statements and detects five different variations of Idealism in Eddington's two books. He describes the first three as distinctly Kantian in type; the fourth as perhaps more reminiscent of Descartes and the fifth as pure Berkeley.

This indicates the main problem that professional philosophers, and some theologians such as Inge, had with the Idealism of both Eddington and Jeans. Firstly, in places the language is so imprecise that two readers take two different understandings from the same passage, and secondly that the attempted philosophical interpretation placed upon new science is not rigorous and consistent. It is an Idealist interpretation, but it is not clear to which particular strand of Idealist thought the authors belong. They lack the precise, thorough-going rigour of a professional philosopher; as a result, it is not always clear what they do believe.

Joad points out the ambiguous nature of the language Eddington uses. Speaking of the status of the physical world, Eddington describes it as abstracted by the mind of the scientist; constructed by the mind of the scientist; and given as embedded in the background or counterpart which is reality.[623]

Joad goes on to say that this ambiguous use of language is serious, if only because Eddington makes use of each conception in turn as the development of his argument proceeds. Eddington is prone to producing a telling and useful metaphor, but then argues forward from that metaphor in a way which can lead to a questionable argument. It is important to emphasise that Eddington does use developing arguments in his written works and it is unwise to take an assertion early on in the book as Eddington's final position.

Nevertheless, Joad's argument on Eddington's use of language is well made. Eddington's language in those passages, which goes beyond the description of the current science to

[623] Eddington, *The Nature of the Physical World,* 283, 285, 286.

philosophical interpretation, is ambiguous or inconsistent. Even to the general reader who is not prepared to skip over a page quickly but only to move through the text when he or she has fully understood the passage, some passages appear unclear and confusing. To the professional philosopher his attempts to deploy Idealism did appear amateurish.

Joad seems to see Eddington's belief that the underlying nature of reality is 'spiritual' as an inference from the fact that the underlying nature of physical reality is 'mind-stuff' and therefore by inference 'spiritual.' This may not be everyone's reading of what Eddington is asserting, but it is a possible interpretation.

Joad's dissection of Eddington's writing is thorough and remorseless. He picks up a loose phrase from one section of *The Nature of the Physical World* and compares it with another seemingly compelling sentence and shows how they are not compatible. He goes into some detail on the multiplicity of worlds which Eddington envisages and quotes Occam's razor 'Essentia non sunt multiplicanda praetor necessitatem.'[624] He argues that Eddington should apply it to his own work:

> I have tried to show that the status of some of these worlds is, to say the least of it, equivocal, that the relations between them are not and cannot be satisfactorily worked out, and that some of them at least are represented to us in ways which are fundamentally inconsistent... That the universe may be and probably is exceedingly complicated is no doubt true. But I find it difficult to believe that it has the particular type of complexity that Professor Eddington suggests.[625]

While there were differences in the views of Eddington and Jeans, the criticisms which Joad and others made of Jeans were very similar to those they made of Eddington. For this reason and because a large part of the chapter 'The Idealism of Sir James Jeans' contains a discussion of Jeans' designing, mathematical deity which has been considered elsewhere, this section will be shorter.

Joad starts off his chapter on Jeans well enough, stating that no work dealing with the philosophical aspects of modern science would be complete without a consideration of the work of Jeans, especially *The Mysterious Universe* and the last chapter 'Into Deep Waters' in particular. He does, however, appear to be less impressed by Jeans' work than by Eddington's, saying that he is considering it not because of its intrinsic merit, but because it illustrates the

[624] Joad, *Philosophical Aspects,* 44.
[625] Joad, *Philosophical Aspects,* 45.

metaphysical views which are held because of the recent developments in the physical sciences. Joad explains that for Jeans, as for Eddington, the starting point for his ideas is the break-up of the mechanistic scheme to describe the physical universe. Joad then goes on to argue that this belated discovery of the uses of Idealism by great scientists is a highly instructive phenomenon.

The main thrust of Joad's criticism of Jeans is that he is a naïve amateur in his application of Idealism to his exposition of the philosophical and theological implications of modern physics. He examines 'Into Deep Water' and describes it as a confession of faith rather than a statement of fact. At the same time Joad acknowledges that it is based directly upon the conclusions of the scientific part of the work. Joad, unlike Russell, respects the scientific work of Jeans and Eddington and there appears to be no irony in the use of the term 'great scientists'. He is just surprised that two such eminent physicists and astronomers can hold such naïve philosophical views.

Joad commented that it seemed that Jeans thought that the only possible alternative to the universe being like a mechanism was it being like a thought. Joad goes on to argue that Jeans':

> … conclusions are based less upon a critique of the nature of our knowledge of the physical world as revealed by an examination of the physiological machinery of perception and of the limitation of scientific method [as Eddington's conclusions are], than upon certain considerations suggested by physics and astronomy with regard to the evidence of design in the universe as a whole, and the nature of the design which he is thereby led to infer.[626]

Joad generally but not always sees the difference between the two astronomers. Joad says Jeans is like the eighteenth century rationalist philosophers Spinoza and Leibniz, although his preoccupation is mainly with the significance of mathematics.

After his thorough and fair dissection of Jeans' comments on time, he says he went into such detail, not because it is an important part of Jeans' argument:

> … but because it exemplifies the light-hearted way in which the writer plays (if I may use such a word to indicate the impression which the author's treatment

[626] Joad, *Philosophical Aspects,* 50.

> undoubtedly produces) with metaphysical notions. In this respect it is typical of many similar suggestions which are scattered up and down the book.[627]

This is a very reasonable point. Jeans' style is very easy to read, but it leaves many questions unanswered. This light style delighted the general reader but annoyed the professional philosopher or theologian.

Joad concludes that Eddington and Jeans, two eminent scientists, are in effect rather poor philosophers. While Joad respects their status as leading, even great, scientists, he is surprised at their naivety. He gives a fair and just summary of their work and shows the inconsistency in their use of language. Joad's lack of scientific training occasionally shows and, in his treatment of Eddington's espousal of the role of the brain in constructing reality, Joad's uncritical Realism leads him to deny any such role. While the idea of the 'construction' of reality is contested, modern Critical Realism in affirming a non-neutral role for the mind/brain is possibly closer to Eddington's Idealism than to Joad's Realism. Critical Realism affirms that, amongst other things, there is a reality to be apprehended but that the brain does have a role in constructing a perception of the reality that is there to be found.

Before moving on it is worth defining the terms 'Naïve Realism' and 'Critical Realism'. Alister McGrath does so thus:

> *Naïve Realism:* Reality impacts directly upon the human mind, without any reflection on the part of the human knower. The resulting knowledge is directly determined by an objective reality within the world.
>
> *Critical Realism:* Reality is apprehended by the human mind, which attempts to express and accommodate that reality as best as it can with the tools at its disposal – such as mathematical formulae or mental models.[628]

Arthur Peacocke in *Theology for a Scientific Age* says:

> 'naïve realism' regards scientific concepts, theories and mechanisms as literal descriptions of the natural world.[629]

He goes on to say that:

[627] Joad, *Philosophical Aspects,* 51.
[628] Alister E McGrath, *The Science of God* (London: T & T Clark, 2004), 141.
[629] Arthur Peacocke, *Theology for a Scientific Age,* 9.

> Critical realism recognizes that it is still only the *aim* of science to depict reality and that this allows gradations in acceptance of the 'truth' of scientific theories.[630]

Polkinghorne discusses the topic at some length and with great clarity in *One World.*[631] While the approaches are not too far apart, McGrath's definition is preferable for this study because of its explicit mention of the human mind in theory construction, the useful contrast with Post-modern Anti-Realism he makes later, and for its brevity of expression.

7.6 William Ralph Inge – A Theologian amongst the Scientists

Dean Inge was the most significant theologian who responded in detail to the work of Eddington and Jeans. While Dr E G Selwyn, Dean of Winchester, and others commented on the books, Inge was the theologian who most got to grips with their thought. His engagement with their books was constructive. He brought his understanding of theology and philosophy to bear on their work and was, unlike Russell and their more uncritical supporters, happy to both agree with and disagree with their thought. Inge is considered in this chapter as he was, along with Joad, accurate and honest on their poor use of Idealism.

William Inge was educated at Eton and King's College, Cambridge, where he studied first classics and then theology. He taught at Eton, was a Fellow of Hertford College, Oxford, and then briefly Vicar of All Saints', Knightsbridge, followed by four years as Lady Margaret Professor of Divinity at Cambridge. Inge was, after this, for twenty-three years Dean of St Paul's. During this time he wrote *God and the Astronomers.* It was published when he was 73.

Inge attacks some of his customary targets - pantheism, modernism and the 'myth of unending progress'. He examines the world-view of physicists and astronomers, and with its help exposes the inconsistencies of '*modernist* philosophy.'[632] Chapters do go by without reference to Eddington and Jeans. There is some justification in McCabe's comment 'Dean Inge's book has for the greater part nothing to do with astronomy'.[633] Inge is clear on his starting point, the Second Law of Thermodynamics.

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[630] Arthur Peacocke, *Theology for a Scientific Age,* 12.
[631] John Polkinghorne, *One World* (London: SPCK, 1986).

[632] Inge, *God and the Astronomers* (London: Longmans, 1933), 13 *italics* as in the original.
[633] Joseph McCabe, *The Existence of God*, 206.

Publishers often choose book titles rather than authors, and this was the case here as Inge's biographer made clear.[634] This title was chosen following the run of eight high-selling popular and semi-popular books from Eddington and Jeans in the years 1927 to 1933. A more accurate title might have been *Theology and the Second Law of Thermodynamic*s, or *The Warburton Lectures, 1931-1933*. During the writing of it Inge referred to it as 'my book on Theism and Cosmology'.[635] *God and the Astronomers* was a more marketable title after the success of Eddington and Jeans, although Inge thought it 'a vulgar substitute'.[636]

There is, nevertheless, a serious consideration of the work of Eddington and Jeans as they write on the Second Law of Thermodynamics and as they relate to Christian doctrines, notably on Creation and Eschatology. On these doctrines, Inge also discusses ideas from classical writers, notably his favourites Plato and Plotinus, from the *philosophia perennis,* 'the great tradition in Christian thought' and modern writers. The range of his reading is impressive, not only in theology, philosophy and the classics, but in the science of the time.

The Second Law of Thermodynamics can be stated in a number of ways but the most famous is probably Boltzmann's - the entropy (or disorder) of a closed system cannot decrease. Eddington talked of this issue in his chapter on 'The Running-Down of the Universe' in *The Nature of the Physical World* and Jeans discusses this more briefly and simply in *The Mysterious Universe.* Inge, who was not a simple theological conservative, uses the Second Law of Thermodynamics to batter that school of theological modernism which is rooted in a belief in never-ending progress. Inge values the work of Eddington and Jeans as scientific popularisers:

The Second Law of Thermodynamics… has lately become a matter of common knowledge through the books of Jeans and Eddington, of which hundreds of thousands of copies have been sold... The fact that books on astronomy, however In summary, Idealism had been a very potent force in British intellectual life. Its influence was still strong when Jeans and Eddington were students but by the time the three key texts were published from 1928 to 1930, it was well past its zenith of influence. The influence of Idealism on first Eddington and then Jeans will now be considered in some detail.

[634] Adam Fox, *Dean Inge* (London: John Murray, 1960), 225.
[635] Fox, *Dean Inge,* 225.
[636] W R Inge, *The Diary of a Dean* (London: Longmans, 1949), 169.

> clearly and brilliantly written, should be reckoned among the best-sellers, is a very remarkable and encouraging sign.[637]

Inge was not always a gloomy Dean.[638] He describes the modern interest in astronomy and asserts that the contrast between the vastness of the universe and the puny dwellers on earth is far more tremendous than the Psalmist knew it to be. But the Psalmist, like Kant, found two things above all worthy of awe and wonder – the heavens above and the nature of man within us.

Inge waxes lyrical on the beauty of the heavens aided by Shelley, Meredith and Tennyson, and then returns to Jeans and Eddington, their books and their lectures on the wireless. Inge then turns to the issue of Idealism and Realism and argues that the two schools are not so far apart as they formerly appeared to be; the dispute between them no longer seems fundamental. But Idealist philosophers are, he says, interested in the coordination of the central concepts of Idealism and the new ideas in physical science. He writes:

> My own position, I will say at once, is nearer to the realists than the idealists; but I do not regard the mind as only the mirror of happenings which are independent of it. Reality, as I understand it, is constituted by the unity in duality of the mind and its objects. Mind does not create the intelligible, nor is the intelligible world independent of the intelligence. The real world is a kingdom of objective 'forms,' which in the mind of God are the perfect counterpart of His own thought.[639]

Much of that quotation, apart from the last sentence, could be seen as an old fashioned way of stating a position not too distant from Critical Realism. But it is not quite Critical Realism, strongly influenced as it was by Plato and Plotinus. Inge agrees that the science of the last century was based on mechanism and determinism and also that it made two fundamental assumptions: that everything can be 'mechanically explained' and that the ultimate nature of matter, at the smallest level, was indestructible.

For most of the subsequent discussion Inge follows the analysis of Joad. But he has his own approach to the topic, which is not surprising as Joad was a philosopher and Inge a theologian. Inge sees Eddington's Idealism as a response to the problems of the Second Law of Thermodynamics.

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[637] Inge, *God and the Astronomers,* 2.
[638] Robert M Helm, *The Gloomy Dean* (Winston-Salem: Blair, 1962).
[639] Inge, *God and the Astronomers,* 7.

Eddington says it was his 'mathematical researches' that led him to his Idealism rather than the Second Law of Thermodynamics explicitly. Beyond this statement, Eddington says little about why he adopted Idealism, except statements to the effect that it works. While it is therefore not possible to refute Inge in asserting that it was from the Second Law of Thermodynamics explicitly that he is fleeing to 'mentalism' or subjective Idealism, the tenor of Eddington's writing is that Idealism works better than Realism when applied to the findings of the physics of his time and not just to the Second Law of Thermodynamics.

Inge gives a detailed critique of Eddington and Jeans, drawing on Joad's *Philosophical Aspects of Modern Science.* Inge acknowledges his debt to Joad but says that his realism is much more uncompromising. Inge writes:

> The modern physicist, says Joad (he is thinking mainly of Jeans and Eddington) first destroys the everyday world of commonsense objects, and proceeds to attribute the difference between the world of common sense and the world of scientific objects to the constructive agency of mind. "Thus between physics on the one hand and idealism on the other the common sense world is dissolved away." [640]

Inge argues that the materialism of the last century was based upon naïve Realism and mechanics – billiard ball atoms, and so on. This was the real world; the world of values was epiphenomenal, or, as Leslie Stephen put it, 'dreams' as opposed to 'realities'.[641] This simple solution of ultimate problems is obsolete, says Inge. Scientists and mathematicians are playing with Berkeleyan idealism or pure mentalism. Their attitude to religion is now courteous and friendly but he does not think that this approach is legitimate.

Inge clearly enjoys Joad the philosopher dissecting the work of the scientists who would be philosophers. He believes that Joad shows conclusively that Eddington never distinguishes between the entities of physics and our knowledge of them. Eddington, according to Joad and Inge, nowhere makes it clear whether for him the world of mathematical symbols has any independent or objective reality. Until this ambiguity is cleared up, says Inge, it is impossible to regard his philosophy as a coherent whole. This is a very reasonable point.

Inge then turns to Jeans quoting his argument:

[640] Inge, *God and the Astronomers,* 37-38, an unreferenced quotation.
[641] Inge, *God and the Astronomers,* 38.

> '… the secret of nature has yielded to the mathematical line of attack. It has won a success such as is not shown by the aesthetic, poetic, or moral pictures of the universe.'[642]

Inge is not prepared to accept that, especially what he sees as an attack on 'higher values'.[643] Inge finds it hard to accept that Jeans really means this, but he says that Jeans leaves us in no doubt about his acceptance of mentalism. Inge believes that while pure mathematics is gloriously independent of concrete fact, physics and astronomy are not and cannot be.

From any Realist position, be it naïve or Critical Realism, that is a given, but from an Idealist point of view, Eddington would argue, that is more a statement of faith in Realism and one not entirely supported by the latest advances in physics. Inge says, with the humility due from a theologian to a scientist, that no science which has its starting-point in the objects made known through perception, can logically issue in pure mentalism. Inge makes a very reasonable point, one that Russell and Joad also made; that Eddington at one moment seems to believe in the substantive reality of the world of atoms and the next he does not. Eddington's writings are not clear on this point. Inge argues that a scientist who starts from the physical world cannot be an Idealist. When Eddington asserts that radiation is nothing, he is surely wrong, because whatever radiation is, it is not nothing. The last step, from radiation to a purely mental concept, is, Inge maintains, illegitimate. From a concrete object to a mental concept there is no road. It is not true that we know only our own minds.

Inge is at his best when, like Joad, he analyses the weaknesses in Eddington's argument. When he turns to assertion of what can and cannot be true, he gets close to aligning himself with 'Common Sense Realism' or naïve Realism.

When Inge considers Jeans, he believes he has found a similar but not identical philosophy. Inge is one of the people who does notice the difference between the two lines of thought. Jeans, Inge argues, is convinced that nineteenth century mechanism has shot its bolt - 'the stream of knowledge is heading towards a non-mechanical reality'.[644] Inge is surprised at the animus of a mathematician against a mechanical view of the universe. He notes Jeans' description of the universe as being more like a great thought rather than a great machine.

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[642] Inge, *God and the Astronomers,* 39.
[643] Inge, *God and the Astronomers,* 39.
[644] Inge, *God and the Astronomers,* 42, an unreferenced quotation to Jeans, *The Mysterious Universe,* 148.

Inge looks at all of the work of Eddington or Jeans with the Second Law of Thermodynamics very much in his mind; as has been said, this is the key theme of the book. But unlike Russell he is prepared to say when he agrees with Jeans:

> He is favourably disposed to the theistic hypothesis. "The objectivity of objects arises from their subsisting in the mind of some eternal sprit." That is what I believe myself; but how does this aid him in his polemic in favour of mathematics against mechanics?[645]

Inge agrees with Jeans and Eddington in their assertion that modern physics describes a non-mechanical and hence non-deterministic universe. He supports their assertion that modern science portrays a physical universe that is time limited, for his own previous theological reasons. He dislikes their 'mentalism' or Idealism, but not as much as Joad and certainly not as much as Stebbing. Inge concludes that Jeans is not better than Eddington at solving the problem of non-reversibility of time inherent in the Second Law of Thermodynamics but yet this law makes a big hole in Jeans' pan-mathematical universe. He is not convinced of the merits of mathematics over mechanics:

> Can these be *explained* any better by mathematics?[646]

The universe portrayed by the new physics is certainly well described by mathematics, but is it explained any better? That is a distinction that neither Inge in *God and the Astronomers* nor Jeans in *The Mysterious Universe* draws.

7.7 Twentieth Century Apologetics

7.7.1 Introduction

At this point it will be useful to set the apologetics of Eddington and Jeans against the apologetics of the early twentieth century. This will be done by considering two leading Christian apologists of that period. The first, G K Chesterton, preceded and worked at the

[645] Inge, *God and the Astronomers,* 43.
[646] Inge, *God and the Astronomers,* 43 *italics* as in the original.

same time as them. The second, Charles Raven, worked at the same time and succeeded them. Both of these were philosophical Realists.

7.7.2 G K Chesterton

One of the key writers of popular Christian apologetics in the early twentieth century in Britain was the journalist and author G K Chesterton. Gilbert Keith Chesterton was baptised in an Anglican church in Kensington in 1874 and as a school boy he attended irregularly a Unitarian Chapel with his family.[647] His wife Frances led him back to the Church of England and he later followed her into the Roman Catholic Church in 1922.

While in a considerable amount of his large output of articles and books he defends Christianity, Christian ethics or its social teaching, three of his volumes were significantly relevant in the field of popular apologetics. The first two, *Heretics* (1905) and *Orthodoxy* (1908), were written while he was an Anglican. The third and possibly his greatest apologetic work *The Everlasting Man* (1925) was written as a Catholic and greatly influenced the young C S Lewis.

Heretics is described by Ian Ker as one of his major if not great works.[648] It consists of twenty chapters, mostly revised articles which he had written for the London *Daily News.* His provocative, paradoxical style is of good-humoured argument and sarcasm. One of his targets is George Bernard Shaw who was both his friend and also his adversary in print and public debate. Another, who is more significant for this study, is McCabe who accused him of 'strained paradoxes', 'literary slight-of-hand' and 'the substitution of imagination for judgement'.[649] These charges are not wholly without basis. The chapter on McCabe is a defence of the place of religion in a happy and balanced life along with the ballet at the Alhambra in London and the fireworks at Crystal Palace. Chesterton's seemingly odd argument develops from a condescending comment from McCabe who had implied that Chesterton has a place in national life rather like the Alhambra ballet or the Crystal Palace fireworks – presumably spectacle with no substance. McCabe thinks Chesterton is frightened that with science taking the place of religion in modern life there will be an increase in

[647] Ian Ker, *G K Chesterton* (Oxford: Oxford University Press, 2011) Chapter One.
[648] Ker, *G K Chesterton,* 149.
[649] G K Chesterton, *Heretics* (New York: Cavalier Classics, 2015) 93.

sensuality. Chesterton assures McCabe that he fears a decrease. Chesterton teases McCabe, accusing him of being clerical in his manner – he was a former Friar – and says that he, Chesterton, has no fear of science, just of scientific 'experts' who pretend to know everything. Chesterton had a dislike of all experts and a love of democracy and the common man and woman. The article is amusing, provocative, sarcastic and very readable. It is easy to see why he was a popular apologist. In the final chapter, he draws together some of his major points on the authors he has considered, G B Shaw, Rudyard Kipling, H G Wells and others. 'Man' is a dogma-making animal he asserts, and we all hold dogmas whether we realise it or not. The chapter and the book give not an argument for belief but challenges arguments against Christianity and a call for all to acknowledge their presuppositions.

Orthodoxy published in 1908 was written as a response to comments by a reviewer of *Heretics* of the need for a positive statement of Chesterton's belief rather than a series of chapters attacking the beliefs of others. Chesterton describes it as not 'an ecclesiastical treatise but a sort of slovenly autobiography.'[650] For Chesterton, orthodoxy was essentially a traditional interpretation of the Apostles' Creed.

Chesterton develops a theme in which he praises wisdom from past times and deprecates the modern view which sees anything old as less valid than that which is modern.[651] Lewis latter described this later approach as 'chronological snobbery.'[652] Chesterton also suggested if Jesus of Nazareth was not the Christ, he was the Anti-Christ. This idea is a possible forerunner of Lewis familiar 'trilemma'.[653] Ian Ker says that Chesterton believed in Christian orthodoxy for the same main reason as Cardinal Newman:

> In both cases the evidence lies in an enormous accumulation of small but unanimous facts that converge.[654]

Ker does not make this point but is it also similar to ideas put forward later by Basil Mitchell in his *The Justification of Religious Belief.*[655] Chesterton concludes *Orthodoxy* with praise for two virtues he saw as especially Christian: joy[656] - again an idea taken up by Lewis – and mirth.[657] One of Chesterton's themes is that laughter is something particularly Christian (he

[650] Chesterton, *Heretics,* 4.
[651] G K Chesterton, *Heretics,* Chapter Four.
[652] C S Lewis, *Surprise by Joy* (London: Collins, 1959) 167.
[653] C S Lewis, *Mere Christianity* (London: Collins, 1952) Book Two, 3 'The Shocking Alternative'.
[654] Ker, *G K Chesterton,* 227.
[655] Basil Mitchell, *The Justification of Religious Belief,* (London: Palgrave Macmillan, 1961).
[656] Chesterton, *Heretics,* 129.
[657] Chesterton, *Heretics,* 130.

has little time for Puritanism or teetotalism) and something which scientific materialism and its associated attitude to life diminishes.

Ker sees *The Everlasting Man* of 1925 as amongst the two or three best books of Chesterton.[658] Ker says that it was at least partly written in response to H G Wells' optimistic *An Outline of History* of 1920 in which he sees 'man' as progressing from savage to twentieth century civilised man.[659] Certainly this book is mentioned in Chesterton's preface and conclusion. The irony of the fact that *The Outline of History,* with its easy optimism about future peace and prosperity, was published so shortly after the Great War seems lost on Wells.

Chesterton's aim is to present the Christian story as if it were new to British people of the twentieth century rather than something which they think they know. This is because only if people see it as something new to their imagination, such as Confucianism appears to most British people, will they see it whole and will see its truth as a coherent body of ideas. His description of Christianity and Catholicism is traditional. He argues that Wells' view of history, with humans as merely animals, and with Christianity as just another religion which is fading into a general type of theism, is intrinsically wrong. Whenever Christianity fades into something vaguely theistic, authentic Christianity such as the French Catholic Revival of the nineteenth century or the Oxford Movement breaks through. They were both a surprise because people thought that religion was dead:

> A dead thing can go with the stream, but only a living thing can go against it.[660]

Chesterton's style was accessible, as was that of Eddington and especially that of Jeans. Hastings, after reporting William Temple's admiration for Chesterton, writes that:

> …. Chesterton may well have succeeded, where Temple failed, in effectively addressing 'Modern Man'. If so, it could be not only because Chesterton had gifts of imagination and a mastery of language beyond Temple's but also because he was a great deal more critical of modernity.[661]

[658] Ker, *G K Chesterton,* 516.
[659] H G Wells, *An Outline of History* (London: Newnes, 1920).
[660] G K Chesterton, *The Everlasting Man* (Connecticut: Martino, 2010), 168-169.
[661] Hastings, *English Christianity*, 233.

Chesterton was a popular writer and journalist who took on the established intellectual orthodoxies of the day and asserted that the Christianity of the Apostles' Creed is a coherent whole.

7.7.3 Charles Raven

The second apologist, Charles Raven, looks much more closely at issues of science and religion so he will be considered at greater length. Peter Bowler[662] describes him as an anti-determinist like Eddington and Jeans but unlike them he was a philosophical Realist or 'Materialist', his preferred term in *The Creator Spirit.*[663]

After Uppingham School, Raven proceeded to Caius College, Cambridge, where he studied Classics. He then read Theology and he was, during this time, influenced by the polymath H M Gwatkin, the Dixie Professor of Ecclesiastical History, especially regarding the attitude of the mediaeval church to the world of nature.[664] During his time as a theology student he also attended the lectures of Professor William Bateson, one of the world's leading geneticists. Raven, like Arthur Eddington, had a lifelong love of the countryside, which, according to Dillistone, he acquired from his mother.[665] Raven not only attended the lectures of Bateson but he was also given permission to work in the biology laboratories. He was a collector of moths and later became a pioneer of bird photography. One of his most notable books was his study of John Ray, the naturalist and natural theologian.

Raven defines nature as the whole of the physical and terrestrial environment 'earth and sky, land and sea, plants and animals, everything from the structure of the atom to the composition of the galaxy'.[666] While Raven did consider the structure of the atom and the composition of the galaxies, his emphasis was on the biological sciences. For the early human race, the starry heavens and the phases of the moon were important:

[662] Bowler, *Reconciling Science and Religion,* 277-286.
[663] Charles E Raven, *The Creator Spirit* (London: Martin Hopkinson, 1928), 60.
[664] F W Dillistone, *Charles Raven: Naturalist, Historian, Theologian* (London: Hodder and Stoughton, 1975), Chapter One.
[665] F W Dillistone, *Religious Experience and Christian Faith* (London: SCM, 1981), 1.
[666] Charles E Raven, *Natural Religion and Christian Theology: The Gifford Lectures 1951-1952,* Vol 1, 3.

> But it is with rain and sun, seed-time and harvest, the way of the beast and bird, the fertility of cattle, the procuring of food and shelter … was always the primary stimulus alike to his activities and his speculations.[667]

Raven's love of nature had been a spiritual experience as a boy and as an undergraduate but study under Bateson brought an intellectual crisis. As a result, Raven became a convinced Lamarckian.

There are two key elements in Raven's thought and work which will now be considered. They are his views on evolution and his reassertion of the importance of biology over against physics and astronomy. These will be examined through consideration of several of his key books.

The Creator Spirit was published in 1927. It is a consideration of the Christian doctrine of the Holy Spirit 'in the light of Biology, Psychology and Mysticism'.[668] Bowler sees this as 'his most original contribution to the new natural theology'[669] and Dillistone as not only 'the most original, most constructive' but also the 'most impressive' of his many books.[670] In this Raven expressed his view that the Lamarckian understanding of evolution was compatible with Christian faith. Raven draws attention to Darwin's statement at the end of his life that he had underestimated the importance of use-inheritance.[671] Weismann's interpretation of the Darwinian account was not compatible with Christian faith, but a Lamarckian approach to Darwin was:

> So long as room was left for the efforts of the individual to influence evolution, moral elements could be allowed a place in the scheme of development, and alongside the mechanism of elimination the Christian could set aspiration and adventure, educability and inventiveness.[672]

Raven saw the mainstream interpretation of evolutionary theory as deterministic whereas a Lamarckian view of evolution allowed behaviour to shape evolution, leaving a door open for moral effort. In his autobiographical *A Wanderer's Way,* he puts it thus:

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[667] Raven, *Natural Religion and Christian Theology,* Vol 1, 5.
[668] Charles E Raven, *The Creator Spirit* (London: Martin Hopkinson, 1928), iii.
[669] Bowler, *Reconciling Science and Religion,* 279.
[670] Dillistone, *Charles Raven,* 127.
[671] Raven, *The Creator Spirit,* 34.
[672] Raven, *The Creator Spirit,* 34-35.

> … if there is no room at all for use-inheritance in evolution, if our whole physical make-up is strictly conditioned by the immutable germ-plasm, and if therefore our struggles and hard-won virtues have no effect whatsoever upon the course of development, then to speak of the Creator as in any real sense the Father is impossible:[673]

His second chapter is key to understanding his thought. This is entitled 'Science and Religion' but might be better described as 'Evolutionary Biology and Religion'. In it he again argues that the approach to evolution put forward by August Weismann in Germany rules out any possibility of the inheritance of acquired characteristics and he regards a 'rigid Weismannism as demonstrably false'.[674] If this understanding of evolution if correct:

> For religion the dilemma is manifest. Theology must take refuge either in the belief that when each new form appears there is a special intervention of God, … or in the sheer Calvinism which finds the ground for the whole process in the pre-determined and inexorable will of God, and leaves no room at all for any modification of that will by the efforts or aspirations of His creatures. [675]

In this book the ideas come thick and fast and the science, history or theology is not always fully explained. An example of this is 'The policy of Julian the Apostate was at last to come to fulfilment.'[676] This is given without comment or context. Raven demonstrates his wide reading but expects others to understand his references.

In November 1935 Raven gave the Riddell Memorial Lectures at the University of Durham. They were published as *Evolution and the Christian Concept of God* in 1936. There were three lectures in the series which were delivered in a Trinitarian format: The Unity of Creation; The Emergence of Deity and The Energy of the Spirit. Here he argues that integration is essential for both world views and that may involve some change in the views of theologians:

> But if we value truth (and without it religion is merely superstition) we must take the data of scientists into account and beware lest our dogmas conflict with them.[677]

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[673] Charles E Raven, *A Wanderer's Way* (London: Martin Hopkinson, 1928), 63.
[674] Raven, *The Creator Spirit,* 44.
[675] Raven, *The Creator Spirit,* 44-45.
[676] Raven, *The Creator Spirit,* 62.
[677] Charles E Raven, *Evolution and the Christian Concept of God* (London: OUP, 1936), 16.

This is somewhat at variance with Eddington's approach which has a slightly different emphasis. Eddington says that neither scientific data nor methods can prove true or false the claims of religion, but that modern physics holds no threats for those who have experienced the Inner Light.[678]

Raven is very honest about the mental struggles of those of faith as they consider the dilemmas some aspects of science present:

> Most of us know the heart-break which accompanies such moods when our honesty seems at war with our faith, when we stand before the inexorable mystery of existence and cry out for a sign – and there is no voice that answers our need.[679]

He later goes on to assert that those who claim that their redemption was achieved by the death of the Son of God cannot be too surprised if creation also involves the cost of many lesser Calvaries.

In this his support for Henri Bergson's *Creative Evolution* is clear:

> It is not my desire either to endorse the Bergsonian doctrine or to suggest an identification of the *élan vital* with what Christians call the Holy Spirit. But I would claim that no one who studies *L'Évolution créatrice* can fail to be struck by the analogy between the activity of the Life-force and the operations of the Spirit.[680]

Raven says that it is easy to criticise the Life-force as a poetic personification or to say that it exists only in individual organisms not apart from them. But, he also points out, such criticism ignores many significant phenomena, such as group behaviour of hive bees and termites.

The book is very theological in its tone. It contains frequent references to the Church Fathers and to early dissidents such as Arius and Apollinarius with little explanation. He clearly does not like Barth and is critical at times of Augustine. There is plenty of discussion of a range of scientists but the information comes thick and fast with little by way of explanation. This may well have appealed to the audience for the lectures, but it is not as accessible as Eddington's Gifford Lectures or Jeans' Rede Lecture. It, nevertheless, has real theological depth. This book

[678] Eddington, *The Nature of the Physical World,* 337, etc.
[679] Raven, *Evolution and the Christian Concept of God,* 18.
[680] Raven, *Evolution and the Christian Concept of God,* 49-50.

may not be popular apologetics but it might well have been appreciated by the clergy and those with a theological or philosophical training.

Raven was appointed to give the Gifford Lectures in 1951-1952 at New College, Edinburgh. These were published in two volumes in 1953 under the title *Natural Religion and Christian Theology.* The first volume had the subheading *Science and Religion* and is a two-hundred-page historical discussion of the relationship of these disciplines. The book starts with an introductory chapter which sets the scene. The second chapter on the biblical attitude towards nature is very theologically rich. There is nothing of such theological depth in the writings of Eddington and Jeans. The subsequent chapters describe a selection of the significant players in the history of the interaction between science and theology. While some, such as the last three seem obvious, they are not all the standard choices. There are chapters on the Aristotelian Bishop Albert of Cologne, Conrad Gesner the Swiss naturalist, Ralph Cudworth the Cambridge Platonist, Newton, Linnaeus and Darwin.

The volume concludes with a chapter entitled 'The New Situation'. It starts by saying that the end of the nineteenth century and the start of the twentieth century saw the high point of the mechanistic philosophy.[681] He goes on to suggest that the relationship between science and religion in Britain was for a time marked by an illogical compromise with both sides following Nelson's strategy of putting the telescope to his blind eye and then speaking the truth. But three series of Gifford Lectures from Samuel Alexander, Conwy Lloyd Morgan and A N Whitehead along with the writings of J C Smuts, John Oman and William Temple made it look by 1934 that 'the divorce between science and religion would shortly be annulled.'[682] The chapter ends by regretting the fact that the work of 'such pioneers of atomic research as Sir Joseph Thomson, Lord Rutherford and Sir Arthur Eddington' could end in the destruction of the city of Hiroshima.

The second volume, *Experience and Interpretation,* after Raven has set the historical context in his first volume, attempts, in the words of the Preface, 'to set out a modern *Religio Medici'.*[683] This volume opens with an introductory chapter which calls for a new Reformation and that is followed by chapters on religious experience, the significance of Jesus and the doctrine of the person and work of Christ. While it is acknowledged that one branch of theology is linked with other branches, it is difficult to see the necessity of going into such

[681] Raven, *Natural Religion and Christian Theology,* Vol 1, 186.
[682] Raven, *Natural Religion and Christian Theology,* Vol 1, 197.
[683] Raven, *Natural Religion and Christian Theology,* Vol 2, vii.

depth on early Christological disputes or rival theories of the Atonement. The later chapters, 'Christ and the Universe' and 'Nature and God' are better, showing once more Raven's depth of theological learning being brought to bear on a modern understanding of the physical world.

The first volume has stood the test of time better than the second volume. The second chapter in the first volume, on the biblical attitude to nature, is still worth reading. Raven's understanding of theology, his love of nature and his understanding of biology are evident in these introductory chapters. The following chapters on the historical figures, particularly on the lesser-known figures of St Albert the Great, Gessner and Cudworth are informative. The attempt in volume two to write a modern *Religio Medici* is not so convincing. While Thomas Browne's work was well received in the seventeenth century the all-encompassing ambition to write a new *Religio Medici* was far more difficult to achieve in the mid-twentieth century. From the beginning of the twenty-first century the second volume appears more dated than the first.

There are two main areas of difference between the work of Raven on the one hand and Jeans and Eddington on the other.

The first area is on the importance of biology. In *The Eternal Spirt,* the official account of the 1926 Church Congress in Southampton which was written by Raven, the following statement is found:

> We have suffered too much from our willingness to relegate to the physical sciences the whole interpretation of nature…[684]

While this was written before the three key texts discussed in this study, it reflected Raven's understanding of the growing importance of physics and astronomy in the public mind. The early years of the century saw a big increase in public interest in the physical sciences partly at the expense of the biological sciences. This is described in Holly Henry's *Virginia Woolf and The Discourse of Science*.[685] Virginia Woolf was an admirer of James Jeans and his popular books were the main source of her understanding of astronomy. Raven was convinced of the continuing importance of biology in the advance of science in general and in the debate between science and religion in particular. In the first volume of his Gifford Lectures he argues that the history of science has too often been a 'papal succession' of notables from

[684] Charles E Raven, *The Eternal Spirit* (London, Hodder and Stoughton, 1926), 32-33.
[685] Holly Henry, *Virginia Woolf and the Discourse of Science* (Cambridge: CUP, 2009), Chapter One.

astronomy and physics, such as Copernicus, Kepler, Galileo and Newton 'with Boyle and Hooke and a few others wedged in the series'.[686] While Vesalius, Harvey and Linnaeus get a mention in some books, Gesner, Ray, Stensen, Redi, Malpighi and Swammerdam are frequently neglected.[687] Raven, it should be noted, pays more attention to the physical sciences than Eddington and Jeans do to the biological sciences. Raven discusses Eddington briefly in *Science, Religion and the Future* where he commends Eddington's Gifford Lectures but suggests that his readers should also consult Stebbing as well and arrive at a balance.[688] Both Eddington and Jeans insist that their training is in physics and mathematics and do not wish to enter biological disputes while briefly acknowledging their acceptance of evolution.

The second area is in the theological depth of their books. Raven's apologetic, which is grounded in his work as a theologian, was, perhaps not too surprisingly, more Christo-centric than the apologetics of Eddington and Jeans. Raven's background as a theologian is obvious when reading his apologetics. His depth of reading is evident in a whole range of Christian thought from the Bible, through the Church Fathers, the medieval scholastics, the Reformation writers and contemporary theology. Along with this strength came the associated issue of the lack of accessibility. There is a lot of untranslated Latin, some untranslated Greek and many unexplained theological references. Raven was clearly not attempting to write popular apologetics whereas Eddington and Jeans were. All three saw the inadequacy of scientific materialism and their books offered varying approaches to Christian apologetics.

Raven's weaknesses were his association with Lamarckism and his disinclination to keep up to date with developing trends in biology. Bowler argues that in his later books such as *Science, Religion and the Future* of 1943 and his Gifford Lectures of 1953, Raven had little to offer except a repetition of his then outdated claims that Lloyd Morgan, J C Smuts, J S Haldane and other anti-mechanists offered the key to a new synthesis.[689] He did, however, acknowledge in his Gifford Lectures, that 'at present Lamarckism is not proven nor in its traditional form probable.'[690] He was, nevertheless, able to make a significant contribution to the science and religion debate in the historical parts of these Gifford Lectures, in *Evolution*

[686] Raven, *Natural Religion and Christian Theology,* Vol 1, 7.
[687] Raven, *Natural Religion and Christian Theology,* Vol 1, 8.
[688] Charles E Raven, *Science, Religion and the Future* (Cambridge: CUP, 1943), 64-69.
[689] Bowler, *Reconciling Science and Religion,* 285.
[690] Raven, *Natural Religion and Christian Theology,* Vol 2, 131.

and the Christian Concept of God, in *The Creator Spirit* and to the history of science with his biography of John Ray.

7.8 Conclusion

This dissertation calls for a re-examination of the work of Eddington and Jeans saying that there is much that is worthy of reconsideration. No serious evaluation of their work should hide the major shortcoming of their poor use of Idealism.

Both Joad the philosopher and Inge the theologian criticised their amateurish use of Idealism; both, nevertheless, did not wholly reject their message. The comments on the use of Idealism by the scientists were well made, Joad's and Inge's books were well argued and objective, and their arguments were delivered without the animus displayed by Russell and McCabe. Joad's weakness was that he did not fully understand the science of the time, particularly with regard to the psychology of perception. Inge was heavily reliant on Plato and Plotinus. Whether or not that is a weakness is a point for debate. Inge calls upon 'common sense': an appeal to this is not a good way forward in astronomy, physics, philosophy or theology. Inge will be considered further in the concluding chapter.

The Idealism of Jeans and Eddington was undoubtedly a major weakness. Chesterton and Raven were both philosophical Realists but many of the readers who read all three of the popular apologists - Chesterton, Eddington and Jeans - would not have noticed this difference between the three. They would have spotted that Chesterton ranged widely over a variety of topics whereas Jeans and Eddington generally kept to the field of the physical sciences. As has been shown, for much of his writing, the contrast between the academic Raven on the one hand and Eddington and Jeans on the other is not over the two sides of the Idealism-Realism debate. Was the fact that two of the apologists were Realists and two Idealist significant? The answer to that question must be in the affirmative as the Idealism of Eddington and Jeans gave an easy target for their critics.

The next respondent to be considered is Susan Stebbing, a philosopher who criticised their use of metaphor and language in general as much as their use of the language of Idealism.

CHAPTER EIGHT

STEBBING AND THE USE OF LANGUAGE

8.1 Introduction

One of the key critics of Eddington and Jeans was Susan Stebbing. As with Joad and Inge she criticised their use of Idealism but linked to this criticism was an attack on their general use of language, which Stebbing considered was emotive and imprecise. Stebbing's *Philosophy and the Physicists* published in 1937 could be cast as the book which ended the popularity of Eddington and Jeans as scientific apologists for the Christian faith.

Stebbing's book had a wide influence both before and after the Second World War. Her attack in this book has been portrayed as so devastating that Eddington and Jeans lost their academic credibility and popular readership in one fell swoop. The attack was seen as significant as that of Elizabeth Anscombe on the popular apologist C S Lewis.[691] This section argues that viewing Stebbing's book as the main cause of their downfall is too simple a description as it ignores the historical context, links too closely the academic and popular responses to their work and ignores their continuing influence.

8.2 Susan Stebbing

L Susan Stebbing was at the time of writing *Philosophy and the Physicists* Professor of Philosophy in the University of London. According to Mary Warnock, as a student she read first history and then moral sciences at Girton College, Cambridge.[692] She decided to change academic track after reading F H Bradley's *Appearance and Reality,* a book described by Anthony Kenny 'as the fullest and most magisterial statement of British idealism.'[693] Her thought was also partly shaped by Whitehead and Russell. It was, however, G E Moore, who influenced her most while at Girton, both as an undergraduate and as a teacher. Margaret Macdonald, a British philosopher writing in the *Dictionary of National Biography,* records no

[691] For a description of the Lewis/Anscombe debate see A N Wilson *C S Lewis: A Biography* (London: Collins, 1990), 210-214.
[692] Mary Warnock, *Women Philosophers*, 93.
[693] Anthony Kenny, *Philosophy in the Modern World* (Oxford: Oxford University Press, 2007), 47.

time as a lecturer at Girton and paints a slightly different picture of her undergraduate career from that given by Warnock. As Warnock is a former Mistress of Girton, her account of the career of Stebbing has more credibility. Macdonald gives the following assessment of Stebbing with which Eddington and Jeans might not have agreed:

> Perhaps her greatest gift was for teaching philosophy. Clear in exposition, fair and acute in criticism, she could analyse without destroying and illuminate without dogmatizing. [694]

Warnock says her influence can properly be described as revolutionary; Macdonald says that she was not an originator. Stebbing was the first woman in Britain to hold a chair of philosophy.

Moore, as has been seen, was one of the leading influences in bringing about the decline of Idealism as a significant force in British intellectual life and one of the founders of the analytical philosophy movement. Moore believed that words in common use should be understood as they are commonly used and that we can truly say that the answer to the question – Can we know anything? – is 'Yes.'

In the *Preface* of *Philosophy and the Physicists* Stebbing identifies Professor E A Burtt's *The Metaphysical Foundations of Modern Science* as another major influence. Burtt was a philosopher working in American universities who, while teaching courses on British philosophy, saw the importance of the developments in physical science and especially the work of Isaac Newton as crucial to British philosophy. Burtt's book deals mainly with the thought of the period from Copernicus to Newton. The first edition of his book was published in 1924, the second edition in 1931. Between these two editions, *Science Religion and Reality, The Nature of the Physical World, Science and the Unseen World* and *The Mysterious Universe* all appeared. Burtt's preface to the second edition is interesting. He says that he has decided to keep the main body of the work as it was in 1924 and then says that the concluding chapter has been almost entirely rewritten: 'Its original emphasis is no longer quite consonant with my present philosophical leads.'[695] Stebbing could have read either or both editions. Her faith in the utility of philosophy to help in establishing the final truth about the nature of the physical world seems ill placed if a philosopher has to reframe completely his or her conclusions after as little as seven years because of his 'current philosophical leads'. Eddington's and Jeans'

[694] Margaret Macdonald, '(Lizzie) Susan Stebbing', *Compact DNB,* 2904.
[695] E A Burtt, T*he Metaphysical Foundations of Modern Science* (New York: Dover, 2003), iii.

tentative approach, using metaphor to describe the current understanding of the nature of the physical world portrayed by modern science, with an acknowledgement that it could change, seems more appropriate.

While Warnock says that Stebbing's *Philosophy and the Physicists* displays wit and humour,[696] Stanley says that Stebbing disapproved of Eddington and Jeans because they entertained their readers and used humour.[697] It is interesting that Stanley only gives two pages to Stebbing; this is the work which some claim led to the demise of the influence of Eddington and Jeans.[698] Possibly the myth of Stebbing's 'destruction' of Eddington and Jeans is not prevalent in the United Sates.

Warnock's *Women Philosophers* is a book where the editor picks an extract from the writings of seventeen female philosophers, preceded by an introduction on the life, work and influence of the author. Warnock picks *Philosophy and the Physicists* from all of Stebbing's output and says:

> The physicists in question were Sir Arthur Eddington and Sir James Jeans, both Cambridge scientists, whose popular writing had a vast following in the 1930s on account of the excitable mysticism of their style. Non-scientists felt a *frisson* of amazement at the vision of reality presented in Jeans' book *The Mysterious Universe* and Eddington's *Science and the Unseen World.* Susan Stebbing's book was a precursor of the wonderful debunking spirit of the post-war world, and undergraduates of the 1950s read it as eagerly as those for whom it was written fifteen years earlier.[699]

Warnock was a young philosophy tutor in the 1950s. The word 'mysticism' can justly be used when describing the work of Eddington but it cannot just be used with regard to Jeans, be it excitable or not.

Stebbing acknowledges that Eddington and Jeans are significant men in the world of physics, saying that both are eminent in their own branch of science. Eddington is an original thinker of the first rank. Jeans does not receive as much praise but is described as showing himself capable of writing lucid and straightforward accounts of current astronomical knowledge.

[696] Warnock, *Women Philosophers,* 93.
[697] Stanley, *Practical Mystic,* 220.
[698] Stanley, *Practical Mystic,* 219-220.
[699] Warnock, *Women Philosophers,* 93-94.

Stebbing goes on to assess Jeans' non-academic work, notably excluding *The Mysterious Universe*, and says it ranks with the popular work of Sir William Bragg, which she rates highly.

Four of Stebbing's main criticisms of the work of Eddington and Jeans will be considered. They are linked together and centre on the use of language. Stebbing dislikes their use of language in general, their use of language to deny solidity at the sub-atomic level in particular, their use of the language of Idealism and their use of metaphor. These four criticisms of Stebbing are important to be examined not just in relation to the two astronomers but because of their wider implications for the communication of both apologetics and the science and religion debate in general.

8.3 Language and the Physicists

Stebbing's criticism of the use made by Eddington and Jeans of language is that their task is approached through 'an emotional fog'.[700] Stebbing acknowledges that Eddington has considered his approach to writing for the general public and quotes him on the subject of non-technical language. Eddington wrote:

> Non-technical books are very often a target for criticism simply because they are non-technical… I take it the aim of such books must be to convey exact thought in inexact language.[701]

Stebbing agrees that there is much truth in this statement, but argues Eddington shows himself to be only partially aware that exact thought cannot be conveyed in inexact language. After agreeing that Eddington had seen, at least to some extent, the difficulties inherent in popularisation, she asserts that Jeans does not seem ever to have noticed that his language is inexact. Stebbing asserts that in his previous books his use of picture language to describe the size of the universe was reasonable, but says that in *The Mysterious Universe* it is used to terrify people. This is untrue. Jeans is trying to convey to the non-astronomer the vastness of the universe. His own conclusion on the subject is as follows:

[700] Stebbing, *Philosophy and the Physicists,* 6.
[701] Eddington, *New Pathways in Science,* 279.

> It is probably unnecessary to add that, on this view of things, the apparent vastness and emptiness of the universe, and our own insignificant size therein, need cause us neither bewilderment nor concern.[702]

Even philosophers can find the silence of space if not the vastness of the universe terrifying - 'The eternal silence of these infinite spaces frightens me.'[703] Stebbing says that the awe that Kant felt when contemplating 'the starry heavens above' is strictly different. Such awe, she said was due to an immediate awareness of the beauty of the night and is wholly independent of any knowledge of astronomical magnitudes. Is this the case? Kant, who lectured in mathematics and physics and formulated a theory on planetary formation, was well aware of the vastness of the universe even though the then current understanding of the size of the cosmos was smaller than was envisaged in 1930. Keith Ward writes:

> Kant finds in the order and intelligibility of nature such a clear indication of the wisdom and intelligence of the unknown cause of nature that 'the belief [in a wise Author of nature] acquires the force of an irresistible conviction'.[704]

Stebbing says that the modes of expression so dear to both Eddington and Jeans obfuscates the common reader whilst pretending to enlighten them. These writers encourage the reader to believe that he has understood theory when he has only been entertained by an irrelevant illustration.

In a key passage Stebbing summarises her understanding of the message of Eddington and Jeans for the common reader:

> He is to be persuaded that there is a God who has created the world, who has designed man as the crown of his creation, and who will not thus leave him uncomforted; that Reality is spiritual; finally that human beings can determine their own destiny.[705]

Stebbing here makes five assertions; only the first is completely correct. On the second assertion, neither Eddington nor Jeans talks of humanity as the crown of creation nor uses any

[702] Jeans, *The Mysterious Universe,* 143.
[703] Blaise Pascal, *Pensées,* trans. W F Trotter (Seattle: PPS, 2011), 28.
[704] Keith Ward, *The God Conclusion: God and the Western Philosophical Tradition* (London: DLT, 2009), 80 quoting Immanuel Kant *Critique of Pure Reason* 2nd ed. 1787 translated by Norman Kemp Smith (London: Macmillan, 1952), 293.
[705] Stebbing, *Philosophy and the Physicists,* 19.

words to that effect without irony, and so the third assertion, which rests upon a 'thus' from the second assertion, falls. The closest Jeans reaches talking of comfort is as follows:

> ...we are not so much strangers or intruders [in the universe] as we first thought.[706]

This notion will give comfort to some, but not others. On the fourth of Stebbing's assertions, while Eddington and Jeans do move, for example, from the statement that the nature of the physical world is not as concrete, straightforward and substantial as pictured by late Victorian science to a suggestion that therefore the material world is in some sense 'spiritual' (Eddington) or 'mental' (Jeans), on the whole they are more subtle and understated than Stebbing asserts. While Stebbing does make some distinction between the two, she is not always correct. In fact, Jeans does not use the word 'spiritual' in *The Mysterious Universe,* the book which Stebbing refers to, at all*,* neither does he use the word 'mysterious' beyond the title page. Finally, while Eddington and Jeans do believe that the state of physical science points to a non-determined universe, they do so in moderate tones and Eddington asserts that psychology, philosophy and theology may yet point in other directions.

Stebbing is guilty of building her argument upon the false foundation of a grossly inaccurate summary of the arguments of Eddington and Jeans in the passage quoted above which occurs at the start of chapter two of her book. This summary of the essential thrust of their work is almost completely wrong apart from the statement they assert that there is a God who created the world. Popular though it was from the time of publication and for approximately twenty years afterwards, it is only completely accurate in its criticisms of the use Eddington and Jeans make of idealism. These criticisms had already been better made by Joad and Inge. Stanley is probably wise in spending only two pages on this book. Nevertheless, because of its importance in the careers of Jean and Eddington and for the thrust of this dissertation, this book will be examined at some length.

It is interesting to note that Stebbing, while castigating Eddington and Jeans for their imprecise use of language, does indulge in the same sin herself. Clearly in a polemical work some exaggeration and misrepresentation is to be expected, but Stebbing does not show the precision in dissecting Eddington and Jeans which is seen in Joad and Inge, while she falls short of the gross lack of accuracy seen in Russell and McCabe.

[706] Jeans, *The Mysterious Universe,* 149.

Stebbing herself suffers from the vagueness of Jeans' writing as much as Inge or Joad. She is puzzled at times when trying to find exactly what Jeans is saying. Russell does not suffer from any misplaced desire, in *The Scientific Outlook* at least, to make sure he has understood his opponent's position. Stebbing, while sometimes reading more into Jeans and Eddington than is actually there, does at times acknowledge that she may not be interpreting people's views accurately:

> The conclusion which Jeans draws from the 'ascertained facts and provisional hypotheses' of astronomy and physics is based upon the assumption that the universe has been designed by a creator. Perhaps Jeans does not regard this as an assumption but rather as an inference from scientific facts. It is difficult to be sure.[707]

Jeans is indeed tentatively asserting that the existence of a Creator is a reasonable inference from the science of the time. Stebbing sees Jeans as arguing from the premise that there must have been a creation, possibly based on the fact of entropy. He then makes, she says, an anthropomorphic leap to a belief that the universe is designed, then to the assumption that there must be a Creator; from that he is led to a Great Mathematician. Having established that, Stebbing is unclear as to whether or not Jeans sees the statement that the universe is designed by a pure mathematician as being equivalent to the statement that the universe consists of the thoughts of a pure mathematician. In this, and her next point, Stebbing is justified in her comments. She says that what is lacking is any clear indication of what Jeans understands by thought and by thinking. Yet it is upon the concept of '*thought*' that the whole of his metaphysics depends.[708] Had he been a philosopher either by training or by inclination he would surely have realised the necessity of attempting to analyse a concept so fundamental for his argument. For the rest of the book, Stebbing's attentions are mainly on the writings of Eddington with fewer references to Jeans.

8.4 Eddington's Description of Sub-Atomic Structure

Stebbing follows her chapter in which she dismisses Jeans as too vague for serious consideration with one entitled 'The Furniture of the Earth'. This is a reference to the famous

[707] Stebbing, *Philosophy and the Physicists,* 23.
[708] Stebbing, *Philosophy and the Physicists,* 25, Stebbing's italics.

passage from Bishop Berkeley quoted by Jeans in *The Mysterious Universe.* But it is also a reference to Eddington's table and chairs. Stebbing in this chapter criticises his use of language, starting with his use of 'real' and 'really' or 'not really'. Then Stebbing quotes one of Eddington's famous references to woodwork:

> I am standing on a threshold about to enter a room... I must make sure of landing on a plank travelling at twenty miles a second round the sun... The plank has no solidity of substance. To step on it is like stepping on a swarm of flies. Shall I not slip through?[709]

Stebbing then proceeds to attack his loose use of language, saying it is gravely misleading to the common reader and that it reveals serious confusion in Eddington's own thinking about 'the nature of the physical world'. Stepping on a plank, she says, is not in the least like 'stepping on a swarm of flies.' We know that such experiences would be quite different. The plank is solid she asserts. Stebbing is in many cases right to criticise Eddington's use of the language of Idealism. It is loose and imprecise. But here she is ignoring Eddington's use of humour. Subsequent comments, seen before, clearly demonstrate that his use of language is often gently humorous and sometimes ironic:

> Verily, it is easier for a camel to pass through the eye of a needle than for a scientific man to pass through a door. And whether the door be barn door or church door it might be wiser that he should consent to be an ordinary man and walk in rather than wait till all the difficulties involved in a really scientific ingress are resolved.[710]

Stebbing does not fully understand either quantum theory or the Rutherford model of the atom. Her belief, influenced by Moore, that well-constructed descriptive phrases in good English can convey what is best described in mathematics is naïve. Eddington is in *The Nature of the Physical World* asserting that the general view of science in 1927 is different from the view of science at the end of the previous century. In *The Nature of the Physical World* he puts forward his view that science is no longer mechanistic and materialistic and that the simple deterministic reductionism of the last century is no longer valid. Both Eddington and Jeans assert that 'reality' is not quite a simple concept as it seems. Eddington believes that the Rutherford model of the atom is at least as revolutionary a conception as the ideas of Einstein

[709] Stebbing, *Philosophy and the Physicists,* 48 quoting Eddington, *The Nature of the Physical World,* 342, the original quotation in Stebbing is longer.
[710] Eddington, *The Nature of the Physical World,* 342.

and Heisenberg. Eddington asserts that the then current conception of the atom is not like the sun and planets conception of late Victorian science. It is far less solid. If, like Dr Johnson, you kick your foot against a stone it does hurt, or if like Dr Stebbing, you stumble against a table, you bruise your leg. Nevertheless, it is not an entirely inappropriate use of metaphor to say 'To step on it is like stepping on a swarm of flies.'[711] The modern picture of the atom is, to some extent, more like a swarm of flies than it is like a billiard ball; though in fact it is neither. What it is, is best described in the language of mathematics: neither the language of metaphor nor the language of precise philosophical description, despite the strictures of G E Moore, can describe it as fully as the language of mathematics. Eddington's question 'Shall I not slip through?'[712] is clearly rhetorical. Eddington knows that he will not. In this passage he sets up what might be termed 'a scientific straw man' who uses the description of the sub-atomic world to stop actions which experience suggests are perfectly safe, such as stepping on a plank of wood.

Eddington is writing a semi-popular book for intelligent people and he expects them to be able to detect irony and metaphor and not to act like a fundamentalist approaching the poetic language of the Psalms. Eddington when he uses the language of Idealism is often imprecise, vague and often contradicts himself, but when he describes the new science he uses metaphor, imagery, irony and humour to good effect. It is difficult to find justification for the term 'emotionalism' in the writings of Eddington.

As has been noted, what Eddington appears to be saying on the final page of his final chapter of *The Nature of the Physical World* (judging on the evidence of the previous pages) is that, in the new physics, what appears at the level of human vision and from experience of standing upon it, to be a solid plank, is actually, at the atomic and sub-atomic level, far from solid. Proportionately, the gaps between, for example, the carbon nucleus in a complex molecule in the wood and its electrons are very, very large. And the electrons are not like tiny planets circling the sun, they are somewhat, but not entirely, like a swarm of flies. So while planks clearly do, as experience shows, support the weight of a man or woman, they do not actually form a continuous support at the atomic level; it is not that simple. Stebbing says 'the plank appears *solid*'; indeed it does; but it isn't.[713] The Oxford philosopher W F R Hardie takes Stebbing's approach to Eddington to task:

[711] Eddington, *The Nature of the Physical World,* 342.
[712] Eddington, *The Nature of the Physical World,* 342.
[713] Stebbing, *Philosophy and the Physicists,* 53.

> But surely it is false that there is no sense in the question whether a plank which, under all the tests we can apply, appears solid, really is solid.[714]

Hardie is critical of Stebbing's approach. He is not convinced that it is a helpful line in establishing truth and concedes that what appears solid to human eyes may not be so. Despite T H Huxley's protestations, the science of physics is far from organised common sense. What appears to be common sense is not always sound physics. Stebbing has not grasped this basic fact. Stebbing uses clearly inaccurate and imprecise phrases such as 'But we do not know how to use a word which has no sensible opposite' or phrases which are vague and not befitting a philosopher 'If the plank appears to be *solid*, but is not really *non-solid*, what does 'solid' mean?' Surely examination of the word 'appears' is required with all the rigour analytic philosophy can bring to bear. Stebbing would have benefitted from reading not only Burtt's *The Metaphysical Foundations of Modern Science* but also some more modern science.

To be fair to Stebbing, she does return to this topic later on in the book, but her argument is interesting; while the researches of modern physics have indeed shown that the plank only appears solid, our conception of the solidity of the plank is still as it was as before so it is not inappropriate to say the plank is solid. While this uses the noun *solidity* in its normal English usage, it is not using the noun *solid* it in its normal English usage, which is surely against the teachings of the school of analytic philosophy. Eddington and Jeans are not alone in being criticised. Stebbing criticises Ernst Zimmer for similar use of language.[715]

Having taken Eddington to task over his use of words in his final chapter, she then castigates Eddington over his use of language in the famous passage at the beginning of *The Nature of the Physical World* which talks of 'two tables, two chairs, two pens'.[716] She charges Eddington with believing there are two distinct tables, two distinct chairs and two distinct pens. A more natural reading is that this is a literary device to show the contrast between everyday perception unaided by scientific advance and what the latest science reveals to be the case at a sub-atomic level. But Eddington with his tables is guilty of using imprecise language. He says in some passages that the two tables are parallel and in others he talks of shadow and substance in a way which is confusing. Stebbing makes parallels between the philosophy of

[714] W F R Hardie, 'Ordinary Language and Perception' in *The Philosophical Quarterly* 5, (April 1955), 97-108.
[715] Ernst Zimmer, *The Revolution of Physics* (London: Faber & Faber, 1936), 51.
[716] Eddington, *The Nature of the Physical World,* xi.

Newton and the work of Eddington, drawing on the work of Burtt. She concludes the third chapter by saying:

> To adopt the striking phrase of Professor E A Burtt, we have allowed the physicists 'to make a metaphysic out of a method'. In doing so they have forgotten, and philosophers do not seem to remember, that their method has been designed to facilitate investigations originating from a study of 'the furniture of the earth'.[717]

This is something of which Eddington is not guilty. His famous metaphor of the fishing net[718] makes this clear, although it should be noted that *The Philosophy of Physical Science* was not published until 1939, two years after *Philosophy and the Physicists.* Part of his basic message through all his books which touch on the science and religion interface is that science is subject to reform and revision and that its findings are not to be taken as final in any sense. He is aware of the epistemological problems inherent in 'the scientific method' and is not foolish enough to make a metaphysic out of the process.

8.5 The Use of the Language of Philosophical Idealism

Stebbing then turns from the poor use of language in general to the poor use of Idealism:

> The two scientists with whose philosophical speculations we have been mainly concerned in the preceding chapters agree in thinking that the implications of contemporary theories of physics tend in the direction of idealism.[719]

Stebbing then sarcastically reminds her readers that Jeans considers it a virtue to have no training in philosophy. She says that it is clear that Jeans has read Plato and Berkeley and also very clear that he has not read the critics of these two authors and consequently has put forward views which have previously been decisively rejected by philosophers. She is again kinder to Eddington, accepting that his views did arise from his study of relativity theory and his appreciation of the work of Russell on the nature of structure, presumably in *The Analysis of Matter* although she does not make this explicit.

[717] Stebbing, *Philosophy and the Physicists,* 64.
[718] Eddington, *The Philosophy of Physical Science,* 16.
[719] Stebbing, *Philosophy and the Physicists,* 265.

Stebbing points out that most physicists of her time who have attempted to construct a philosophy upon the basis of their physical researches have ended by elaborating some form of idealism. She asks what is the nature of the changes in physical conceptions that have seemed to support the conclusion that the implications of the physical world-picture are idealistic in trend. Stebbing sees two main factors as responsible for this desire to adopt idealism. The first is a new conception of matter. The second is a change in the status of natural laws.

On the first, as physicists have attempted to draw far-reaching philosophical conclusions from these undoubted significant changes, they have fallen into 'gross confusions' and have failed to take seriously the nature of the distinctions between matter and mind. Stebbing writes:

> This dissimilarity of mind and matter, familiar to every student of philosophy since, at least, the times of Descartes and somewhat waveringly accepted by lay men, has been the source of philosophical controversies and the basis of many attempts to reduce matter to mind or to reduce mind to matter. The latter attempt is what is commonly called 'materialism', the former 'idealism'.[720]

Stebbing expands these outline definitions and then asserts that the sharp-cut distinction between the two views is probably the heritage of the dualism introduced into modern philosophy by Descartes and, she asserts, this is certainly wholly untenable in the form in which Descartes held it. Peter Harrison in a lecture in Oxford in 2012 has asserted that this common representation of the thought of Descartes is a shallow reading of too narrow a selection of his writings.[721] In *Galileo Goes to Jail: And Other Myths about Science and Religion* Harrison has a chapter 'Myth 12 That René Descartes Originated the Mind-Body Distinction'[722] which sums up his view concisely. Harrison says that three significant people who have put forward this view are Gilbert Ryle, his pupil Daniel Dennett and particularly Antonio Damasio who talked about an abyssal separation.[723] in his *Meditations* Descartes does talk of mind and body as being made of distinct substances; he also talks about them being intermingled and a unitary whole. Harrison concludes:

[720] Stebbing, *Philosophy and the Physicists,* 269-270.
[721] Professor Peter Harrison 'Descartes' Error? Dualism and the Immortal Soul', Science and Religion Forum, Regents College, Oxford: 6 September 2012.
[722] Peter Harrison, 'That René Descartes Originated the Mind-Body Distinction', 107- 114.
[723] Harrison, 'That René Descartes Originated the Mind-Body Distinction', 109.

> The doctrine of an abyssal separation of body and soul was not propounded by Descartes, and neither is it a tenet of Christian belief.[724]

Stebbing turns to her defence of a common-sense view of solidity and concludes that while matter is now regarded as more tenuous, the distinction between the material and the mental is in no way diminished. Bertrand Russell, she says, is sometimes guilty of this mistake. We have, she points out, no experience of mind apart from some manifestation in a material body.

Thus in six short pages she moves from 'This sharp-cut distinction between the two ... is certainly wholly untenable in the form in which he [Descartes] held it.' to 'It is hard to find any justification for maintaining that the distinction between the mental and the material has been diminished or in any way lessened.' While holding both of these propositions could possibly be justified, Stebbing does not fully establish a position which is not that of Descartes, but which maintains a clear distinction between mind and matter. Possibly she considers it self-evident.

Her next target, however, the abstractness of modern physics, is a theme which is found in both writers, and most notably in Eddington. Stebbing says modern mathematical physicists are obsessed by this, and that the conception of abstraction has been misused by some, including not a few preachers, who have told their congregations that 'science has shown' that the chairs upon which they sit are *abstract*.[725] This, again, is not how Eddington describes the chair or table, he describes the explanation given by modern physics of the structure at the atomic and sub-atomic level. He does use the word abstract of the descriptions of atomic physics, but not of the chairs, and he certainly does not build a metaphysic upon it.

Stebbing concedes that physicists are increasingly using mathematical models which cannot be pictured, and in this sense physics is more abstract, but physics has always of necessity been abstract. It is Stebbing's opinion that modern theories of the atom afford not the slightest justification for saying that the then recent developments in physics have any tendency to show that materialism is false or are capable of being used to provide any arguments in favour of Idealism.

[724] Harrison, That René Descartes Originated the Mind-Body Distinction', 114.
[725] Stebbing, *Philosophy and the Physicists,* 278, Stebbing's italics.

Stebbing then turns to her second factor which others point to as supporting idealism, namely the change in status assigned to physical laws. As the book continues, the harsh tone of her comments about Eddington abate and something close to admiration appears at points:

> It is not at all surprising that Eddington, mathematician as well as physicist gifted beyond the common race of physical scientists, and unshrinkingly aware of the gulf between our achievements and our hopes, should find in the theory of relativity a hint that the world we live in is made by mind.[726]

Stebbing is sometimes content with Eddington's descriptions of the nature of the physical world but rejects his conclusion that this means Idealism is a better description of reality. Eddington's view on the role the scientific community plays in the formulating of 'scientific laws' is more in tune with the general modern understanding on the topic. Stebbing's thoughts on the status of the 'discoveries of the experimental physicists' are somewhat naïve: she sees them as based upon 'inescapable facts'. These discoveries, she states, are formulated in laws which are in no sense imposed by the mind of the discoverer. Stebbing does go on to qualify this somewhat but her use of the phrase 'imposed by mind' is significant. She has a view shaped by naïve Realism of the epistemological status of experimental data, scientific 'facts' and scientific laws which would be unlikely to be seen in the writings of a philosopher today as she or he discusses the philosophy of science.

Stebbing is somewhat guilty of the approach castigated by Polkinghorne namely that science is a process which always produces certain knowledge rather than an enterprise which involves judgement and sometimes produces erroneous results. Nevertheless, she may be correct when she asserts that when a scientist turns philosopher he or she tends to find support in his or special studies for the metaphysical theory which on other grounds was found attractive, although Eddington asserts that it was his studies in relativity which turned him into an Idealist.

Stebbing sums up her opposition to Eddington and Jeans thus:

> It is odd to find that the view that 'all is mysterious' is to be regarded as a sign of hope. The rejection of the 'billiard-ball view' of matter does not warrant the leap to any form of Idealism.[727]

[726] Stebbing, *Philosophy and the Physicists,* 279.
[727] Stebbing, *Philosophy and the Physicists,* 285.

Stebbing is mischievous in using quotation marks around 'all is mysterious' as it is a phrase used by neither Eddington nor Jeans, neither, as has been pointed out already, does Jeans use the word 'mysterious' beyond the title page. Quite the opposite: when discussing consciousness, Jeans writes '… we need find no mystery …'[728]. Stebbing is correct, however, in asserting that a rejection of a billiard ball, or sun and planets, conception of the atom does not lend conclusive support to philosophical Idealism.

Stebbing concludes her book on a tone found in Russell's writings at the time – despair at the state of the human race. This is not too surprising if the events in Europe in 1937 are considered:

> Our limitation is due to ignorance, not to the 'blind forces of Nature', not to the astronomical insignificance of our planet, but to the feebleness of our desires for good. This limitation is not to be removed by the advances of physical knowledge, nor should our hopes be placed in the researches of the physicist.[729]

Stebbing finds the language used by Eddington and Jeans disturbing. She says it is perverted or emotional. Her comments seem to be over-reactions to their popular or semi-popular accounts of modern science. It appears possible that she is either reacting more to third person accounts of what Eddington and Jeans say or she is misrepresenting what is said in the three key texts. Stebbing is closer to Russell and McCabe in style than to Joad. It does appear that she is not above misrepresenting the two astronomers. Stebbing is particularly scathing of accounts which move from a description of the size of the physical universe to a statement of the significance of humanity. Eddington does not make this type of statement. Jeans says at first glance the size of the universe appears to argue against a designing deity, but that modern physics tends to show that we are not strangers in an alien universe. Stebbing also appears to believe that modern science can be expressed in precise English. In this she appears naïve, as much of modern physics can only be communicated in the language of mathematics.

Stebbing says that the language employed by Jeans and Eddington in which they uphold an Idealism based understanding of the nature of reality is imprecise and that they betray their lack of philosophical training. In particular they are not clear on what they mean by thought. In this she is accurate. What Stebbing says is similar to what Joad and Inge have already said. She is not as detailed as they are, but she is more entertaining. She sometimes misrepresents

[728] Jeans, *The Mysterious Universe,* 143.
[729] Stebbing, *Philosophy and the Physicists,* 286.

Eddington's and Jeans' opinions and often ignores their understatement and nuanced use of language in their support for Christian theology.

As a result of their poor use of language, Stebbing argues, the two physicists have not justified their assertion that modern physics leads to philosophical Idealism. In this Stebbing is correct, even if at times she is not as precise as she expects Eddington and Jeans to be in their writing. Throughout Stebbing shows herself to have a too simple understanding not only of then current science, but also of how science advances. If Eddington and Jeans are amateur and not very competent Idealists, Stebbing is a rather naïve Realist. Her summary criticism of the thought of Eddington, Jeans and others is:

> Contemporary physicists are apt to suffer from the same defects – a too hasty passage from physics to metaphysics.[730]

8.6 Metaphors for the Indescribable?

One of the uses of the language deployed by Jeans and Eddington that Stebbing comments upon unfavourably is their use of metaphor. In her book *Metaphor and Religious Language,*[731] Janet Martin Soskice records that Ullmann has identified 125 different definitions of 'metaphor'.[732] Soskice then goes on to give her own:

> As a working definition of metaphor, we shall say that *metaphor is that figure of speech whereby we speak about one thing in terms which are seen to be suggestive of another.*[733]

Soskice makes the very reasonable point that a definition of metaphor which works in one discipline is sometimes not useful in another academic area. Keith Ward gives another definition:

> *Metaphors are statements that are literally false, or false in their primary sense,* but that communicate truth in an indirect and sometimes cryptic form.[734]

[730] Stebbing, *Philosophy and the Physicists,* 266.
[731] Janet Martin Soskice, *Metaphor and Religious Language* (Oxford: Oxford University Press, 1985), 15.
[732] Stephen Ullmann, *Semantics: An Introduction to the Science of Meaning* (Oxford: Blackwell, 1962).
[733] Soskice, *Metaphor*, 15 *italics* as in the original.
[734] Keith Ward, *The Word of God?* (London: SPCK, 2010), 63 *italics* as in the original.

Keith Ward asserts that what a metaphor says could be said in straightforward language, but it would not have such 'richness'.[735] Soskice makes the point that not all metaphors are of the form 'x is a y' such as 'man is a wolf', 'time is a thief' or 'The Lord is my shepherd'. She argues that not all metaphors are assertions and also that the metaphorical focus is not always on the predicate. Different syntactic forms can be seen in metaphors. So while 'Is that wolf back again?' could be a literal question regarding a large and fierce canine, it could also be metaphorical in nature. Both Eddington and Jeans use metaphors in a variety of settings and not all of them are in the form 'x is a y'. This is especially true of Eddington, whose use of metaphor is subtler than Jeans' use.

The distinction between an analogy and a metaphor is disputed.[736] One simple delineation is that 'The Lord is my shepherd' is a metaphor while 'God is wise' is, in the tradition of Aquinas, an analogy.[737] The distinction is not crucial for this study. Jeans and Eddington sometimes call what Astley and others would describe as a metaphor, an analogy, but the term 'metaphor' will be used in this study.[738] The term 'model' is sometimes used in both theology and in science. Sallie McFague describes a model as 'a metaphor with 'staying power.' '[739] An example of this in science would be the Standard Model in particle physics, often spelt with initial capitals, the currently accepted theoretical model describing matter, particles and the forces between.[740] Whether this has staying power remains to be seen. It does not currently extend to include the force of gravity and further understanding of that could stretch the model to breaking point. Polkinghorne in his book *Scientists as Theologians* points out that Ian Barbour argues that models have a systematic character while metaphors have emotional and valuational overtones. Polkinghorne himself wishes to maintain a sharp distinction between the two. He sees metaphor as central to the task of theology but not of science.[741] Astley defines a model as a 'systematically developed, stable and long-lasting metaphor.'[742]

Astley writes that there is a long tradition of distrust and suspicion of metaphor by philosophers with many encouraging the notion that metaphor can be replaced by literal

[735] Ward, *Word of God?,* 63.
[736] Jeff Astley, *Exploring God-talk* (London: Darton, Longman and Todd, 2004), Chapter 5.
[737] Astley *God-talk,* 53.
[738] Jeans, *The Mysterious Universe,* 112, Eddington, *The Philosophy of Physical Science,* 117.
[739] Sallie McFague, *Models of God* (London: SCM, 1987), Chapter Two.
[740] Jim Baggott, *Higgs: The Invention and Discovery of the God Particle* (Oxford: Oxford University Press, 2012), 248.
[741] John Polkinghorne, *Scientists as Theologians,* (London: SPCK, 1996), 20.
[742] Astley *God-talk,* 41.

language.[743] He gives John Locke as an example of such distrust and says that those who follow this line view metaphor as at best an unnecessary ornament and at worst deceptive. Locke described metaphors, Astley reports, as 'perfect cheats' that 'insinuate wrong ideas'.[744] Soskice quotes Hobbes who regards as absurd 'The use of Metaphors, Tropes, and other Rhetoricall figures, instead of words proper.' [745] Soskice points out that early twentieth century philosophers, such as those influenced by logical positivism, tended to speak of empirically testable statements as those which possessed literal meaning, rather than statements which had metaphorical meaning. Even more recently J L Austin and other linguistic philosophers have not had a high regard for metaphor. Theologians have generally valued metaphors as a means of expressing concepts about the ultimate, while realising their limitations; philosophers have often been sceptical about their use.

Stebbing in her *Philosophy and the Physicists* reveals herself to be very much in this tradition of philosophical scepticism of the use of metaphor. As has been seen previously, she acknowledges that Eddington and Jeans are significant men in the world of physics. But she does not like Eddington's and Jeans' use of metaphor:

> Both these writers approach their task through an emotional fog; they present their views with an amount of personification and metaphor that reduces them to the level of revivalist preachers.[746]

These comments are very similar to those of the research scientist J L Russell in an article 'The Scientific Best Seller' in the March 1934 issue of the quarterly *Scrutiny.* J L Russell accuses Eddington and especially Jeans of 'indiscriminate use of adventitious aids such as unnecessary metaphors and similes'.[747]

The use of metaphor by Jeans and Eddington will be considered closely to establish if this charge is justified.

[743] Astley *God-talk,* 37.
[744] Astley *God-talk,* 37.
[745] Soskice, *Metaphor*, 67 quoting Thomas Hobbes, *Leviathan* (London: Dent, 1914), 20-21.
[746] Stebbing, *Philosophy and the Physicists,* 6.
[747] J L Russell, 'The Scientific Best Seller', *Scrutiny* 2, (March 1934), 348 – 349.

8.6.1 Metaphor in Jeans' Writings

The majority of Jeans' metaphors are deployed to explain current science to the lay person, although Macchia argues that they were 'obscure' and confusing to the general reader.[748] It is sometimes difficult to categorise his use of language and some commentators might describe sections of his prose as illustration rather than metaphor. In *The Mysterious Universe* the longest chapter devoted to the explanation of the current state of science is the penultimate one 'Relativity and the Ether'.[749] This chapter will be examined as an example of Jeans' use of metaphor.

Firstly, the earth is described as a ship ploughing its way through a sea of ether as it circles the sun. Next, the earth is a ship becalmed. Following this, the ether is compared with a system of bell pushes, bell wires and bells. Then there is a metaphor in which the ether theory is compared with a hypothetical Newtonian system which has two theories of gravitation: one to explain why apples fall in the summer and one why they fall in the autumn. The non-absolute nature of space time is compared with a cricket field. This is followed by a time/distance graph of a train journey from Paddington to Exeter which is probably best described as an illustration but could be seen as an extended metaphor. Next there is a metaphor which again shows the inadequacy of the ether system by saying that, according to its conceptualisation, the propagation of radiation is an abstraction, like the propagation of astronomical noon as the sun travels over the earth. As this contains the word 'like', some may wish to describe this as a simile, but Astley argues that similes often function as explicit metaphors.[750] The next is a double metaphor, with a gravitating mass in the four dimensional continuum being compared with either a blister on the two-dimensional surface of a hand or a mole hill on a cricket ground. In the penultimate metaphor in the chapter, Jeans says that electromagnetic forces will be resolved before long into 'a new type of crumpling of the continuum'.[751] The final metaphor is of the universe as soap bubble, a concept suggested earlier in the book.

Jeans often uses an apt metaphor. Some may think they are contrived or perhaps not the best possible. Others may want to query details, is the surface of the hand really two-dimensional, for example? Others may query the classification as a metaphor of the penultimate example –

[748] Macchia 'J. Jeans' idealism about space and its influences on E.A. Milne at the dawn of modern cosmology', 309.
[749] Jeans, *The Mysterious Universe,* 78-114.
[750] Astley, *God-talk,* 45.
[751] Jeans, *The Mysterious Universe,* 112-113.

a electromagnetic force, if not literally a crumpling in the continuum, is the closest that the English language can get to describing what is best explained in mathematics. Nevertheless, it is 'suggestive' to the lay reader of a crumpling of bedclothes and therefore apt. All of these metaphors are homely (in the English sense of the word). They are good teaching devices.

The final chapter of *The Mysterious Universe* - 'Into the Deep Waters' - contains around thirty-one metaphors, again definitional problems make it hard to be precise and one of the metaphors is attributed to Plato and another to Galileo. It is here where Jeans attempts to draw philosophical and theological conclusions from the state of science. This is the chapter which is likely to have been the source of a good share of the annoyance that Stebbing felt, as metaphor is laid upon metaphor in a way which many philosophers would find questionable.

It would be tedious to detail them all but the first few pages of the chapter will suffice to give a flavour of their nature. The first metaphor is a return to the soap bubble metaphor, the second compares the world line (which itself is possibly a metaphor) of the sun with a multi-stranded cable, the third compares the surface of the metaphorical soap bubble with a tapestry whose threads are the world lines of atoms. The next describes the world line of the earth as a cable smaller than the cable of the sun. Then eternity is a picture spread before us, but we are only in contact with a part of it, as a bicycle wheel is in touch with only one part of the road. In the next two metaphors the picture remains but first it is a fly being drawn across it and then the painter's finger. Jeans' metaphors do sometimes appear very frequently and some are mixed together in the same paragraph in a way which would disturb any traditional teacher of school English. A professional theologian would have advised a rewrite of this section of the book but it was published the day after the lecture was given and does show signs of this. Interestingly, the second edition does not improve some of the theologically weak sections of the book. Nevertheless, Jeans was trying to write a popular book and, from what could be perceived as a riot of metaphors, he does manage to draw the often conflicting metaphors together and convey a message. As with the penultimate chapter, throughout the final chapter the reader may query the use of metaphor, and English language purists will certainly disprove of laying metaphor upon metaphor, but Jeans uses this figure of speech to convey the meaning of complex physics and occasionally the nature of consciousness in a way appropriate for a general readership.

8.6.2 Metaphor in Eddington's Writings

Eddington's use of metaphor is different from that of Jeans. Eddington's are more considered. In the whole of the forty-nine pages of text of *Science and the Unseen World* there are fewer than in either of the last two chapters of *The Mysterious Universe,* just six in number, although counting is again difficult because of definitional difficulties. One of these difficulties is illustrated by his extended metaphor concerning a scientist visiting from another planet who arrives on Armistice Day and wonders if the cessation of sound is comparable to a solar eclipse. This example of an Eddington metaphor is not delivered in the staccato fashion of Jeans' metaphors. It is drawn out over three pages of text and makes the point that while the visiting scientist may think he can trace the physical causes of the silence, he is totally unaware of the significance of the event.[752]

Eddington uses metaphor to good effect in *The Nature of the Physical World.* As in *Science and the Unseen World* the metaphors do not come as often as in Jeans' *The Mysterious Universe* and they appear to be more considered. Take, for example, Chapter XIII of *The Nature of the Physical World,* entitled 'Reality'. It is one of the key chapters where Eddington moves from a description of the current science to setting out his theological and philosophical viewpoint. In twenty pages there are eleven metaphors. The first states that the stuff of the world is mind-stuff, which may not be a metaphor if you are a through-going Idealist. The second and more subtle is 'The symbolic matter and fields of force of present-day theory are more relevant, but they bear to it the same relation that the bursar's accounts bear to the activity of the college.'[753] In the third, after giving a literal description of visual perception and talking of nerves, he uses the metaphor of a central clearing station instead of the mind or brain. This is one of his poorer metaphors. In the next he returns to his conception of the circular nature of the epistemological status of scientific truth claims saying that scientists are like a kitten chasing its own tail and never reaching the world stuff at all. The next metaphor asserts that 'The external world of physics is thus a symposium of the worlds presented to different view-points.'[754] The next metaphor says that atoms have girdles of circulating electrons darting hither and thither. The next occurrence is an unacknowledged allusion to the Shakespearian metaphor of the insubstantial pageant which fades like a dream.[755] Eddington then points out

[752] Eddington, *Unseen World,* 41.
[753] Eddington, *The Nature of the Physical World,* 276.
[754] Eddington, *The Nature of the Physical World,* 284.
[755] Shakespeare, *The Tempest,* Act IV, Scene I.

that the idea of an electron being 'tossed up'[756] to another energy state is a metaphor, not a literal description, and he then goes on to what is possibly another metaphor referring to Lewis Carroll's slithy toves which/who did gyre and gimble in the wabe. The reader does not really know what is happening in Carroll's poem and neither do we when we describe the actions of electrons, for no familiar conception can be woven round the electron and, like Trinculo in The Tempest, says Eddington, we can grasp the tune but not the player.[757]

Another of Eddington's famous and most delightful extended metaphors according to Coulson,[758] is that of the fishing net found in *The Philosophy of Physical Science.*[759] Eddington describes this as an analogy but it is a metaphor within the definitions of Soskice, Ward and Astley.[760] An 'ichthyologist' is exploring the life of the ocean. He casts his net with a two inch mesh into the water and brings up a fish assortment. Surveying his catch, he proceeds in the usual manner of a scientist to systematise what it reveals. He arrives at two generalizations, firstly that no sea-creature is less than two inches long, and secondly that all sea-creatures have gills. To the sceptic who points out that there are creatures smaller than two inches, but the net will not catch them, the ichthyologist replies:

> "Anything uncatchable by my net is *ipso facto* outside the scope of ichthyological knowledge, and it is not part of the kingdom of fishes which has been defined as the theme of ichthyological knowledge. In short, what my net can't catch isn't fish."[761]

Here again we see Eddington, noting the circular nature of scientific knowledge, this time in terms of definition of the scope. He continues to describe the selective nature of scientific study and its limited scope:

> Dropping analogy, if we take observation as the basis of physical science, and insist that its assertions be verifiable by observation, we impose a selective test on the knowledge which is admitted as physical. The selection is subjective, because it depends on the sensory and intellectual equipment which is our means of acquiring observational knowledge. It is to such subjectively-selected knowledge,

[756] Eddington, *The Nature of the Physical World,* 290.
[757] Shakespeare, *The Tempest,* Act III, Scene II quoted in Eddington, *The Nature of the Physical World,* 292.
[758] C A Coulson, *Science and the Idea of God* (Cambridge: Cambridge University Press, 1958), 19.
[759] Eddington, *The Philosophy of Physical Science,* 16-21.
[760] Eddington, *The Philosophy of Physical Science,* 16.
[761] Eddington, *The Philosophy of Physical Science,* 16.

> and to the universe which it is formulated to describe, that the generalisations of physics – the so called laws of nature – apply.[762]

He does not make any apologetic point in the text, which is, as the title implies, on the philosophy of science, but its application is obvious and this analogy or metaphor has been used by Christian preachers and is still found in popular apologetic books or introductory books on science and religion, such as Francis Collins' *The Language of God* or Gillian Straine's *Introducing Science and Religion*.[763] This metaphor is possibly a model according to the definition of McFague – a metaphor with staying power – but not according to the definitions of Barbour or Polkinghorne.

Does the use of metaphors made by Eddington and Jeans reduce to the level of revivalist preachers as Stebbing suggested? Both of them are adept at their use to describe the state of current physics and astronomy. Both use metaphor and illustration to describe astronomical distances; they seldom use personification. While the metaphors are homely, the description of an 'emotional fog' seems unjustified. Eddington's metaphors tend to be more subtle and sometimes much longer than Jeans'. For an example of subtlety, take Eddington's 'The symbolic matter and fields of force of present-day theory are more relevant, but they bear to it the same relation that the bursar's accounts bear to the activity of the college.'[764] This is rich in meaning, to use Ward's term, or suggestive to use Soskice's word. The college bursar's accounts are (or should by law be) an account of the truth, but not the whole truth and, while finance is a key part of any institution, much of the significance of the college's teaching and research is only described in the accounts by the salaries paid to the staff. His metaphor of the fishing net is rich in unpacked meaning, as is the aforementioned Armistice Day metaphor.[765] Jeans' metaphors do come thick and fast and, at some stages of the final chapter of *The Mysterious Universe,* possibly too fast even for a popular book, but, as a whole, the book does work. But the term 'emotional fog' does not apply to the work of either of the writers. Both are attempting firstly to describe the findings of modern science and then to explain the philosophical and theological significance of these ideas. Jeans attempts to do this in a short popular book, Eddington in a longer, semi-popular book. Of necessity metaphor and non-

[762] Eddington, *The Philosophy of Physical Science,* 17.
[763] Francis Collins, *The Language of God: A Scientist Presents Evidence for Belief* (London: Simon & Schuster, 2007), 229; Gillian K Straine, *Introducing Science and Religion: A path through the polemic* (London: SPCK, 2014), 66.
[764] Eddington, *The Nature of the Physical World,* 276.
[765] Eddington, *The Philosophy of Physical Science* 16 and *Unseen World,* 41.

technical language must be employed. Only a small proportion of popular readers would have been deluded enough to think that they fully understood an area of scientific research after reading a popular or semi-popular book on the subject. It is obvious that in an inexact, non-technical presentation of, say quantum mechanics or relativity, the theory is only partially conveyed.

8.7 Clearing Away the Emotional Fog of Stebbing

While there are some things to commend in Stebbing's book, she does appear at times to labour under the impression that there is one 'truth' to be discovered by the work of scientists which can be expressed not only in the language of mathematics but also by the rigorous use of good plain English. Here the influence of G E Moore is obvious. Stebbing is missing the very essence of the chapter 'Reality' from *The Nature of the Physical World,* the chapter selected to illustrate Eddington's use of metaphor. This says that relativity and quantum physics suggest that we do not fully understand the nature of reality, that the physical world is a world of shadows best described by mathematics but very difficult to picture or explain in words. Indeed, it is one of the main arguments of Eddington and Jeans that modern science reveals a world which is not straightforward to describe. The nature of the physical world shown by the current physics is an 'insubstantial pageant' and, as such, metaphor is a way to describe this reality to a popular audience if they cannot understand the mathematics involved.

Stebbing's book was influential both at the time of its publication in 1937 and, as Warnock has stated, with undergraduates in the 1950s, some of whom went on to fill teaching posts in universities and schools in the 1960s. It is an amusing but poorly constructed book with many errors. Stebbing's summary of the central thrust of the message of Eddington and Jeans found at the start of chapter two of her book is a gross misrepresentation of their position and also assumes that they have basically the same message, which they do not. Just as Eddington's and Jeans' Idealism was inadequate so too was Stebbing's analytic philosophy inadequate in its belief that ideas best expressed in mathematics could be expressed in plain English. She did not fully understand the physics involved and she did not understand Eddington's humour.

It is evident that Joad, Stebbing and Inge were accurate in their descriptions of the inadequacies of the use made by Eddington and Jeans of Idealism. It is also clear that Russell, McCabe and Stebbing sometimes confused the ideas of the two and sometimes mispresented

what Eddington and Jeans were saying. McCabe, Stebbing and Joad did not fully understand the physics involved. Inge was remarkably well informed on this topic and obviously Russell had no problems in this area.

The question then remains why their popularity declined and what is their abiding significance. Thus there will now be an assessment of both the influence of Eddington and Jeans in the years between the two World Wars noting their pre-World War II rise and their post-World War II fall in influence. An assessment will be made of their importance as transitional figures in apologetics and the science and religion debate following on from the post-Darwinian controversies of the late Victorian era. The strengths and weaknesses of *The Mysterious Universe* and *The Nature of the Physical World* will be considered. Their continuing legacy for academic theology and popular apologetics will be examined.

CHAPTER NINE

ASSESSING THE LEGACY

9.1 Introduction

The historical significance of the popular and semi-popular Christian apologetic writings of Arthur Eddington and James Jeans has been examined against the theological and scientific contexts of the time. This dissertation has concentrated on three key apologetic texts: *The Nature of the Physical World* of 1928; *Science and the Unseen World* of 1929, both by Eddington, and Jeans' *The Mysterious Universe* of 1930. Other books written by the two physicists have also been considered. This is primarily an historical work but a number of general points have emerged worthy of consideration by writers of popular apologetics. Eddington's *The Philosophy of Physical Science* of 1939 is likewise possibly worthy of reconsideration, but it is largely outside the scope of this historical study of popular apologetic works.

The rise of the influence of Eddington and Jeans will be summarised first, followed by a longer examination of their decline. Their significance as transitional figures in the science and religion debate and as popular apologists will be shown. An analysis of the strengths and weaknesses first of *The Mysterious Universe* and then of *The Nature of the Physical World* will be made. In the last section there will follow an account of Eddington's continuing influence.

9.2 The Rise of Eddington and Jeans

This thesis has demonstrated the significance of the work of Eddington and Jeans in Great Britain in the inter-war years. The reading public bought their books in numbers exceeding those of well-known novelists or bishops. They gave popular radio broadcasts and wrote in and were interviewed by the press on a regular basis. The Church of England as an institution, for example, concerned itself with the debates around the new Prayer Book of 1928, and largely ignored Eddington and Jeans. The pages of *Theology* reflect this. The bishops at the Lambeth Conference of 1930, however, did pay some attention to issues of science including

how recent 'discoveries of the size of the stellar universe have emphasised the apparent insignificance of the planet on which we live.'[766] The public did not ignore Eddington and Jeans. According to Milne they were looking out for 'the next Jeans' almost as much as the next Edgar Wallace.[767]

Eddington and Jeans started the inter-war period as moderately well-known academics, became famous scientific popularisers, and to the end of this period, emerged as the leading popular scientific apologists for Christianity. They were celebrity scientists before the term was coined. They received attention from academic scientists, philosophers and, to a lesser extent, theologians.

It has been seen that the highpoint of their influence as apologists started with the publication of *The Nature of the Physical World* from Eddington in 1928 and Jeans' *The Mysterious Universe* in 1930. It is the contention of this thesis that they would not have been as successful as popular apologists for Christianity if they had not first been popular apologists for science. The reading public knew them as able expositors of modern physics and new scientific concepts. The first phase served two useful purposes for their future careers as popular Christian apologists. It honed their skills, to a certain extent, as writers of popular books and as givers of public lectures – *The Nature of the Physical World, Science and the Unseen World* and *The Mysterious Universe* were all given first as lectures. Secondly, it made their names as writers and led to newspaper articles and radio talks, some of which are preserved as books, for example*, Science & Religion*[768] and *More Points of View.*[769] Their sales figures alone, shown in chapter one, would make their work worthy of a reappraisal for the influence they had on popular theology, but they also influenced both academic theologians and popular apologists as will be demonstrated.

9.3 The Decline of Eddington and Jeans

The idea that Stebbing's book *Philosophy and the Physicists* published in 1937 caused the downfall of Eddington and Jeans is too simplistic. This idea that Stebbing's *Philosophy and the*

[766] Lambeth Conference, *Encyclical Letter from the Bishops with Resolutions and Reports* (London: SPCK, 1930), 70-71.
[767] E A Milne, *Obituary Notices of Fellows of the Royal Society* 5, (Feb 1945), 585.
[768] Julian Huxley, et al, *Science & Religion: A Symposium* (London: Gerald Howe, 1931).
[769] William Temple, et al, *More Points of View: A Second Series of Broadcast Addresses* (London: BBC, 1930) which included Jeans' broadcast talk on human progress and evolution.

Physicists had destroyed the reputations of Eddington and Jeans was not only told to me in the science sixth form, but also hinted at by Mary Warnock,[770] made explicit by Archbishop John Habgood both in writing and again at a Science and Religion Forum conference in Durham in 1999. John Habgood says Stebbing devastatingly exposed the absurdity of Eddington's and Jeans' work.[771] Stebbing's book could indeed easily be cast in the starring role as the major factor in the decline of the influence of Jeans and Eddington. Stebbing's book sold well, it was written by a skilled philosopher who, it could be argued, dismantled their amateurish Idealism and unmasked their philosophical pretensions with rapier wit and the analytic skills of an Elizabeth Anscombe or a Mary Midgley. This is the thrust of Habgood's argument, but that is too simple an analysis for a number of reasons.

Much of what is said in *Philosophy and the Physicists* can be found in Russell's *The Scientific Outlook,* Joad's *Philosophical Aspects of Modern Science* and, to a lesser extent, McCabe's *The Existence of God.* True, it was done in a more accessible form by Stebbing than by Joad, but Russell and McCabe were yet more accessible than Stebbing. There is no correlation between the publishing date, 1937, of *Philosophy and the Physicists* and the decline of the sales of Eddington and Jeans. Many of the ideas that Stebbing popularised, but not all of them, had been in the public domain since the publication of Russell's *The Scientific Outlook* in 1931.

Michael Whitworth attempts an analysis of the decline in their sales and the lack of success of Sullivan's *Science: A new outline* of 1935. While one explanation of Sullivan's poor performance was that he was not as accomplished a writer as either Eddington or Jeans, it does not explain their decline. Whitworth quotes extracts from Richard Hughes, writing in *The Spectator* in April 1935, who said that the intelligent readers 'have already turned elsewhere.'[772] Richard Hughes does not say to where the public had turned but Whitworth writes:

> … given the quickening pace of political events in Europe since 1933, it might have been to politics. The Penguin 'Specials' series of books on political topics which began to appear from 1937 onwards often sold 250,000 copies.[773]

Malcolm Muggeridge in his book *The Thirties* published in 1940 lists some of these:

[770] Warnock, *Women Philosophers,* 93-94.
[771] John Habgood, *Varieties of Unbelief,* 17.
[772] Whitworth, The Clothbound Universe', 75 quoting Richard Hughes, *The Spectator* 12 (April 1935), 62.
[773] Whitworth, The Clothbound Universe', 75.

Nazi Germany Cannot Win, Why Germany Cannot Win, Hitler's Last Year of Power – good titles all.[774]

Whitworth has pointed out that Jeans and Eddington's success with the educated general reader faded as the rise of fascism across Europe had taken the interest of such people from interesting but esoteric questions of the universe and its creation to the hard reality of politics. Muggeridge agrees saying that 'Germany's growing power was the chief preoccupation.'[775]

The rise of fascism was undoubtedly taking the interest of the intelligent non-scientist general reader elsewhere, but Whitworth's article shows that the sales of the Cambridge edition of *The Nature of the Physical World* were at an all-time low in 1939 at 179, and then rose in 1940 to 203 and in 1941 to 238, followed by a large leap to 1,122 copies in 1942 when a cheaper Cambridge edition was produced, followed by another leap to 1,751 copies in 1943. What is the explanation of this post-1939 rise? Possibly that by the time that war was declared on 3 September 1939, the time for books on the possibility of war was over. After the 'phoney war' had ended and the war in earnest began, the closeness of death may have brought a renewed interest in theological topics, including why the universe exists. Clearly this is speculative, but it does attempt to account for the rise in Eddington's and Jeans' sales figures from 1940 onwards, which Whitworth makes no effort to explain.

Another factor to be borne in mind by those who advocate the Habgood position is that, while Stebbing was vituperative, she also paid tribute to Eddington's original thought and the contribution of both Eddington and Jeans to popularising the new science and for helping to expunge the Victorian scientific belief in the simple materialistic 'billiard ball' realism of the physics of the period. The book was not wholly critical, especially about Eddington. Eddington's and Jeans' exposition of the tentative nature of scientific knowledge proved to be more in line with developing thought than Stebbing's views. Stebbing's thought is not always expressed consistently (a sin she finds unforgivable in Eddington and Jeans); she shows a lack of scientific knowledge, a simplistic view on the efficacy of good English to explain mathematical ideas and a naïve Realist approach to the certainty of scientific knowledge.

Other factors can be seen influencing the decline of the influence of Eddington and Jeans. The first of these was age. By 1937 Jeans was 60 and Eddington was 55. This was well past the age

[774] Malcolm Muggeridge, *The Thirties* (London: Hamish Hamilton, 1940), 308.
[775] Muggeridge, *The Thirties,* 290.

at which mathematical physicists are at their best. The life of a populariser after they have finished producing original work in the subject can be limited, especially in an area such as mathematical physics. Jeans had not had a university position since 1912. Eddington was, of course, still Plumian Professor of Astronomy at Cambridge but, according to Clive Kilmister, since he began work in 1933 on the 'obscure' *Relativity Theory of Protons and Electrons,* published in 1936, he had passed a turning point.[776] The great work of the previous decade with the publication of the truly ground-breaking *The Internal Constitution of the Stars* in 1926 was over and Eddington was not the force he once was. Eddington had also long been eclipsed by Paul Dirac who was now seen as the leading mathematical physicist at Cambridge, a position generally viewed as being held until this point by Eddington. Kilmister writes:

> Everything changed, and not only for Eddington, in 1928 when Dirac published his wave equation for the electron, which was consistent with relativity and yet of a different form from any envisaged by the relativists.[777]

In 1928 *The Nature of the Physical World* was published. Dirac's biographer, Farmelo, likewise sees this as a crucial time. Writing of the period April 1928 to March 1929 he says:

> No longer were the two leading lights of the university's experimental and theoretical physics cited as Rutherford and Eddington, but as Rutherford and Dirac. Eddington's star was waning and he knew it.[778]

By the end of 1937, the year of the publication of Stebbing's book, the situation was worse, according to Farmelo. In the sometimes 'gory' seminars in the mathematics department, Eddington was timorous and unable to defend himself against pillory by his younger colleagues.[779]

The sales, but not necessarily the influence, of Eddington and Jeans undoubtedly faded as the 1930s ended but the nature of the decline and the factors behind that decline and subsequent bounce in sales are multi-factorial and more complex than the simplistic suggestion that Stebbing's book caused the process. Whitworth asserts that the very popular nature of the final chapter of *The Mysterious Universe* brought increasing criticism from academic writers over the years after publication.[780] While the previous chapters were welcomed as good

[776] C W Kilmister, *Eddington's Search for a Fundamental Theory,* 187.
[777] C W Kilmister, *Eddington's Search for a Fundamental Theory,* 2.
[778] Graham Farmelo, *The Strangest Man* (London: Faber and Faber, 2009), 157.
[779] Farmelo, *The Strangest Man,* 295.
[780] Whitworth, 'The Clothbound Universe', 64.

popularisation of the new science, the conclusions of 'Into Deep Waters' were seen as poor philosophy. As Jeans' reputation sank, it dragged down that of Eddington. As they rose to prominence together, so they declined together even if their views were not identical.

An undoubted factor in their decline was the fact that academics did not approve of their use of Idealism. While Eddington and Jeans were taken seriously by the press and the radio, their allegiance to philosophical Idealism was viewed with suspicion by academic audiences. The general public did not always spot the Idealism in their work, as McCabe's comment, noted previously, suggests, 'Nobody even reminded the public that these two leading authorities on the material universe and the new interpretation of it did not believe in the objective existence of anything.'[781] This is, of course, an exaggeration. They were not thorough-going Idealists. Many members of the public were not awake to the nuances of Idealism and Realism, but academic philosophers and theologians and to a certain extent scientists, were. The fragility of Eddington's and Jeans' use of philosophical Idealism was an issue for academics. Their lack of academic training in this discipline was obvious. As Stebbing pointed out, Jeans had clearly read Plato and Berkeley but not their critics. His use of the language of Idealism was shallow and amateur. Against this it must be said that Stebbing's use of the language of science was inadequate showing a narrow range of reading and at times naivety. Eddington was, in this aspect at least, no better than Jeans and in his use of Idealism he was undoubtedly inconsistent. Joad, as has been seen, detects five different varieties of Idealism in Eddington's work. Keith Ward's use of Idealism shows that it is still deployed by a minority of serious academic theologians, but neither Eddington nor Jeans had the philosophical training of Ward.

While the influence of Eddington and Jeans declined in the post-war years, they still have a continuing influence as transitional figures in the history of both popular science writing and as popular apologists.

[781] McCabe, *Riddle Today,* 191.

9.4 The Continuing Significance of Eddington and Jeans as Transitional Figures

The use of Idealism by Eddington and Jeans brought down the ire of serious academics, and their popular style of writing did not suit all, but their important role in changing the public understanding of physics and astronomy should not be underestimated. Even those who disagreed with them on much else acknowledged this. Stebbing stresses their important role in popularising the new understanding of physics.[782] McCabe writes, as has already been seen, that 'Eddington is largely responsible for this.'[783]

Joad too agrees on the significance of the writing of Eddington:

> Of the various interpretations of the physical world which have been advanced by modern scientists, none has obtained a wider currency than that put forward by Professor Eddington.[784]

While Eddington made outstanding contributions to astronomy and the acceptance of relativity, the significance of Eddington and Jeans to the development of quantum theory was not as important as that of Bohr, Schrödinger, Heisenberg, etc, but they made three notable contributions in the inter-war years and beyond.

First, they introduced the general public to quantum theory. They not only 'discredited' the physics of the previous century but helped the reading public understand the complexity of the new physics. They were iconic figures for part of the middle of the twentieth century on the way science and religion should engage. They used their understanding of the universe as then portrayed to deliver a popular message to non-academic readers not just through their books but aided by the mass circulation press and the wireless.

Secondly, they modelled a different form of the engagement between science and religion. John Hedley Brooke has rightly pointed out the complexity of the relationship between science and religion, 'There is no such thing as *the* relationship between science and religion.'[785] This complex relationship is illustrated in the contrast between two periods of the second half of the nineteenth century on the one hand and the first half of the twentieth

[782] Stebbing, *Philosophy and the Physicists*, 6.
[783] McCabe, *The Existence of God*, 143.
[784] Joad, *Philosophical Aspects,* 19.
[785] Brooke, *Science and Religion: Some Historical Perspectives,* 321.

century on the other. The major area of discussion between scientists and theologians in the late nineteenth century had centred on biology. The popular accounts of this discussion emphasised the conflict between the two areas of study, personified sometimes in schoolboy essays as 'Bishop Samuel Wilberforce versus Scientist T H Huxley', as at the Oxford debate of 1860. The popularity of Eddington and Jeans from the late 1920s helped to shift the popular debate from one mainly focused on evolutionary biology to one which included the new physics and astronomy as well. The fact that both of them were scientists and laymen rather than clerics also tended to emphasise a more co-operative view in the public mind. This might conceivably have helped some realise that when one scientist debated with another from different positions on the issue of the nature of the physical world, for example, Eddington with Russell, that a simple conflict model was not adequate to describe the science and religion debate. Nevertheless, *The Times* of 8 November 1919 managed to keep alive the conflict model of scientific development with its headline 'Einstein v Newton' and was typical of press reaction in the inter-war years.[786]

Finally, they gave an alternative path for Christians to follow that did not involve six-day creationism. An interesting question in modern church history is why so many Christians in America hold to one of the Creationist or Intelligent Design understandings of the origin of the world while so many of the Christians in Great Britain in many of the same denominations and of a similar theological stance otherwise do not. In *Galileo Goes to Jail,* Ronald L Numbers gives figures of support for evolution or creation in Great Britain.[787] Numbers' contention is that Creationism or Intelligent Design theories are not uniquely American. Numbers quotes a BBC survey from January 2006 in which 48% of Britons believed that the theory of evolution best described their view on the origins and development of life, 22% said that 'creationism' best described their views and 17% favoured 'intelligent design' with 13% undecided. He does not give any breakdown by religious affiliation. In his lengthy *The Creationists,* Numbers gives figures for America.[788] In 2005 a Gallup poll found that 53% of Americans affirmed that 'God created human beings in their present form exactly the way the Bible describes it' and 65.5% affirmed that 'creationism' is definitely or probably true.[789]

[786] Stanley, *Practical Mystic,* 114.
[787] Ronald L Numbers, 'That Creationism is a Uniquely American Phenomenon' in Ronald L Numbers (ed.), *Galileo Goes to Jail: And Other Myths About Science and Religion* (Cambridge Massachusetts: Harvard University Press, 2009), 218-219.
[788] Ronald L Numbers, *Creationism: From Scientific Creationism to Intelligent Design,* (Cambridge Massachusetts: Harvard University Press, 2nd ed. 2006).
[789] Numbers, *Creationism,* 1. See also chapter eight of this book on 'Evangelicals and Evolution in Great Britain'.

The influence of Eddington and Jeans on the popular theology of the man-and-woman-in-the-pew was such a significant factor in the inter-war years that it helped shaped the British perspective of the different approaches to creation seen on either side of the Atlantic. These differences persist to this day. Their popularity as authors, demonstrated by Whitlock, along with their exposure in the written press and the wireless, gave them an opinion-shaping impact.[790]

9.5 The Strengths and Weaknesses of *The Mysterious Universe*

Both Eddington and Jeans explained the changes in the physics of the twentieth century and how the new physics was not inimical to Christian faith as the physics of the nineteenth century had been construed to be; but after that their approach was different. Jeans relied on a revised, mathematical form of the design argument. Eddington looked to intuition, for him the study of nature could lead to a vague pantheism but the colour of Christianity must be provided by the Inner Light, by religious experience. Neither all of their critics nor all of their supporters spotted this basic difference.

Jeans was five years older than Eddington and in many ways Jeans' use of even a modified mathematical version of the design argument represented a more nineteenth century approach to theology while Eddington was more in line with modern developing thought. Chadwick writes:

> Paley's argument from design became irrelevant to any late Victorian theology that mattered. The first shadow of the knowledge of God seemed to lie in the heart or the conscience, not in nature; and only after God was apprehended through feeling or through moral judgment did nature become evidently sacramental of his being.[791]

Stebbing considers Jeans in the second chapter of *Philosophy and the Physicists* and largely dismisses him as a serious writer. She notes that there is a greater subtlety in the argument of Eddington than in Jeans. In this she is accurate. But like Eddington, Jeans acknowledges that what science is suggesting in the 1930s could be seen to be wrong by later developments.

[790] Michael H Whitlock, 'The Clothbound Universe', 53-82.
[791] Owen Chadwick, *The Victorian Church: Part II,* 30-31.

Eddington's work is more substantial than Jeans and the reader of *The Mysterious Universe* will often ask him or herself what Jeans actually means while reading the book. *The Nature of the Physical World* is based upon the more substantial Gifford Lectures series and the book shows depth, being semi-popular in nature and at times considerably more difficult and technical than that. *The Mysterious Universe* is a popular book based on one lecture at Cambridge.

What are the strengths of Jeans? The first and most obvious is that he was accessible. *The Mysterious Universe* was more widely read than *The Nature of the Physical World* of Eddington, because it was an easier read and cheaper, selling at five shillings rather than the twelve shillings and sixpence of *The Nature of the Physical World*. What *The Mysterious Universe* lacked in subtlety of theological approach, it made up for by accessibility. *The Mysterious Universe* was undoubtedly a gateway for some to further study of the borderline issues between science and theology, but it did not provide much depth in itself and this lack of depth sometimes led to ambiguity as shall be shortly seen. Jeans' Christianity is a rather general public school form of Anglicanism without much of a theological anchor, while Eddington's book is deeply embedded in his Quaker understanding of Christianity. There is a lack of theological depth in the writing of Jeans.

This thesis has demonstrated that, while accessible, *The Mysterious Universe* has the merit that it recognises the limits of normal speech to explain both the 'mysterious' universe as shown by modern physics and astronomy and any reality which lies behind it. Jeans argues that the world displayed by the new physical science is less 'concrete' than Victorian science and more 'shadowy'. He does not present an over-simplified account of modern science and then attempt to prove the existence of God. While it is not as deep or as extensive as *The Nature of the Physical World* there is a developing argument, perhaps not the most refined, towards a view for a designing, mathematician God.

Jeans' written style is different from Eddington's and more straightforward. This is a merit. He does not use terms such as 'mystical' and 'spiritual' in phrases which the common reader will misunderstand. Likewise, we do not find Jeans rejecting the idea of an expanding universe in *The Mysterious Universe* as Eddington does in *The Nature of the Physical World,*[792] but the lectures on which *The Mysterious Universe* were based were delivered fully three and a half years after Eddington's Gifford Lectures and Jeans was aware of developing thought on the

[792] Eddington, *Nature of the Physical World,* 84-85.

expanding universe. Jeans is awake to the criticism of anthropomorphism but argues consistently that there is evidence in the then current understanding of science for a designing, mathematical Deity. He makes no claim for finality, but states that, as a professional scientist, he believed that the current understanding of the universe points to the possibility of a traditional understanding of a Creator God and also to the death of the physical universe.

Jeans' use of spatial metaphors was vividly descriptive. He could convey the size of the universe or the structure of an atom or the scarcity of matter in the whole creation with a telling illustration, for example, the aforementioned six specks of dust within the vastness of Waterloo Station represent the spread of stars in space.[793] But sometimes, most notably in the last chapter of *The Mysterious Universe,* his general metaphors come so thick and fast that they convey little solid information and leave some readers with more questions than answers. The text is not long, but it does makes a good, reasoned case for the proposition that the physics of the early twentieth century is radically different from the physics of the late Victorian era.

While there is a clear and developing argument towards the view of the existence of a designing, mathematician God, the argument is not as detailed as it might be. Jeans asserts the thesis rather than makes a case for his position at some points. For those who are happy to accept his argument because he was a leading scientist, this may matter little, but, again, some readers will lament the lack of substance in his writing. The second edition of *The Mysterious Universe* does little to improve this.[794] Jeans' argument from mathematical order evident in the creation as seen by modern science to a designing Deity, suffers from the normal weakness of 'design arguments'. Namely, all that it can really say is that the type of universe that we can see is shaped in such a way as to give life in the types and forms that we observe. The conditions necessary for there to be observers make what is observed appear to be the product of design. This obviously does not take the argument very far. It does not prove the existence of a designing, let alone a mathematical Deity. The universe we observe is consonant with the existence of God, but it in no sense gives us conclusive evidence of God's existence. Other explanatory alternatives are available, such as 'chance', but that term, as does the term 'God', requires careful analysis.

[793] James Jeans, *The Universe Around Us,* 106.
[794] James Jeans, *The Mysterious Universe* (Cambridge: Cambridge University Press, 2nd ed. 1931).

As has been seen, both Hoyle and Inge took support from Jeans. For Inge, the death of the physical universe was proof against pantheism. For Hoyle, *The Mysterious Universe* may well have eased his path towards pantheism. The brevity of *The Mysterious Universe* means that it is capable of such multiple and even diametrically opposed interpretations. For the historian A J P Taylor, Jeans (and Eddington) supplied, as has been seen, 'unrevealed religion and ... a vague religiosity'.[795] Adrian Hastings in his history of modern English Christianity sees Jeans in a similar light.[796] Teilhard de Chardin describes him as an agnostic.[797] He is best understood as re-asserting a traditional, but non-Creationist, understanding of the creation and end of universe based upon a renewed design argument. This is how the American atheist writer Woolsey Teller, author of *The Atheism of Astronomy,* viewed him along with Russell and McCabe.[798] Inge also views Jeans thus, but in contrast to Teller, approves of Jeans' traditional understanding of the creation and Eschaton.[799] Jeans' statement, 'The whole of the creation of the universe could be summoned up in the phrase "Let there be light" 'might be read as a conservative restatement of a traditional view of a Creator God.[800] Even more so might the following passage from *Eos,* possibly with the exception of 'or times':

> Everything points with overwhelming force to a definite event, or series of events, of creation at some time or times, not infinitely remote. The Universe cannot have originated by chance out of its present ingredients, [801]

The Mysterious Universe and *The Universe Around Us* are very readable books without too many technical terms, too much mathematics or too many difficult concepts. Jeans' works introduce complex ideas in an understandable way and were for many, such as Hugh Montefiore, the first introduction to cosmology and its implications.[802] *The Mysterious Universe* was by no means a piece of serious theology. Compared with *The Nature of the Physical World*, *The Mysterious Universe* is a nut with a very small kernel, to paraphrase Hoyle, but Jeans' accessible style and his use of simple metaphors makes him worthy of reappraisal as a successful popular writer on science and religion issues.

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[795] Taylor, *English History 1914-1945,* 169.
[796] Adrian Hastings, *A History of English Christianity,* 229.
[797] Pierre Teilhard de Chardin, *The Future of Man,* (London: Collins, 1960), 212.
[798] Kragh, *Matter and Spirit in the Universe,* 99-100 referring to Woolsey Teller, *The Atheism of Astronomy* (New York: The Truth Seeker, 1938) no page given.
[799] Inge, *God and the Astronomers,* 43.
[800] Jeans, *The Mysterious Universe,* 78.
[801] Jeans, *Eos,* 55.
[802] Hugh Montefiore, *The Probability of God* (London: SCM, 1985), 43.

9.6 The Success of *The Nature of the Physical World*

Eddington's essay, 'The Domain of Physical Science' is significant as Whitworth[803] and Joad[804] argue explicitly and the whole volume was important as Roy Hattersley's reference to it, and to only one other volume of theology within his history of the inter-war years, implies.[805] Eddington's essay is nevertheless only just over twenty-nine pages long and the substance of it is repeated in chapter twelve of *The Nature of the Physical World. Science and the Unseen World* is too brief and not as well thought through or professionally finished, with typographical errors and leaps in arguments. While it is interesting as it was written for a Quaker audience, it shows distinct signs of being produced in a hurry.

The Nature of the Physical World is very well researched and written. It shows all the signs of being properly prepared, as befits a Gifford Lecture book. It is pedagogically successful in that it conveys information in a developing argument and it is nuanced and does not pretend to finality of knowledge. It is the contention of this thesis that this book is a significant volume in the interaction between theology and science and worthy of a reappraisal by theologians and scientists as Neil Spurway has recently suggested.[806] Spurway sees it as a book ahead of its time. He compares *The Nature of the Physical World* favourably with the neurophysiologist Charles Sherrington's Gifford Lectures of 1940, published as *Man on His Nature* on the question of mind-brain interaction. Spurway is not concerned with Eddington's use of the term 'mysticism', in fact, he welcomes it:

> And if, as a Quaker, he was disinclined to be expressly theological, he was warmly at ease with mysticism.[807]

Major theologians of the time generally did not give lengthy attention to Eddington and Jeans, Inge being a significant exception. Other theologians would quote or reference them briefly as they discussed the doctrine of Creation, for example Canon Bezzant, Fellow of Exeter College and later Chancellor of Liverpool Cathedral, in the William Belden Nobel Lectures of 1937.[808]

[803] Whitworth, 'The Clothbound Universe', 62.
[804] Joad, *Philosophical Aspects of Modern Science,* 23.
[805] Roy Hattersley, *Borrowed Time,* 199.
[806] Neil Spurway, 'A Book That Made a Difference' *Reviews in Science and Religion* 59, (May 2012), 7 – 14.
[807] Neil Spurway, 'A Book That Made a Difference', 13.
[808] J S Bezzant, *Aspects of Belief: The William Belden Nobel Lectures of 1937* (London: Nisbet, 1937), 68.

B H Streeter in his influential *Reality* of 1926 quoted, 'The Domain of Physical Science' with evident approval.[809] Bishop Barnes referenced Eddington and Jeans frequently.[810] Popular writers on Christianity often quoted or referenced both, for example F C Bryan's *The New Knowledge and the Old Gospel.*[811] This contains eight references to Eddington in seventy-six small pages in a straightforward book designed for 'the ordinary folk in our churches.'[812]

The journal *Theology* paid a little attention to Eddington with one article devoted to him, 'The Revolution in Modern Science'. This was written by Arnold Lunn, a Christian apologist who made the journey from Methodism to Catholicism, converting in 1933. The article was published in 1930 and gives warm, if not over-scholarly support, to *The Nature of the Physical World,* comparing its impact to *The Origin of Species.*[813] The Editor, Dr E G Selwyn, in 1928 a Hampshire Rector and by January 1931 Dean of Winchester, made occasional, more scholarly references to Eddington in the journal, as did the Anglo Catholic scholar E L Mascall.[814] An article in the September 1930 edition of *Theology,* 'Physics and the Modernist: "What is Truth"' by Arthur John Hubbard made favourable reference to both Eddington and Jeans, [815] as does the misleadingly titled 'The House that Jeans Built' by E C Mortimer.[816] This paper, originally 'read to the South Molton Ruridecanal Chapter' ranges widely over current issues in theology and physics, lacking theme, clarity or conclusion.[817]

Eddington was not a professional theologian. The strength and depth of Eddington's Quaker theology and of Quaker theology in general has become apparent in the writing of this thesis. The Quaker emphasis on personal experience along with an acknowledgement 'of the delusional potential of the inward Light' can be regarded as a strength which balances the minister or priest-led approach that can lead to a leader-dependency culture in other Protestant churches and within Catholicism as well.[818] The Society of Friends engagement with moral and political issues which blossomed from 1820 onwards has given it an impact beyond what its numerical strength would suggest on such areas as factory and penal reform. Another strength of Quakerism is one which goes back to George Fox in 1656, who in a letter

[809] B H Streeter, *Reality: A New Correlation of Science and Religion* (London: Macmillan, 1926), 29.
[810] E W Barnes, *Scientific Theory and Religion* (Cambridge: Cambridge University Press, 1933).
[811] F C Bryan, *The New Knowledge and the Old Gospel* (London: Kingsgate Press, nd circa 1930).
[812] F C Bryan, *The New Knowledge and the Old Gospel*, 10.
[813] Arnold Lunn, 'The Revolution in Modern Science', *Theology* XXI*,* (November 1930), 259-264.
[814] E L Mascall, 'The Divine Logos and the Universe', *Theology* XXI*,* (September 1930), 146-151.
[815] Arthur John Hubbard, 'Physics and the Modernist: "What is Truth" *Theology* XXI*,* (September 1930), 138-146.
[816] E C Mortimer, 'The House that Jeans Built' *Theology* XXI*,* (November 1930), 250-259,
[817] Mortimer, 'The House that Jeans Built', 250.
[818] Pink Dandelion, *An Introduction to Quakerism* (Cambridge: Cambridge University Press, 2007), 184.

acknowledged 'that of God in everyone'. This approach to the acknowledged spirituality of others has often, but not always, made them open to dialogue with other denominations and other faiths.[819] While these topics are outside the scope of this thesis, there is a coherence in the Quaker approach, an approach of constructive engagement with science, with political and moral issues and dialogue with those of other theological stances. This is clearly not unique to Quakerism but it is deeply imbedded in Quaker thought.

Eddington's written work was well constructed, lucid and it contained irony, humour and relevant quotations from English literature and the classics which engaged his readers. His use of metaphor was more skilled than Jeans', he was more restrained in their use; they never come in a rush as they do in the final chapter of *The Mysterious Universe,* and they are generally better thought through. His intellectual honesty in not overstating the case for his theological beliefs and his repeated assertion of the tentative nature of science are both strengths.

Stebbing wrote, as has been seen, that 'Contemporary physicists are apt to suffer from the same defect - a too hasty passage from physics to metaphysics.'[820] While there is truth in this, Eddington was aware that he was venturing into an area in which his own lack of expertise could land him in trouble.[821] But clearly physics then and now has theological and philosophical implications and he was surely right to engage in dialogue even if he was concerned about 'expert philosophical critics'.[822] This criticism from philosophers included comments on his usage of the terms 'mysticism' and 'spiritual' in connection with the study of the natural world. His use of these terms was rooted in the Quaker tradition rather than in the aesthetic tradition, of, for example, the Desert Fathers. For Eddington, mysticism is the normal religious experience of believers and not just Christian believers. Bowler sums this up well:

> Knowledge of God must still come from personal experience – mystical experience, perhaps, but in a more everyday sense than the ecstasies of the great religious mystics.[823]

[819] 'God' Hugh S Pyper in Abbott, Margery Post *et al., The A to Z of the Friends* (Maryland: Scarecrow Press, 2006), 121.
[820] Stebbing, *Philosophy and The Physicists,* 266.
[821] Eddington, *Nature of the Physical World,* viii. Jeans realised this too, see *The Mysterious Universe,* vii and viii.
[822] Eddington, *Nature of the Physical World,* viii.
[823] Bowler, *Reconciling Science and Religion,* 108.

He makes a strong case for intuition in science and this approach has its roots in the Quaker emphasis on the Inner Light and seeking. An intuition-influenced approach generally worked for Eddington as a route to advance in scientific knowledge, but not always.

Eddington defends the complementarity doctrine without using this term. To those who feel that the language of theology or poetry is too fanciful, he points out that certain ideas about the physical world, for example solidity, are projected by the mind on to the external world.[824] He also reminds his readers that pure mathematicians are not always convinced by what passes for proof in physics.

Eddington was an original thinker. He was not just a populariser. This is shown in his ideas on intuition as well as his work on the internal constitution of the stars. The judgements he makes on the significance of developments are individual and not always the received view.[825] Even though his use of Idealism was poor, his statement that, '… mind is the first and most direct thing in our experience; all else is remote inference' was a point worth making after the simplistic materialism of much Victorian science, as Eddington's approach emphasised the role human perception played in all cognition, including our understanding of the natural world.[826] The criticism of Stanley Jaki that Eddington's approach amounted to solipsism is an exaggeration of the nuanced position of Eddington.[827] Jaki jumps to a conclusion in a way similar to the student who has not read the whole of a book. Jaki says Eddington was the third physicist Gifford Lecturer who 'preferred to remain silent about God'.[828] Eddington was not silent about God; merely understated.

Eddington is generally understated and this is one of his strengths. He does not say in *The Nature of the Physical World* that the new physics shows that Christian belief is in any way beyond refutation true: 'I repudiate the idea of proving the distinctive beliefs of religion either from the data of physical science or by the methods of physical science.'[829] Critics in the early twentieth century were, like Jaki, often inaccurate in the comments about him. This was true of Stebbing, McCabe and Russell. Joad was scrupulously fair, as was Inge, who opposed him on Idealism but supported his views on the eschatology of the physical universe for his own theological reasons.

[824] Eddington, *Nature of the Physical World,* 318.
[825] Eddington, *Nature of the Physical World,* 1.
[826] Eddington, *Unseen World,* 24.
[827] Stanley L Jaki, *Lord Gifford and His Lectures* (Edinburgh, Scottish Academic Press, 1995), 25.
[828] Jaki, *Lord Gifford and His Lectures,* 25.
[829] Eddington, *Nature of the Physical World,* 333.

Eddington does not fall into the trap of presenting a simplistic account of the theological or philosophical implications of modern science; nor does he attempt to give a too certain conclusion, but he does make a good case that the science of the time holds no terrors for those who are aware of the Inner Light and religious experience. Inge said that 'The form of Christian apologetic must be determined by the prevalent ideas and the pressing needs of the time.'[830] Eddington was fully aware of the prevalent ideas of the time concerning the nature of the physical world and saw the pressing need to move away from the over-simple, outdated Victorian materialism. His rooting in Quaker theology gave his work depth. Eddington was a modest, cautious, thoughtful and successful popular apologist.

9.7 The Legacy of Eddington to Academic Theology

The legacy influence of Jeans on academic theology is not as great as that of Eddington. He was read by people such as Montefiore as an introduction to the area of astronomy and theology but references to him post war in serious theology are very rare.[831] Eddington's significance was greater.

One of the key figures of British Protestant theology in the twentieth century was Thomas Torrance, a leading but not uncritical champion of Karl Barth. On the relationship between theology and the natural sciences, Thomas Torrance had quite a different view from that of Barth, 'my old teacher'.[832] Alister McGrath, Thomas Torrance's biographer, says that in effect Barth treats Christian theology and the natural sciences as non-interactive disciplines, each with their own respective fields of competence.[833] This is close to the position of Stephen Jay Gould who talks of 'non-overlapping magisteria'.[834] McGrath asserts that Torrance saw Barth's failure to engage with the natural sciences as 'perhaps' his most serious weakness.[835]

Torrance's first venture into this field was the lecture series he gave at Auburn Theological Seminary in New York State in 1938 and 1939. These were unpublished but McGrath has

[830] Inge, *God and the Astronomers,* 15.
[831] Hugh Montefiore, *The Probability of God,* 43.
[832] Thomas F Torrance, *Space, Time and Resurrection* (Edinburgh: Handsel Press, 1976), xi.
[833] Alister E McGrath, *T F Torrance: An Intellectual Biography* (Edinburgh, T & T Clark, 1999), 196.
[834] Stephen Jay Gould, *Rock of Ages: Science and Religion in the Fullness of Life* (New York: Ballantine, 1999) see also Richard Dawkins *The God Delusion* (London: Bantam, 2006), 77-85.
[835] McGrath, *T F Torrance,* 198.

studied the typescript of these lectures entitled 'Science and Theology'. These lectures were, he says, 'generously spiced' with references to Arthur Eddington.[836] Eddington's influence was still at its height, in isolationist America, thousands of miles away from the evolving events in Europe. Cleary Torrance, a Scot born in China, still saw value in Eddington's work. His next major venture into the area of science and religion did not occur until The Hewitt Lectures of 1959. His theme was the nature of theology and the scientific method. It was published in 1969 after revisions, expansions and spin-off books such as *Theological Science.* This book considers apologetic matters in the light of 'the philosophy of the science of God, a discipline which the theologian must undertake if he is really to do his or her job.'[837] In this he draws on Eddington's *The Philosophy of Physical Science* of 1939 with obvious approval making numerous references to the book. He writes:

> … A. Eddington, M. Polanyi and von Weizsäcker in their different ways have shown how the personal factor inevitably enters into scientific knowledge for the very fact of our knowing explicitly enters into what we know. It is therefore unscientific to pretend that the subjective element is eliminated when it cannot be.[838]

The personal nature of scientific and theological knowledge is a major theme which Torrance acquired from Eddington the Quaker and this was reinforced by Michael Polanyi and others. Eddington was clearly a major influence on Torrance. The titles of Torrance's later books *Space, Time and Incarnation*[839]and *Space, Time and Resurrection*[840] are obviously a nod in the direction of Eddington's *Space Time and Gravitation.*

Eric Mascall took a First in Mathematics at Pembroke College, Cambridge. After an unsuccessful time teaching the subject in a secondary school he went to Ely Theological College and was ordained in 1933. He obtained doctorates in theology from Oxford and Cambridge. He was a traditional Anglo-Catholic and distinctly Thomist in his theology. After a curacy in south London and a time at St Margaret's Westminster, he was Sub-Warden at Lincoln Theological College from where he moved to Christ Church Oxford. He was Professor of Historical Theology at King's College, London from 1962 to 1973. As a school boy he had

[836] McGrath, *T F Torrance,* 204.
[837] Torrance, *Theological Science,* iv.
[838] F Torrance, *Theological Science,* 93.
[839] Thomas F Torrance, *Space, Time and Incarnation* (London: Oxford University Press, 1969).
[840] Thomas F Torrance, *Space, Time and Resurrection* (Edinburgh: Handsel Press, 1977).

'devoured' Eddington's *Space Time and Gravitation.*[841] As an undergraduate at Cambridge from 1924 to 1928 he came into contact with Eddington through a mathematical society.

One of Mascall's best-known books is *He Who Is.*[842] This title is a reference to one of St Thomas Aquinas' names for God. Here Mascall re-examines some of the key issues in natural theology as set forth by Aquinas in the light of modern science. In this volume he makes six references to Eddington, all but one of which are positive. As with many theologians, it is while he discusses the Creation that he refers to Eddington.[843] Here he argues against Newton on the nature of time:

> We agree, in contrast, with St Augustine, St Thomas and the Relativity Physicists, that time is impossible except in connection with the things that exist in it.[844]

Mascall's footnote reference is to Eddington's *The Nature of the Physical World.* Mascall finds Eddington understated, but his mode of expression is more balanced than Jaki, saying that scientists of the nineteenth century tended to claim for science 'far too high a status of insight into objective reality; their present day successors often go to the other extreme.'[845]

John Macquarrie wrote in Mascall's obituary that his book on science and religion, his Bampton Lectures of 1956, *Christian Theology and Natural Science,* was regarded by many as the best book on the subject in English at the time of its publication in 1956.[846] While this can be dismissed as an obituary compliment which should not be taken seriously, the book displays a sharpness of mind, a breadth of range and a great depth of reading. The book contains more references to Eddington than any other scientist or mathematician, twenty-three in total. The next most cited is E T Whitaker, editor of Eddington's *Fundamental Theory*. Only St Thomas Aquinas has more references than Eddington at thirty references. Jeans has four references to his work, three of which are critical.

Mascall sees Eddington's *The Nature of the Physical World* as containing 'brilliant popular expositions'. He mentions in particular 'the vivid picture of matter as being nothing but a pucker in space time' found in chapter six.[847] He defends 'Eddington's two tables, which

[841] E L Mascall, *Saraband: The Memoirs of E L Mascall* (Leominster, Gracewing, 1992), 67.
[842] E L Mascall, *He Who Is* (London: Longmans, 1943).
[843] Mascall, *He Who Is,* 99.
[844] Mascall, *He Who Is,* 100.
[845] Mascall, *He Who Is,* 124.
[846] *The Independent* Wednesday 17 February 1993
http://www.independent.co.uk/news/people/obituary-canon-e-l-mascall-1473551.html
[847] E L Mascall, *Christian Theology and Natural Science* (London: Longmans, Green and Co, 1956), 59.

Professor Susan Stebbing castigated so drastically, and perhaps not entirely fairly in her book *Philosophy and the Physicists'.* He says that Eddington wrote *The Nature of the Physical World* with 'conscious humour'.[848]

Mascall, however, sees Eddington as more than just a good populariser. Mascall acknowledges his role as an astronomer; a view which he suggests is widely held.[849] Mascall spends a large part of chapter three of *Christian Theology and Natural Science* contrasting the epistemological ideas of Eddington and Milne. He starts with the selective subjectivism outlined in chapter eleven of *The Nature of the Physical World* but most fully explained in *The Philosophy of Physical Science* and introduced by the metaphor of the fishing net. Mascall asserts that for Eddington all the characteristics which we believe we discover about the universe are in fact 'manufactured by ourselves in the acts by which we observe it.'[850] This is slightly to overstate Eddington's position in *the Nature of the Physical World.* Eddington saw the scientist's choice of method of observing the universe as influencing what is found and what is missed. Mascall sees Eddington's position as influenced by Kant as others have done.

For Mascall, Eddington is a scientist whose work in astronomy is outstanding. He thinks that Eddington is not just a populariser but a serious thinker. Mascall quotes Chapman to good effect on *Fundamental Theory:*

> As Professor S. Chapman has remarked, "whereas Eddington was regarded among astronomers throughout the world with immense admiration and respect, his work on 'fundamental theory' brought him obloquy, scoffing and suspicion from the theoretical physicists."[851]

This quotation illustrates another finding of this thesis, namely that writing a speculative final book will not always enhance your academic reputation. This is not a trivial or flippant point. If *Relativity Theory of Protons and Electrons* had not been published in 1936 and, even more so, *Fundamental Theory* in 1946, Eddington's post-war reputation would have undoubtedly been much higher. Those who see past Eddington's last two books to *The Internal Constitution of the Stars* will have a higher opinion of him as an a academic scientist as will those who read *The Expanding Universe* will see his strength as a populariser of science. In the same way,

[848] Mascall, *Christian Theology and Natural Science,* 48.
[849] Mascall, *Christian Theology and Natural Science,* 109.
[850] Mascall, *Christian Theology and Natural Science,* 110.
[851] Mascall, *Christian Theology and Natural Science,* 109 citing G J Whitrow, *The Structure of the Universe* (London, Hutchinson, 1949), 96.

those who see past Eddington's last two books to *The Nature of the Physical World* will have a high view of him as a semi-popular writer of apologetic theology.

CHAPTER TEN

CONCLUSIONS

10.1 Introduction

In this chapter two lessons learned in writing this thesis, slightly at a tangent from the main thrust, will be described. This will be followed by a description of the influence of Eddington and Jeans on two later apologists. A description of their continuing influence on and significance for popular apologetics will be given. The chapter will conclude with a summary of the central thesis.

10.2 The Importance of General Cultural Trends

This thesis has demonstrated the interconnectedness of theology with current culture and the significance of important developments in technology in conveying an apologetic or theological message. This gave Eddington and Jeans an opportunity to reach a wider audience than Asa Gray, for example, had in his time. Eddington and Jeans were not alone in mastering the use of radio as a means of communicating a religious message. Since the inception of the British Broadcasting Company in 1922,[853] clergy such as Dick Sheppard of St Martin's-in-the-Fields and W H Elliot of St Michael's, Chester Square in London, had secured committed 'congregations' for the broadcasts from their churches.[854] Archbishop Randall Davidson acknowledged radio's power and influence as early as 1926.[855] Eddington and Jeans were adept at the new medium and this further enhanced their influence and increased their readership. The broadcast media and the printed press were playing a larger role in the shaping of public opinion and their contribution was significant. The church or chapel had somewhat lost their position as one of the premier shapers of public opinion and Eddington

[853] Andrew Marr, *The Making of Modern Britain: From Queen Victoria to VE Day* (London, Pan, 2010), 270.
[854] Gardiner, *The Thirties,* 510.
[855] Marr, T*he Making of Modern Britain,* 274.

and Jeans had become masters of the new formers of public opinion: the newspaper article (along with Dean Inge); the newspaper interview; the popular book and the wireless.[856]

The importance of general cultural trends is further illustrated by the size of their book sales, huge numbers compared with Darwin's both seminal and very readable *The Origin of Species.* There was now a bigger market for popular and semi-popular books amongst a growing middle class and a now literate working class following the Education Act of 1870. With their books Eddington and Jeans and their main publisher, Cambridge University Press, tapped into the growing demand for accessible non-fiction.[857] The unemployment which marred the inter-war years meant that many people had time for reading and visiting the new free libraries to satisfy the demand. Gardiner records the account of one former army officer who 'joined the public library and read numerous books. I read no fiction at all, but turned my attention to many other subjects, astronomy, physics, economics, history…'[858]

It has become clear in the writing of this thesis that the Second World War was a significant watershed for theology as was the First. Books on Karl Barth and neo-orthodoxy stress the importance of the First World War on the shaping of early twentieth century European theology and the challenge to theological liberalism that the war presented. The Second World War likewise changed the culture of Great Britain profoundly. Philip Jenkins in a recent book has argued that the effect of The Great War was more significant in the changes it brought to the popular expression of not just Christianity but also Judaism and Islam.[859] This is an interesting thesis. For Eddington and Jeans undoubtedly the Second World War was a significant watershed in the progress of their influence.

The significance of general cultural trends for theology, not just those in 'high culture' such as trends in philosophy and science, is easily neglected. Theology has for a long time understood the importance of philosophical changes, particularly on systematic theology. Those theologians, church and general historians who have an interest in the science and religion debate have long understood the importance of developments in science on how Christian belief is expressed, but in the science and religion debate the importance of the general historical and cultural context and the march of political events are sometimes ignored. Just as the rise of Eddington and Jeans was aided by the cultural context of the 1920s and 1930s their decline was influenced by political events across Europe in the late thirties and the bounce of

[856] On Inge Taylor, *English History 1914-1945,* 235.
[857] Taylor, *English History 1914-1945,* 179.
[858] Gardiner, *The Thirties,* 134.
[859] Philip Jenkins, *The Great and Holy War* (Oxford: Lion Hudson, 2014), 368, 377.

the sales from 1940 onwards by the military events that followed. Theology is written and discussed in a cultural context. It does not take place in a cultural vacuum and general culture can be as significant as high culture. This conclusion resonates with David Livingstone's *Dealing with Darwin* where he fully demonstrates 'the salience of *place* and *politics* in religious engagements with scientific claims.'[860]

10.3 The Strength of *God and the Astronomers*

As a theology undergraduate, the picture of Dean Inge of St Paul's that was both given and absorbed was that of 'the gloomy Dean'. He was dismissed as a grumpy, anti-working class eugenicist, and a throw-back to a previous age. This viewpoint has been reaffirmed in a recent popular group biography of four early twentieth 'eccentrics', *The Last Victorians,* and in Trevor Beeson's study of Anglican Deans.[861] There is undoubtedly some truth in this picture, but this is not the whole of the story.

In the writing of this thesis the strength of *God and the Astronomers*, published, it should be noted, when Inge was 73, have become apparent. Inge clearly has a better grasp of the physics than Stebbing or Joad. Inge has read widely in physics and astronomy beyond Jeans and Eddington and digested it well. He brings his knowledge of theology, classics and philosophy to bear upon the science. The popular image of Inge as an irascible, gloomy Dean is a partial reading of his output, notably his Romanes Lecture of 1920 entitled *The Idea of Progress* and his popular journalism: for many years he contributed articles to the London *Evening Standard.* The commitment to produce a regular column can possibly lead to negativity. The term 'the gloomy Dean' was bestowed upon him by *The Daily Mail,* a journal not known for theological depth. Robinson has commented recently on the offence cause by Inge's journalism.[862] The theology found in *God and the Astronomers* is not gloomy but positive. He welcomes the new science, seeing it as a purgative for theology. While Inge does not see *God and the Astronomers* as one of his best books, in fact he describes it as 'not very well written', he does think that it embodies 'my most mature convictions on the central

[860] Livingstone, *Dealing with Darwin,* 198.
[861] W Sydney Robinson, *The Last Victorians* (London: Robson, 2014), 67; Trevor Beeson, *The Deans* (London: SCM, 2004), 134.
[862] Robinson, *The Last Victorians,* 97.

doctrines of theology.'[863] He wonders why 'my clerical brethren do not seem to be interested in these questions?'[864] It is interesting to contrast Inge's comment with that of Peter Harrison on an earlier age when 'clergymen seemed to have time to devote to natural history.'[865] Or possibly it was not so related to time but more to the scientific discipline. Patrick Armstrong in his *The English Parson-Naturalist* maintains that while the nineteenth century was the hey-day of this species, the 'tradition also continued into the twentieth century'.[866] Was the new physics considered too complex by many of the clergy?

Inge is in some ways a model for a theologian interacting with scientific knowledge. Inge brought his learning to the debate; he grapples with the new ideas and responds in lectures and writing. He is not afraid to disagree with scientists, for example, he doubts Jeans' view on planetary formation, correctly as it now appears.[867] He also condemns the use of Idealism by Eddington and Jeans but he is not a naïve Realist and is happy to agree that he concurs in part with them. His position is much more nuanced than Stebbing's. While simplistically accused of being gloomy, he had a 'frosty brilliance' which meant that his writing was worth reading even if the reader did not agree.[868]

10.4 Eddington and Jeans as Popular Apologists

In this section, the importance and significance of Eddington and Jeans will be explored, the uses of their texts examined and their motivations in writing will be discussed.

Their contemporary importance as popular writers has been demonstrated by reference to not only their book sales but the wideness of their reach. They explained the new physics and astronomy to the public, the clergy and academics outside of the physical sciences. They elucidated the science of their time and argued that it held no problems for believers (Eddington) or suggested a mathematical Deity (Jeans).

[863] W R Inge, *Vale* (London: Longmans, 1934), 105.
[864] Inge, *The Diary of a Dean*, 173-174.
[865] Peter Harrison, *The Bible, Protestantism, and the Rise of Natural Science* (Cambridge: Cambridge University Press, 1998), 171.
[866] Patrick Armstrong, *The English Parson-Naturalist: A Companionship Between Science and Religion* (Leominster: Gracewing, 2000), 3.
[867] Inge, *The Diary of a Dean,* 173.
[868] Inge, *Vale,* 105.

The abiding significance of Eddington and Jeans in this field is that they provided the context in which popular scientific apologetics took place for the rest of the twentieth century and thus into the twenty-first century as well. Their role as popular apologists has influenced not just specific apologists who name them or quote them but the whole approach of many apologists, especially as they deal with the physical sciences as opposed to the biological sciences. Their desire to make their work accessible for the reading public, their use of metaphors and their use of the latest technology has set the standard for succeeding generations. Clearly they were not the only Christian scientists writing on the relationship between science and religion, but their book sales indicate their pre-eminent position and importance. Their influence on Coulson and Lewis, discussed below, indicates their opinion-shaping role in the mid twentieth century and beyond. Eddington was also an influence on the apologetic writings of Dorothy L Sayers and not merely mentioned in just one of her short stories.[869] They remain significant for historians of the relationship between science and religion and for historians of Christian apologetics. As has been indicated before, part of this significance flows from widening the science and religion debate from one mainly focused on biology to one which recognised the significance of physics and astronomy.

It has been said that scientists working in the physical sciences are more positively disposed to the possibility of a religious interpretation of life than those working in the biological sciences. Mark Vernon argues thus, drawing on a September 2014 YouGov poll which said that while 90% of academic biologists were atheists, a smaller proportion of physicists described themselves as such.[870] While it is very difficult to prove a causal link, again, their book sales indicate that they were the market leaders for popular books on the physical sciences and the reviews of their works and references in articles indicate that not only did the general reader buy their apologetic works but so did scientists. Their assertion that mid twentieth century physics and astronomy was compatible with Christian faith did influence succeeding generations of young physical scientists such as Charles Coulson.

Jeans' major influence has been on the continuing use of the design argument or arguments in Christian apologetics. While Darwin was crucial in moving many theologians away from Paley-like design arguments based on anatomy in particular and biology in general, Jeans presented a modified form of the argument, relying on the physical sciences, and pointing to a Deity who is a mathematical designer. It is conceivable that Jeans was aware of the comments of T H

[869] Dorothy L Sayers, *The Mind of the Maker,* (London, Methuen, 1941) 1, 15, 27, 35.
[870] Mark Vernon, 'How biology is evolving to encompass its critics' *Church Times,* 10 October 2014, 12.

Huxley on the possibility of design being built into 'the primitive nebulosity' of the early universe.[871] The design argument within the context of physics and astronomy proved to be popular in the late twentieth century and early twenty-first century and Jeans was the best-selling author who set the scene for what was to follow.[872]

Eddington, and Jeans to a lesser extent, have had a continuing influence on popular apologetics, as evidenced by the apologetic writings of C S Lewis and Charles Coulson.

Lewis, unlike Coulson, was not a scientist but studied first classics and then English at Oxford. The influences upon Lewis are legion and include the Greek and Latin classics, northern European literature and the medieval and modern English canon. It would be an exaggeration to say that Jeans and Eddington were a major influence upon him, but they were not insignificant. Lewis was very interested in astronomy, keeping a telescope on the balcony of his bedroom.[873] It has already been suggested that Eddington may have shaped Lewis' view on life on other planets.[874] Lewis was familiar with the work of Giovanni Schiaparelli and Sir Robert Ball, Professor of Astronomy at Dublin and then Eddington's predecessor at the Cambridge Observatory. He was one of the leading popularisers of astronomy before Jeans' *The Universe Around Us* became the market leader. Lewis also had regular conversations with his Magdalen College colleague Erwin Schrödinger on physics and astronomy for the five years they overlapped as Fellows. His works contain references to Eddington and Jeans as has been seen.[875] Michael Ward says that Lewis was 'reasonably au fait' with their works.[876] Lewis had, like Eddington, once been a Realist but turned to a form of Idealism in the early 1920s.[877] Did the Idealism of Eddington and Jeans appeal to Lewis? James Patrick points out Berkeley as a

[871] T H Huxley 'On the Reception of the *Origin of Species'* in Francis Darwin, (ed.), *The Life and Letters of Charles Darwin,* Vol 2, 201.
[872] See Neil A Manson, *God and Design: The Teleological Argument and Modern Science* (London: Routledge, 2003); Rodney Holder, *The Heavens Declare: Natural Theology and the Legacy of Karl Barth* (Pasadena: Templeton Press, 2010); Larry Witham, *By Design: Science and the Search for God* (San Francisco: Encounter Books, 2003); Paul Davies, *God and the New Physics* (Harmondsworth: Pelican, 1983) and *The Mind of God* (London: Simon & Schuster, 1992); John D Barrow and Frank J Tipler, *The Anthropic Cosmological Principle* (Oxford: Oxford University Press, 1986); Hugh Montefiore, *The Probability of God* (London: SCM, 1985); Fred Hoyle, *The Intelligent Universe (*London: Michael Joseph, 1983); Ian Stewart and Martin Golubitsky, *Fearful Symmetry: Is God a Geometer?* (Mineola: Dover, 1983), etc.
[873] Michael Ward, *Planet Narnia* (New York, Oxford University Press, 2010), 247.
[874] Eddington, *The Nature of the Physical World,* 178.
[875] C S Lewis, *Mere Christianity* (Glasgow, Collins, 1952), 54. See also *The Problem of Pain* (London: Collins, 2002), 83, *Essay Collection,* 631, etc.
[876] Michael Ward, 'Science and Religion in the Writings of C S Lewis' in *Science and Christian Belief* 25 (April 2013), 1, 3.
[877] C S Lewis, *Surprised by Joy* (Glasgow, Collins, 1959), 167-169, 181.

significant influence on Lewis.[878] Berkeley was a major influence on Jeans and a lesser one on Eddington. One passage where Lewis' regard for Eddington and Jeans is obvious occurs in *The Abolition of Man* where Lewis writes:

> It is not the greatest modern scientists who feel most sure that the object, stripped of its qualitative properties and reduced to mere quantity is wholly real. Little scientists, and little unscientific followers of science, may think so. The great minds know very well that the object, so treated, is an artificial abstraction, that something of its reality has been lost.[879]

Their influence on Coulson is evident from his well-known *Science and Christian Belief.* Coulson comes to the same conclusion as Eddington on the study of nature – it can point to belief in a god or gods, a vague pantheism, but not the full colour of the Christian faith, as Eddington described it.[880] Coulson takes this line of argument further by saying that the study of nature 'has got us started' and that the spiritual quality of the unity which is experienced in the study of nature must be expressed in terms that are at least personal. He quotes with approval and in support of this argument the following passage from Jeans, 'the universe begins to look more like a great thought than a great machine' and then a further eleven lines from the final chapter of *The Mysterious Universe.*[881] Coulson does not dwell upon Idealism and Realism and their respective merits but takes from this passage support for the idea of a personal God of nature.

Coulson gave the Rede Lecture of 1954. This was, of course, the lecture series which gave rise to *The Mysterious Universe* in 1930. In this he makes brief reference to Eddington and Jeans and in both cases it is favourable.[882] Coulson gave the eleventh Arthur Stanley Eddington Memorial Lecture in 1958.[883] Coulson knew Eddington when he was a young don at Cambridge before the war. Coulson says in this lecture that when he started as an undergraduate in the 1920s the split between science and religion was absolute, but three Cambridge scholars

[878] James Patrick, 'C S Lewis and Idealism' Ed Andrew Walker and Fames Patrick in *A Christian for All Christians: Essays in Honour of C S Lewis* (London: Hodder and Stoughton, 1990), 161, 173.
[879] C S Lewis, *The Abolition of Man* (Oxford: Oxford University Press, 1943), 43-44, see also 'The Seeing Eye' in C S Lewis, *Christian Reflections,* ed. Walter Hooper (New York: Ballantine, 1986), 229 and *The Screwtape Letters* (Glasgow: Collins, 1985) 14 'There have been sad cases among the modern physicists.'
[880] Charles Coulson, *Science and Christian Belief* (London: Oxford University Press, 1955), 102-103.
[881] Coulson, *Science and Christian Belief,* 103.
[882] C A Coulson, *Science and Religion: A Changing Relationship* (Cambridge: Cambridge University Press, 1955), 14, 24.
[883] C A Coulson, *Science and the Idea of God* (Cambridge: Cambridge University Press, 1958).

helped to bring about a change in attitude. They were Alex Wood, the physicist at Emmanuel, Raven, the theologian at Christ's, and Arthur Eddington of Trinity.[884] Coulson is generally very positive about the work of Eddington, but can be critical at times.[885] Speaking of Eddington's approach to science in general and of his metaphor of the fishing net in particular, Coulson writes:

> I think Eddington has done us a good service here. For he has shown us, with more emphasis than any other, just how fundamentally any reception of our experiences by the brain depends upon recognition of order or structure.[886]

Coulson is less positive about Jeans in this lecture, asking if his Great Architect of the Universe 'is not really Sir James Jeans in disguise.'[887] Arie Leegwater sees Eddington as a key figure of influence upon Coulson as he developed as a scientist speaking about the relationship between science and religion:

> Eddington served as an example for Coulson of a leading scientist who was adamant in allowing God to play a role in a scientist's search for reality. Coulson was also impressed by the way Eddington was able to speak to lay audiences about his religious outlook and relate it to the science of the day. Eddington was a scientist who could give reasons for his faith.[888]

One of the strengths of Eddington and Jeans was that they were happy to risk the opprobrium of their scientific colleagues and philosophers as they engaged with some of the philosophical, theological and apologetic issues that the new physics and astronomy had raised. They were both well aware of the dangers of this approach as the Preface to *The Nature of the Physical World* and the Foreword of *The Mysterious Universe* make clear.[889]

Another of their strengths as apologists was that they were not ordained. The Christian apologist Arnold Lunn, a contemporary of Eddington and Jeans, writing in *Theology,* put it thus:

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[884] Coulson, *Science and the Idea of God,* 4.
[885] Coulson, *Science and the Idea of God,* 29.
[886] Coulson, *Science and the Idea of God,* 20.
[887] Coulson, *Science and the Idea of God,* 21.
[888] Arie Leegwater, 'Charles Alfred Coulson: Mixing Methodism and Quantum Chemistry' in Nicolaas A Rupke, *Eminent Lives in Twentieth Century Science* (Frankfurt am Main: Peter Lang, 2nd ed. 2009).
[889] Eddington, *Nature of the Physical World,* viii and James Jeans, *The Mysterious Universe,* viii.

> The man in the street is, of course, less impressed by the merits of an argument than by the credentials of the arguer. He would have ignored Eddington's views had they been expressed by a bishop, but he sits up and takes notice when a prominent scientist attacks the creed associated with Victorian materialism.[890]

David Wilkinson likewise points out the apologetic value of lay scientists in 'The Art of Apologetics'.[891] Eddington and Jeans were seen as unbiased witnesses as they were not paid by the churches to promote religion. This helps explain that for a number of years their influence was greater than the established religious leaders in promoting the Christian faith. Their position as leading scientists meant that they were well placed to be taken seriously by the press, the radio and the public at large. Their existing reputation as expositors and evangelists of the new understanding of physics meant that they were already known to the public.

At this point it might be good to consider two important points from Topham's chapter 'Science, religion and the history of the book' in *New Historical Perspectives*.[892] The first is on the use of the text, the second is on the motivation of the authors and publishers.

Topham shows that *The Bridgewater Treatises* were very often used as a 'above all religiously and politically 'safe' account of the latest finds of the several sciences.' [893] There is less evidence of this in the work of Eddington and Jeans. Society had changed significantly since the time of the publication of the *Treatises* from 1833-1840. The church had less influence in the universities and the proportion of church schools over board schools had gone down after the Education Act of 1870, although their number had increased. There was less scope for the institutional church to control what members of their congregations and schools read or what was studied in the universities. The public were better educated, wealthier, and now had access to free municipal libraries provided by Boroughs and County Councils following the Public Libraries Act of 1850. This meant that people had far greater power to pick what they read than was the case in 1830 and they chose these three books in large numbers. The books were, nevertheless, recommended by clergy from the pulpit and elsewhere as suitable reading for congregations.[894] While parts of the books could be used as safe texts for science

[890] Arnold Lunn, 'The Revolution in Modern Science', *Theology,* November 1930, 259-260.
[891] David Wilkinson, 'The Art of Apologetics', *Anvil,* 19, (2002) 1, 9.
[892] Topham, 'Science, religion and the history of the book' in Dixon et al (eds.) *New Historical Perspectives*, Chapter 11.
[893] Topham, 'Science, religion and the history of the book', 223.
[894] Milne, *Jeans,* xi.

education, such as the first four chapters of *The Mysterious Universe,* this use appears to be less common than with the Bridgewater Treatises.

As Eddington and Jeans were laymen, without a 'professional interest' in promoting Christianity, Topham's second point on motivation for writing is relevant. The motivations of Cambridge University Press are expressed with admirable honesty by S C Roberts, the Secretary of the Press, in his Memoir contained in Milne's biography of Jeans:

> I realized, especially after the promptings from my colleague, R. J. L. Kingsford, that cosmogony might contain the potentialities of best-selling beyond the dreams of academic avarice.[895]

This occurred after his attention had been drawn to the final chapter of *Astronomy and Cosmogony* and Roberts' approach to Jeans resulted in *The Universe Around Us* of 1929. Cambridge University Press was the publisher of the majority of Eddington and Jeans' books and of two of the three key texts which have been examined. The third, *Science and the Unseen World,* was published by George Allen and Unwin, the regular publisher of the Swarthmore Lecture series. When Eddington agreed to give these lectures, it was inevitable that the book would be published, and published by Allen and Unwin.

The motivations of the two authors are less easy fully to evidence. The first point to note is that all three key texts were delivered first as public lectures. For Eddington's two key texts, the Gifford Lectures and the Swarthmore Lecture, publication in book form was the norm. To be asked to deliver these lectures, especially the Giffords, was an honour and publication a natural consequence. The annual Rede Lectures were not normally issued in book form as it is a single lecture. Most of the lectures appeared as a short pamphlet or booklet. The book *The Mysterious Universe* is an expansion of this lecture rather than a slightly edited version of it. Neither is there any requirement for the Rede Lectures to consider natural theology as in the case of the Gifford Lectures. Jeans appears to have deliberately chosen, firstly, a contentious topic and then secondly, in collaboration with Roberts, the popular book format over the more conventional academic pamphlet.

Money does not seem to have been the main motivation. Both authors, especially Jeans, were financially very secure by this stage of their careers. This interpretation is backed up by Roberts who reports that Jeans never haggled over his royalties.[896] Roberts also says that

[895] S C Roberts 'Memoir', in Milne, *Jeans,* ix.
[896] S C Roberts in Milne, *Jeans,* x.

Jeans entered into the publication of the easy-to-read *The Universe Around Us* as part of his 'friendly rivalry' with Eddington following the success of *The Nature of the Physical World* in 1928.[897] Following the popularity of *The Universe Around Us*, Roberts persuaded Jeans to use Cambridge as the publishers for *The Mysterious Universe* in 1930. As far as can be ascertained, both scientists accepted the call to give the lectures and choose the topics knowing they would receive adverse attention but did so because they considered what they said on matters of belief to be a valid inference from the current science. Both authors had had success as popularisers of science with Eddington's *Stars and Atoms* and Jeans *The Universe About Us.* The three key texts go beyond the normal bounds of scientific popularisation and into the deeper water of apologetics. This controversy was foreseen by both authors as the Forward to *The Mysterious Universe*[898] and the Preface of *The Nature of the Physical World* predicted.[899] It is difficult to see these three books as merely popularisations of science, unless the two authors wished to boost sales by the publicity that entering religious controversy would entail. Eddington appears to have lost the admiration of Bertrand Russell following the publication of his two key texts. There was a cost for him.

On the question of the particular apologetic objectives of the books, *Science and the Unseen World* is in a different category to the other two books. It was first given as a lecture to a Quaker audience and assumes belief in the main tenets of the faith of the Society of Friends. It speaks of 'an Inner Light of conviction and guidance'[900] and of 'the experience which comes to us in our silent meeting'.[901] The lecture clearly assumed a practising Quaker audience. Its overall tone does suggest that Eddington is encouraging the faith of other Quakers and implicitly if not explicitly commending the Quaker approach to Christianity. This Quaker approach he sees as completely compatible, but not proved, by the then current science.

The other two books first appeared as lectures to a more mixed, academic audience. It is clear from the texts themselves that both authors considered that the new physics and theism were compatible. Jeans in the Foreword explains that in the first four chapters he describes what the new physics shows and in the fifth, 'Into the Deep Waters' he gives what he believes are the philosophical interpretations to be placed upon this – notably a modified mathematical form of the design argument.[902] Eddington, likewise, starts by laying out the new physics in

[897] S C Roberts in Milne, *Jeans,* x.
[898] Jeans, *The Mysterious Universe,* viii.
[899] Eddington, *The Nature of the Physical World,* viii.
[900] Eddington, *Unseen World,* 27.
[901] Eddington, *Unseen World,* 30.
[902] Jeans, *The Mysterious Universe,* vii.

greater depth and then turns to his own thoughts on the implications in the last five chapters and the Conclusion. Both could have stopped after describing the new science but chose to press on into the field of popular apologetics. This reinforces the point that they were not merely writing popular science books.

Both certainly wished to challenge current thinking, but both have been described in this dissertation, with reason, as modest and cautious apologists. Jeans said that:

> We have already considered with disfavour the possibility of the universe having been planned by a biologist or by an engineer; from the intrinsic evidence of his creation, the Great Architect of the Universe now begins to appear as a pure mathematician.[903]

Jeans' language is always tentative and the final paragraph of the book states plainly that while this is the current implication of physics and astronomy, this view could change with further developments in science. Eddington is yet more definite on the issue of the lack of certainty in both science and religion:

> We cannot pretend to offer proofs. *Proof* is an idol before whom the pure mathematician tortures himself. In physics we are generally content to sacrifice before the lesser shrine of *Plausibility*.[904]

Neither of them attempt to establish beyond doubt the plausibility of specific religious beliefs or to demonstrate conclusively the existence of a transcendent spiritual reality. Jeans' argument was that the science pointed to a designing Creator. Eddington said that 'all that our inquiry justifies us in asserting is a purely colourless pantheism'.[905] For Eddington experience is key, his argument is that nothing in current physics, or the psychology of perception, means that this experience of the Inner Light should not be taken seriously.

Both authors are aware that (except for the Swarthmore Lecture) their audiences would be mixed both in terms of their understanding of the science and in religious background. There is no indication that they saw themselves as clearing the way for an acceptance of special revelation, but Jeans did, of course, offer a modified form of the design argument, one of the traditional justifications for belief in God. Eddington as a liberal Quaker believed in the revelation of God in Christ but laid greatest stress on 'the revelation implied in the indwelling

[903] Jeans, *The Mysterious Universe,* 134.
[904] Eddington, *Nature of the Physical World,* 337, see also 335-342.
[905] Eddington, *The Nature of the Physical World,* 338.

of the divine spirit in the mind of men' that is in the Inward Light rather than the revelation in the Word.[906]

All three books could be seen as pre-evangelistic texts and the last sentence of the last full chapter of *The Nature of the Physical World,* which has been commented on before, indicates that Eddington may have seen his writings in this light:

> Verily, it is easier for a camel to pass through the eye of a needle than for a scientific man to pass through a door. And whether the door be barn door or church door it might be wiser that he should consent to be an ordinary man and walk in rather than wait till all the difficulties involved in a really scientific ingress are resolved.[907]

It may be helpful to consider by way of summary of their contribution to popular apologetics McGrath's six points of effective apologetics found in *Bridge-building: Effective Christian Apologetics.* This can be summarised as follows: to identify points of contact; to allow the apologists to lodge the proclamation in the experiential world of the audience; to anticipate and answer some of the obstacles to faith; to challenge existing non-Christian world views; to create an intellectual and imaginative atmosphere favourable to faith and finally to explain how assent to Christianity becomes faith in Christ. While McGrath's original context was 'effective apologetics within evangelistic preaching' the points can also be applied to apologetic books. [908] Both Eddington and Jean's work satisfied the first five of these six criteria.

Clearly Eddington and Jeans were good at establishing points of contact between themselves and their readers. They also saw the need to address concerns that many people had at the time of the relationship between science and religion. This was a genuine part of the readers' experimental world. Jeans and Eddington had seen how a deterministic, reductionist, materialist view of science based upon an outdated view of science could be an obstacle to faith, but they did not, for example, discuss issues beyond the science and religion debate which form obstacles to faith. They also did not, likewise, discuss at any length issues in the field of biology. They did challenge non-Christian world views based upon a view of the world from the previous century and created, by their use of vivid metaphors, an intellectual and imaginative atmosphere conducive to faith, often explaining the new science along the way.

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[906] Eddington, *Unseen World,* 44-45.
[907] Eddington, *The Nature of the Physical World,* 342.
[908] Alister E McGrath, *Bridge-building: Effective Christian Apologetics* (Leicester: IVP, 1992), 242-243.

They did not, however, in McGrath's words, attempt 'to explain how assent to Christianity becomes faith in Christ'.[909] In apologetic terms, they thus fit closely with the description of their work as pre-evangelistic. They were experts in physical science and used their knowledge to build a convincing apologetic for their time within a specific but vitally important field. They were effective apologists of a reasoned, subtle and understated kind.

Wilkinson makes three points related to McGrath's concerning St Paul's apologetic approach. Paul shows respect for the cultural context, he looks for conversation partners and he argues the gospel with a commitment to reason. All three factors can be found in the work of Eddington and Jeans. They were alive to the cultural context, engaged in dialogue beyond their books, and were committed to arguing a case and accepting that subsequent scientific advances might alter their position. McGrath makes a point similar to Inge in *Bridge-building*. He argues that textbooks on apologetics can look back to golden ages in the subject; second century Alexandria, thirteenth century Paris or seventeenth century Cambridge for example. 'Their situations do not necessarily bear much relation to our own.'[911] Eddington and Jeans in their role as apologists understood the prevalent ideas of the time in the physical sciences and used their knowledge and skill to enter in to dialogue with the contemporary culture. They did this not only through their popular and semi-popular books but through the wireless and the printed press. Their apologetic was rooted in the then current situation; Jeans, for example used a non-teleological, mathematical design argument, ignoring the formulation of this concept from one of the luminaries of thirteenth century Paris, Thomas Aquinas. While Eddington drew on his Quaker heritage, he used his expertise as a scientist to devise an apologetic suitable for his age and transmit it in a way appropriate for his time. McGrath also identifies imagination as a tool in service of apologetics.[912] The use made by Eddington and Jeans of imaginative metaphors captured the attention of the general reading public. Eddington was skilful in this area. His metaphors were well constructed and resonant or '*suggestive*' to use Soskice's term.[913] While Jeans sometimes mixed his metaphors he was adept at conveying the size of the universe or the distribution of matter by a very easily understood metaphor. Their imaginative approach to apologetics captured the attention of large numbers of the public.

[909] McGrath, *Bridge-building,* 243.
[911] McGrath, *Bridge-building,* 11.
[912] McGrath, *Bridge-building,* 246.
[913] Soskice, *Metaphor*, 15. *Italics* as in the original.

10.5 Summary

While *The Mysterious Universe* has its faults it also has a number of virtues. It is a simple, accessible (another of McGrath's criteria for good apologetics) apologetic book on science and religion.[914] Its influence was very significant as a starting point for those considering the questions on the relationship between physics and astronomy on the one hand and the Christian faith on the other. Along with *The Universe Around Us* and the works of Eddington, *The Mysterious Universe* helped move the general public on from a Victorian, mechanistic, deterministic, naïve view of science to a more nuanced understanding of physics from the sub-atomic world to the universe at large and of the important role of human perception in observation and cognition. It is very good popular writing. It is a book which could be read by school boys and girls, the average person in the pew or the proverbial man or woman on the Clapham omnibus. For this reason the work of Jeans and his role as a populariser in the science and religion debate is worthy of reappraisal.

It is the contention of this thesis that Eddington's *The Nature of the Physical World* is a very significant book in the history of the development of the science and religion debate as Spurway has suggested. Its importance has been forgotten because of a number of factors. The first was both Eddington's adoption and poor use of philosophical Idealism in this otherwise admirable book. This made him an easy target for philosophers and probably assisted his neglect by theologians. It must also be said that the Church of England displayed its normal talent for concentrating on internal matters (Prayer Book reform) and ignored what the general public were concerned about as they read the books of Eddington and Jeans. Another factor was the reception of *Relativity Theory of Protons and Electrons,* published in 1936 and even more so the posthumously published *Fundamental Theory* of 1946. This soured the success that Eddington had had with *The Internal Constitution of the Stars* of 1926. As a batsman is remembered for his last innings, so the failure of *Fundamental Theory* stuck in the minds of scientists, philosophers and theologians interested in the science and religion debate. The third factor was the Second World War itself. In post war Britain there was a desire for a new start in many fields and Lewis became the leading popular Christian apologist and Eddington's work was forgotten by many, though not by Lewis. While Lewis' works are readily and cheaply available, *The Nature of the Physical World* is not. *The Nature of the*

[914] McGrath, *Bridge-building,* 14.

Physical World is a subtle, understated, intelligent and well-written piece of semi-popular apologetics. The book and its author are truly worthy of reappraisal.

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