

Practical Mystic

Religion, Science, and A. S. Eddington

{} MATTHEW STANLEY {}

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Religion in Modern Life Science, Philosophy, and Liberal Theology in Interwar Britain

The challenge now comes not from the scientific materialism which professes to seek a natural explanation of spiritual power, but from the deadlier moral materialism which despises it. . . . But is it true in history that material forces have been the most potent factors? Call it God, or the Devil, fanaticism, unreason; but do not underrate the power of the mystic. Mysticism may be fought as error or believed as inspired, but it is no matter for easy tolerance.

A. S. EDDINGTON, *Nature of the Physical World*, 1928

Eddington is often referred to as one of the great popularizers of science of the 1920s and 1930s, usually in the same breath with James Jeans.¹ His writings were astoundingly widely read, especially given the difficulty of topics such as quantum mechanics and relativity.² Indeed, his ability to make such abstruse topics comprehensible was a major selling point. He and his ideas were sufficiently diffused in British culture that the mystery writer Dorothy Sayers could comfortably have one character admonish an overanalytical colleague: "For heaven's sake, don't go all Eddington."³ He had already gained a public reputation from the 1919 eclipse and his expositions of Einstein, which likely gave him a ready audience willing to grapple with difficult issues. His 1927 *Stars and Atoms*, taken from a public address, was further evidence that his conversational lecturing style made for good reading and interested audiences, and he was a commonsense choice to give the famous Gifford Lectures.⁴ But it was not just his scientific exposition that made him a significant figure; rather, it was how his popular science was embedded in the dominant social and economic issues of the interwar period, particularly Britain's grappling with the question of socialism. Eddington's popularizations were not just tools for education, they were weapons in the battle to defend traditional values—an obituary described him as "one of mankind's most reassuring cosmic thinkers."⁵ It is this aspect of Eddington as a *reassuring* scientist that made him so beloved. In a century during which science and technology seemed to be an increasingly mixed blessing, he persuaded his readers that they did not have to leave their lifelong beliefs behind to embrace the new.

One of the important issues for the interwar period in Britain was the simple question of what *kind* of people scientists were. Good? Evil? What were their moral intentions? The widespread tendency to blame the horrors of the Great War and the subsequent economic instability on science and technology meant scientists had a great deal at stake in portraying themselves as morally upstanding citizens who were aware of the larger implications of their work.⁶ The particular question of religion was ubiquitous in both the United States and Great Britain; in the former largely because of increasing tensions around evolution, in the latter largely because of anxiety about declining church attendance and Christian belief. Popular science, and Eddington's work, played an important role in addressing these issues.

An important inflection point in the history of science popularization was the shift from a natural theological to a scientific naturalist form of communication between scientists and the public.⁷ Britain, unsurprisingly, provides a particularly vivid and informative location for observing this shift and what it implies for the change in the cultural standing of science and the role of the scientist as public intellectual. The British culture that produced William Paley and William Whewell had never quite come to accept that it also produced John Tyndall and T. H. Huxley, and the tensions between the naturalistic and natural theological perspectives on science remained in force when Eddington became a household name. The banner of materialist science was brought vigorously forward in Britain in the late 1920s by communists and socialists inspired by the example of the new Soviet Union and its application of science to all aspects of life.⁸

This group would eventually become the social relations of science movement. The materialist and left-wing scientists that would fuel this movement clustered at Cambridge, and Eddington was literally in the epicenter of a resurgent materialist community that sought to apply their beliefs to all of society, including science, work, and belief. This community chose the public understanding of science as one of their prime battlefields; they would change the nature of science by persuading the common person. Popularization was a primary weapon in the revolution.⁹

British science popularization had traditionally relied heavily on natural theology, particularly in the prestigious Gifford Lectures. They were typically a soapbox for proclaiming the harmony of current science with an ecumenical Christianity. Eddington, of course, was no exception to this, and his emphasis on approaching science through liberal theology makes him an excellent example of the religious tenor of the time. But he also had a particular kind of science popularization in mind to refute. His writings were explicitly aimed against both a philosophical materialism and a moral materialism of the

sort that many of his Cambridge colleagues were espousing. Coming out of his experiences during the war, Eddington felt a moral responsibility to try and improve Britain as a society. He had worked for internationalism, and this was his opportunity to work closer to home. The Gifford Lectures, Eddington's initial broadside against the sort of materialism he saw ruining Britain, developed into a decade-long battle between differing views of science for the public's allegiance. The ensuing debates are extremely valuable for teasing out the subtle and varied meanings given to the concepts of science, religion, materialism, and idealism between the wars. Further, we can see the high stakes placed on the resolution of these varied forces—public leaders inside and outside the scientific community felt they were battling for the very future of the British state and British culture.

Becoming a Spokesman for Science

Eddington's 1927 Gifford Lectures, delivered in Edinburgh, were published as *The Nature of the Physical World*.¹⁰ This book would become one of the most influential popular books on science published between the wars and would go on to sell 72,000 copies in Britain by 1943 (it was translated into French, Swedish, German, Japanese, Polish, Italian, Spanish, and Hebrew).¹¹ His humor, literary allusions, and engaging style were highly effective at creating an immersive experience for readers. Eddington described his lectures as treating of "the philosophical outcome of the great changes of scientific thought." His goal was to show the "scientific view of the world as it stands at the present day, and, where it is incomplete, to judge the direction in which modern ideas appear to be tending." He saw the lectures as contributing "new material" for the philosopher; the philosophical consequences presented were supposed to flow directly from the physics. For example, he described his own idealist philosophy as having come from his research in relativity. While he felt the material presented was critical for modern philosophy, he did display some reservations about pushing beyond his own discipline's boundaries. "From the beginning I have been doubtful whether it was desirable for a scientist to venture so far into extra-scientific territory. The primary justification for such an expedition is that it may afford a better view of his own scientific domain." Elements that professional philosophers might find suspicious, then, were to be eventually justified on the grounds of science, not philosophy.¹²

The lectures and the book were not identical; Eddington rewrote the text in August 1928 for two reasons. The first was to incorporate the implications of Heisenberg's indeterminacy principle (later and more widely known as the uncertainty principle). The second was to trim the freer speculations of the

lectures. He described a public lecture as a forum in which unrigorous speculation was acceptable, but a publication needed to be on firmer ground. Let philosophical critics take advantage. Wide-ranging speculation was more acceptable in a transient lecture than in a permanent book.¹³ For the remainder of this chapter, I will reference the book directly, rather than the lectures, as the book was the form that was most widely known.

The majority of *Nature of the Physical World* was structured around explications of the relativity and quantum theories, with Eddington's philosophical interpretation integrated directly. The structuralism he had been developing since *Space, Time and Gravitation* was one of the main themes. He described the two worlds, the symbolic/scientific and the commonsense. Eddington said the "aloof" world of scientific symbols was one of the most important advances in modern physics, but he counted himself unusual as a scientist in considering the philosophical meaning of that: "The frank realisation that physical science is concerned with a world of shadows is one of the most significant of recent advances. I do not mean that physicists are to any extent preoccupied with the philosophical implications of this. From their point of view it is not so much a withdrawal of untenable claims as an assertion of freedom for autonomous development." Scientists were concerned with the use and development of theories like relativity and quantum physics, not their essential truth. The significance attached to symbols was solely a product of the alchemy of the mind and had no direct link to science itself. He re-presented his tautological interpretation of Einstein's physics, famously asserting, "The law of gravitation is—a put-up job."¹⁴

Eddington wrote his Gifford Lectures soon after he read Werner Heisenberg's famous 1925 paper, and he eagerly drafted the new quantum mechanics to support his structural physics. He argued that that paper (and particularly Paul Dirac's interpretation of p and q numbers) showed that individual symbols had no actual numbers behind them, but became physical numbers only in combination. This suggested that, as Eddington had been arguing, the symbols themselves were not adequate for a description of the world. As Einstein had shown a decade earlier, *relations* between symbols were necessary before the mind could turn them into something recognizable. Eddington acknowledged that the quantum theory certainly did not demand this interpretation; rather, he said the suggestion of this implication should be taken seriously because it fit so closely with the implications of relativity. The building material of the world was again shown to be relations and symbols, not crude matter. Physics had accepted that it could attain great progress without any real knowledge of the nature of entities. Of course, the quantum theory was quite new; the scientific worldview would likely be modified in the future, but the

interpretive exercise nonetheless "widened our minds to the possibilities" and had given science a new sense of physical law.¹⁵

Eddington continued to defend his philosophical interpretation as springing straight from scientific practice: "I should like to make it clear that the limitation of the scope of physics to pointer readings and the like is not a philosophical craze of my own but is essentially the current scientific doctrine. It is the outcome of a tendency discernable far back in the last century but only formulated comprehensively with the advent of the relativity theory."¹⁶ There were conclusions that were philosophical, and then there were conclusions that were "definitely scientific." Among these was the conclusion that science no longer identified the real solely with the concrete and the corollary that those things that lack concreteness need no longer be automatically condemned. This liberated science from having to deal with parts of the world that did not submit easily to its treatment:

The cleavage between the scientific and the extra-scientific domain of experience is, I believe, not a cleavage between the concrete and the transcendental but between the metrical and the non-metrical. I am at one with the materialist in feeling a repugnance toward any kind of pseudo-science of the extra-scientific territory. Science is not to be condemned as narrow because it refuses to deal with elements of experience which are unadapted to its own highly organised method; nor can it be blamed for looking superciliously on the comparative disorganisation of our knowledge and methods of reasoning about the non-metrical parts of experience. But I think we have not been guilty of pseudo-science in our attempt to show in the last two chapters how it comes about that within the whole domain of experience a selected portion is capable of that exact metrical representation which is a requisite for development by the scientific method.¹⁷

The religious subtext is clear, but this was presented as a benefit for science. This was not disingenuous on Eddington's part. He felt and argued passionately that recognizing the nonmetrical aspects of human experience was essential to both progress in science and correct insight in religion. The value of experience did not belong to one realm of thought; it underlay all.

Eddington warned his readers when he thought he was veering from strict science. They were venturing "into the deep waters of philosophy; and if I rashly plunge into them, it is not because I have confidence in my powers of swimming, but to try and show that the water is really deep." His attribution of mental states as the foundation of observation, which he credited to Bertrand Russell, meant the world was built from the "mind-stuff" of relations.¹⁸ This conclusion rested, fundamentally, on the internal recognition that mind was the first and most direct thing in experience.

The structuralism presented in *Nature of the Physical World* was more developed than that presented earlier by Eddington and had the added support of Heisenberg's matrix mechanics. The novel addition to his philosophy was the analysis of quantum indeterminism. He had considered the classical statistical laws of thermodynamics before, but he saw the uncertainty principle as a wholly new way to approach the problem (the addition of the implications of the principle was one of his primary tasks in revising his manuscript). Like relativity, the uncertainty principle related directly to measurement techniques. It was a perfect embodiment of positivist, instrumentalist physics. "It reminds us once again that the world of physics is a world contemplated from within, surveyed by appliances which are part of it and subject to its laws. What the world might be deemed like if probed in some supernatural manner by appliances not furnished by itself we do not profess to know." The fact that it was an immensely powerful tool of physics was further evidence for the significance of identical and transcendental laws. And, like relativity, it added nothing new. It instead "represents the abandonment of a mistaken assumption which we never had sufficient reason for making."¹⁹ In the light of the uncertainty principle, scientists must discard analogies between microscopic elements of the world and gross particles, in the same way that scientists had discarded their primitive theories about ether.

Heisenberg's uncertainty principle denied classical determinism because it eliminated the foundational elements of the Laplacian calculator: precise measurements of position and velocity. Eddington described his personal struggle with the question of determinism. While he knew in his heart that predestination was not right, he could not conceive of a kind of scientific law other than deterministic. This all changed with quantum mechanics, because "*physics is no longer pledged to a scheme of deterministic law.*"²⁰ Thus, Eddington's and the reader's innate intuition that they have free will needed no special defense. Instead, the traditional objection (the tyranny of deterministic physics) was simply gone, so, for the first time since Descartes, volitionists started on an equal footing with determinists. "We may note that science thereby withdraws its moral opposition to freewill. 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 the idea that they are thereby making it more conformable with our experimental knowledge of the laws of inorganic nature." This "emancipation" from determinism affected both the mind and the physical world, and the philosopher and the psychologist must now play their parts and consider the freedom of the human mind and spirit as an elementary datum. Eddington admitted that it was unclear how this freedom was to be reconciled with the statistical laws of quantum mechanics and that

quantum indeterminacy was "only a partial step towards freeing our actions from deterministic control."²¹

The defense of mysticism Eddington conducted in *Science, Religion, and Reality* was stronger than ever in his Gifford Lectures, but he made a special effort to link it to the practice of science. As I discussed in chapter 2, this alliance of the mystical outlook with scientific practice was evident in Eddington's day-to-day activity, but this was one of his first substantial presentations of it in a formal fashion. Scientists were driven to look for truth regardless of the symbolic nature of their field: "The path of science must be pursued for its own sake, irrespective of the views it may afford of a wider landscape; in this spirit we must follow the path whether it leads to the hill of vision or the tunnel of obscurity."²² The justification of science as an entity was to be found in the spiritual realm because "the impulse to this quest is part of our very nature." Eddington was concerned to refute those scientists who claimed science's justification was solely in its material benefits, as he felt many of his Marxist colleagues were arguing. He said no scientist would "allow his subject to be shoved aside in a symposium on truth."²³ Science, then, had something beyond the material world, and this something was an inherent seeking in human nature. This was also a response to those critics who said Eddington's tautological approach to fundamental laws made science meaningless, a mere mathematical game of symbols. *It did not matter* whether scientific symbols connected to a real world beneath, Eddington replied, because what motivated the scientist was internal and independent of any particular subject.

To Eddington, the spiritual life was ubiquitous whether it was recognized or not. The indication of a spiritual world was simple—it was that which was "good enough to live in." This was contrasted with the scientific world of symbols, which cannot be inhabited in any meaningful sense: "My conception of my spiritual environment is not to be compared with your scientific world of pointer readings; it is an everyday world to be compared with the material world of familiar experience. I claim it as no more real and no less real than that. Primarily it is not a world to be analysed, but a world to be lived in."²⁴ Everyone lived in the spiritual world, whether they knew it or acknowledged it. Mysticism was simply the embrace of this reality and the use of it for productive ends. This was the fundamental premise of the Quaker Renaissance: spirituality was everywhere, and its importance was in how it changed people, not in how it fit a sectarian doctrine.

The target of Eddington's arguments was specific and significant. Even beyond those who attacked religion as untrue, there were those who discarded it as irrelevant or unworthy of attention. The materialists who dismissed religion based on physics had been disposed of by his structuralism, but the

Marxist view of history needed to be dealt with as well. The Marxists were clearly in the cross-hairs:

The challenge now comes not from the scientific materialism which professes to seek a natural explanation of spiritual power, but from the deadlier moral materialism which despises it. Few deliberately hold the philosophy that the forces of progress are related only to the material side of our environment, but few can claim that they are not more or less under its sway. . . . But is it true in history that material forces have been the most potent factors? Call it of God, of the Devil, fanaticism, unreason; but do not underrate the power of the mystic. Mysticism may be fought as error or believed as inspired, but it is no matter for easy tolerance.²⁵

Eddington saw the forces of materialism at work in British society, probably in the wake of the General Strike and the subsequent agitation that stoked fears of communism across the country.²⁶ He was hardly alone in seeing a genuine threat from Marxism, and one of the overriding agendas of *Nature of the Physical World* was a refutation of the ideology that would turn Britain into another Soviet Union.

Eddington was firm that his role was a defender of religious experience, not an evangelist who sought to prove a theological conclusion:

This must be emphasised because appeal to intuitive conviction of this kind has been the foundation of religion through all ages and I do not wish to give the impression that we have now found something new and more scientific to substitute. 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. Presupposing a mystical religion based not on science but (rightly or wrongly) on a self-known experience accepted as fundamental, we can proceed to discuss the various criticisms which science might bring against it or the possible conflict with scientific views of the nature of experience equally originating from self-known data.²⁷

He harshly dismissed the "naïve" idea that thermodynamics could be used to demonstrate Creation and warned that religious believers should be apprehensive of any "intention to reduce God to a system of differential equations, like the other agents which at various times have been introduced to restore order in the physical scheme. That fiasco at any rate is avoided." The changing conclusions of scientific knowledge made it far less reliable as a basis of religion than personal experience. "The lack of finality of scientific theories would be a very serious limitation of our argument, if we had staked much on their permanence. The religious reader may well be content that I have not offered him a God revealed by the quantum theory, and therefore liable to

be swept away in the next scientific revolution." He acknowledged that many in his audience wanted a silver bullet to be used against unbelievers, but he demurred that "I could no more ram religious conviction into an atheist than I could ram a joke into [a] Scotchman."²⁸

Eddington argued that in any case the desire for a proof of religion was a misplaced value. Proof had no use or meaning outside tortured systems of logic. Religion, like physics, had to make do with what was known based on transitory evidence based on experience. "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*."²⁹ He was concerned that he not be misread as saying that religion was only justified by the new physics: "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 we must consider that most tiresome person, the consistently reasonable man, we may point out that not merely religion but most of the ordinary aspects of life first became possible for him in that year."³⁰ Religion was in the same category of experience as aesthetics, happiness, and love. All had clearly been in evidence (and therefore *de facto* possible) since the emergence of humanity; modern physics only resolved a criticism that had been leveled against them by misguided materialists. Someone who truly lived the spiritual life already knew these things were true, and Eddington's job was just to reassure them that they were right.

Nature of the Physical World's impact was dramatic. It was seized upon by journalists, theologians, and community religious leaders across the English-speaking world. Readers were impressed with the clarity of the scientific exposition, but it was the religious ideas that made it a cultural phenomenon. Many influential theologians stated that Eddington was essential reading.³¹

It quickly became a standard against which to judge the currency of arguments on science and religion. A *Hibbert Journal* review of a book on the free will problem dismissed the work as out of date because it made no reference to Eddington. His demonstration of the collapse of determinism in physics was said to qualitatively change the landscape of discussions of determinism in philosophy, and his ideas about free will were even used to justify particular interpretations of political events.³² Similarly, Gifford Lectures in subsequent years were inevitably compared to Eddington's.³³

The *Times* reviewer declared that "it is a book which every one interested in the modern developments of science should procure and study."³⁴ One review of *Nature of the Physical World* congratulated Eddington on the book's success, calling its great sales "highly creditable to the intelligence of the British reading public." The book was called "brilliant, thoroughly expert," but its

ideas "require careful re-examination and co-ordination in order to form the basis for anything which could be called a new philosophic view of the universe embracing the latest conclusions of physics." The sections on mysticism were singled out as being of special interest to the general reader.³⁵ A less positive article in the same issue gave Eddington credit for recognizing "that the garment of truth is seamless" and being willing to speak about religion and philosophy in concert with physics. But the author, the Oxford philosopher H. W. B. Joseph, was very concerned to defend the necessity of a proper philosophical investigation. He criticized Eddington for making imprecise analogies and (indirectly) for using his fame as a scientist to support unsubstantiated ideas.³⁶

The literary skill evident in *Nature of the Physical World* cemented Eddington's standing as a public spokesman for science. This book and his carefully prepared lectures and radio broadcasts smoothly moved between technical matters, literary allusions, and whimsical humor. Lecturing in person, he seamlessly brought together verbal deftness, mathematical equations, and carefully chosen props to fully engage his audience.³⁷ Eddington constantly sought out opportunities to address the public, even regularly taking invitations from undergraduate societies, but his smooth public lectures often contrasted with his famously difficult style in the classroom and shy personal manner. Sometimes hesitant to the point of incommunicability in ordinary conversation, Eddington became witty, verbose, and charming when on prepared ground or when discussing a subject of personal interest.³⁸ The many honors he received in the following years (including a knighthood and the Order of Merit) invariably referred to his writing talents alongside his scientific achievements. When Eddington received the freedom of his hometown, Kendal, J. J. Thomson paid the following tribute: "He has by his eloquence, clearness, and literary power, persuaded multitudes of people in this country and in America that they understand what relativity really means. . . . Sir Arthur is one of those rare cases where great literary ability is combined with great scientific ability."³⁹ A later book was described as having "a beauty little short of the sublime."⁴⁰ Soon Eddington had become a celebrity whose name could sell books on its own—for the "cheap edition" of *Nature of the Physical World*, his name was unusually set above the title, indicating that he was the draw.⁴¹

Smooth prose and strong reviews were not enough to deflect his critics, however. Sir Oliver Lodge's public response to Eddington, in the journal *Nineteenth Century*, expressed concern that *Nature of the Physical World's* restriction of science would serve science's enemies, and "it undoubtedly has enemies."⁴² He wrote privately to Eddington to express concern about the emphasis on pointer readings, echoing similar thoughts held by many in the

scientific community. Lodge was concerned about the implications this had for a full "philosophical outlook." He had two points. First, he was skeptical about extending the abstraction of physics to all aspects of physical reality. He worried that this would have deleterious effects on religion by abstracting away "transcendental realities" like the Deity. Second, he took issue with Eddington's assertion that measurement was the basis of science:

I don't feel sure that I agree with all you say about pointer-readings. I half-feel this is confusing the measure of the thing with the thing itself. I am not ready to admit that science deals only with the metrical aspect of things. If that were seriously true it would indeed have been presumptuous in taking any philosophic outlook at all. It is well for science to be modest and decay its own competence; but there is a tendency among philosophic, theological, and artistic people to hope that the scientific treatment, which they don't understand, is far less important than it is, and that their ignorance of it is not deleterious.

He quoted his own son, a literary and artistic critic, as saying "How then can the soul of man and the universe be dealt with by people whose only real concern is pointer-readings?" Fundamentally, he was concerned that Eddington's emphasis on metricality, however well intended, would prevent physicists from saying anything meaningful about the world at all.⁴³ In an important sense, this was Eddington's agenda: to prevent physicists from linking the substance of their science to the *spiritual* world. But Lodge was continuing to defend a position in which physics was supposed to directly defend the truth of a worldview. This was a direct clash between the orthodox and liberal outlooks on both religion and science: the former outlook required universal proof and the authority to speak about proof in all contexts, and the latter depended on notions of progress, change, and personal experience.

One reviewer called the lectures "brilliant" but "dangerous," because they could make complex ideas seem more intelligible than they really were. Old-fashioned idealist philosophers were said to be pleased by Eddington, and old-fashioned scientists were suspicious. The real danger came from making unqualified people feel like they could understand what was being discussed: "Meanwhile the very width of [Eddington's] sympathies and the catholic range of his thought invite comments upon his argument from those who are least qualified to follow it in its more technical aspects. And this implied invitation is hereby pleaded as the excuse for what is here written by one who cannot claim even an elementary knowledge of those special subjects in which Prof. Eddington is a recognised authority."⁴⁴ He applauded Eddington's efforts to provide "a fresh and powerful vindication of this faith which to so many

to-day appears a pathetically groundless paradox." Eddington was criticized for focusing too much on the mind's intimate knowledge of itself. He was also skeptical that Eddington's theory of mind and matter, even if true, actually made any contribution to idealism.⁴⁵

While the reception of Eddington's ideas was to a certain degree smoothed by the long tradition of British religious scientists, it was complicated by the expectation that those scientists would be discussing some flavor of natural theology. Confusion about whether Eddington was a natural theologian was further engendered by the entry of his old rival James Jeans into the arena of popular science. Cambridge University Press was excited by the success of *Nature of the Physical World* and approached Jeans about writing a similar volume. Jeans's contact at the press suggested that he accepted the offer at least partly to maintain his "friendly rivalry" with Eddington.⁴⁶ His *Universe around Us* was a straightforward popular astronomy book and did modestly well, but it was his Rede Lecture, published as *The Mysterious Universe* in 1930, that put Jeans in the same public category as Eddington. The university press planned carefully to ensure the success of *The Mysterious Universe*, including distributing large numbers of advance copies to the press and coordinating publicity.⁴⁷

Most of the book was straightforward exposition of scientific ideas, but the last chapter, titled "Into the Deep Waters," made the dramatic claim that "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."⁴⁸ This is as straightforward a natural theological claim as one could hope for: science has shown the existence of a "Great Architect of the Universe" and reveals His character ("a pure mathematician").⁴⁹ It should be no surprise that Jeans originally wanted to title the book "Religio Physici."⁵⁰ His book was quite comfortably in the tradition of natural theology, and *Mysterious Universe* sold a huge number of copies.⁵¹ Nor was he alone. Linking science and religion in this way was still a popular (if increasingly divergent) project at the time, and books by Lodge and others filled the shelves along with Jeans's.⁵²

Jeans's emphasis on the importance of mind and "pure thought" in the universe and its creation no doubt helped link him with Eddington in the thoughts of many readers and observers (including, as I will soon discuss, Bertrand Russell). But it is crucial to note that they differ on the most important point of natural theology: whether any point of religion can be proven via science. Jeans unequivocally said yes; Eddington unequivocally said no.

Both were seen (correctly) as defending religion and traditional values, however, and their important differences were frequently glossed over in favor of "Eddington-Jeans" idealism by both supporters and enemies.

Indeterminism

Eddington's next major project in philosophy and popularization was a refinement of his interpretation of indeterminism. His contribution to the Aristotelian Society meeting in 1931, his presidential address to the Mathematical Association in 1932, and his address to the British Institute of Philosophy in the same year all focused on the precise meaning and implications of the collapse of determinism in physics.⁵³ Eddington described his contribution to the Aristotelian Society meeting as his fullest treatment of indeterminism, and I will rely most heavily on it for an examination of his views. This 1931 meeting brought together the Aristotelian Society and the Mind Association for a discussion of "Indeterminism, Formalism, and Value." The symposium on "Indeterminacy and Indeterminism" consisted of C. D. Broad, R. B. Braithwaite, and Eddington. All three agreed that determinism as a concept was either no longer useful or no longer true, although they disagreed on precisely what determinism meant. (Was it causality, predestination, distinction between past and future, etc.?)

Broad's analysis was conventionally philosophical in strategy and terminology, and Eddington explicitly declined to follow his example. Eddington instead stated that he wanted to express the ideas that best fit his outlook. By this he seemed to mean an emphasis on scientific practice and personal experience; he noted that Broad's definition of determinism was one "only an expert could employ."⁵⁴ The basis of old physical determinism was the straightforward concept of "predictability," which was simply the ability to predict the state of the world (including human behavior) at any future time. The Heisenberg principle of indeterminism (a name which Eddington noted he was apparently responsible for) did not introduce indeterminism into this scheme, but it did make it impossible to ignore. Determinism had left physics, and no amount of wishful thinking by prominent physicists could bring it back. Simply hoping that there was some underlying property of radium that would explain its decay was "a frivolous conjecture."⁵⁵ Neither indeterminism nor determinism could be proven, and Eddington argued that in science belief implied active assent—so someone talking about determinism at all was making a "groundless assertion." The onus of proof is on the person making a positive claim, in other words, the determinist. Disproof of strict causality was not necessary. Like the idea of the moon being made of green

cheese, determinism had been dismissed but not disproved.⁵⁶ Now that determinism had been dethroned in physics, it made no sense to retain it in other categories, and free will became a reasonable idea. Eddington speculated that there was clearly some kind of trigger mechanism in our bodies that eventually depended on indeterminate phenomena, but thought it would happen on the cellular scale rather than depending on a single quantum jump. The important consequence was that indeterminism in mind meant it was reasonable to attach importance and significance to bodily motions, because one was no longer obligated to explain thoughts and emotions away as being other than what they seem.⁵⁷ Our daily experience of control over our actions and interest in the outcome no longer needed to be an outrageous illusion. As he put it in a later interview: "Determinism is opposed both to our intuitions and to the evidence. Why not drop it?"⁵⁸

Eddington's audience in Trinity College that July was comparatively receptive, but sharks lay in wait. The Liberal MP, socialist, and social reformer Sir Herbert Samuel wrote a critique of Eddington's indeterminism that was the sharpest and most vigorous yet. The stakes for Eddington's arguments were said to be the very highest—the future of British society. Eddington and his colleague in popularization James Jeans were described as living in "an underworld" where shady physicists and philosophers met to discuss the most abstract of ideas. Ordinarily the average person would have no interest in this, but "suddenly they may be stirred out of their complacency by reading accounts of a sensational raid by intellectual bandits who, after stupefying their victims with mathematical formulae, try to rob them of their most valuable beliefs. There has, in fact, been lately such a raid, led by that very distinguished scientist Sir Arthur Eddington. It is high time he and his accomplices were arrested!"⁵⁹ This highly polemical article spared no energy in accusing Eddington of undermining the very foundation of society: the faith that events are the result of causes. Samuel was dedicated to the idea of social improvement through deliberate action, a philosophy he would later call "meliorism." He saw Eddington as endangering the possibility of national progress: "This, then, is no remote or unimportant discussion. It touches the very springs of thought and action in contemporary life." Eddington had led people to think they could believe anything they wanted to, a conclusion which Samuel called "perverted."⁶⁰ Albert Einstein, Max Planck, and Ernest Rutherford were all invoked as definitive authorities in physics who still held to determinism and thus refuted Eddington. Further, determinism was the basis of the productive everyday activities of chemists, engineers, and even politicians. Those interested in politics should be particularly concerned, because their project of making the world better based on reason would be made meaningless in an

indeterminate universe. If it were true that there were no causes or effects, "why trouble with our vast organisations for child welfare, education, sanitation, penal reform, anti-war propaganda or all the rest? You can have no ground for thinking that, at the end, things will be any different from what they would have been without them." Thus, indeterminism was demonstrably false because attempts at improving the world actually do make it better—and to give up on cause and effect was to prevent people from doing so.⁶¹

Samuel's article was one of the few attacks on his work to which Eddington responded directly and in a substantial way. Why might this have been the case? Samuel's critique was not particularly robust or threatening from an intellectual standpoint, but it did call out the political implications directly. And these sociopolitical implications were one of the major factors that Eddington was particularly concerned to address with his popularization. Specifically, he wanted to restore the importance of personal conviction to questions of society and politics. As a Quaker scientist, he felt he had a moral responsibility to defend liberal values.

Eddington responded to Samuel first by clarifying his position on causality. He said he did not deny that events followed from causes. Rather, he denied the universal predetermination that followed from an infinite chain of causality. Further, he argued that he had no need to prove indeterminism; the onus of proof was on the determinists. It was Samuel and other "popular science writers" who relied on a principle of causality "which has not been experimentally verified." Eddington pointed out that even Einstein admitted determinism was a positive principle. He did not shy away from Samuel's appeal to authority and particularly attacked Planck's claim that the statistical regularities of nature showed there was nothing like free will at work. Eddington retorted that life insurance companies would be shocked to learn that the free will of humans invalidated the statistics that generated their profits. He was firm that his position was not merely the idiosyncrasies of a particular scientist: "The law of causality does not exist in science to-day." The hope of Einstein and others that determinism would someday be restored was irrelevant, since interpreters in physics must base their interpretations on current theory, not on a theory that Einstein might someday produce.⁶² Eddington's payoff to his clarifications was that Samuel's worry about the "social and political consequences" was invalid—the exceedingly probable physics produced by indeterminism was identical with classical certainty for day-to-day work. Samuel was therefore wrong not just on the phenomenological front, but also in his understanding of the basis of social progress. Eddington denied the socialist principle that he saw Samuel espousing (that determinism of thought and action was necessary to improve the general welfare) and

said a future that was not prearranged by physical law was incomparably better. In such a universe one can have confidence that humans can change the characteristics of the world in which they live and have good reason for thinking their actions can have a demonstrable effect. Thus, indeterminism reproduced the best circumstances possible: physical science was useful in the world while still allowing the individual volition and responsibility that were essential to social stability and progress.⁶³ Eddington was arguing not just for a philosophical principle. His values of experience not only gave justification for indeterminism, they also invested the principle with tremendous social significance. To Eddington, the stability of a future Britain could be built only on a recognition of the reality of human experience, and his popularization and philosophy would return to this goal again and again. The foundations of physics would become the touchstone for the progress of the liberal state.

Different Forums

The success of *Nature of the Physical World* brought Eddington special recognition within the Quaker community. He was invited to give that year's Swarthmore Lecture, an annual address to the London Yearly Meeting meant to present new ideas about the meaning and role of Quakerism. His fame as a scientist and attention as a popularizer made him probably the best-known Quaker in Britain (even if most of the public was unaware of his Dissenting identity). The invitation for him to give the prestigious lectures was a measure of how well the Society of Friends thought he had represented their community through personal example. His address was published almost immediately in a slim volume as *Science and the Unseen World* and was extremely popular, going through three printings in four months.⁶⁴

He covered many of the same themes as in his Gifford Lectures, but he was clearly thoughtful about his audience. His emphasis on what he saw as the most important themes for his fellow Quakers reveals two useful features. First, he directly revealed what issues in the community he thought most pressing or fruitful to address. Second, seeing how he discussed topics also presented in *Nature of the Physical World* shows us how the Quaker labels had often been removed from those topics in the interest of ecumenicism.

Eddington's choice to begin with a poetic exposition of the evolution of the universe and human beings was interesting, as it was rather unrelated to the larger topic. It was perhaps aimed at the remnants of that older generation of evangelical Quakers who still held to scriptural literalism, or perhaps he was anticipating an outside audience with such views. Having obliquely addressed an expected conflict between science and religion, he reframed the problem in

what he saw as a more Quaker fashion. Eddington stated that the issue at hand was experience, defined as the interaction of the self with the environment. If science claimed any authority, it was because it dealt with experience, and religion dealt with experience or it "is not the kind of religion which our Society stands for."⁶⁵

With a rare scriptural reference, he explained his move away from natural theology in favor of a mystical approach to the divine:

"And behold the Lord passed by, and a great and strong wind rent the mountains, and brake in pieces the rocks before the Lord; but the Lord was not in the wind; and after the wind an earthquake; but the Lord was not in the earthquake; and after the earthquake a fire; but the Lord was not in the fire; and after the fire a still small voice. . . . And behold there came a voice unto him, and said, What doest thou here, Elijah?"

Wind, earthquake, fire—meteorology, seismology, physics—pass in review. . . . the Lord was not in them. Afterwards, a stirring, an awakening in the organ of the brain, a voice which asks "What doest thou here?"⁶⁶

The lecture focused on the mystical, seeking outlook that was the result of this focus on experience. This was present in *Nature of the Physical World* as well, but it is clear that Eddington wished to stress this aspect of science when addressing the Friends. He was validating the pursuit of scientific truth as something worthy of a religious man. His words would have been familiar to anyone in attendance at the 1895 Manchester Conference: "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 ask to attain it; it is better far that we be permitted to seek." And later: "Quakerism in dispensing with creeds holds out a hand to the scientist. . . . The spirit of seeking which animates us refuses to regard any kind of creed as its goal."⁶⁷ He sought to evoke as much kinship as possible between the religious and scientific quests.

Eddington's familiar antimaterialist position (the symbolic nature of physics, etc.) appeared without much detail, and his efforts to streamline his argument help reveal what he felt to be the essential elements. In particular, he was concerned to describe the ideas he was battling: "Let us for a moment consider the most crudely materialistic view of [the connection between mind and matter]. It would be that the dance of atoms in the brain really constitutes the thought, that in our search for reality we should replace the thinking mind by a system of physical objects and forces, and that by so

doing we strip away an illusory part of our experience and reveal the essential truth which it so strangely disguises."⁶⁸ This is what he calls elsewhere "billiard ball" materialism, and he admitted that this view perhaps was no longer widely held. But he used a rhetorical strategy whereby he took the weaknesses and unpleasantness of this philosophical viewpoint and married them to a more sophisticated materialist position, without reevaluating the new position's implications for mind. He smoothly made the struggle against this outmoded materialism synonymous with any view that placed science or matter paramount: "It is this belief in the universal dominance of scientific law which is nowadays meant by materialism."⁶⁹

To illustrate the profound limits of materialist physical explanations, Eddington spun a fable based around a moment of great emotional significance for all his readers: the annual minutes of silence commemorating the end of the Great War. "Let us suppose that on November 11th a visitor from another planet comes to the Earth in order to observe scientifically the phenomena occurring here. He is especially interested in the phenomena of sound, and at the moment he is occupied in observing the rise and fall of the roar of traffic in a great city. Suddenly the noise ceases, and for the space of two minutes there is the utmost stillness, then the roar begins again."⁷⁰ The visitor was a trained, materialist scientist and looked for an explanation for this in terms of forces and matter. There did not seem to be any reason why such an explanation would not be possible—the silence was the result of a clear series of physical events, such as feet pushing on brake pedals, and so forth. There was no supernaturalism evident. Each event came from a chain of physical antecedents ending in the human brain, but if the visitor knew the location and movement of all the atoms in the brains of all the people there, would he *understand* Armistice Day? "He understands perfectly why there is a two-minute silence; it is a natural and calculable result of the motion of a number of atoms and electrons following Maxwell's equations and the laws of conservation. . . . Our visitor has apprehended the reality underlying the silence, so far as reality is a matter of atoms and electrons. But he is unaware that the silence has also a significance. . . . The more complete the scientific explanation of the silence the more irrelevant that explanation becomes to our experience." The Martian materialist could not understand the silence, because the significance of Armistice Day could not be explained in terms of matter and motion; the significance came from human values, experiences, and emotions. It was the human reaction to the tragedy of the slaughter in the trenches that caused the silence, and that human reaction could not be captured in materialist terms. Thus, human consciousness caused, outside of the scheme of physics, a *real event*. "If God is as real as the shadow of the Great War on Armistice Day,

need we seek further reason for making a place for God in our thoughts and lives?"⁷¹ No one in the generation that had lived through the war would deny the significance of that moment of silence, and Eddington was challenging them to consider their experience of God with the same seriousness.

Comparing *Science and the Unseen World* to *Nature of the Physical World* provides a clear example of Eddington's sense of shared values between religion and science. The everyday world of solid tables and waves on the ocean described in his Gifford Lectures became, in Friends House, the *spiritual* world. What was spiritual about the everyday world? It was based on values of practicality, efficiency, and utility—the very bases of the Renaissance Quaker. Eddington had argued in many scientific situations the importance of these values, and his Swarthmore Lecture gave him the first opportunity to explicitly celebrate their importance for a Quaker life as well.

Science and the Unseen World received wide circulation despite its small printing and was popular perhaps because of its more succinct presentation of the ideas found in the somewhat lengthy *Nature of the Physical World*. The emphasis of *Science and the Unseen World* on personality was attractive to many who sought to defend idealism, as was Eddington's refusal to base religion on scientific discovery.⁷²

An edited version of *Science and the Unseen World* was even published by a freethinker press in the United States. Following in a long-established pamphleteering tradition, Emanuel Haldeman-Julius of Girard, Kansas, printed an edited *Science and the Unseen World* so he could append his own rebuttal to Eddington.⁷³ Haldeman-Julius (born Julius, he adopted his wife's name) was an extremely successful publisher focusing on self-help, education, and freethinking material. His "Little Blue Books" were a tremendous marketing innovation, selling over 100 million copies in a decade. The books, among the first mass paperbacks, sold for a nickel and were widely read.⁷⁴

Haldeman-Julius originally entered publishing through a socialist newspaper, and his books provided a forum for many atheist and anti-Catholic writers. His reply to *Science and the Unseen World* elaborates the antireligion materialist position as it stood in the middle of the interwar period. Its similarity in America and Britain, despite the significant differences in the Marxist movement in those countries, indicates that the literati of socialism were perhaps more homogeneous across borders than might be expected.

His attack on Eddington aimed at the very point that *Science and the Unseen World* was most concerned to defend: the validity of the identity of the religious scientist. His jeremiad opened with incredulity at the entire concept: "The combination of a scientist and mystic must ever seem too curious for belief. . . . Consistency is an obstacle that can be evaded in many adroit—or

even unconscious—ways. . . . Perhaps it would be unfair to say that Prof. Eddington is trying hard to make himself believe something which his reason cannot very plausibly or firmly endorse; yet that is the impression which is somehow left, after a perusal of his feeble sermon. . . . Undoubtedly he is sincere. It seems he really finds satisfaction in his incongruous twofold character of scientist and mystic. But how little it takes to satisfy him!"⁷⁵ As with many other polemics against Eddington, this one portrayed him as a good-natured but feeble-minded dupe being manipulated by the forces of oppressive theology. Haldeman-Julius expressed relief that few scientists led such a "double life." Eddington's reliance on spiritual experience as evidence was portrayed as a pathetic retreat to primitivism. "But essentially there is no difference between Prof. Eddington, talking about what the spirit feels of God and the 'unseen world' and a Tennessee yoked dancing and yelling under the influence of the Holy Ghost. I say [this] quite seriously as defining the sort of 'experience' which Prof. Eddington would have us look upon respectfully, aye believably." If we were to accept that kind of evidence, Haldeman-Julius argued, we would have to be charitable to assume it had been arrived at "without the aid of whiskey or dope."⁷⁶ He insisted that materialism was wholly competent to explain not just religion, but also the aesthetics to which Eddington appealed. Eddington's attempt at being a mystic-scientist was a futile attempt to defend the indefensible.

Pamphlets like this were part of an explosion of popular writing on science and religion, of which *Nature of the Physical World* was part of the vanguard.⁷⁷ These issues found their way into new media as well; in late 1930 the recently established BBC aired a symposium on science and religion.⁷⁸ Public interest had been whetted, and there was demand to hear the opinions of the experts.

The broadcasts were made between September and December, and their stated purpose was to make available "a personal interpretation of the relation of science to religion by speakers eminent as churchmen, as scientists, and as philosophers; and to determine, in the light of their varied and extensive knowledge, to what degree the conclusions of modern science affect religious dogma and the fundamental tenets of Christian belief."⁷⁹ The disciplines of participants were varied, though philosophy was heavily represented and a few religious leaders seem to have been brought in solely to assuage fears of a disrespectful discussion.

J. S. Haldane and Eddington were among the main scientists invited to speak, and they represented two of the bodies of thought on religion that were becoming influential in the scientific community. Eddington, of course, described the symbolic skeleton of physics and the eclipse of determinism. He made it clear that this was all he could say as a scientist, and he appealed to

personal intuitions of spirituality as necessary to move beyond. His presentation of the spiritual world was broadly conceived and included "a sense of beauty, of morality, and finally at the root of all spiritual religion an experience which we describe as the presence of God." As always, he was concerned to connect religious experience with human experience as a whole, to integrate religion with life as deeply as possible. He made his rejection of the need or possibility of the proof of religion a major part of his broadcast; he was likely responding to the many reviewers of *Nature of the Physical World* who either critiqued him for not providing proof or thought he was providing proof.⁸⁰

Haldane argued against the preeminence of the physical science that supported many religious perspectives like Eddington's. Holism was the answer to science's problems, and physics was nothing but trouble: "Neither biology nor philosophy can afford to cringe before the physically interpreted or mathematically formulated universe." The exactitude of the physical sciences came only from their idealized view of the universe, and this idealized view had become a "nightmare" that the world was trapped in. Biology and its implied holism was needed, first, to save science from itself and, then, to provide a justification for concepts like personality and God. If holism was accepted, Haldane reasoned, then we would need to recognize things that have no material existence as emergent properties of those that do. The human mind was a holistic property of the brain, and God was a holistic property of the universe.⁸¹

The theologians and philosophers present had a mixed reaction to Eddington's ideas. Samuel Alexander disputed that we could know our own mental states better than the material world, while Dean Inge was suspicious of attempts to strictly demarcate intellectual territory.⁸² Inge was not so impressed by claims that science and religion were no longer in conflict, but was intrigued that so many eminent scientists seemed to have been "driven" to theism.⁸³ He was pleased that Eddington was defending a liberal theological position and rejecting syllogistic proof in favor of the unanimity of mysticism. L. P. Jacks agreed that Eddington's and Haldane's stress of personality was more in line with contemporary theology; Eddington's striving after truth was more like Rudolph Otto's *mysterium tremendum* than was Alexander's metaphysically motivated deity.⁸⁴ Jacks called Eddington's contribution "the pivot of the symposium," in that it best expressed the values that liberal theology was championing: the centrality of the person, experience, and the human desire for truth.⁸⁵

The symposium was a fascinating snapshot of British viewpoints on science and religion. The theologians and religious leaders included both the old guard and the new, and the style of their contributions is a useful barometer for the cultural position of their religious outlooks. The orthodox High Church

representatives' contributions were virtually indistinguishable from what would have been written in a similar discussion fifty (or even a hundred) years before. To them, science either had not fundamentally changed since then or its change was of no significance. Their arguments about religion and science were in principle identical to Paley's and Whewell's. This reflected the state of their religious community as well; they had been resisting change strongly and generally reacted to attempts at modernization by a hardening line.

The representatives of the liberal religious community, however, had a completely different character to their contributions. They were daring, ambitious, and aggressively sought to bring the most modern of knowledge (scientific or otherwise) into play. They were optimistic about the notion of both improving the state of religion and using religion to improve society at large. To them, progress was key to resolving all issues of religion, especially those bordering on science. They thought of themselves as defending a particularly modern approach to religion. One spokesman declared that it was "the conviction of the Modernist that religion meets an indispensable human need. The Modernist desires to preserve and conserve all those values in our personal and social life." Attachment to scripture was discarded, and the liberal approach was seen as a way to restore religion to a leading role in British society: "[Modernism's] mission [is to] seek to educate the alienated masses in moral and essential truth."⁸⁶ The liberals' embrace of innovation and improvement was fundamental to their arguments, and the confidence of those arguments in the BBC symposium was a striking contrast to the bland conservatism of the orthodox religionists. The British religious community was at an inflection point where the tension between the liberal and orthodox outlooks was shaping the course of the nation's religiosity. Eddington had chosen the liberal side and, indeed, was embraced by them. Eddington's ideas, particularly those in *Nature of the Physical World*, were seen as important resources for the liberal theological outlook and provided an influential framework for progressive thinking on science and religion. His valence values allied him with the forces of social liberalism, but those bonds were seen by many as dangerous violations of the boundaries of proper science. The same contributions to liberal thought that made Eddington such a celebrated public figure also made him a target for academics with a different social agenda.

When Philosophers Attack

One of Eddington's best-read critics, and one of his credible rivals as a science popularizer, was Bertrand Russell. By the 1920s, Russell was already equally famous, both for his contributions to logic and his political agitation. Largely

fueled by his need for financial stability, his writings became gradually more accessible after 1920 or so, and the combination of his razor-sharp intellect and his role as unending social disruption helped attract public interest.⁸⁷ His reaction to Eddington's philosophy provides an interesting case study: Russell performed a nearly complete about-face with respect to Eddington's capabilities after reading *Nature of the Physical World*. In this he is an excellent example of how both critics and supporters thought about Eddington. Once Eddington made clear his thinking on spirituality, his ideas became an inextricable part of the debate about the nature and role of religion in the modern world.

Russell's 1926 *Tarner Lectures* eventually became his widely read *The Analysis of Matter*.⁸⁸ Here he investigated the philosophical outcome of modern physics. He was particularly concerned with how logical analysis could be brought to bear on the problems of matter, causality, and natural law. A significant amount of the book was spent addressing the impact of relativity on the philosophy of science, and Russell returned again and again to Eddington's writings on the subject. He did not agree with all of Eddington's ideas, but he was clear that Eddington's proposals (such as tautological and epistemological laws) needed to be treated carefully and seriously. He said that Eddington's methodology for unifying relativity with laws of nature might appear unorthodox but was essentially no different from conventional scientific methods. Criticisms of Eddington were respectful and often were simple requests for Eddington to clarify or further develop his ideas.⁸⁹ In treating Eddington's theory of matter, he did not accept the theory, but he used it as a model of "the sort of definition to which modern physics is bound to be led."⁹⁰ Russell even credited Eddington with being his guide in thinking about the philosophy of relativity and explicitly said that *Mathematical Theory of Relativity* and *Space, Time and Gravitation* were important philosophical resources: "The theory of relativity, to my mind, is most remarkable when considered as a logical deductive system. That is the reason, or one of the reasons, why I have found occasion to allude so constantly to Eddington. He, more than Einstein or Weyl, has expounded the theory in the form most apt for the purposes of the philosopher."⁹¹ At all times, he treated Eddington respectfully and as a colleague in philosophy. Eddington was portrayed in *Analysis of Matter* as someone who knew what he was doing and who could make meaningful contributions to the philosophy of physics.

This was about a year before Eddington's Gifford Lectures, which completely changed Russell's treatment of Eddington and his ideas. *The Scientific Outlook* was Bertrand Russell's first major response to Eddington's popularizations. Eddington received credit for his expository abilities, but that was nearly all.⁹² The book was highly critical of scientists speaking outside their

fields of expertise, and it is easy to see that the targets are Eddington and Jeans even before their names appear. Russell railed against any careful scientist who expressed "wholly untested opinions with a dogmatism which he would never display in regard to the well-founded results of his laboratory experiments." Scientific versus religious knowledge was an important theme of the book, with the former being associated with induction and the latter with deduction. His example of this conflict in the trial of Galileo made his thoughts on their relative value quite clear, and pure deduction was singled out for as much bile as theology.⁹³

Eddington was explicitly targeted as a danger to the very existence of science. "Whoever wishes to know how and why scientific faith is decaying cannot do better than read Eddington's Gifford lectures." Eddington's idea about identical laws, which in *Analysis of Matter* was treated as worthy of serious investigation, was now dismissed with: "respect for Eddington prevents me from saying it is untrue."⁹⁴ Russell was angry with Eddington's reservation of a nonscientific part of human experience: "Eddington proceeds to base optimistic and pleasant conclusions upon the scientific nescience which he has expounded in previous pages. This optimism is based upon the time-honoured principle that anything which cannot be proved untrue may be assumed to be true, a principle whose falsehood is proved by the fortunes of bookmakers. If we discard this principle it is difficult to see what ground for cheerfulness modern physics provides." Eddington's claim that religion was somehow aided by modern physics was dismissed as fantasy. Further, he wondered whether Eddington's "scientific scepticism" would bring about the "collapse of the scientific era."⁹⁵ Russell speculated that the recent tendency for intellectuals to profess reconciliation of science and religion was only coming about because bishops saw Bolshevism as a common enemy with science. "It follows, of course, that science, if pursued with sufficient profundity, reveals the existence of God." Eddington and Jeans were giving up science's claims to total knowledge and were approaching the old order and apologizing for science's past arrogance. "In return, the established order showers knightshoods 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."⁹⁶

Russell grew increasingly cynical through the course of the book, and his prose was liberally scattered with accusations and insinuations that scientists like Eddington were simply capitulating to a corrupt, aristocratic, and capitalist system: "what they have said in the way of support for traditional religious beliefs has been said by them not in their cautious, scientific capacity, but rather in their capacity of good citizens, anxious to defend virtue and property." The war and the Russian Revolution had made all timid men

conservative, and all professors were said to be timid men.⁹⁷ He seemed particularly bitter about James Jeans's knighthood.⁹⁸ There was plenty of scorn for the religious institutions as well: "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. 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 more sensational accounts of the theologians, so that the general public has derived the impression that physics confirms practically the whole of the Book of Genesis."⁹⁹

Eddington's interpretation of quantum indeterminism in defense of free will was attacked from every possible angle. Russell denied that mind could influence matter in any way, that atomic behavior was in any way indeterminate, that the uncertainty principle implied any kind of scientific ignorance, and that quantum indeterminacy would be a permanent part of physics. He also denied Eddington's defense of free will as something that we can experience, invoking Pavlov's experiments as evidence that conscious choice was subject to empirical laws.¹⁰⁰

Jeans was dismissed as a modern-day Bishop Berkeley, and Eddington as a modern day Descartes. Russell was particularly irritated that the two professed completely incompatible views about the universe, but were both seized upon by religious leaders: "Eddington deduces religion from the fact that atoms do not obey the laws of mathematics. 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 the cold reason and must not interfere with our deeper religious feelings." He marveled that theologians could be enthused at all about the sort of God given to them by modern physics: the deity was either a supremely distant mathematician or quantum fluctuations, neither of which Russell thought would provide much comfort.¹⁰¹

Russell said that Eddington's attack on scientific knowledge was coming at a time when humanity was having great difficulty integrating science into modern society, and Eddington was just making it more difficult. Crises such as the Great War indicated there were serious dangers, but Russell warned that going back to the "infantile fantasies" of religion was not going to help. To lose faith in our ability to have knowledge was to "lose faith in the best of men's capacities."¹⁰²

The difference between Russell's treatment of Eddington in 1926 and 1931 is stark. Ideas that were formerly considered to be worthy of serious

investigation were now dismissed with barely any consideration. More importantly, Eddington was no longer being treated as a professional colleague who could be disagreed with respectfully. Instead of being an important ally in examining the philosophical implications of modern physics, he was a lackey to theologians and knightly honors. Not only was he wrong, he was *completely* wrong, with every statement or suggestion being useless. Why did this shift occur?

Despite his claim otherwise, Russell clearly did not think intellectuals should never speak outside their direct area of expertise—the last section of *The Scientific Outlook* was devoted to his ideas on social engineering.¹⁰³ It is clear that what changed Russell's view of Eddington was specifically the issue of religion. When Russell could read Eddington's philosophy as being solely motivated by physical science, it was useful and worthy of study. But when *Nature of the Physical World* revealed that Eddington's religious values were involved significantly in his philosophical thought, the whole structure of Eddington's work underwent redefinition from scientific to religious. Russell's outlook on science and religion was wholly binary. Science was inductive, rigorous, empirical, and the future of humanity. Religion was scholastic, dogmatic, and a throwback to primitive times. Something could only be properly scientific if it had no trace of roots in or support for religion.

Of course Eddington's religious values were involved in *Nature of the Physical World*; it could not have been written without them. Russell's allergic reaction to those values, and his shifting of the categorization of Eddington's ideas, made it impossible for him to see what the actual project of the book was. Even though Eddington explicitly rejected any notion of proving the existence of God or the truth of religion, he was still grouped together with Jeans in that task. Both were reduced to the role of stooge to the religious establishment, because that was the only role Russell could imagine for a scientist writing amicably about religion.

It should be no surprise that Eddington's and Jeans's philosophical writings were more widely read than those by almost all other "professional" philosophers. Many philosophers were frustrated not only that the physicists did not seem to be doing very good philosophy, but also that the two were representing the discipline of philosophy of science to the larger public. One influential philosopher who tried to remedy this was L. Susan Stebbing, a professor at the University of London.

Stebbing wrote a series of articles in the 1930s criticizing the "nebulous philosophy" of Jeans and Eddington and a book in 1937 that summarized her arguments. She sought to reveal the grounds of their philosophical views to free the reading public and philosophical community that had been trapped

by their speculations. They "are not always reliable guides. Their influence has been considerable upon the reading public, upon theologians, and upon preachers; they have even misled philosophers who should have known better." Eddington's fundamental problem was described as "his strong philosophical bent [which] makes him anxious to connect his philosophy of science with his philosophy of life at all costs."¹⁰⁴ This led to his tendency to omit critical information and provide a misleading emphasis.

Jean's and Eddington were both censured for their desire to be entertaining in their writings. More precisely, their problem was that they tried to arouse a reader's emotions, which was an intolerable abuse of the common person's interest in science. While acknowledging that Eddington was an "original thinker," his and Jean's appeal to emotion reduced them to "the level of revivalist preachers." This, Stebbing announced, was a violation of the scientific spirit.¹⁰⁵ It leaves the reader in a state of mental confusion, unable to distinguish between metaphor, inexactitude, and science. Even attempts at humor are counterproductive, because readers think they understand something when they have really only been entertained.¹⁰⁶

Stebbing acknowledged that Jean's and Eddington had different arguments, but both were trying to claim that it "is within the competence of physics to establish that there is a God." Jean's was dismissed quickly as "almost pathetic" and an out-of-date pretender to philosophy.¹⁰⁷ Most of the book was dedicated to refuting Eddington or, more precisely, to showing that his expositional strategies made him unreliable as an authority. She attacked his tendency to use commonsense language to make important points, without making it clear when metaphor or analogy was being used. Eddington's folksy descriptions could not be defended as mere illustration, because they were fundamental to the argument being made. This imprecision of language was a sign of his confused thinking.¹⁰⁸ Her criticisms with respect to content revolved around a denial that Eddington's schism between the mental and material worlds was correct or even meaningful. Like Russell, she saw this split as a rejection of empiricism and a misunderstanding between the symbol and the symbolized. Again like Russell, she was piqued by the tendency for Eddington and Jean to be given positions of great cultural authority: scientists "have long aspired to the mantle of the prophets; now we thrust the mantle upon them."¹⁰⁹ Stebbing saw herself as a defender of knowledge and was frustrated by the elevation of scientists who celebrated that science knew less than it once did.

The only substantial defense Eddington offered against his philosophical critics was in his 1934 Messenger Lectures, delivered that spring at Cornell, which were published shortly after as *New Pathways in Science*. One chapter was devoted to addressing his critics and his "over-enthusiastic friends,"

and he lamented not having had the opportunity to respond in all circumstances.¹¹⁰ He first defended himself against those reviewers who in some sense objected to any nontechnical presentation of technical material. His defense of the project of popularization provides insight into his motivation and methodology:

The aim of such books must be to convey exact thought in inexact language. . . . [The author] will not always succeed. He can never succeed without the cooperation of the reader. . . . It is not a question of stepping down from the austere altitude of scientific contemplation to a plane of greater laxity. To free our results from pedantries of expression, and to obtain an insight in which the less essential complications do not obtrude, is as necessary in research as in public exposition. We strive to reduce what we have ascertained to an exact formulation, but we do not leave it buried in its formal expression. We are continually drawing it out from its retreat to turn it over in our minds and make use of it for further progress; and it is in this handling of the truth that the rigor of scientific thought especially displays itself.¹¹¹

So the deep thought and concentration needed to make science comprehensible without technical language was actually useful for scientific research, in that it forced the constant reevaluation necessary for progress. The values that supported popularization, then, were the same that supported science as a whole.

Eddington saw his philosopher critics as all starting from a basic disbelief in the primacy of mind. His attempts to directly refute the philosophical arguments of attackers such as the philosopher of religion W. T. Stace were generally weak, and it seems that Eddington was aware of this weakness. He instead tried to defend his enterprise as something slightly new, a "scientific philosophy" that should be treated differently. Philosophy, he said, often attacked only those problems accessible to the full tools of logic: that is, ones that could be brought to a rigorous conclusion. Eddington, on the other hand, said his goal was never the elaboration of a philosophically complete and final position. Rather, his job was merely to show that "the new scientific philosophy is not quite the defenceless victim" that philosophers assume.¹¹² To him, this disarmed the earlier criticisms of the philosopher C. E. M. Joad, which were merely about inconsistencies of expression. Eddington felt that because his task was scientific, it should be judged by scientific standards, not philosophical ones:

I do not think that such discrepancies will appear so heinous to a scientist as they do to a philosopher. In science we do not expect finality. The theories described in the scientific part of this book do not form a complete and

flawless system; there are incoherencies which we cannot remedy until further research gives us new light. It may well be that the scientific theory will be substantially modified in its future progress toward completion; nevertheless we feel justified in claiming that our present imperfect results embody a large measure of truth. I naturally look on scientific philosophy as subject to the same progressive advance.¹¹³

It did not disturb him if there were loose ends that did not yet fit into a system. There was no surprise when that happened in science: why should scientific philosophy be any different? Formal consistency was not as important in physics as in philosophy, because physics did not have to rely on formal consistency alone. Eddington did not want to "suppress the many-sidedness of the truth" in physics, with the result that he saw himself as easy prey for those seeking inconsistency.¹¹⁴

As for the occasional criticism that he had been too dogmatic in his assertions, Eddington blamed the mathematicians: "In summarising conclusions for the general reader, mathematical and physical considerations become fused together, and it is impossible to show without elaboration of technical detail where the dogmatic mathematical deduction ends and the plausible physical inference begins. You may therefore find that a book which on the whole reflects the liberal undogmatic attitude of science is chequered with pronouncements which suggest omniscience and intolerance."¹¹⁵ One of the philosophers most concerned with Eddington's apparent dogmatism was Russell. Eddington seemed somewhat offended that Russell had treated him so harshly, especially since he considered their philosophies as kindred projects: "I think that he more than any other writer has influenced the development of my philosophical views." He was frustrated that Russell, like many other readers, had suggested that he was proving religion via physics. "I have not suggested that either religion or free will can be deduced from modern physics; I have limited myself to showing that certain difficulties in reconciling them with physics have been removed."¹¹⁶

Engagement with the Materialists

The science popularizers who argued for the materialism that Eddington saw as so dangerous did not generally become active until *after* his early popular writings. There were some earlier publications, but for the most part Eddington was responding directly to one or both of two manifestations of Marxist thought. The first possibility was that he learned of Marxist approaches to physics through his colleagues at Cambridge and their enthusiasm for the

philosophy. This could have been through word of mouth, casual conversation, and personal communications that have left no documentary record. If Eddington was reacting to this, he would have been reacting to the earliest emergence of these ideas in Cambridge, because Marxism did not gain serious momentum among scientists there until a few years after *Nature of the Physical World*.¹¹⁷ A more likely target for him was the ill-defined notions of socialist materialism that had been causing tremendous anxiety in Britain in the wake of the Bolshevik rise to power in Russia. This anxiety was particularly present in the religious community, as they saw their very way of life endangered by the idea of a materialist universe. Materialism as a threat to religion was certainly not a new issue in Britain—intellectuals had been grappling with that issue for most of the nineteenth century. The consequence of this was that Christians of all flavors, including Eddington, were already on guard against anyone arguing for materialism. Eddington's arguments about the dangers of mechanism were similar to other liberal Christian thinkers and can probably be traced back indirectly to the Hans Driesch Gifford Lectures of 1907–8.¹¹⁸ These lectures put forward the basic twentieth-century version of the concern that a materialist outlook would destroy moral responsibility, and their basic framework appeared all over the English-speaking world up to World War Two. Their arguments had been designed to refute X-Club-style materialism but were smoothly adapted to battle Marxism after the Russian revolution.¹¹⁹

Churches across Great Britain panicked in the late 1920s over what they saw as encroaching materialist atheism spurred on by the Soviet Union.¹²⁰ The General Strike of 1926 was seen by many as a dramatic sign that Christian civilization was in mortal danger from materialist philosophy. Many blamed materialist views for the disaster of the Great War itself.¹²¹ The Quakers were no exception, although their interaction with socialism was somewhat complicated and evolved over time. Eddington's Jesus Lane Meeting had provided meeting space for socialists before and during the Great War as part of a program to raise funds (he and his sister were on the committee that decided to rent out the space). During the war, the Quakers and the socialists found themselves allies as persecuted pacifists—the Cambridge Socialists had even been dragged out of the Jesus Lane Meeting House by the police.¹²² This brief alliance soured after the war, when the aggressively atheist Bolshevik regime and its British supporters seemed to threaten all forms of religious belief. The Quakers as a body, and Cambridge Quakers in particular, split internally on how to think about socialism and its more threatening cousin, Marxism. The Cambridge Friends Meeting grappled with these issues in 1927, just as Eddington was revising the manuscript of his Gifford Lectures. The

meeting examined the question "What is the function of the Society of Friends as a Christian Group with regard to Industry and organised society?" Their answer to themselves was:

We believe that the true function of the Christian Church is to lead men individually to Jesus Christ and His way of Life; and by this way alone can human society be redeemed from the disharmony in which it now lies. It is desirable that some, perhaps many, of our members as individuals or groups should be concerned in the details of schemes for the improvement of the economic and social conditions of men, but the true function of our Society . . . is to lay down general principles of Christian Conduct . . . [rather] than to enter into the details of economic and industrial reconstruction.¹²³

Religion, not Marxism, was agreed to be the route to social improvement. Many Friends felt that their commitment to social justice included issues of economic justice and tried to persuade their meetings to support socialist goals. Very few meetings ever achieved consensus on this issue, leaving the conservative opposition to socialism and Marxism as the official stance of most Friends meetings.

Discussion tied to the basic issue of the proper relationship of religious people to socialism and Marxism was a constant feature of Quaker communities in the late 1920s and 1930s. Eddington could not have avoided thinking about this; in some sense, it was one of the dominating concerns of the day. He was similarly confronted with Marxism at the university. Cambridge was a hotbed of Marxist approaches to science, and the popular writings of J. D. Bernal and others were having an increasing public impact. There is no indication that Eddington read deeply in any materialist writings. His vision of a "moral materialism" appears to have been formed through secondhand conversation and late nineteenth-century mechanical philosophy. The version of materialism he presents in his writings shows no links to actual contemporary materialists, but it is strikingly similar to the version spoken of in the British Quaker community at large.

British materialists themselves were quick to react to Eddington's idealist philosophy of science. He represented all that was wrong with bourgeois science: he was an idealist, a religious believer, and ignored the need for applying scientific ideas to society.¹²⁴ For example, Lancelot Hogben's *The Nature of Living Matter* was explicitly, and by request, written to refute the dangerous idealism of Eddington and his fellow idealists.¹²⁵ Hogben called Eddington's arguments "profoundly misleading" and "solipsistic." J. D. Bernal, the crystallographer and passionate Marxist, warned that, through Eddington, "a new scientific mythical religion is being built up."¹²⁶

Writers like Hogben, Bernal, Hyman Levy, and V. A. Ambartsumian would eventually go on to be the mainstays of the social relations of science movement, and Eddington remained a popular target for them throughout the 1930s. There are many possible examples of this worth examining, but here I will pursue Christopher Caudwell's *The Crisis in Physics*.¹²⁷ Caudwell's Marxist credentials were unimpeachable (he devoted his life to spreading the gospel of Marx and was killed on the Republican side of the Spanish Civil War), and his argument was so purely ideological that it provides a crystal-clear distillation of the standard Marxist objections to Eddington's ideas.

Crisis in Physics was aptly named, as its goal was to articulate a worldwide, interrelated crisis of economics, politics, and "bourgeois physics." Caudwell thought that the writings of contemporary physicists "reveal a general feeling of collapse of the old order, together with a complete helplessness and lack of understanding as to its cause, which is characteristic of certain elements of society in a revolutionary crisis." This crisis destroyed all true synthetic views, and conservatives could react only in ways such as Eddington's "mystical positivist attitude to all spheres of ideology outside one's little garden."¹²⁸ Physics was inherently bourgeois because it placed humans over nature just as capitalism put the owners over the workers; or, in different language, nature was a machine, and the machine was a slave to the bourgeois. The goal of bourgeois physics, as demonstrated by Eddington, was to create a "closed world": this had the mind outside the world and was designed to dominate the environment.¹²⁹ Eddington's attempts to do so "indicate the extraordinary confusion and helplessness of the scientists of to-day" when faced with the breakup of the bourgeois worldview. They were driven to outrageous kinds of reactionism, and Eddington wallowed in "the double-decadence of positivism and mysticism."¹³⁰ Bertrand Russell and Eddington were both singled out for relying on mathematical manipulation instead of experiment, and they were said to be symptomatic of the drift of theory away from practice. Caudwell closed with the common Marxist accusation that what Eddington really wanted in the end was determinism—just determinism run by the brain.¹³¹

Generally, Eddington proved reluctant to engage his critics in public debate. Consider that most of his rebuttals to nearly a dozen different critics were packed into one chapter of one book. At one point he claimed that his arguments simply needed no continued support: "I have not hitherto replied to any unfavourable criticisms of my book . . . If my contentions are of value they will ultimately find their proper level without continual parental intervention to save them from determined opponents—and, perhaps it should be added, from over enthusiastic friends."¹³² This seems not completely likely at first glance. Certainly he did not feel his scientific contentions should be left

to stand without defense—his famous controversies with Jeans and Chandrasekhar make it clear that he was more than willing to fight for his ideas when challenged. And as discussed above, his Messenger Lectures contained some counterattacks against his critics. There is the possibility that Eddington thought of his popular works as falling into a different category from his physics and therefore needing a less aggressive approach.

There is some indication that Eddington was particularly sensitive about *Nature of the Physical World* coming under attack from trained philosophers.¹³³ As he was formally untrained in philosophy, it may be that he did not feel entirely comfortable dealing with their criticisms. In any case he was right that his book would become a target (e.g., Russell's and Stebbing's attacks), and his only real public response in his Messenger Lectures was hardly a substantial defense. There may have been a personal psychological issue at work here. Many colleagues, students, and friends noted that he was essentially quite shy, and his reluctance to engage in public debate outside his area of direct expertise may have reflected this. This leaves us with the puzzling circumstance of his public exchange with Chapman Cohen (see fig. 6.1), the head of the National Secular Society, editor of the aggressively atheist newspaper the *Freethinker*, and highly visible spokesman for materialism. Cohen devoted over two months of weekly articles to attacking Eddington's views as presented in *Nature of the Physical World* and *Science and the Unseen World*, and Eddington responded at length in the *Freethinker*.

Why was Eddington willing and eager to reply directly and at length to Cohen when he explicitly said he had no interest in intervening to defend his philosophical ideas? Why did he spend more time in debate with Cohen than with any other person? At the beginning of his response, he said this was because Cohen was “a downright opponent; at the same time he is a fair-minded opponent, anxious to avoid misrepresenting my meaning, and too sincere to strive after merely verbal triumphs. In such a case there is an inducement to try to elucidate the position.”¹³⁴ While one could reasonably call Cohen fair-minded in the sense that he was careful to clearly state his opponents' positions, he was famously gifted at scoring “merely verbal triumphs.” There was little in Cohen's extensive and sharp-toothed debating history that justified Eddington's warm assessment. Certainly, he had no moral or intellectual high ground relative to Eddington's serious philosopher critics such as Russell. So why, then, was Eddington so interested in contesting Cohen's criticisms? It was because Cohen, as an atheist materialist, was the exemplar of the social danger *Nature of the Physical World* and *Science and the Unseen World* were written to combat. Eddington's disagreements with Russell, while probably more interesting to Eddington and more dangerous to his academic reputation, turned



FIGURE 6.1
Chapman Cohen.

on matters of far less volatility and social importance. As with his response to Herbert Samuel, Eddington saw his engagement with Cohen as making a substantial contribution to the burning question of interwar Britain: Would the country reclaim its endangered heritage as a moral, religious nation, or would it spiral into the totalitarianism and materialist moral bankruptcy of the Russian revolution?

Chapman Cohen grew up in England in a nonreligious Jewish family. As he described it, he was brought into the world a decade after *The Origin of Species* and grew up alongside the materialism the book inspired. He had no dramatic story of his conversion to atheism and was scornful of atheists who felt the need for such stories. Cohen felt that anticreation stories only gave

credence to religious belief and harmed atheism by putting it on an equal footing with religion. Religion belonged to "the childhood of the race" and should not be compared to the triumph of science.¹³⁵

His approach to religion was simple. He argued that the history of free thought in Britain had been too much concerned with putting atheism and agnosticism on the same level as religion, whereas he sought to put "the Christian army on the defensive from the very first."¹³⁶ This was necessary because religion was so deeply ingrained in British society that it needed to be confronted directly. Belief in religion was always being perpetuated under other names because it underlay the "thinly disguised aristocratic form of government" that continued to rule the country.¹³⁷ Christianity had a low moral value and was just "a form of camouflaging an unintelligent selfishness." It was a religion that functioned on the capitalist profit model—be good so you will be rewarded later.¹³⁸ The religious theory of life was hopelessly wrong. Religious experience was just a kind of abnormal psychological state brought on by social suggestion and physical practice and had no more validity than the visions of an opium addict.¹³⁹

Cohen took over the *Freethinker* from its founder, G. F. Foote, in 1915 and described its mission as being to "employ the resources of Science, Scholarship and Ethics against the claims of the Bible as Divine revelation."¹⁴⁰ He wanted to defend atheism, the highest state of evolution of a society, and this would be achieved by the bound engines of science and materialism. The newspaper received a great deal of negative attention from the religious community: Dean Inge described it as "a newspaper called the *Freethinker*, which exists partly to deny with vehemence the possibility of free thinking."¹⁴¹ Foote thought the essence of science was the concept of natural law, and this was the base of his belief in materialism. Atheists were supposed to hold that the cause of life and mind was to be found in matter as an emergent property. Any attempt to find an underlying reality beneath matter was simply a remnant of half-understood ideas about God.¹⁴² Cohen explicitly and definitively rejected any sort of separate-spheres argument. Science and religion came from differing interpretations of the same phenomena, and conflict was inevitable. Indeed, conflict was essential to ensure the victory of "civilised" over "uncivilised" thought.¹⁴³

Cohen argued for a thorough and unbreachable determinism. This was somewhat more sophisticated than a Laplacean man-as-machine viewpoint but still allowed no room whatsoever for free will or moral responsibility in the Christian sense. He wrote a manifesto for this position in 1919 in which determinism was described explicitly as the application of the principle of causality to human nature.¹⁴⁴ There was no boundary between mind and matter, so there was no a priori reason to restrict causality. If we knew all the

forces acting on a person, "the forecasting of a conduct would become a mere problem in moral mathematics. . . . The Determinist claims, therefore, that his view of human nature is thoroughly scientific."¹⁴⁵ The advanced sciences had already replaced a kind of volitional, animistic interpretation of nature with a mechanistic view insisting on deterministic laws. This had not yet happened in the human sciences, but there could "be no reasonable doubt" that it would.¹⁴⁶ The only resistance to this was from theology and its continuing ability to manipulate society. "Volitionists" had no evidence other than that of consciousness, but what could consciousness ever really tell us? It could do no more than testify to its own states, but not what those states meant. The will had no concrete existence that was meaningful. Any sense in which humans were able to make choices was illusory, because any choice would be determined by external forces and social laws.¹⁴⁷ Determinism, thus, was not restricted to mechanical models (though it was closely associated with them). It was, instead, a declaration that all phenomena in the universe, including mind and morality, were subject to causation that could be divined by science.

In addition to his work on the *Freethinker*, Cohen constantly sought out opponents to engage in public debate. He began his career as a professional atheist by standing atop boxes in Victoria Park and addressing hostile crowds. (He even claimed to have been beaten by a Christian mob on more than one occasion.) Cohen still felt that high-profile confrontations were critical to the growth of free thought. As I discussed earlier, Eddington's and Jeans's books triggered an upsurge in claims that materialism and atheism had been wrecked on the shoals of modern physics. This encouraged both defenders of idealism or religion to promulgate their views more widely and defenders of materialism to challenge them.

This led to a 1928 public debate between Cohen and the philosopher C. E. M. Joad on whether materialism had been "exploded" by the new physics.¹⁴⁸ Their confrontation turned largely on ideas put forth by Eddington in *Nature of the Physical World*, and both debaters positioned themselves with respect to that book. Cohen wasted no time in making his position clear: "When I talk of Materialism I mean the conception that the whole of the phenomena of Nature—physical, chemical, moral, mental, and social—are ultimately explicable in terms of the composition of forces. Materialism means that, and I say that science means that or nothing." He said this view was in no way tied to a particular understanding of matter; it was simply a question of naturalism versus supernaturalism.¹⁴⁹ Joad retorted that he was no believer in supernaturalism and that such questions were beside the point. The issue was that physics had "dissolved" matter into a space-time continuum that had no resemblance to the billiard-ball materialist universe. He

denied that Cohen could say materialism did not depend on matter and particularly that mind could be so easily subsumed under natural laws. Joad virtually recapitulated Eddington's arguments that our positivist knowledge of matter and tautological physical laws demonstrated the primacy of mind. He explicitly followed Eddington further in holding that there was a part of experience below the structuralist metricalism of physics, making room for aesthetics and personality.¹⁵⁰ Thus, a simple account of the forces at work was insufficient for a complete description. Cohen was unimpressed with Joad's invocation of Eddington: "Throwing down Professor Eddington does not matter a hang. Mr. Joad says I have been knocking down God Almighty for thirty years. You cannot expect, after knocking down God Almighty, that I am going to jib at Professor Eddington." He flat out denied that science could deal only with certain things. If science had trouble explaining something like aesthetics, it was only because our knowledge was incomplete.¹⁵¹ Joad brought in Eddington again, this time intended to finish the debate. "I merely quoted him in order to show that I, who am not a scientist, can claim support from persons who are eminent scientists." He read directly from Eddington's contribution to *Science, Religion, and Reality* as though it was a point of fact: "at issue is whether Professor Eddington excludes mind, and, what is even more shocking than mind, spiritual values, or whether he does not. I think it is perfectly clear that he does not; in fact, he says so. This, then, is not a question of argument: Mr. Chapman Cohen is wrong."¹⁵² It is remarkable how quickly Eddington became a definitive source about the existence of spiritual values, to the point where professional philosophers and theologians were willing to immediately give him authority over their own lifetimes of experience and training. In one sense Cohen was completely right, in that many guardians of traditional values did seize on anything that supported their case (even if they often did not completely understand what was being said).

At some point in early 1929, Cohen decided that Eddington himself was the real danger, and there was no point in skirmishing with proxies. He thought that if he could strike down Eddington, he could show that the defenders of religion were continuing to grasp at straws. There was also some pressure to respond from within the atheist community, and Cohen took this opportunity to demonstrate to many of his allies the danger of relying exclusively on a billiard-ball, physics-dominated view of nature.¹⁵³ Doing so played right into the hands of misguided scientists like Eddington, and he needed to show that the physicists could not be allowed to dominate the discussion. For nearly three months, Cohen devoted his front pages and headlines to crushing Eddington's idealist-religious philosophy, which would

eventually draw Eddington himself to participate directly in the columns of the *Freethinker*.

Cohen placed the highest possible consequences on the country's embrace of Eddington; to the leaders of the church and the nation "it is the truth of Christianity that is at stake." He argued that Eddington was fundamentally wrong in his understanding of materialism, and thus talk about materialism being dead or not being believed by science was just "pulpit jargon."¹⁵⁴ Eddington's materialism was appropriate for the eighteenth century, and could be attacked easily as a straw man. It was essentially the religious view of materialism that had been designed and propagated solely for theological purposes. Cohen reproved his own colleagues for supporting those antiquated views and called for a more general understanding based on deterministic forces: "Determinism is an absolute condition of sane and ordered thinking. It is not merely that in science and sound philosophy, it is a case of Materialism or nothing, it is implied in the structure of our mental life."¹⁵⁵ He was very interested in the social reasons for the wide interest in Eddington's books and was particularly harsh on the very liberal kind of religion allowed for in *Nature of the Physical World* and *Science and the Unseen World*. *Religion* used in such a broad sense ("from beer-drinking to the much more subtle form of intoxication, theosophic meditation"), he said, was essentially meaningless. Cohen claimed that using such a broad definition was a ploy of the religious superstructure of British society and served two social functions. It gave the social respectability of religion to everyone who wished to claim it, and it allowed "the professional religionist" to claim large numbers of believers in God. Eddington was therefore complicit in the continuing domination of free-thinking, poor, and uneducated people by the theocracy.¹⁵⁶

The *Freethinker* was extremely harsh on Eddington as a scientist: he had been "defiled" by his contact with religion. *Unseen* as it appeared in *Science and the Unseen World* was a synonym for ignorance, and "religion is the deification of ignorance." Scientific men (with the examples of Isaac Newton and Michael Faraday given) trying to talk about religion became particularly absurd, because their intelligence got in the way. A simple man could state his religion simply, but an intelligent one could not: "In this respect nature has not been kind to Professor Eddington. A man with the brain of a scientific thinker trying to establish a religion, commences his task with a handicap that is fatal to his chances of success."¹⁵⁷

Eddington's extension of physics to all science was the source of his most profound errors. The example of the Armistice Day observance gave no trouble at all to science, but it was outside physics. The need to invoke psychology,

sociology, and economics to explain a phenomenon was surely not a capitulation of the scientific ability to explain the world. Restriction of science to measurable quantities was an a priori consideration of no merit and belonged more in the pulpit than in the mouth of a scientist. The claim that physics was an exact science had no metaphysical significance; it just meant that we were more aware of the various factors involved. Psychology would one day be just as exact.¹⁵⁸ Cohen argued that the distinction between the physical and psychological processes was critical for Eddington, but "it is plainly and hopelessly wrong." The mind responded just as well to stimulus as bodies did (hit someone or take away their rights, and you will see a reaction). Further, Eddington clearly thought so too, or he would not make arguments that he thought could persuade people. Cohen argued that this was again "the argument from ignorance. . . . It is the helplessness of science which is stressed, not the possession of knowledge."¹⁵⁹

Cohen acknowledged that he was not technically qualified to contest Eddington's challenges to causation and claimed that he was really concerned with "the way in which they have been welcomed by religious leaders." He attacked these leaders as hypocritical, because they had until recently said that a world governed by laws was proof of God and had done a quick about-face with Eddington. Cohen attacked Eddington himself for accepting quantum theory as a final truth, especially when leading physicists like Einstein expected a return to determinism. The final blow was the accusation that Eddington's science popularizations were nothing but new bottles for old, weak wine: "The truth is, I fancy, that Professor Eddington's opinion as to the current bearing of science is dictated largely by pre-existing beliefs. . . . The confession of Professor Eddington that he can't hope to convert an Atheist is the implication that religious belief has nothing of the nature of reasoned conviction behind it."¹⁶⁰

The next issue of the newspaper brought with it a rather startling feature, a lengthy column written by A. S. Eddington. Cohen expressed both surprise and pleasure that Eddington had responded to his criticism and gladly made several pages available to the astronomer. Eddington emphasized his purpose in *Nature of the Physical World* and the insufficiency of materialism. He reiterated vigorously that his goal was not to prove religion, which is somewhat surprising since Cohen had explicitly acknowledged this. He described his goal in the Gifford Lectures to have been to address one specific issue: defending religion against the charge that it was incompatible with physical science. Eddington thought this clarification ameliorated several of Cohen's objections. This explained why he restricted his discussion to physical science (explicit in the stated problem), why he was willing to accept scientific results as final (he was responding to critics using a particular group of scientific

ideas), and why he took the essential truth of religion for granted ("the soldier whose task is to defend one side of the fort must assume that the defenders of the other side have not been overwhelmed").¹⁶¹

Eddington expressed confusion about Cohen's use of the term *materialism*. First, he questioned whether the term was not merely tautological: "We must assume that the Materialist, in asserting the all-sufficiency of physical or mechanistic conceptions, intends to rule out some conceptions as non-physical and non-mechanistic; otherwise he is merely asserting a truism; and in drawing the line the only guide is the boundary of physical science accepted at the present day."¹⁶² He also distinguished here (which he generally did not do in his books) between billiard-ball materialism and a wider sense of the term: "Crude Materialism, which asserts that matter is the sole reality, has been replaced by a modern Materialism which asserts that the world built out of the concepts of physics is the sole reality—that the whole of experience is the interplay of these physical entities fulfilling the laws of physics, and that's all there is to it. That is the position I attempt to refute in my book."¹⁶³ Eddington's arguments against materialism in *Nature of the Physical World* were clearly aimed at what he called "Crude Materialism," and he took pains here to extend the validity of his arguments to cover Cohen's more general materialism. In some sense, it appears that Eddington was unwilling (or possibly unable) to distinguish between those two positions. To him, the differences were unimportant insofar as they both supported "moral materialism." In his conclusion he lapsed back to criticizing Crude Materialism and, particularly, the sufficiency of that idea to explain the fundamental qualities of humans: "A particular belief may correspond with a particular configuration of atoms in a brain-cell, but the mechanistic conception of the atoms cannot be transferred into a mechanistic conception of belief. The configuration of the atoms is an indifferent phenomenon; the belief matters."¹⁶⁴

Unsurprisingly, Cohen penned a lengthy reply. He described himself as an admirer of Eddington, saying that if the professor fell into error, it was only because of his attempts to mix science and religion. He reserved the greatest scorn for the clergymen and journalists using the "weakest and least scientific part" of Eddington's book to defend positions that Eddington himself rejected.¹⁶⁵ He described Eddington as not so much proving his claims about the division of the world into material and spiritual as simply asserting them. This was simply a consequence of his religiously driven search for "an ultimate reality which is beyond experience." Essentially, he distorted science in his misguided quest.¹⁶⁶

Cohen reprinted his and Eddington's *Free thinker* essays in a book two years later, in which he also took aim at Jeans, Julian Huxley, and Einstein. His aim

was to show that, first, these scientists were not representative of their profession's attitude toward religion; and, second, that the old idea of "two truths" was completely untenable. Science and religion belonged to two culture stages, one developed and one primitive. It was, therefore, absurd to link them in the modern world: "It is one thing to say that certain scientific men—as an outcome of their early religious prepossessions—are making overtures to religion, but it is quite another thing to say that science is becoming more religious." The majority of scientists were mechanists, they simply did not receive the same publicity for their ideas from the religion-dominated press.¹⁶⁷ The basic problem with science popularizers was their possession of knowledge without understanding.¹⁶⁸ Further, any defense of two truths was based on a hoped-for ignorance of science and a willful ignorance of the biological and social roots of religion. "Once again, and for the thousandth unanswering time, will anyone show a substantial difference between the visions of a dipsomaniac and those of a Christian saint? The fact that one is produced by overindulgence in alcohol, and the other by over absorption in religion is surely not enough to establish a scientific difference."¹⁶⁹

Eddington surely played a dangerous game by engaging in debate on his opponents' terms and territory. He clearly felt the stakes were high and that he needed particularly to dissuade the application of materialism to questions of human consciousness and social behavior. Cohen was correct to say that Eddington's understanding of materialism was old-fashioned and probably of religious origin. As discussed at the beginning of this section, Eddington was chasing the ghosts of a long-dead materialism. It is perhaps because of this that he never registered the details of Chapman Cohen's position. In some sense Cohen was an odd choice for Eddington to single out as an opponent. Cohen was unquestionably an atheist and a declared determinist, but he was explicitly *not* a materialist in the sense that Eddington was refuting. Cohen had no particular stake in the billiard-ball view of the universe, but Eddington assumed he did. Eddington simply lumped anyone who called themselves a determinist, mechanist, or materialist into one category associated with the Marxist threat to religious belief. Similarly, Cohen's choice of Eddington as a primary opponent was somewhat odd. There were plenty of scientists and theologians using classical arguments from design and seeking the proof of religion that Cohen found so reprehensible. In contrast, Eddington's position was quite moderate and did not in any way seek to support the authority of the established Church or its hierarchy. What seems to have infuriated Cohen was Eddington's personal stance as a believing scientist and, more importantly, that Eddington's writings were being read and used as though they were proofs of religion. Eddington was simply labeled an ally of antideterminism and that was enough.

Thus, both sides of the debate were misunderstanding the other in important and profound ways. Both Eddington and Cohen set out to dispel the myths that they had designated as most hostile to their worldview (materialism and religion, respectively) without making serious effort to appreciate that those myths actually described a range of positions instead of a singularity. They both acknowledged that they agreed on several issues, but there was no attempt to moderate their arguments accordingly. Instead, they both relied on their perceived knock-out arguments. They had significantly different understandings of what *religion*, *materialism*, and *determinism* meant, and thus it was inevitable that their arguments would pass at right angles.

Conclusion

Eddington's supporters were staggeringly numerous and startlingly varied. His writings were so widely disseminated that parodies of popular hymns were written to celebrate his expertise.¹⁷⁰ Many schoolchildren were inspired to pursue careers in science after reading his books—historian Gerald Holton places Eddington's works among the "tribal books" that taught a generation of scientists what it meant to do science.¹⁷¹ From the pulpit to Parliament, Eddington's views were proclaimed to be the apex of scientific thought, although most readers did not appreciate how idiosyncratic his ideas were.¹⁷² Despite the varied reasons for this enthusiasm, there were strong common themes. The first was excitement about Eddington's defense of traditional values. In a time when it seemed science had either given up on values (and thus caused the devastation of the Great War) or was actively fighting them (through encroaching socialism), the calm reassurance of a major scientific figure caused a cultural sensation. Even beyond defending the values themselves, Eddington defended the traditional ways of thinking about and addressing values. That is, he said it was perfectly acceptable for citizens of the modern state to base their desires and actions on their innermost religious, spiritual, and aesthetic beliefs, just as they had for centuries. Science, far from imperiling values, was a route to a deeper realization of them: "I believe that science, like art, enables mankind to approach nearer to the realization of the absolute values that alone give an aim and meaning to life. . . . A life spent in complete devotion to an absolute value is a good life."¹⁷³

The second major theme was that Eddington's arguments supported a distinctly modern understanding of religion. The supporters of liberal theology were enthused that a scientist famous for his work on the most modern aspect of science (relativity) would ally himself with the most modern religionists. He was a living example that the ideals of liberal theology were alive

and valid: religion and science could be reinforcing partners in the quest for progress. The death of liberal theology with the coming of the Second World War crushed these hopes, a transition well documented by Peter Bowler.

Eddington's critics were similarly united in certain ways. Three basic categories were salient. First, critics censured him for speaking outside his area of expertise. Scientists were welcome to talk about their research, but there were firm (if sometimes invisible) boundaries past which they had violated their disciplinary obligations. Many attacks claimed he was not talking "scientifically" and therefore should be accorded no authority. Interestingly, nonscientists (mostly philosophers) were much more willing to do this than scientists were. This was complicated by Eddington's own ambivalence about what he was doing in his popular writings. He sometimes said he was speaking as a scientist, sometimes not. Sometimes he described writings like *Nature of the Physical World* as philosophy and sometimes as "scientific philosophy." As when he compared mathematicians and physicists in *Internal Constitution of the Stars*, Eddington's presentation of disciplinary boundaries was epiphenomenal to the values that could move underneath them.

The second widespread criticism was that Eddington, as a scientist, should have nothing to do with religion. He was seen to have violated the boundary between religion and science that had been established with such difficulty in the late Victorian period. His willingness to move between those categories threatened the independence that made science viable in a world still dominated by religion.

Finally, there was the argument that he should not be as influential as he was. The results of science and philosophy were complex and could only be understood by trained experts. Popularization would have no result but to confuse and mislead the public. Attempts to translate specific technical concepts into common language would inevitably be disastrous, no matter how skilled the expositor.

Eddington's various detractors and enthusiasts were key players in the social debates in interwar Britain. These revolved around a series of very broad concepts, such as religion, morality, socialism, and Englishness.¹⁷⁴ All parties involved had their own native categories in which these concepts made sense, but there were large numbers of subgroups in Britain that interpreted the concepts differently. Religion could be the Church of England, Quakers, Catholics, Jews, or practitioners of folk traditions. Consider Eddington's and Jeans's differing beliefs about the nature of religion and the role science should play in it. The poles of the debates around science and religion had been so deeply established in the culture as Tynndallian materialism versus natural theology that Eddington's and Jeans's books were read by many as virtually

identical. If they were religious scientists, they must be providing proof of religion; that was what religious scientists did. Indeed, the two popularizers became so closely associated that it was quite common to see their names reflexively paired as "Eddington and Jeans" or "Jeans-Eddington." Few readers were thoughtful enough about the issues to appreciate the serious gulf that separated their ideas. Eddington's liberal approach confused many readers who expected him to fit the mold of natural theology. Many critics of *Nature of the Physical World* (including Bertrand Russell) had either never read it and were simply relying on secondhand assumptions or misinterpreted it as yet another proof of God.

Eddington's defense of religious values rather than religious ontology was typical of the liberal theology of the time. The confusion over exactly what this meant helps point out the weaknesses of liberal religion as a movement. The groups that had always focused on questions of values (mostly Dissenters) found liberal thinking to be straightforward and Eddington to be an excellent spokesman. Most British Christians, however, came from Anglican traditions that were having trouble adapting to a values-oriented approach to religion. In some sense the conversion to a liberal approach was never successful, and the continued reading of all religious scientists as natural theologians indicates that Anglicans still had a powerful desire for orthodox religious belief. Perhaps, then, part of Eddington's success as a popular writer was an accident. There is no question that he had a great gift at explaining physics to the public, but if his readers had understood his ideas better, he would not have registered so strongly with a body of religious practitioners who longed for the reassurances of the past.