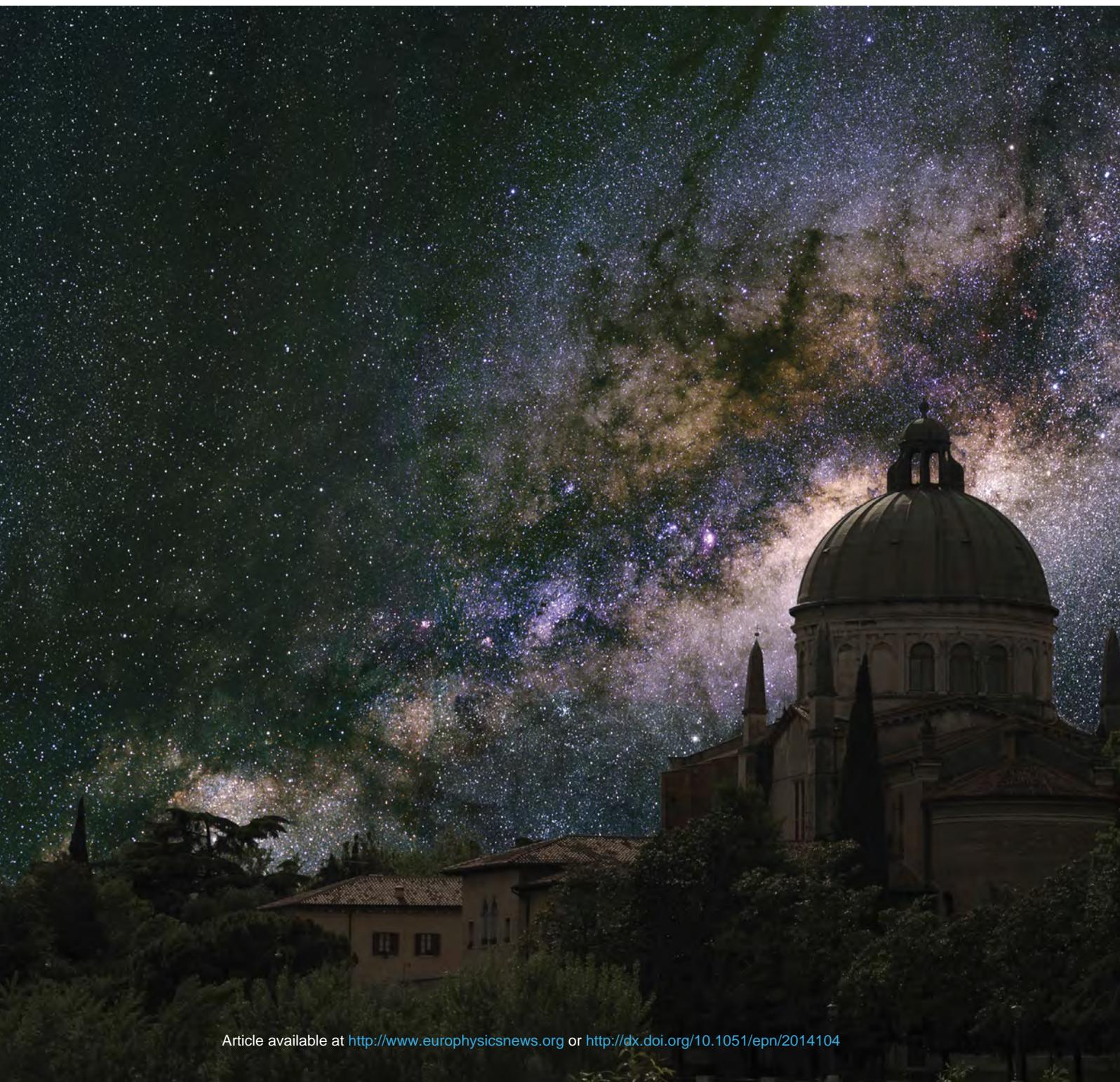


# PHYSICS AND THEOLOGY

■ John Polkinghorne FRS – University of Cambridge, UK – DOI: 10.1051/ePN/2014104

The role of theology in relation to science is not to try to tell physics how to answer its own proper questions. We have every reason to believe that physics questions will eventually receive physics answers. However there are meaningful and necessary questions which arise from considering the results of physics but which exceed its self-limited power to address.



**P**hysics has been wonderfully successful in answering its own questions because it has carefully limited its ambition. Its concern is solely with questions of process (how things happen in the world) and it has bracketed out other questions, such as those of value, meaning and purpose (is there something going on in what is happening?). It is just these questions which lie at the heart of religious concern and they surely need to be addressed if we are to gain a full understanding of the nature of reality. When this kind of questioning is prompted by physical discoveries, learned people call the issues raised metaquestions, that is to say, questions which take us

beyond their initial starting point. One of the roles of theology is to deal with these metaquestions by setting the discoveries of science in a yet broader and deeper context of understanding.

An example of such a metaquestion is to ask ‘Why is physics possible at all in the deep way that it has proved to be?’ Of course, it is no doubt true that evolution has so shaped our brains and minds that we can understand the workings of the everyday world in which we have to survive. But our human powers of discovery and understanding vastly exceed the needs of simple survival. Why can we understand regimes such as the subatomic quantum world or the cosmic realm of curved spacetime, which are counterintuitive in character and remote from directly discernible impact on everyday life? The fact that we can discover the nature of these regimes raises the question of why we are so lucky. Anyone seeking an understanding as deep and comprehensive as possible – a quest so natural for the scientist – is surely bound to seek a wide perspective which can make deep cosmic intelligibility itself intelligible.

### Intelligibility

In fact the issue of intelligibility is deeper than simply the remarkable scope of scientific success, for not only has the universe proved to be rationally transparent to our enquiry, but it is also rationally beautiful. It has turned out to be the case that a fertile guide to discovery in fundamental physics has been to seek theories whose expression is in terms of equations possessing the unmistakable character of mathematical beauty. Paul Dirac made his great discoveries in quantum physics through a relentless, and highly successful, search for beautiful equations. He once said that this was a ‘very profitable religion’ to have. His brother-in-law, the Nobel nuclear theorist Eugene Wigner, called the ability of abstract mathematics to unlock the secrets of the physical universe, its ‘unreasonable effectiveness’ and said it was a gift that we neither understand nor deserve. Albert Einstein was deeply impressed by the wonderful order of the physical world, saying that when he made his great discoveries he felt like a child in the presence of the Elders.

Theoretical physicists are happy to exploit the opportunities provided by the fact of deep and beautiful intelligibility, but simply as physicists, they are unable to explain why this is the case. Yet it would surely be intolerably intellectually lazy just to treat it as an amazingly fortunate accident. A religious perspective on the physical world, understanding it to be a divine creation, can offer the insight that deep cosmic rationality is an indication that the Mind of the Creator lies behind its wonderful order and our access to it reflects the fact, to use an ancient and powerful phrase, that we are creatures made ‘in the image of our Creator.’



It is not logically inevitable to understand intelligibility in this way but, in my opinion, it is the most intellectually satisfying way to do so. This discussion illustrates the right way to understand how religion and physics relate to each other. They are not foes, offering conflicting explanations of the same thing, but friends that complement each other in the quest for truthful understanding. Religion should accept gratefully all that physics can tell it about the structure and history of the physical world and then seek to set that knowledge in a wider and deeper context of intelligibility.

### Cosmic fine-tuning

One of the most remarkable discoveries of recent physics has been the recognition that the fertile process of cosmic evolution – in the course of which the initial almost uniform expanding ball of energy emerging from the big bang has turned into a world containing the diverse and richly complex realm of terrestrial carbon-based life – has only been possible because the basic laws of physics take a very particular, ‘fine-tuned’ form. In a journal like this it is not necessary to go into the details of what leads to this unexpected conclusion, though it is worth recalling that among those necessary conditions is that the cosmological constant is  $10^{-120}$  smaller than straightforward estimation would lead one to expect.

Once again we face a metaquestion taking us beyond the scope of physics itself. For the physicist, the form of the fundamental forces of nature is a just *given* brute fact from which the explanation of particular physical processes is to be derived. Yet it would surely again be intellectually lazy just to leave the matter there and treat fine-tuning as an incredibly happy accident. A religious perspective will see fine-tuned potentiality as the gift

of the Creator to a creation ordained to have a fruitful history. Those who reject this insight are driven to turn to the hypothesis of the multiverse, a vast, possibly infinite, collection of different universes,

each separate from each other and with different laws of nature, in which ours is, just by chance, the one in which carbon-based life is a possibility. Of course, just by itself, the assumption of even an infinite collection of different universes would not be enough to explain fine-tuning. An infinite array does not necessarily include members with all desirable properties (there is an infinite number of even integers, but none has the property of oddness). The notion of the multiverse can

to some extent be motivated by highly speculative ideas of quantum gravity, such as string theory, but in my opinion the basic unobservability of those other worlds makes their existence in a multiverse a metaphysical assumption, just as the existence of a divine Creator is a metaphysical assumption. There is no logically coercive principle to settle the choice between these two possibilities (it clearly cannot be settled empirically), but I would assert that the creation hypothesis is the stronger because it is supported by collateral evidence, such as both cosmic intelligibility and the fact of religious experience, which seems lacking in the case of the multiverse.

### Causality

In the second half of the eighteenth century, the deterministic character of Newton’s equations encouraged many people to see the physical world in strictly mechanical terms, as if the universe is a gigantic piece of cosmic clockwork. Since classical fields are as deterministic as classical particles, the discovery in the nineteenth century of classical field theories did not significantly alter the picture (though some theologians seem mistakenly to suppose it did!). However, there was always something suspicious about this point of view since human basic experiences of freedom and choice surely show that, though we are inhabitants of the physical world, we are not mere automata. In any case, twentieth-century physics saw the death of this merely mechanical picture through the discovery of intrinsic unpredictabilities present in nature, first in quantum theory and later in chaos theory. The physical world has proved to be something more subtle than clockwork. The vital question then is, is it also more supple, to some degree open to the future?

Unpredictability can be due to two quite different reasons. One would be an actual degree of intrinsic indeterminism present in nature, such as that which is supposed in Niels Bohr’s Copenhagen interpretation of quantum theory. The other possibility would be that unpredictability is simply the result of a necessary ignorance, arising from an intrinsic inaccessibility preventing us from gaining knowledge of all the detailed factors which in fact actually fully determine what is happening. David Bohm’s deterministic interpretation of quantum theory has this character due to the presence of a ‘hidden wave’ which influences the behaviour of particles. The fact that the theories of both Bohr and Bohm, though radically so different in character, yield the same empirical consequences shows that the choice between them cannot be made simply on purely physical grounds but it requires an act of metaphysical judgement. I personally find Bohm’s ingenious theory to be too contrived to be persuasive and so I side with most other physicists in giving my vote for Bohr.



**Religion and physics are not foes, offering conflicting explanations of the same thing, but friends that complement each other in the quest for truthful understanding**

This little story makes a very significant point. Though our ideas about the causal structure of the world are certainly constrained by what physics has to say, they are not fully determined by it. It has not established the causal closure of the world on its own terms alone. There is the possibility of a degree of openness which allows for other causal principles also to be at work in playing a part in bringing about the future. I personally believe that these principles exist and include the intentional acts of agents, both human and divine. According to this picture, divine providence operates in the history of the creation, but not by occasional interference from outside (a view that has serious theological difficulties about a god who would seem to be capricious and arbitrary in interfering with his own decreed order of creation), but within the open grain of created nature.

### Surprise

Our exploration of the physical world has often shown that it has characteristics of a surprising kind that we could not have guessed beforehand. Any philosophically minded person in 1899 would have been willing to 'prove' the impossibility of something sometimes behaving like a wave (spread out and oscillating) and sometimes like a particle (a little bullet). When light was discovered to have this counterintuitive duality, it certainly gave physicists a problem which it took them 25 years to resolve. Only the stubborn nudge of nature could have led eventually to the discovery of quantum superposition, with states made up of an indeterminate number of particles being the ones that manifest wavelike properties.

An important lesson can be learnt from this story. The instinct of a physicist faced with a surprising possibility should not be to ask 'Is it reasonable?' as if we were sure we knew beforehand the shape that rationality has to take. No-one in 1899 would have thought wave/particle duality reasonable. Instead our instinct should be to ask, both within physics and beyond it, a different question which is both open and demanding: 'What makes you think that might be the case?' No possibility is ruled out beforehand, but if a strange proposal is made, it must be backed up with evidence for its truth. The essence of rationality is to seek to conform our thinking to the actual nature of what we are trying to think about and that must be dictated by the object of our thought, however surprising its nature may turn out to be.

This is a lesson that is valuable also for theology. If the physical world, which we transcend and can manipulate experimentally, can surprise us, should we not expect the same to be true of the God who transcends us and is not to be put to the experimental test? To say this is not to endorse ungrounded speculation, but to

seek truth through engagement with carefully evaluated evidence. I believe that physics and theology are cousins under the skin in that both, in their respective ways, are concerned with a search for truth

attainable through well-motivated belief. I call this intellectual strategy 'bottom-up thinking', seeking to move from experience to understanding, in contrast to 'top-down thinking', which believes that it can start with clear and certain general ideas, before descending to the consideration of particulars. The trouble with the latter approach is that the claimed general ideas have often proved to be neither clear nor certain. I believe that theology can proceed in this bottom-up fashion though obviously its motivations derive from the evaluation of a deeply personal kind of experience, not open to repetition at will in the way that gives physics its great secret weapon of open access to experimental confirmation. I have sought to treat Christian theology in a bottom-up fashion as it wrestles, for example, with belief in the duality of the human and the divine in Jesus Christ [1].

I would like to end on a personal note. In 1979, when I resigned from my chair of mathematical physics at Cambridge to study theology and train to become an Anglican priest, my life changed in all sorts of ways. But in one important respect it remained unchanged. Both as a physicist and as a theologian, I have been concerned with the search for truth through well-motivated belief. ■

### About the Author



**John Polkinghorne FRS** worked for 25 years in theoretical elementary physics. In 1979 he resigned his chair at Cambridge to study theology and train for ordination as an Anglican priest. For the last 25 years his principal intellectual interest has been the relationship between science and religion, on which he has written many books. He is a Fellow of the Royal Society and in 2002 he was awarded the Templeton Prize.

### Reference

[1] J.C. Polkinghorne, *Science and Religion in quest of Truth*, SPCK/ Yale University Press, 2011.

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