Revd Dr. John Polkinghorne KBE FRS

You were Professor of Mathematical Physics here in Cambridge and you gave that up to train for the Anglican Ministry. Most people would see that as a fairly large shift. What prompted that change?

I very much enjoyed being a theoretical physicist and I looked upon it as being a sort of Christian vocation, using such talents I had. But, unfortunately, in these mathematically based subjects you don't get better as you get older. You don't do your best work before you're twenty-five usually, but almost certainly by forty-five you've made most of the contribution you can. So after twenty-five years in theoretical physics I thought I'd done my bit for the subject and I'd do something else. And because Christianity had always been central to my life, the idea of seeking ordination seemed the right the next step.

We're talking about the cosmic fine-tuning argument, which seems to connect physics and theology quite significantly and closely. Can you just unpack and explain what cosmic fine-tuning is?

We know a lot about the history of the universe. We know that it started about 13.7 billion years ago, essentially as a ball of energy, and now it's very rich and diverse, with ourselves as its inhabitants. And that's happened through a long, evolving process. But there's a sense in which the universe was pregnant with the possibility of carbon-based life almost from the start. Because it turns out - and this is a very surprising and unexpected discovery - that the laws of physics, the basic given fabric of the world, had to be very specific, very finely-tuned as we sometimes say, for the possibility of carbon-based life appearing at all. So it's a very surprising conclusion, but it's true, and all scientists would acknowledge that's the case.

Can you give a specific example of what you're talking about when you say that the laws of physics are finely tuned?

A very simple and central example is the question of where does carbon come from. The very early universe doesn't make any carbon. It's very simple and only makes very simple things: hydrogen and helium, and they're pretty boring in terms of chemistry. Now where does carbon come from? There's only one place in the universe where carbon is made, and it's in the interior nuclear furnaces of the stars.

We are people of star dust, made of the ashes of dead stars. It turns out that the process by which carbon is made inside the stars is an extraordinarily delicate process. In fact it looks at first sight as though it couldn't happen at all. It's only possible because of a very large enhancement effect, called a resonance in the trade, which makes it go much quicker than we might have expected. That resonance is there because the laws of nuclear physics take a very specific form. If they were a little bit different, either there'd be no resonance or it would be in the wrong place, at the wrong energy. That's a very striking example of how finely tuned the universe has to be for us to be inhabitants of it.

People use the fine-tuning as a pointer to the reality of a creator. Is that a valid inference?

I think I want to say something first about the relationship between science and theology: we have every reason to think the scientific questions will receive scientific answers. But there are many questions that are important and go beyond science. One of those would be the question of what is the significance of fine-tuning. Because, of course, physics uses the laws of nature to explain what is going on in the world, but it doesn't explain where the laws of nature themselves come from. That's a deeper question that goes beyond physics, and one possible answer to that is given by theology which says that the laws of nature take the particular form they have because they are not just happy accidents, but they are expressions of the will of a divine creator who has brought into being the universe with potentiality to be as fruitful as ours has been.

One response is to say that there isn't anything that needs to be accounted for: the example that is given is that if you go to a car park and you see a car with a particular number plate this number plate in itself is highly unlikely, but in a sense there had to be cars there with some number plate, so any number plate is unlikely. So is there something here that needs to be explained here or not?

When we feel we need explanation we're not simply concerned with something that's very rare and only occasionally happens. If you went into a car park and saw a number plate with HRH 1 on it you wouldn't think that's just a random thing. You'd think there must be some further significance attached to that number plate. So it's a question not only of rare events but also of rare events that seem to carry particular meaning. Now, of course, our universe might have all sorts of different laws of

nature. When we see the ones we've actually got have this amazing consequence of the richness and diversity of carbon-based life, that seems to me to be something you shouldn't just shrug off and say, 'Well, we're here because we're here; it's just a happy accident' - that sort of thing. It does seem to demand an explanation. I think most people who've thought about these things would think that's the case. Though, of course, not everyone would agree what the right explanation is.

One explanation says that the only kind of universe we could live in is one that is fine-tuned for life. So it isn't surprising that we observe ourselves in such a universe. We wouldn't be here otherwise. Is this an explanation?

I don't think it's an explanation simply to say that if the universe wasn't the way it is we wouldn't be here to think about it. Of course, that's obviously true. But the fact is that it is such a remarkable fact about the universe. Somebody who writes about these things, and I find very helpful, is a philosopher called John Leslie. He tells a story about an execution: you are about to be shot. Your eyes are bandaged. There are fifty highly trained marksmen pointing their rifles at your chest. Shots ring out You find you have survived. Now, what do you do? Do you just stroll away saying, 'Gee, that was a close one!' Of course, if you hadn't survived you wouldn't be in a position to say anything at all. But it's so remarkable a fact that you survived the execution that, surely, the only rational thing is to say, 'Well, maybe more was going on there than I realised.' So Leslie suggests there are only two possible genuine explanations of your good fortune: one is that maybe there are lots and lots and lots of executions taking place today, and, of course, even the best of marksmen occasionally miss. You happen to be in the one where they all missed. Of course, there'd have to be a lot of executions taking place today, but at least it's a rational possibility. But there's another rational possibility, which is that maybe there's only one execution (and it's yours) but more was going on than you were aware of. The marksmen were on your side and they missed by design. Now that charming story, that parable if you like, translates into thinking about the fine-tuning of the universe. On the one hand you could say maybe there are trillions and trillions of different universes - the multiverse as people say. We just happen to be in the one that's suitable for carbon-based life. But the other possibility is that maybe there's only one universe, which the way it is, because it's not any old world, but it's a creation which has been endowed by its creator with the finely-tuned laws that will make it's history fruitful.

What's your view of the multiverse option?

The multiverse option is a very extravagant suggestion. It postulates the existence of all these trillions and trillions of universes, all unobservable by us, all different in their characters and so very different that, by chance, one of them turns out to be OK for carbon based life. Now that's a very bold speculation, and it's certainly not a scientific theory. It's a metaphysical guess, as we might say. It goes beyond physics into some sort of philosophy. As, of course, does the idea that the universe is a creation, in the same sort of way. But I think that the multiverse is first of all a very uneconomic assumption to make. Secondly, it seems to me that it only does one piece of explanatory work. It explains - or it explains away - the fine-tuning of our universe by saying we're just the winning ticket in the cosmic lottery. But I believe seeing the universe as a divine creation does lots of pieces of explanatory work. It not only explains the fine-tuning, it explains why the universe is rationally beautiful, with wonderful laws of nature. It explains our widely attested human experience of an encounter with the sacred reality of God and so on. So there's a cumulative case for seeing the universe as a creation, which doesn't seem to me to have a counterpart on the multiverse side of the argument.

Is there any evidence for a multiverse, or could there, indeed, ever be any evidence for it?

I don't think there would be direct evidence, because these universes are, by hypothesis, unobservable to us. The question is, is there other motivation? Physics in the last thirty years has become extraordinarily speculative. (Since I left it in fact, but there isn't a connection between the two.) The present speculations centre on something called string theory. The string theorists are very bold, they're very clever and imaginative and they claim to tell us how nature behaves sixteen orders of magnitude - that's sixteen powers of ten - beyond anything of which we have direct experience. That's an enormous leap into the dark, and I think that's over-bold. Now there's some motivation for the string theory and thinking there might be lots and lots of different universes, because it turns out that the string theory isn't a unique theory, as people hoped at the beginning. In fact it's a tremendously profligate theory. People think there are 10 to the 500 (that's 1 followed by 500 zeros) different solutions to string theory. My more speculative colleagues in physics don't hesitate to say, well then there must be 10 to the 500 universes. Actually, even that wouldn't necessarily solve the fine-tuning problem. Simply by having a large - or indeed an infinite - array of universes you couldn't be sure that you'd get one that was right for

life. For example, there are an infinite number of even numbers, but never in that collection will you find a number with the property of oddness. So it's not clear that having an infinite collection means you've got everything you might want.

You have a background in theoretical physics, you're a theologian and a Christian minister, do you personally find the fine-tuning argument persuasive as a pointer to God's reality?

I think that the fine-tuning argument is a very useful pointer to the need to think about the universe as being a divine creation. It's not a proof of it. There is no knock down proof either of the world as a creation or that it's not a creation. These matters are too deep for that sort of thing. But it puts the question of God, if you like, on the agenda. I, myself, find the creation view of the universe a more economic and persuasive and attractive explanation of fine-tuning than a multiverse idea would be. However, even if you give me the greatest success in making that argument, it will only give me a rather limited idea of the nature of God. It will show me a God who is, if you like, the architect of the universe; a God of great power and so on, but there are many other questions we will want to ask about God: 'Does God care about individual human beings?' and so on and so on, that won't be answered by that type of argument. So I think it's useful and it's helpful, and I think it's a hint of the divine presence, but that's as far as it goes.