

## Dr Graham Swinerd

*Can I start by asking you to say what your job is?*

I've been working in spacecraft engineering, both in industry and at university, for some years now. I'm currently working at this School of Engineering Sciences, in the University of Southampton, where I teach spacecraft design and spacecraft engineering.

*What are your research interests?*

My research interests are wide, but more recently focused on the problems of orbital debris.

*You'll need to explain that a bit!*

When we operate in space we leave junk in orbit, and those pieces of junk are not like pieces of junk you find on the floor, which are static. They're moving around at about seven or eight kilometres per second. So it becomes a problem, because they can intersect other spacecraft orbits and cause damage to people and to hardware.

*We're talking today about cosmic fine-tuning and the argument to a creator from cosmic fine-tuning. You wrote something a while back about going on holiday in Guernsey, and reading a book that brought you face to face with the fact that, as you put it in your words, 'The universe is defined by our existence within it, it is fine-tuned for life.' Can you unpack that?*

It's quite difficult to do that in a small amount of time, but there are a number of examples. One of my favourite examples is to do with the nuclear reactions that take place in the sun to produce energy. That's the life-giving energy that the sun gives us. There is Einstein's famous equation  $E = mc^2$  where it says that energy and mass are the same thing. So with what's taking place in the sun, you can do a simple calculation to work that out for the energy that we receive on earth. The sun is converting mass into energy at a rate of about four and a quarter million tons per second, which I think is amazing. But getting down to the details, when we think about these nuclear reactions that go on in the sun, there's a number which is the efficiency of the reactions - which is the amount of mass of the particles that is being

converted into energy. This is a number which is 0.7 of a percent, seven thousandths if you like. Now, the point about that is that if it were six thousandths then it would change the universe completely. If it were six thousandths then the universe would consist entirely of hydrogen. There would be no chemistry and no people. If it were 0.8 percent on the other hand, then all the hydrogen in the beginning of the universe would have been converted to helium. We wouldn't have hydrogen to fuel ordinary stars, and there'd be no water. So the difference between six thousandths and eight thousandths for that particular parameter that defines a fundamental characteristic of the universe has profound effects on the outcome. In other words, we wouldn't be here.

*As I understand it, there are a whole lot of other numbers that are like that. It isn't just that one?*

There is another idea that is perhaps a little simpler. That is to do with the Big Bang (which is currently accepted in the scientific community) and the initial conditions: if you think about it, you have an expansion like the Big Bang, with all the energy and mass going out. There's an amount of gravity which will slow it down. If you have too much mass and energy at the beginning, then the expansion takes place, but it contracts again too quickly and you wouldn't have the formation of stars and galaxies. On the other hand, if there were a bit less mass, then the expansion would be so rapid that stars and galaxies wouldn't condense. It's amazing because the initial conditions which are required in order for us to be here, if you change those by one part in a million billion (and that's what I call fine-tuning) then we wouldn't be here. So it seems like many of the fundamental characteristics of the universe have this profound thing where if they weren't the way they were, we wouldn't be here to think about it, which I think is amazing.

*You thought about and looked at several possible explanations. One was that while we don't understand it at the moment, maybe one day scientists will come up with the 'Theory of Everything,' which will define that these numbers just have to be that way. But you also seem to dismiss that fairly quickly as a possibility?*

When Stephen Hawking published his book, 'A Brief History of Time', he said in there that in a few years time we'd have a 'Theory of Everything.' (I thought at the time it was a bit naïve really, but anyway.) As time has gone by, as the decades have gone on since the publication of that book, it turns out that maybe we're not quite there.

We haven't got a Theory of Everything. Another thing about the scientific theories that we have at the moment, is that we understand a great deal about the universe, but we have to input the numbers in order to make the theories work. The current theories don't tell us why, for example, this fine-tuning takes place with the nuclear reactions of the sun, or why the initial conditions of the Big Bang are the way they are. So if it happens it may happen centuries away or something. I don't really think it's going to happen in my lifetime. Maybe that's not a good reason for dismissing it, but I dismissed it anyway.

*One of the explanations of fine-tuning that's often put forward is the idea that maybe there is a large number of universes with different settings, and in one of them the settings just happened to be right. That's the one we're in, because we couldn't be in one that wasn't fine-tuned for life. But you also seem to dismiss that idea fairly quickly?*

I guess I dismissed the idea of a multiverse on the basis that it's speculation. There's no scientific foundation for that particular idea.

*Do you think there ever could be scientific evidence for it?*

Possibly ... I don't know.

*So, having ruled out the theory of everything and the multiverse, you came down to saying that this fine-tuning points to at least the possibility of a creator God who's made the universe the way it is for us. Do you want to unpack that line of thought a bit?*

This was not easy for me because I spent most of my life - fifty years or so of my life - as an agnostic scientist. To come up with the notion... it's not a proof that God exists, but it pointed in that direction very strongly for me. It seems all these arguments about fine-tuning currently are a challenge to the Physics community. Why is it like this? At the end of the day, I just felt that the simplest argument, or the simplest solution to this conundrum was that there was a creator.

*Having thought through that process, and come to the conclusion that there was a creator, starting from the position of being an agnostic, what did you do?*

I struggled with it a long time, because I didn't really want to come to that conclusion. The other thing that happened was that while I edged towards the notion that perhaps the universe does have a creator, perhaps there is a God, I didn't have any feeling about what this God was about. I didn't know anything about that. But in the September of that year when I was on this holiday in Guernsey, there happened to be an Alpha course running at the local church in the autumn. I'd always resisted the idea of going on one. My wife is a 'cradle Christian' - she's been a Christian a long time, and she was always trying to persuade me to go on these courses, but it always seemed to be out of the question. But at that time I seemed to be in the right place and I decided I would give it a try. I must admit I was probably quite a pain for the people on the tables who were leading the discussions, because I had a very intellectual approach or head approach to everything rather than a heart approach to everything. So at the end of the day I went on that, and I learned about Christianity and the Christian God, and also, as part of this course, I had what you might regard as a spiritual encounter. That was a real eye-opener for me because I didn't acknowledge any kind of spiritual dimension to life whatsoever prior to that.

*You've been a Christian believer for something like eight years. To you now, where you are intellectually and spiritually, as you think about fine-tuning does that still play a part in your belief structure. Is it still an important pointer to God for you?*

I think it is an important pointer to God because when you become a Christian you become more aware of creation and caring for creation. So that's one aspect. Another thing is the notion that the fine-tuning doesn't go away. It is still a challenge to the physicist, and even the people who don't profess to have a faith who are scientists also share that view. So, for example, the stuff about fine-tuning that I've mentioned, there's a really great book by Martin Rees (who's not a Christian) and it's called 'Just Six Numbers'. I hope you don't mind me giving him an advert because it is a really good book for people who want to follow up this stuff. It's written from the perspective of someone who is not a Christian, and it's still a challenge to the scientific community.

*If next week you read in 'Nature' a paper that demonstrated some scientific explanation of fine-tuning that didn't involve God would that cause you to re-think your Christian faith?*

That's a good question. It wouldn't actually, because now that I've taken that step of faith, there is now my own experience of God. I can't disregard that just because someone comes up with some kind of scientific thing. OK a scientific view of the world is someone who wants to understand everything before they can believe it. That's a way I think of myself prior to becoming a Christian. However, I think St Augustine said something like, 'I believe in order that I understand,' which is the other way round. And that was the case for me, I think. You have to take a step of faith, and I think God helps you to do that. Once you've made that step and you believe, it's easier to understand. It's a strange thing. It's not the scientific outlook. It's something that is counter to the scientific outlook, which was very alien to me, and was very difficult for me, but nevertheless I'm glad I took that step because I have that experience of God now.