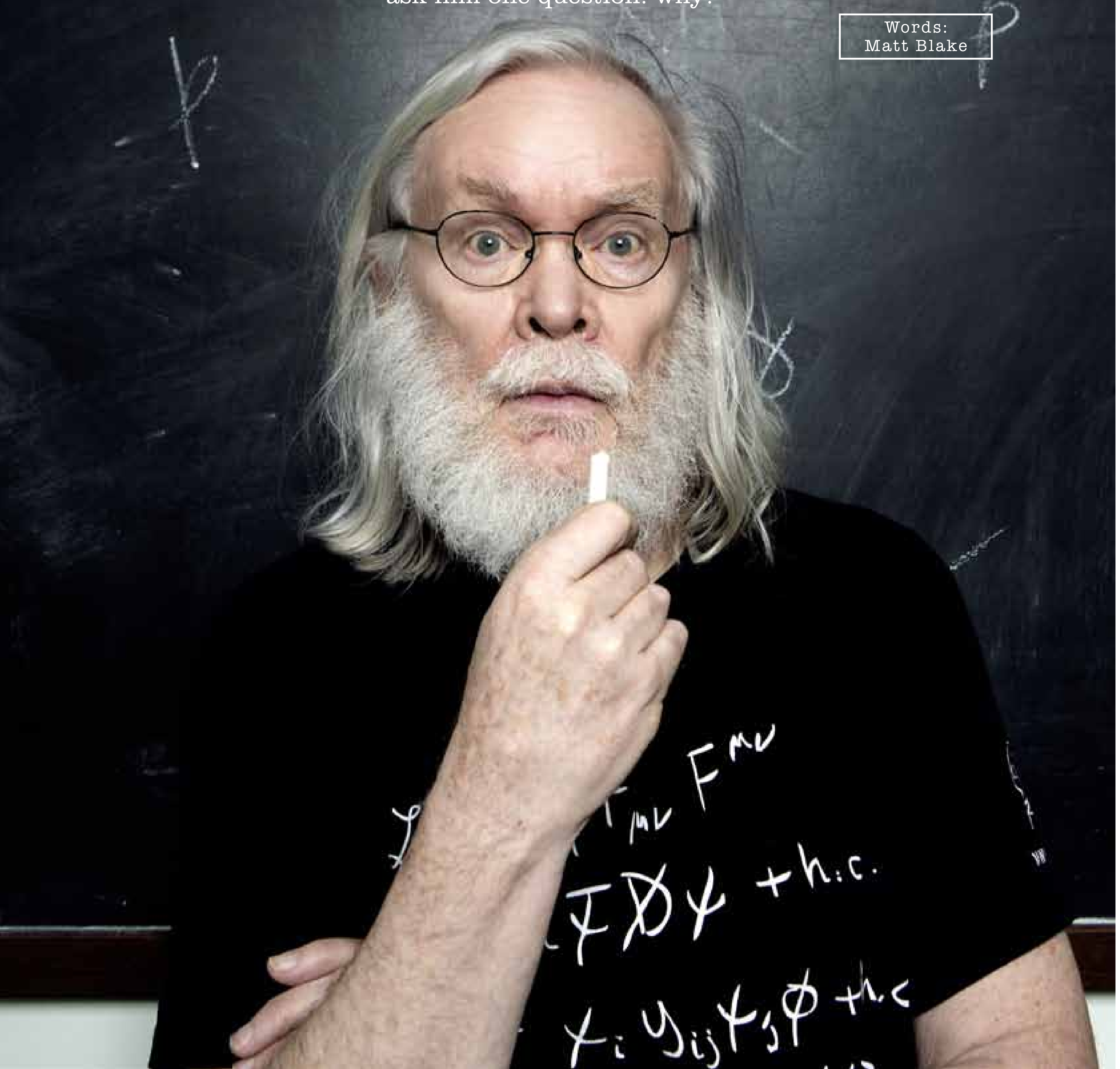
TO INFINITY AND (WAy) BEYOND

FHM goes to King's College London to spend the day with one of the world's most renowned theoretical physicists to ask him one question: why?

Words: Matt Blake



Picture in your mind what a theoretical physicist should look like. You may not know it, but you're probably imagining Professor John Ellis. In the same way you would expect a 1980s hair-metal guitarist to be all tattoos and perm, a butcher to have a bloody apron, or an IT specialist to wear a sweat-stained *Minecraft* t-shirt, Prof. Ellis is the living embodiment of a man who probes the boundaries of space and time for a living. His long, white hair blends into his long, white beard. A pair of thin-rimmed spectacles perches at the end of his nose and he has a corduroy jacket slung over the chair in his office. He is even wearing a t-shirt which displays the algebraic equation describing all visible matter in the universe. If theoretical physics were rock and roll, Prof. Ellis would be Keith Richards.

And right now, he is talking about the God particle – the special sauce that makes the universe possible; the energy field that endows every other particle with mass and, therefore, allows nature to build things… like humans. It's easy to see why it gets that nickname. Just don't call it that to Prof. Ellis.

"The term 'God particle', is something that us physicists find very embarrassing," he says. "It gives rise to all sorts of misconceptions. For starters, it has absolutely nothing to do with God."

We've come to meet the professor at King's College London where he is Clerk Maxwell professor of theoretical physics. Walking with him from the lift to his office feels like the science equivalent of strolling through a hip-hop after party with Jay Z. Clever-looking post-grads scurry out of our way, nod reverently as we walk past or rush to hold open the doors. Even so, the professor is humble, modest and smiley. And today, his only rider is a cup of coffee and a piece of chalk.

His office is filled with large stacks of papers to do with anything from high-energy astrophysics and cosmological inflation to dark energy (some of his fields of expertise) and CERN's Large Hadron Collider (LHC), in Geneva, where he is a lead scientist.

It was at CERN that scientists discovered what they believe is the God particle in 2012. Anyway, Prof. Ellis prefers to address it by its proper name, the Higgs Boson (after Peter Higgs, the British physicist who first proposed its existence in the 1960s).

He begins drawing a chalk diagram on a blackboard of how the Higgs Boson was discovered by colliding two protons together in the LHC. "The Higgs Boson is the last piece of the puzzle," he tells us. "It fills in a huge hole in the Standard Model, which I believe is the most precise and complete scientific theory, full stop. I'm talking about in all of science."

The Standard Model of particle physics lays out the basics of how elementary particles and forces interact in the universe. The Higgs Boson is the particle that gives the tiniest known particles of all matter their mass.

"If [elementary particles] didn't have mass, they would travel around always at the speed of light and would never bind to a nucleus to make an atom," he says. "No atoms means no molecules which means no us, hence no *FHM*. And that would be sad indeed."

That theory settles the question: how are we here? But not why. When we put this to Prof. Ellis, he looks at us with mild bemusement.

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"I'm going to stop you straight away," he sighs. "As scientists, we don't do 'whys'. We do whats, wheres, hows and whens. Not 'whys', not in the philosophical sense anyway. We can do 'why' in giving mechanical explanations as to what happened. But not a metaphysical, or theological or philosophical 'why'."

There is one theory, however, that comes as close to explaining the meaning of life as science can get. String Theory, also known as The Theory of Everything, a term first popularised by Prof. Ellis himself in his 1986 paper, *String Theory: Theory of Everything or of Nothing?* In essence, it seeks to outline the entire structure of the universe in a few brief equations.

"String Theory is an incredibly ambitious theory," he tells us. "It puts together all the interactions – magnetism, gravity, electricity into the same package. There are other theories but none of them have the power or beauty of String Theory." To fully explain String Theory in all its mind-boggling complexity, we would need many more pages than *FHM*'s own gods would allow us. Still, if anyone can do it under pressure, Prof. Ellis can.

"You first have to liberate your mind from the concepts of particles, time and space," he says. "We know the universe is described in terms of space and time. But are those fundamental concepts or did they emerge from something else? There is good reason to think that way back in the early history of the universe, there wasn't just smooth space – it would have been jiggling around with quantum effects. Those effects would have been so important that they put into doubt that space and time are actually fundamental concepts."

In other words, they may not even exist, other than in our minds. Particle physicists describe all matter of the universe as points in space. "If you're happy to think of time as the fourth dimension," he continues, "then those points evolve in time, extending into lines. String theory envisages that fundamental particles might actually be extended like strings on a musical instrument. But then people realised that, if you are going to make the conceptual leap from points to extended objects, then they might be extending not just in one dimension, but in two dimensions, like a vibrating membrane on top of a drum, or in three dimensions, or indeed any number of dimensions."

Matter, then, would be made up, not of point-like entities such as neutrons or quark, but of small strings of energy that vibrate. A string that vibrates one way becomes an electron while another, vibrating differently, becomes a quark. Another might become one of the carriers of the force of gravity.

"You could see the universe, then, as like a song or a symphony," says Prof. Ellis. "Both are composed of notes made by strings vibrating differently. But then, should one think of these strings as vibrating in some pre-existing space, or as creating space and time themselves?" We say our minds are beginning to feel as tiny as some of the particles we're discussing. "Well, join the club," he laughs. "I don't think any of us fully understand String Theory yet." So far so not-so-simple. And he still hasn't explained who or what made the strings in the first place.

"When I give big lectures, somebody always asks what happened before the Big Bang. My answer, as a scientist, is that I don't know and I'm not sure that we will ever be able to answer that question. We've got a bunch of laws of physics but if we go back to time equals zero, then all our equations break down. We simply don't have the mathematical tools."