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Q&A Brian Schmidt

Illuminated Universe

In 1998, Brian Schmidt discovered that, contrary to expectations, the expansion of the Universe is accelerating. The discovery won him a share of the 2011 Nobel Prize in Physics and launched the search to uncover the nature of dark energy.

Why does science need dark energy?
In 1994, I started measuring how fast the Universe had expanded in the past by looking at very distant type Ia supernovae. Along with the rest of the High-Z SN Search team, I compared that past rate with what we saw in supernovae in the nearby Universe, and it showed us that expansion had accelerated.

Gravity is normally attractive and should draw the stars together, so if you're going to speed up expansion, you need to find a way to overcome that. In 1917, Einstein posited the idea of the cosmological constant — an adjustment to the general theory of relativity that amounts to assigning an energy value to empty space. If almost 70% of the Universe is this dark energy, then it makes sense of our findings.

What other evidence is there that dark energy exists?
Probably the most profound evidence comes from the cosmic microwave background. This radiation is a relic of the early Universe that we can still see today. Mapping the apparent temperature of this background radiation across the sky shows us that the Universe is around 5% normal matter, 27% dark matter and 68% dark energy. All the bumps and wiggles in the data match exactly both the theory of the cosmological constant and what was predicted by looking at supernovae in 1998.

For the Universe to not be made up of dark matter and dark energy, and just happen to exactly fit a very complicated curve that was predicted in advance, well, that seems pretty crazy.

What's the more difficult problem: dark energy or dark matter?
Dark energy is really hard; dark matter is much easier. It's hard because there's so little of it. In any given cubic metre of space, there's roughly 10–27 kilograms of the stuff. Earth has a density of 5,500 kg m^{-3}, so there's 30 orders of magnitude difference.

Furthermore, the only way that dark energy really interacts is through gravity, and gravity is a very weak force, so you have to compete with all the other stuff that's going on. There's no sensible way of doing experiments on Earth; the only way we know how to do experiments is by using the entire Universe.

To see if Einstein's cosmological constant is right, we're attempting to show that it's fixed in time. We keep trying to measure the behaviour of the Universe better, to see if the constant holds up, and so far it has. As for what else we can do, no one's come up with another idea. We are stuck.

If the constant does break, are there any other theories?
Quintessence was the first cab off the rank as an alternative. It's postulated to be an energy field, like the Higgs field, which gives particles mass. Unlike the Higgs field, which has no energy density in the Universe, a quintessence field could have an energy density that would change over time, but not be zero.

Einstein's cosmological constant always stays the same, so if the rate of expansion of the Universe doesn't reflect a constant energy for space, that would indicate the existence of something like quintessence. The problem is, a reasonable quintessence field may change by only 1 part in 10,000 over the age of the Universe, and we would only be able to measure it to 1 part in 10, at best.

In April your co-recipient of the Nobel Prize, Adam Riess, suggested that the expansion rate of the Universe might be 8% faster than previously thought. How big a deal would that be?
If it's true it would be profoundly exciting, because it would show something's not right with the cosmological model. I've had a good chat with Adam, and he's cautious because he knows how difficult a measurement it is. I'm 50:50 at this point, but that's not bad. I'm a real sceptic, so for me to say there's a 50% chance that it's interesting is a pretty strong endorsement from me!

How certain were you of your prizewinning finding?
I was about 90% sure it was correct before we published. I was actually 99.9% sure we hadn't made a mistake, but I was worried about an 'unknown unknown' — something no one knew about that would later emerge. That was the 10% uncertainty. But science is about getting out and occasionally being wrong, it's what we're there for.

Do you think it is a good time to be a physicist starting their career?
Yes and no. I'm a 'low-hanging fruit' kind of a guy. Cosmology has got into these huge problems, and that's fine, but personally I find it more interesting and rewarding to do smaller-scale things.

There's a huge range of stuff in the works: the James Webb Space Telescope and the Square Kilometre Array are both on the horizon. When I finished my PhD 23 years ago, everything you did was new. Now, you need to be a bit choosier. To my mind, the interesting stuff is something that is a fundamental part of the story of the Universe, rather than just the gloss on top.

Is it important that astronomers convince the public that what they do is interesting?
I think you have to put what you do in context for people, and astronomers are better at that than most. We shouldn't only do things that everyone in the world can comprehend, but we do need to frame it so that people understand why they should be investing in us. It's not just for us to have fun. I think it's part of our job to explain why countries are spending around 2% of their gross domestic product on research and development. Scientists are motivated because it's interesting — that's part of being human — but in the end we do it because it's useful. ■

INTERVIEW BY RICHARD HODSON
This interview has been edited for length and clarity.