PETER BADGE

Q&A George Smoot
Cosmic cartographer

George Smoot shared the 2006 Nobel Prize in Physics for the discovery of small temperature variations in the cosmic microwave background radiation, providing support for Big Bang theory. Smoot spoke to Nature *about last year's big cosmological discovery, gravitational waves.*

Is the fanfare around the detection of gravitational waves justified?
It is a really big discovery — not just because LIGO (Laser Interferometer Gravitational-Wave Observatory) detected gravitational waves and proved Einstein's 100-year-old theory right, but because it opens up a whole new window on the Universe.

The first event was a pair of 30-solar-mass black holes circling each other and merging. That's an amazing thing to find in itself. The stellar theorists will tell you that even when 100-solar-mass stars go supernova, they don't leave behind black holes that big. The black hole would be more like 5 or 10 solar masses, not 30. So, immediately, there's a question of where these big black holes came from; we may have to correct our stellar theory.

How long have people been trying to detect gravitational waves?
We've been looking for a long time. Rainer Weiss at the Massachusetts Institute of Technology (MIT) in Cambridge — one of the co-founders of LIGO along with Ron Drever and Kip Thorne at the California Institute of Technology in Pasadena — devised the interferometric gravitational-wave detector in 1972. I've known Weiss for a long time — I met him while I was a graduate student at MIT. He doesn't have a lot of patience, and 40 years is a long time to wait for an experiment to pay off. I know those guys have had a lot of fun over the past few months, but it wasn't so much fun to be working on gravitational waves before that!

LIGO detected the first wave while it was being calibrated, four days before it was due to start taking data. What does that swift result tell us?
It tells us that binary black holes are abundant. We had little idea of how many black holes there are. We thought there would probably be more binary neutron stars, which are what LIGO was designed to spot. But in the first four months of running the system we've seen two confirmed black hole mergers and possibly another event. That's at the very top of the range of what we expected to see.

The LIGO team has already started to work out the population of black holes, and in the next couple of years the sensitivity of the two LIGO interferometers should improve and they will start seeing a lot more. If it's around one a month at the moment, we should be getting ten a month down the line. Improved sensitivity will give us an even better idea of how many there are.

What other experiments can we expect to see in the coming years?
There are other laser interferometers coming online. Advanced Virgo, in Italy, is due to switch on at the end of 2016; there's KAGRA in Japan and LIGO-India is planned for the next two or three years. This is what we need: the more detectors you have, the more precisely you can tell the direction the wave is coming from.

I've been pushing for a space-based interferometer as well, like the proposed European Space Agency eLISA mission. These would allow astrophysicists to see lower frequency gravitational waves from larger objects, such as from the merger of two supermassive black holes. There would be thousands to millions of big signals — if we can get an interferometer up there, we'd definitely be in business.

How big an impact do you think gravitational waves are going to have on astronomy?
It's led to a new branch of astronomy, and we're going to be seeing things we've never seen before. Do I expect it to be as revolutionary as astronomy based on the electromagnetic spectrum? No, 99% of what we know about the Universe has come from photons. But there are phenomena, such as black holes, which we wouldn't expect to be associated with electromagnetic radiation, and the way we're going to detect them is through gravitational waves.

It's a very exciting time. Over the next 20 years, people will be building more gravitational-wave detectors and developing new ways of observing the Universe. I think the 20 years after that will be the heyday of astronomy. For young scientists getting started now, there's a great career path ahead if you like maths. It's a field in ascendancy. And experiments such as LIGO meet one of the criteria I have for awarding a Nobel prize: it led not only to a great discovery, but also to a whole new area of enquiry. ■

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

B. WANKERL/MPP

View from a Lindau Young Scientist
"I'm extremely excited about the detection of gravitational waves; it's like gaining a new sense. It has the potential to provide experimental evidence for and against possible modifications of general relativity. For example, my work proposes a gravitational mechanism for generating small neutrino masses. Prospective measurements of gravitational waves could prove us wrong."

Lena Funcke, PhD student at the Max Planck Institute for Physics and the University of Munich, attended the 66th Lindau Nobel Laureate Meeting.