Discovery that shook the world wins US scientists Nobel prize in physics

Detection of gravitational waves opened up cosmos Breakthrough confirmed Einstein's original theory

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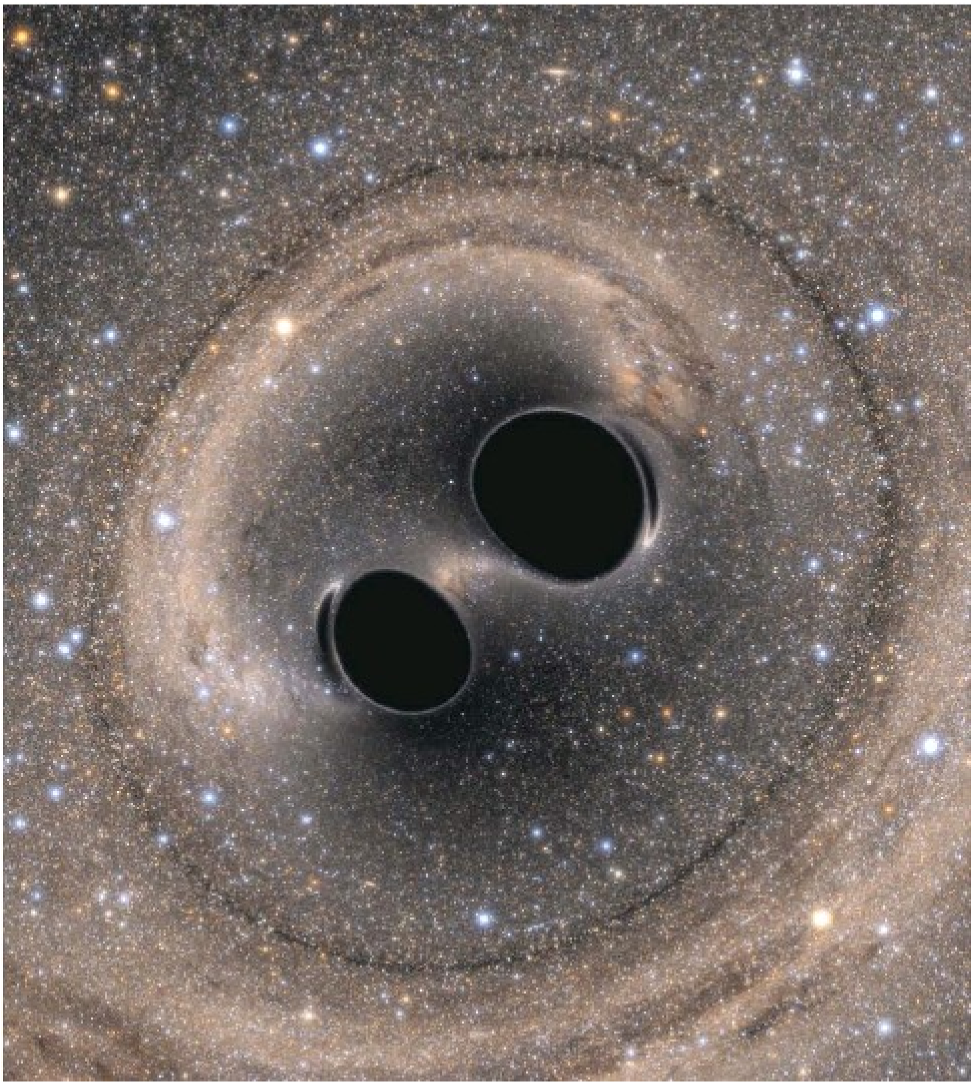
Three American physicists have won the Nobel prize in physics for the first observations of gravitational waves, ripples in the fabric of spacetime that were anticipated by Albert Einstein a century ago.



Rainer Weiss has been awarded half of the 9m Swedish kronor (£825,000) prize, announced by the Royal Swedish Academy of Sciences in Stockholm yesterday. Kip Thorne and Barry Barish will share the other half of the prize.

All three scientists have played leading roles in the Laser Interferometer Gravitational-Wave Observatory (Ligo) experiment, which in 2015 made the first historic observation of gravitational waves triggered by the violent merger of two black holes a billion light years away.

Prof Olga Botner, a member of the Nobel committee for physics, described this as “a discovery that shook the world”.

The Ligo detections finally confirmed Einstein’s century-old prediction that during cataclysmic events the fabric of spacetime itself can be stretched and squeezed, sending gravitational tremors across the universe like ripples on a pond.

The direct detection of gravitational waves also opens a new vista on the “dark” side of the cosmos, to times and places from which no optical light escapes. This includes just fractions of a second after the Big Bang, 13.7bn years ago, when scientists believe gravitational waves left a permanent imprint on the cosmos that may still be perceptible today.

Speaking at a press conference after the announcement, Weiss, an emeritus professor of physics at Massachusetts Institute of Technology, said the 2015 detection was the culmination of decades of work, involving more than 1,000 scientists. “It’s as long as 40 years of people thinking about this, trying to make detections, sometimes failing … and then slowly but surely getting the technology together to be able to do it,” he said.

The notion that spacetime is malleable was predicted by Einstein’s general theory of relativity. But he was unsure whether this was merely a mathematical illusion, and concluded the signal would be so tiny it would “never play a role in science”.

It was a significant career gamble then, when in the 1970s Weiss and Thorne, who is now Feynman professor of theoretical physics at California Institute of Technology (Caltech), began the decades-long quest to detect gravitational waves.

Weiss designed a detector, called a laser-based inferometer, which he believed would be capable of measuring a signal so tiny that it could easily be masked by the background interference of the ocean waves. Thorne, a theorist, began predicting what the signal of a gravitational wave emanating from two black holes colliding would actually look like.

Independently, Ronald Drever, a Scottish physicist, also began building prototype detectors in Glasgow and after moving to Caltech, he, Weiss and Thorne formed a trio that laid the groundwork for Ligo. Drever died in March after suffering from dementia, but is widely recognised as having made a decisive contribution.

Barry Barish, a former particle physicist at Caltech (now emeritus professor), joined at a much later stage, but is often credited for making Ligo happen. When he took over as director in 1994, the project was at risk of being cancelled, but Barish turned things around.

In the end, detection required a peerless collaboration between experimentalists, who built one of the most sophisticated detectors on Earth, and theorists, who figured out what a signal from two black holes colliding would look like.

Ligo’s twin detectors, two pairs of 4kmlong (2.5 miles) perpendicular pipes, one in Hanford, Washington state, the other in Livingston, Louisiana, are so sensitive that they can spot a distortion of a thousandth of the diameter of an atomic nucleus across a 4km length of laser beam.

Weiss recalled that when the detection was eventually made, his initial response was disbelief. The phenomenon detected was the collision of two giant black holes, one 35 times the mass of the sun, the other slightly smaller, 1.3bn light years away. At the start of the 20 millisecond “chirp” in the signal, the two objects were found to be circling each other 30 times a second, accelerating to 250 times a second before colliding. Since then, three further black hole collisions have been detected.

In the future, scientists hope to observe supernovae, pulsars and the insides of stars as they collapse into black holes. A network of gravitational-wave observatories could even allow us to gaze back to almost the beginning of time itself.

Thorne said: “The prize rightfully belongs to the hundreds of Ligo scientists and engineers who built and perfected our complex gravitational-wave interferometers, and the hundreds of … scientists who found the gravitational-wave signals in Ligo’s noisy data and extracted the waves’ information.”

Barish said he was humbled and honoured to receive the award. “The detection of gravitational waves is truly a triumph of modern large-scale experimental physics,” he added.

Sheila Rowan, director of the Institute for Gravitational Research at Glasgow University, said: “We are really on the threshold of a whole new way to study our universe and that’s hugely exciting.”