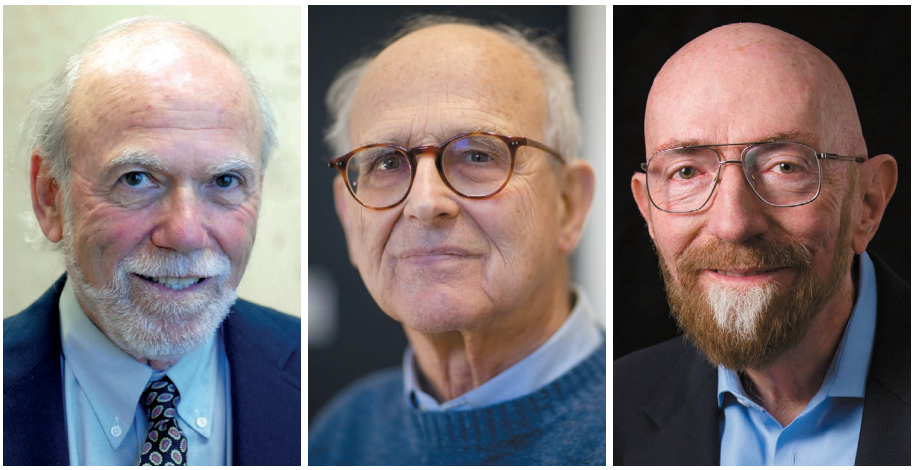
ASTRONOMY

Physics Nobel awarded for gravitational-wave detection

Rainer Weiss, Barry Barish and Kip Thorne share the prize for their work at LIGO.

BY DAVIDE CASTELVECCHI



LEFT: CALTECH; CENTRE: BRYCE VICKMARK/MIT; RIGHT: CALTECH ALUMNI ASSOC.

Catching waves (from left): Barry Barish, Rainer Weiss and Kip Thorne.

Three physicists who had leading roles in the first direct detection of gravitational waves have won the 2017 Nobel Prize in Physics. Rainer Weiss, at the Massachusetts Institute of Technology (MIT) in Cambridge, and Barry Barish and Kip Thorne, both at the California Institute of Technology in Pasadena, share the 9-million-Swedish-krona (US$1.1-million) award for their work at the US-based Laser Interferometer Gravitational-Wave Observatory (LIGO). In September 2015, LIGO picked up the deformations in space-time caused by the collision of distant black holes.

That discovery, which was announced in February 2016, opened up a new field of astronomy, in which scientists listen to the space-time vibrations emitted by some of the Universe's most cataclysmic events. And it confirmed the existence of gravitational waves, which Albert Einstein had predicted a century before.

Weiss and Thorne are two of three physicists known as the troika — the founders of LIGO's giant twin detectors in Livingston, Louisiana, and in Hanford, Washington. The third troika member, Ronald Drever, died on 7 March this year. Barish, who was LIGO director from 1997 to 2005, is widely credited with transforming the collaboration from a chaotic endeavour to a well-oiled machine.

"I view this more as a thing that recognizes the work of about 1,000 people, a really dedicated effort that's been going on for — I hate to tell you — as long as 40 years," said Weiss in an interview with the Nobel Committee. He is awarded half the prize, with the other half split between Barish and Thorne.

UNIMPEDED MOTION

Few physicists doubted the existence of gravitational waves before LIGO's discovery. These distortions in space-time are a consequence of Einstein's general theory of relativity, and propagate across the Universe almost unimpeded. In 1974, they were confirmed indirectly when researchers examined the radio flashes emitted by a pair of merging neutron stars; the shifts in the flashes' timing matched predictions of how gravitational waves would carry energy away from the event. That discovery was rewarded with the 1993 Nobel Prize in Physics.

But sensing the waves themselves was a monumental task. Even the most powerful deformations — those produced by collapsing stars or colliding black holes — would typically be tiny by the time they reached Earth. The waves detected in 2015 stretched and squeezed LIGO's perpendicular 4-kilometre vacuum pipes by a fraction of a proton's width, but that was enough to noticeably shift out of sync the laser beams bouncing inside the pipes.

Physicists in the United States and the then-Soviet Union first proposed using laser interferometers to detect gravitational waves in the 1960s. Weiss made the first detailed calculations for how an interferometer would work in 1972. The idea seemed so far-fetched that even he was not sure it would work. "It might come to a junction in a year or so when we will decide it ain't worth it," he told science sociologist Harry Collins at the time (H. Collins *Gravity's Shadow*; Univ. Chicago Press, 2004).

Weiss, who was born in Germany in 1932, emigrated with his family to the United States in 1938 to escape from Nazism. He built his first prototype interferometer in the mid-1970s, followed by researchers in Europe — among them, Drever and his collaborators at the University of Glasgow, UK.

Thorne specialized in general relativity and had also been developing ideas on the waves. At a conference in Washington DC in 1975, he and Weiss shared a room in an over-booked hotel. During their conversations, Weiss convinced Thorne that interferometers were the right approach. Thorne, Weiss and Drever joined forces in the early 1980s, when it became clear that the US National Science Foundation would not fund two separate efforts, and the LIGO collaboration was born.

The troika did not always work smoothly and, at its members' own admission, did not have the right skills for managing what was quickly becoming a vast operation. Things improved dramatically after Barish, who had been LIGO's principal investigator since 1994, became director in 1997. "Without Barish turning things around, it would have collapsed," says Collins.

LIGO ended up being the largest and most expensive experiment in the history of the US National Science Foundation. Its two detectors first opened in 2002, with an admittedly scant chance of finding anything during their first phase of data collection. The observatory shut down in 2010 for an overhaul and restarted in September 2015, three times more sensitive than before. The Universe was kind to LIGO, providing a dramatic event for it to record on 14 September while the interferometers were still being calibrated, days before their official science run was due to start. Since then, LIGO has detected at least three other gravitational-wave events — the most recently reported with Virgo, a similar interferometer near Pisa, Italy.

Thorne and Weiss were generally considered shoo-ins for the Nobel. Before Drever's passing in March, the troika racked up almost every prize there was to win, including the $3-million Special Breakthrough Prize in Fundamental Physics; the $500,000 Gruber Foundation Cosmology Prize; the $1.2-million Shaw Prize in Astronomy; and the $1-million Kavli Prize in Astrophysics. ■