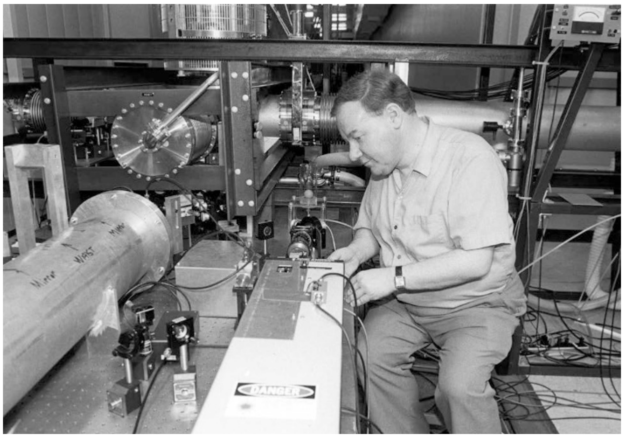
Ronald Drever

(1931–2017)

Experimental physicist key to the detection of gravitational waves.



CALTECH ARCHIVES

Ronald (Ron) Drever was a hands-on physicist with a child-like joy for experimentation. He co-invented several important techniques to directly detect gravitational waves — ripples in space-time created by accelerating masses. He co-founded the Laser Interferometer Gravitational-wave Observatory (LIGO) project, which announced the first direct detection of those long-sought waves in 2016.

Drever, who died aged 85 in Scotland on 7 March, was an intuitive and imaginative physicist who thought primarily in pictures. Those pictures — of concepts or devices — gave him an elegant way to circumvent a lot of analytical reasoning, and provided a way to think about problems that often resulted in an invention.

As a child in Scotland, guided by an engineer uncle, Drever assembled a television receiver from parts left over from the Second World War. He did not do well in preparatory school, but came into his own at the University of Glasgow, UK. There he studied nuclear physics, including particle detectors and their electronics. His 1958 PhD thesis was on radiation counters for nuclear decay.

As a lecturer at Glasgow, Drever tested an idea newly proposed by theorists. This was that objects on Earth might have one inertial mass when travelling in the plane of the Milky Way, and another when travelling perpendicular to it, owing to the uneven distribution of the Galaxy's mass. He and a scientist at Yale University in New Haven, Connecticut, independently checked the motions of nuclei in lithium atoms to see whether they were affected by the orientation of the nuclei relative to the Galactic plane. Drever did his experiment in his parents' back garden, away from the magnetic disturbances of the university, using equipment borrowed from the teaching labs. Neither saw any effect, thereby establishing the uniformity of space to an unprecedented precision. It was a landmark result.

The work took Drever into cosmology and astrophysics. When pulsars were discovered in 1967, he searched for γ-rays that might accompany the radio-wave pulsations. After researchers announced in 1969 that they had detected gravitational waves coming from the Galactic Centre (a result later found to be spurious), Drever hunted for radio pulses coming from the same location. And he began a new research programme at Glasgow for the detection of gravitational waves.

First, Drever devised a more-sensitive and broader-band version of the 'acoustic bar' gravitational-wave detector that others were using at the time to try to replicate the 1969 result. But in the early 1970s, several groups were exploring a technique that involved laser interferometers. The idea was to measure the distortions of space-time caused by gravitational waves by timing how long laser light took to travel between mirrors in an interferometer. Drever, as well as experimenters in Germany, showed that scattered laser light made noise that restricted the sensitivity of the interferometer.

One solution was to stabilize the frequency of the laser. On a sabbatical to Harvard University in Cambridge, Massachusetts, in 1979, Drever learned about a method devised during the Second World War to stabilize the frequencies of microwaves for radar by reflecting them with a resonant cavity. Drever and his colleagues adapted the technique for lasers and optical cavities, creating what is now called Pound–Drever–Hall cavity stabilization. That has become a central technique in precision optical systems, including LIGO.

Other ideas further improved laser interferometer detectors in the 1970s. Drever, with colleagues in Germany and Glasgow, came up with systems for power and signal recycling to increase the sensitivity of the interferometer and to adjust its response. Both systems involved adding more partially reflecting mirrors to the input and output components of the instrument.

By this time, Drever was working at the California Institute of Technology (Caltech) in Pasadena, having been invited by US theoretical physicist Kip Thorne. There, he initiated plans for a 40-metre prototype gravitational-wave detector. Meanwhile, a German group started up a 30-metre prototype, and the Massachusetts Institute of Technology (MIT) in Cambridge also began a study of the science, concept and cost of a device.

In 1983, the Caltech and MIT research groups joined forces to build and operate a full-scale device: LIGO. The collaboration was initially directed by a committee of Drever, Thorne and myself. But we had different visions and were unable to make decisions. In 1987, the project moved forward under a single director, Rochus Vogt, who helped us to write a definitive proposal that attracted the funds to design and construct the initial detector. The project — the largest ever funded by the US National Science Foundation — consisted of two L-shaped detectors, each with arms 4 kilometres long, in Washington state and Louisiana.

Drever was a strong contributor to the conceptualization of LIGO. But he struggled to move from the freedom of table-top science to the rigorous schedule and firm decision-making necessary to pin down a large-scale project. In such projects, thorough engineering practice and careful analysis take priority over intuition and pictorial reasoning.

In 1994, LIGO's then-director Barry Barish supported a decision made at Caltech to give Drever a separate laboratory, where he could develop new ideas and techniques for future gravitational-wave detectors. LIGO started collecting data in 2002, and detected gravitational waves from a pair of colliding black holes in 2015. This led to many prizes and awards for Drever and his colleagues.

It is well known that Drever and I had different views about the direction for technical development for LIGO. I disagreed with him about the use of optical cavities; it turned out he was right. I held out for a solid-state laser while he insisted on a green argon one; Drever was wrong on that one. But we always respected each other's views, and as LIGO's construction progressed we became close colleagues and friends. ■

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