An international collaboration of scientists, the LIGO Scientific Collaboration, has announced the first detection of gravitational waves, ripples in the fabric of space and time that carry information about the cosmos. This discovery is not only an important milestone for physics and astronomy, but also a reminder of how powerful and broad the impact of scientific research can be.

The detection of these gravitational waves not only confirms Albert Einstein's predictions about the awesome power and strength of gravity, it also gives us new information about black holes, the compact orbs of gravity that form when large stars collapse. Never before has a system of colliding black holes been observed, and we now know these merger events may be relatively common in the universe. All of this would not have been possible without public funding and oversight from the U.S. National Science Foundation, the only American funding agency devoted primarily to basic research. Public funding for basic research, however, has long been in decline.

This transformative discovery was made using the twin detectors of the Laser Interferometer Gravitational-wave Observatory (LIGO) in Louisiana and Washington. These optical instruments are so sensitive they can measure the separation of two mirrors, 2.5 miles distant from each other, changing by a distance less than the nucleus of an atom. This is equivalent to measuring the width of a human hair over the distance to the nearest star. These detectors were not always this sensitive; they were upgraded by the NSF's Advanced LIGO project. The NSF has supported gravitational wave detection efforts for nearly 50 years starting with pioneering work at the University of Maryland. In the 1980s, NSF support laid the groundwork that led to the $200M Advanced LIGO project of the last seven years. Building the Advanced LIGO detectors was done both on budget and on schedule – an outstanding example of American scientific project management at its best.

The bipartisan support for the 2016 federal science budget that increases funding for all major science agencies is encouraging. But overall, federal science funding has been allowed to stagnate in recent years, and the lack of a long-term commitment makes planning future projects like LIGO difficult. NSF had the vision to support LIGO and stay with it for many years – even in the absence of hard knowledge about the likelihood of gravitational wave detection. It takes a large number of scientists and engineers working over many years to produce a scientific breakthrough of this magnitude.

The U.S. effort is part of a worldwide collaboration including colleagues from Europe and Japan who operate similar detectors. Academic scientists led this research effort, but it took a team of over 1000 scientists, students, engineers, technicians, and also volunteers from the public to achieve this result. Hundreds of students have been trained by working on LIGO in a variety of technical fields, including optics, computer programming, electrical engineering, and many others. The difficult technical challenges in detecting gravitational waves have led to spin off technologies that have made improvements in lasers, glass technology, semiconductor manufacturing, and information processing among other applications. LIGO shows that sustained funding from a federal agency guided by a peer-review process can lead to breathtaking and inspiring results along with practical innovations. This is just the beginning for LIGO as continuing observations will lead to new discoveries, the next generation of scientists being inspired and educated, and further technological improvements.

We appreciate the interest all Americans have in understanding the value and relevance of the research that they fund. LIGO scientists, like nearly all NSF-funded researchers, spend time and energy on reaching out to the wider community. This includes explaining our science to students, amateur scientists, entrepreneurs, and the general public. LIGO has embarked on a nationwide outreach campaign to explain both the excitement and the importance of our detection of gravitational waves. Educated and engaged citizens are crucial to the modern technological economy which depends on continuing innovations. These innovations impact not just our economic competitiveness but also our national defense, energy independence, environmental impact, and overall quality of life. Technical innovation comes from discovery-based research projects like LIGO, which challenge researchers to solve difficult problems and make unexpected breakthroughs.

An exciting new field of physics and astronomy has begun, one that will play a major role in our exploration of the universe during the 21st century. Federal funding agencies, with public support, can invest vigorously in basic science research that will drive both practical applications, and a deeper understanding of the wonders of the universe and of the world around us.

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