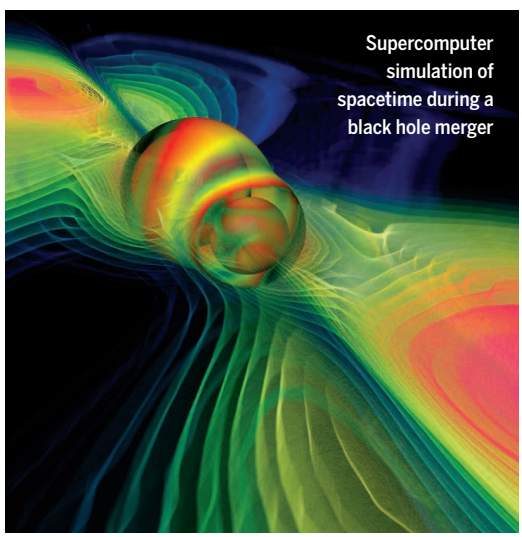
EDITORIAL

Throwing deep

In a galaxy far, far away (a billion light years away, to be more precise), two massive black holes merged. Spacetime twisted, contorted, and rearranged itself in dramatic fashion, and ripples within its very fabric shot out across the cosmos. Occurrences like this happen hourly somewhere in the universe. What is notable is that on Earth, we detected these ripples, an event now known as GW150914. In the fraction of a second that we "heard" black holes shake up spacetime, a new window on the universe was opened where we hope to hear more black holes, cosmic phase transitions, and even the birth of the universe. The last big prediction of general relativity—the existence of gravitational waves—has been directly confirmed, and we now have a new way of advancing our understanding of gravity, the force that shapes our universe.



Supercomputer simulation of spacetime during a black hole merger

"GW150914...marked an extraordinary scientific milestone by a very curious species."

Galileo Galilei urged, "Measure what is measurable, and make measurable what is not so." The team of scientists that built the Laser Interferometer Gravitational-Wave Observatory (LIGO) did the latter, big time. On 14 September 2015, during its first engineering run, spacetime ripples from GW150914 wiggled the separation of mirrors 4 km apart in the LIGO detectors, situated in Hanford, WA, and Livingston, LA, by about 10^{-16} cm, one-thousandth the size of a proton. They made the too-small-to-measure measurable by using interferometry, a technique invented by physicist Albert A. Michelson, the first Nobel Prize winner from the United States. Galileo must be smiling. GW150914 not only awed scientists but also captured the attention and imagination of much of humanity, which is no small feat.

This is big science well done. Researchers identified a lofty and worthy goal, and the U.S. National Science Foundation (NSF), in partnership with the California Institute of Technology and the Massachusetts Institute of Technology, funded and stuck with it until they succeeded, a timeline of almost 50 years. There were ups and downs. The brilliant invention of the first gravitational-wave antenna by physicist Joseph Weber was followed by false-alarm detections. NSF built LIGO in the face of skepticism by astronomers, and had to reorganize the project after an early management meltdown. Although the world of science today is more globally collaborative than competitive, there is still a place for national pride and strategic commitment. Just as Japanese scientists targeted neutrinos for their research in elementary particle physics and are proud of their great discoveries in that area (including a 2015 Nobel Prize in Physics), U.S. scientists can be proud of U.S. leadership in the discovery of gravitational waves.

In "The Chirp Heard Across the Universe," the *New York Times* editorial board argued that the justification for NSF's billion-dollar investment in LIGO was simply curiosity about our place in the universe, with no expectation that it would lead to "a better toaster." I agree, but that is not the whole story. Among federal science agencies, NSF is unique in its mission to fund discovery science; it is the throw-deep agency committed to satisfying the boundless curiosity of our species. And, if history is any guide, some of the new knowledge generated by these discoveries will result in future technological advances that transform our very existence. Michael Faraday's tinkering with magnetism in the 19th century led to the science that underpins everything that involves electricity and light, making good on his reply to British Chancellor of the Exchequer William Gladstone when asked about the utility of his research: "One day, sir, you may tax it."

GW150914 may have been an ordinary event in the larger cosmos, but here on Earth, it marked an extraordinary scientific milestone by a very curious species. And best yet, we still don't know where it will all lead. NSF, keep throwing deep!

– Michael S. Turner

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PHOTOS: (RIGHT) UNIVERSITY OF CHICAGO; (INSET) WERNER BENGER, ALBERT EINSTEIN INSTITUTE/ZUSE INSTITUTE BERLIN/CENTER FOR COMPUTATION & TECHNOLOGY AT LSU

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