Observation of neutron star collision called a game changer in astronomy

By Hannah Devlin, The Guardian, adapted by Newsela staff on 10.18.17
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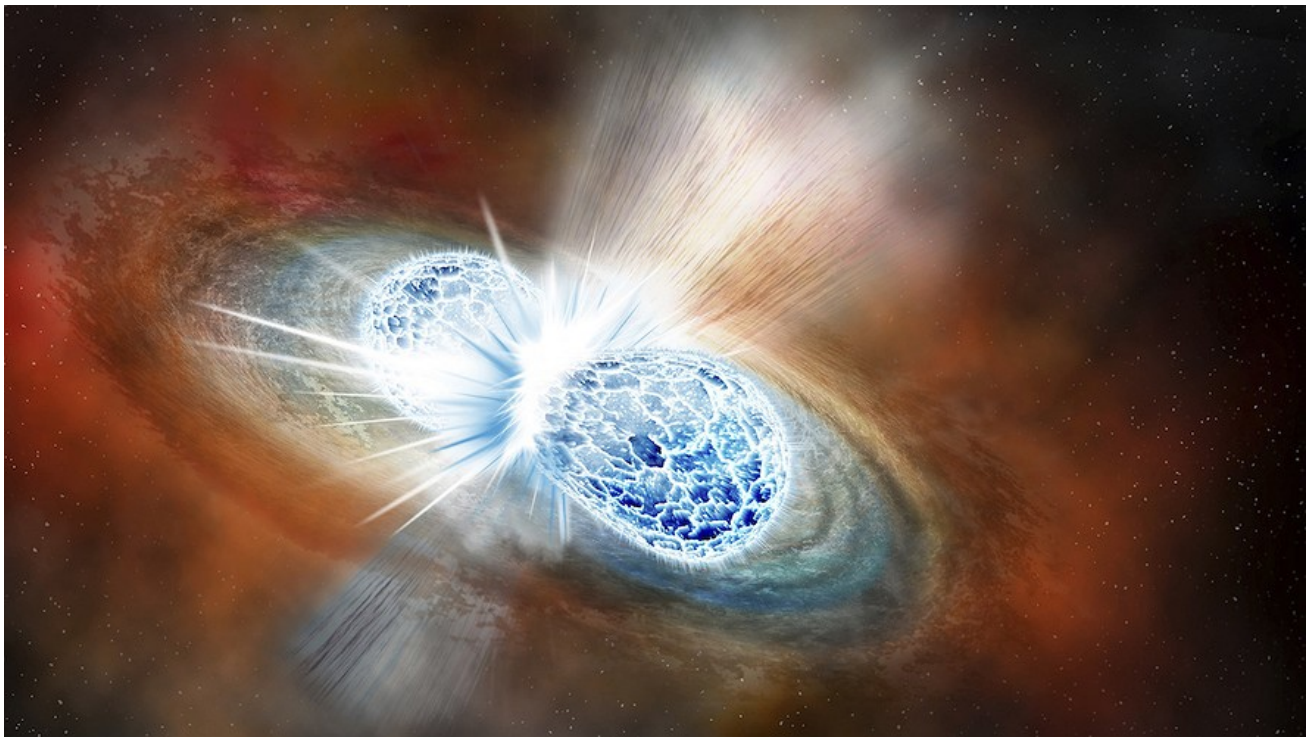

This illustration provided by the Carnegie Institution for Science depicts the collision of two neutron stars detected on August 17, 2017. The explosion threw matter, light, radiation and gravitational waves into space. The discovery was reported on October 16, 2017. Photo from Robin Dienel/Carnegie Institution for Science via AP

Two neutron stars have crashed into each other, creating waves through the fabric of space-time and a flash brighter than a billion suns. This was this first time that humans have witnessed this kind of event.

A neutron star is the collapsed core of a large star. Neutron stars are the smallest and densest stars known to exist. They are about 12 miles wide. Only a teaspoon of neutron star material would have a mass of about a billion tons. The core of the star is a soup of pure neutrons. The crust is smooth, solid and 10 billion times stronger than steel. These stars are awe-inspiring, and watching them collide is even more amazing.

During this incredible event, these two ultra-dense stars spiraled inwards and violently crashed into each other. Then they probably collapsed into a black hole. A black hole is a part of space which has such strong gravitational effects that nothing — not even light — can escape from inside it.

LIGO Observatory Detected The Collision

The events were first picked up by the U.S.-based Laser Interferometer Gravitational-Wave Observatory (LIGO). LIGO is a type of observatory that searches for gravitational waves.

Unlike other observatories, LIGO has no telescope. LIGO is blind. The tool is not searching for light, it is feeling for gravitational waves. LIGO also cannot operate alone and needs numerous detectors to know whether a gravitational wave has taken place.

LIGO's twin detectors are in Louisiana and Washington state. They picked up the ripples in space-time that had spilled out from the crash 1.3 million light-years away. This triggered an alert that went out to astronomers who study space across the globe. Within hours, 70 space- and ground-based telescopes turned in the same direction. They all observed the red-tinged afterglow.

Dave Reitze is the executive director of LIGO. He said, “What is amazing about this discovery is it is the first time we’ve got a full picture of one of the most violent, cataclysmic events in the universe. This is the most intense observational campaign there has ever been.”

Each Star Was Bigger Than The Sun

Einstein first predicted the existence of gravitational waves a century ago. However, the first experimental proof that space itself can be stretched and squeezed did not come until 2015. That was when LIGO scientists detected a collision of black holes. But this dark merger and the three detected since then could not be seen by typical telescopes. As the stars collided, they gave off an intense beam of gamma rays, which are similar to x-rays. The sky was showered with heavy metallic elements. This resolved a longstanding debate about where heavy metals like gold and platinum come from.

The 100-second hum picked up by LIGO told the story of how the two stars, each slightly heavier than the sun, approached their death. Initially separated by 200 miles, they circled each other 30 times a second. As they whirled inwards, they picked up speed.

Two seconds later, the Fermi space telescope used by the National Aeronautics and Space Administration (NASA) picked up an intense burst of gamma rays. Gamma rays are powerful invisible rays that are sent out from some radioactive substances. These were sent out as shockwaves rushed through jets of matter funneled out of the poles at the moment of the crash.

What happened next is uncertain. A neutron star weighing more than twice the mass of the sun has never been seen before, but neither has a black hole so small.

David Shoemaker, a spokesman for the LIGO Scientific Collaboration, said, “It’s [probably] the first observation of a black hole being created where there was none before, which is pretty darn cool.”

Enhanced Study Of The Universe

The observations herald a new era of rapid-response astronomy. This means that quickly moving and unexpected cosmic events can be observed in detail for the first time. When LIGO's software picked up a signal on August 17, Shoemaker was one of a small team at LIGO to be alerted by a ringtone on his phone. That ringtone was reserved for when black holes or neutron stars collide.

“My phone went off and I smiled,” he said.

Within an hour, the detection had been confirmed by Virgo, a European gravitational wave detector near Pisa, Italy. The source of the signal had been traced to a small patch of sky and a global alert was triggered.

Professor Stephen Smartt teaches at a university in Northern Ireland. He was leading a five-day observation run of supernovae on the New Technology Telescope at La Silla, Chile, when the news came in.

Smartt’s team, and those on other telescopes, observed the faint new blob and measured its range of light to assess the chemical composition.

Previously, scientists had speculated that the sheer force of neutron star collisions would be enough to force extra neutrons into the nuclei of atoms, forging heavy elements like gold and platinum, but until now this idea was purely theoretical.

“People have been looking for that forever,” said Freise.

“This is the first real confirmation that heavy elements such as gold, platinum and uranium are either solely or predominantly produced in binary neutron star collisions,” said Reitze. “The wedding band on your finger or the gold watch you’re wearing was most likely produced a billion years ago by two neutron stars colliding. That’s pretty cool.”