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Einstein's general relatively passes latest test

John Rangel

It took 100 years for technology to catch up to Albert Einstein’s genius, but physicists can finally close the book on the existence of one of the most difficult aspects of his theories to verify.
The physics world celebrated Thursday the first direct observation of "gravitational waves" — ripples in space, generated from rapidly moving, massive galactic objects — a century after they were first predicted by Einstein in his theory of general relativity.

While the validation is a major scientific milestone, the ability to simply observe gravitational waves is a landmark achievement in itself. The extreme sensitivity required by instruments to measure ripples in space-time only became possible within the past few years after decades of international research.

“The description of this observation is beautifully described in the Einstein theory of general relativity formulated 100 years ago, and comprises the first test of the theory in strong gravitation,” said Rainer Weiss, professor of physics at the Massachusetts Institute of Technology, in a press release. “It would have been wonderful to watch Einstein’s face had we been able to tell him.”

Weiss is one of the scientists who originally proposed the experiment that eventually made the discovery — LIGO, or “Laser Interferometer Gravitational-wave Observatory.” The LIGO detectors are located in Livingston, Louisiana and Hanford, Connecticut.

David Toback, physics and astronomy professor at Texas A&M and member of the Mitchell Institute for Fundamental Physics and Astronomy, said gravitational waves can be envisioned as ripples in a pond after a throwing a rock that breaks the surface.

“[Gravitational waves] are basically ripples of information that go through space because of the disturbance produced by huge amounts of mass move through space,” Toback said.

To grasp what gravitational waves are requires a basic understanding of general relativity. Toback said Newtonian physics describes gravity as a force between two objects such as the sun and Earth — the one with larger mass exerts a force on the other, drawing it into orbit. This simple understanding went out the window however in 1915 with Einstein’s general relativity.

“General relativity says however that the sun creates a big ‘dent’ in space-time, and in some sense you can think of the Earth as ‘falling’ towards the sun as it moves in the dent,” Toback said.

The curves in space-time created by massive objects such as the sun ‘move’ with the object as it travels about the universe — hence the analogy to liquid ‘waves.’ The phenomenon is more pronounced the larger the object, and a cataclysmic event that occurred over a billion years ago created the disturbance that scientists only now measured.

“The discovery from the LIGO experiment was they saw the gravity waves from two black holes, each with a mass of about 30 times that of the sun, spiral into each other very rapidly and violently, and because there’s so much mass spinning so quickly it produced huge amounts of gravity waves — like churning up a swimming pool — and turned into a single, much bigger black hole about 60 times the mass of the sun,” Toback said.

Toback said while the discovery was celebrated as yet another validation of Einstein’s theories, the scientific community was more in awe of the instrumentation that made the detection possible.
"[The discovery] is a remarkable thing," Toback said. "Two black holes a billion light years away from us spiraling in, and we could see that. Not with our eyes — they are black, there’s nothing to see — but because of the way they disturbed the fabric of space [and] rippled through space for a billion light years, and we were able to detect that."

Posted in Science & Technology on Thursday, February 11, 2016 6:38 pm. Updated: 9:06 pm.

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