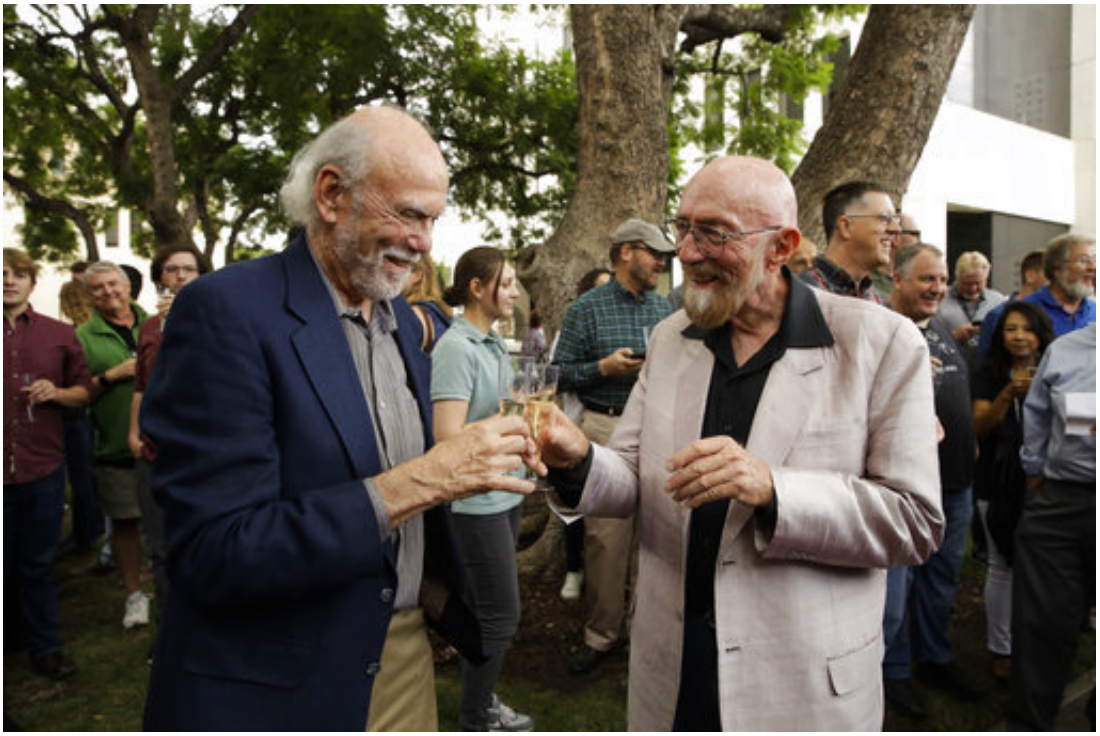
Explainer: Why gravitational wave researchers won a Nobel

October 3 2017, by Seth Borenstein



Scientists Barry Barish, left, and Kip Thorne, both of the California Institute of Technology, share a toast to celebrate winning the Nobel Prize in Physics Tuesday, Oct. 3, 2017, in Pasadena, Calif. Barish and Thorne won the Nobel Physics Prize on Tuesday for detecting faint ripples flying through the universe, the gravitational waves predicted a century ago by Albert Einstein that provide a new understanding of the universe. (AP Photo/Jae C. Hong)

Three U.S.-based astrophysicists won the Nobel prize in physics Tuesday

for their discovery of gravitational waves, a phenomenon Albert Einstein predicted a century ago in his theory of general relativity. Here's what their discovery means and why they won the prize worth $1.1 million (9 million kronor).

WHO WON?

Rainer Weiss of the Massachusetts Institute of Technology, a German-born scientist who initially flunked out of MIT, won half the prize as the astronomer who initially spearheaded the push for the $1.1 billion project called LIGO. Theorist Kip Thorne and physicist Barry Barish, both of the California Institute of Technology, split the other half.

So far the LIGO twin detectors in Louisiana and Washington—and a new one in Italy—have spotted four gravitational waves in about two years since going online in September 2015.

WHAT IS A GRAVITATIONAL WAVE?

Gravitational waves are extremely faint ripples in the fabric of space and time that come from some of the most violent events in the universe. The four observations came from the merger of two black holes. The first one was 1.3 billion light-years away.

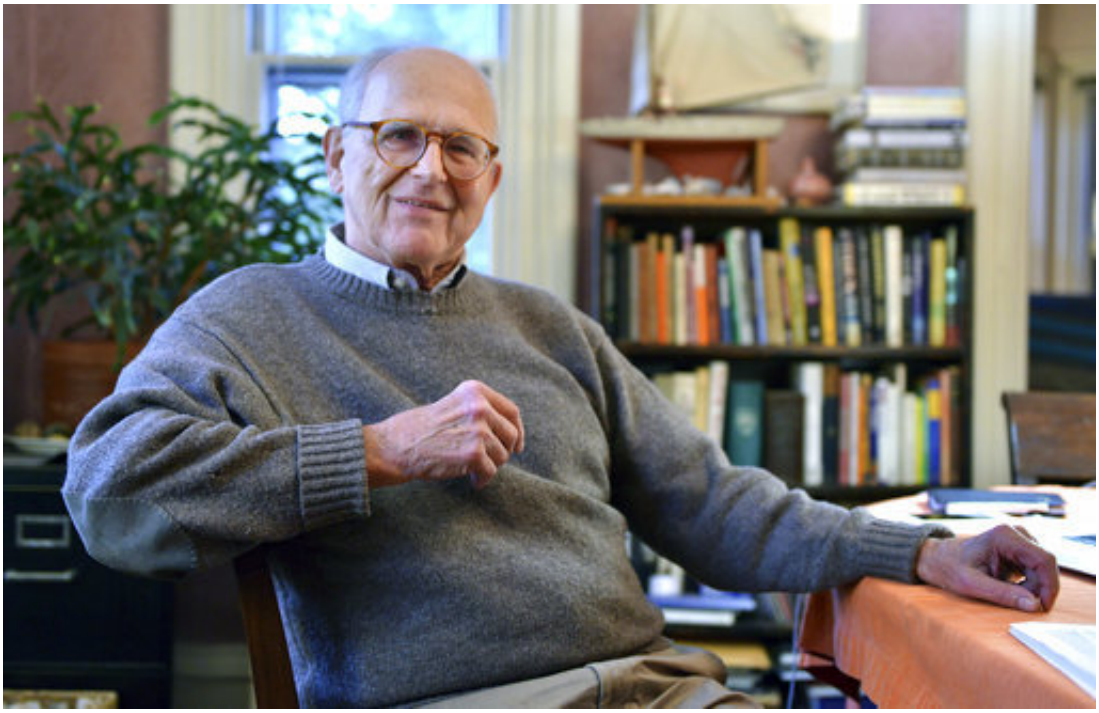
These waves stretch in one dimension—like left and right—while compressing in another, such as up and down. Then they switch, Weiss explained.

"They are ripples that stretch and squeeze space and everything that lives in space," Thorne said.

WHAT IS SPACE-TIME?

Space-time is the mind-bending, four-dimensional way astronomers see the universe. It melds the one-way march of time with the more familiar three dimensions of space.

Einstein's general relativity says that gravity is caused by heavy objects bending space-time. And when massive but compact objects like black holes or neutron stars collide, their immense gravity causes space-time to stretch or compress.



Rainer Weiss poses for a photograph at his home, Tuesday, Oct. 3, 2017, in Newton, Mass. Weiss, of the Massachusetts Institute of Technology, is one of three awarded this year's Nobel Prize in physics for their discoveries in gravitational waves. (AP Photo/Josh Reynolds)

When two black holes collide you get "a storm in the fabric of space-time ... vortices of twisting space fighting with each other," Thorne said.

Ironically, Einstein would have been quite surprised because even though he theorized about gravitational waves, he didn't think humans would ever have the technology to spot them. And he didn't believe black holes existed, Weiss said.

WHY IS IT IMPORTANT?

Unlike other types of waves that go through the universe such as electromagnetic waves, gravitational waves go through matter—stars, planets, us—untouched. So it's an entirely new type of astronomy, with experts comparing it to Galileo's observations of the solar system. There's information in gravitational waves that cannot be found elsewhere.

The first gravitational wave detected was in the form of an audible chirp that some call the music of the cosmos. University of Florida's Clifford Will said it offers a new way of observing the cosmos beyond light and particles.

HOW IS THIS "HEARING" THE COSMOS?

Scientists mostly use the word "hear" when describing gravitational waves, and the data does, in fact, arrive in audio form. The researchers can don headphones and listen to the detectors' output if they want. But Weiss said it is not quite like sound waves.

WHAT'S NEXT?

Scientists are waiting to detect crashes of neutron stars, which many thought would be the first collision to be heard.

Other types of gravitational detectors are being built including one in India.

The European Space Agency is planning a multibillion-dollar probe to be launched in about 17 years that would look for gravitational waves from space. With better technology, Weiss hopes astronomers will learn more about nuclear physics, states of matter, how heavy elements are made and detect information from "the very moment when the universe came out of nothingness."

"We expect surprises," Weiss said. "There has to be surprises."