Closing in on Einstein's window to the universe

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(Phys.org) —Nearly a century after the world's greatest physicist, Albert Einstein, first predicted the existence of gravitational waves, a global network of gravitational wave observatories has moved a step closer to detecting the faint radiation that could lead to important new discoveries in our universe.

David Blair is a Winthrop Professor of Physics at The University of Western Australia and Director of the Australian International Gravitational Research Centre at Gingin - 87km north of Perth. He leads the WA component of a huge international team that has announced a demonstration of a new measurement technique called 'quantum squeezing' that allows gravitational wave detectors to increase their sensitivity.

"This is the first time the quantum measurement barrier has been broken in a full scale gravitational wave detector," Professor Blair said. "This is like breaking the sound barrier: some people said it would be impossible. Breaking that barrier proved that supersonic flight was possible and today we know that it is not a barrier at all.

"This demonstration opens up new possibilities for more and more sensitive gravitational wave detectors."

Gravity waves are ripples in space generated by extreme cosmic events such as colliding stars, black holes, and supernova explosions, which carry vast amounts of energy at the speed of light.

These events are thought to be happening about once a week within the range of new detectors. They should achieve first detection within a few years of beginning operation as their sensitivity is steadily improved.

With the addition of quantum squeezing, physicists will be able to see much more distant sources. However a southern hemisphere detector is needed to be able to pinpoint the location of signals and to reduce interference.

"Already gravitational wave detectors have been proved to be the most sensitive gravitational instruments ever created. They measure motions measured in attometers...one millionth of one millionth of one millionth of a metre. The motions they detect are tiny, even compared to the size of a proton," Professor Blair said.

"The new results prove that the physicists are on track to take them to even higher levels of sensitivity. This will open up the gravitational wave spectrum and allow humanity for the first time to hear the myriad of gravitational sounds that are thought to be constantly rippling through space at the speed of light."

In the research: "Enhanced sensitivity of the LIGO gravitational wave detector by using squeezed states of light," published in the journal *Nature Photonics*, squeezed vacuum is injected into the dark port of the beam splitter to improve the performance of one of the detectors of the Laser Interferometer Gravitational-Wave Observatory (LIGO) beyond the quantum noise limit.

The experiment was carried out on the LIGO detector at Hanford, Washington, known as 'H1'.

The researchers are now developing the techniques for converting squeezed vacuum into frequency-dependent squeezed vacuum for use in Advanced LIGO.

More information: www.nature.com/nphoton/journal … photon.2013.177.html

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