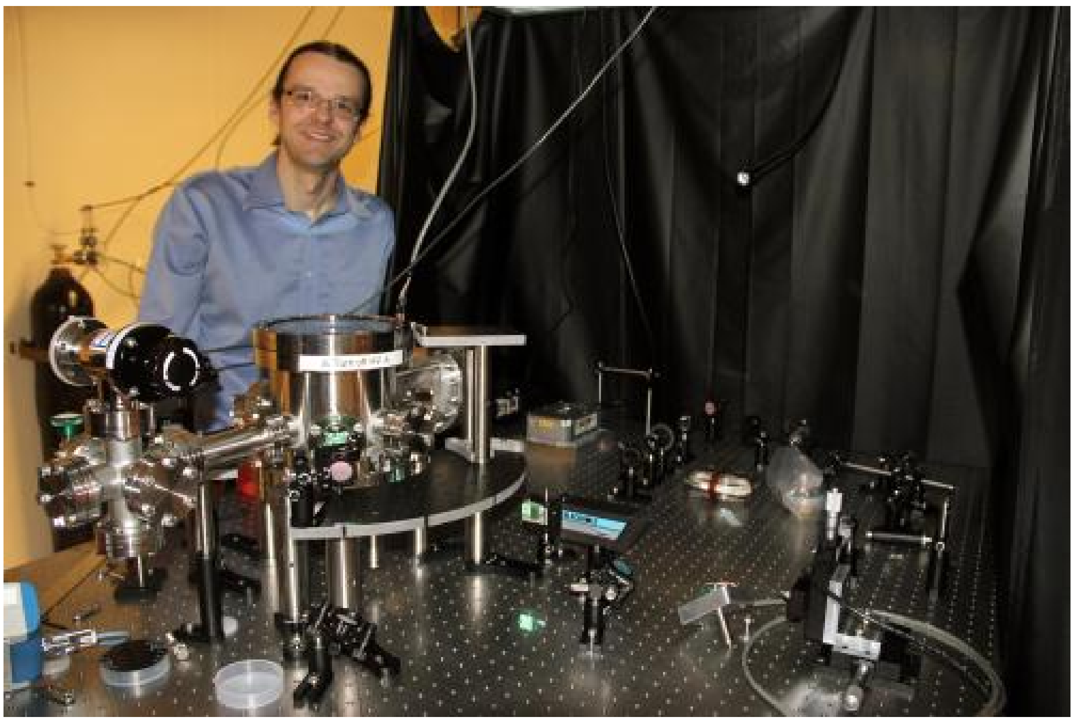
New method proposed for detecting gravitational waves from ends of universe

May 16 2013



A new window into the nature of the universe may be possible with a device proposed by scientists at the University of Nevada, Reno and Stanford University that would detect elusive gravity waves from the other end of the cosmos. Their paper describing the device and process was published in the prestigious physics journal *Physical Review Letters*. Andrew Geraci, assistant professor in the University of Nevada, Reno physics department, demonstrates an apparatus that is of part of an experiment that uses similar technology to his gravitational wave detector. This equipment uses levitated nanospheres in an optical trap for investigations of the gravitational force at the micron length scale, where some theories in high-energy physics predicts there will be a deviation from the Newtonian inverse square law of gravitation. Credit: Mike

Wolterbeek, University of Nevada, Reno.

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"Gravitational waves represent one of the missing pieces of Einstein's theory of general relativity," Andrew Geraci, University of Nevada, Reno physics assistant professor, said. "While there is a global effort already out there to find gravitational waves, our proposed method is an alternate approach with greater sensitivity in a significantly smaller device.

"Our detector is complementary to existing gravitational wave detectors, in that it is more sensitive to sources in a higher frequency band, so we could see signals that other detectors might potentially miss."

Geraci and his colleague Asimina Arvanitaki, a post-doctoral fellow in the physics department at Stanford University, propose using a small, laser-cooled, tunable sensor that "floats" in an optical cavity so it is not affected by friction. Geraci is seeking funding to begin building a small prototype in the next year.

"Gravity waves propagate from the remote corners of our universe, they stretch and squeeze the fabric of space-time," Geraci said. "A passing gravity wave changes the physically measured distance between two test masses – small discs or spheres. In our approach, such a mass experiences minimal friction and therefore is very sensitive to small forces."

While indirect evidence for gravity waves was obtained by studying the changing orbital period of a neutron star binary, resulting in the 1993 Nobel Prize in Physics, gravity waves have yet to be directly observed.

"Directly detecting gravitational waves from astrophysical sources enables a new type of astronomy, which can give us "pictures" of the sky analogous to what we have by using telescopes," Geraci said. "In this way the invention of a gravitational wave detector, which lets us "see" the universe through gravity waves, is analogous to the invention of the telescope, which let us see the universe using light. Having such detectors will allow us to learn more about astrophysical objects in our universe, such as black holes."

The approach the authors describe can exceed the sensitivity of next-generation gravitational wave observatories by up to an order of magnitude in the frequency range of 50 to 300 kilohertz.

Their paper, "Detecting high-frequency gravitational waves with optically levitated sensors," appeared in *Physical Review Letters*, a publication of the physics organization American Physical Society.

Geraci also presented his research at the annual American Physical Society Meeting in Denver in April. The meeting is attended by particle physicists, nuclear physicists and astrophysicists to share new research results and insights.

More information: arxiv.org/abs/1207.5320

Provided by University of Nevada, Reno

May 16) retrieved 28 April 2024 from https://phys.org/news/2013-05-method-gravitational-universe.html