Quantum Sensor Developed by LSU Researcher Breaks New Limits

March 16 2010

(PhysOrg.com) -- Researchers at Louisiana State University have invented an optical sensor that surpasses a quantum limit to sensitivity previously believed to be unbeatable. The breakthrough has a broad array of applications, from gravity wave observatories seeking to observe distant and bizarre astrophysical phenomena, to optical gyroscopes used in commercial navigation.

Optical interferometers are some of the most sensitive devices on Earth, and they have a 100 year long history at the forefront of breakthroughs in science - from turn of the century experiments measuring the speed of light and paving the way for Einstein's theory of relativity - to current day laser interferometer antennas that scan the skies for evidence of gravity waves emitted from colliding black holes.

Practical applications are navigational gyroscopes found in jet planes and magnetic field sensors used in oil drills. It was previously thought that the there was an ultimate limit on the sensitivity of such devices imposed by the laws of quantum physics.

"We uncovered this ground breaking new sensor concept in an analysis of optical sensors that exploit some of the stranger predictions of quantum mechanics in their workings," said Jonathon P. Dowling, Hearne Research Chair in Theoretical Physics at LSU and lead researcher on the project.

The LSU team, led by Dowling, has now demonstrated conclusively that

this limit can be broken in a work that appeared recently in *Physical Review Letters*. This work exploits quantum properties of light to design of the most sensitive optical interferometer ever devised.

“This project began as a research project for one of our physics and astronomy undergraduate students, Gretchen Raterman,” said Dowling. “The work quickly took on a life of its own with different contributions from Ms. Raterman and other members of our LSU team. The end result - the beating of this thought to be unbeatable limit - came as quite a surprise and it illustrates how basic scientific research at LSU can lead to potentially practical advances in technology in unexpected ways.”

More information: Quantum Metrology with Two-Mode Squeezed Vacuum: Parity Detection Beats the Heisenberg Limit, Phys. Rev. Lett. 104, 103602 (2010). DOI:10.1103/PhysRevLett.104.103602

Provided by Louisiana State University