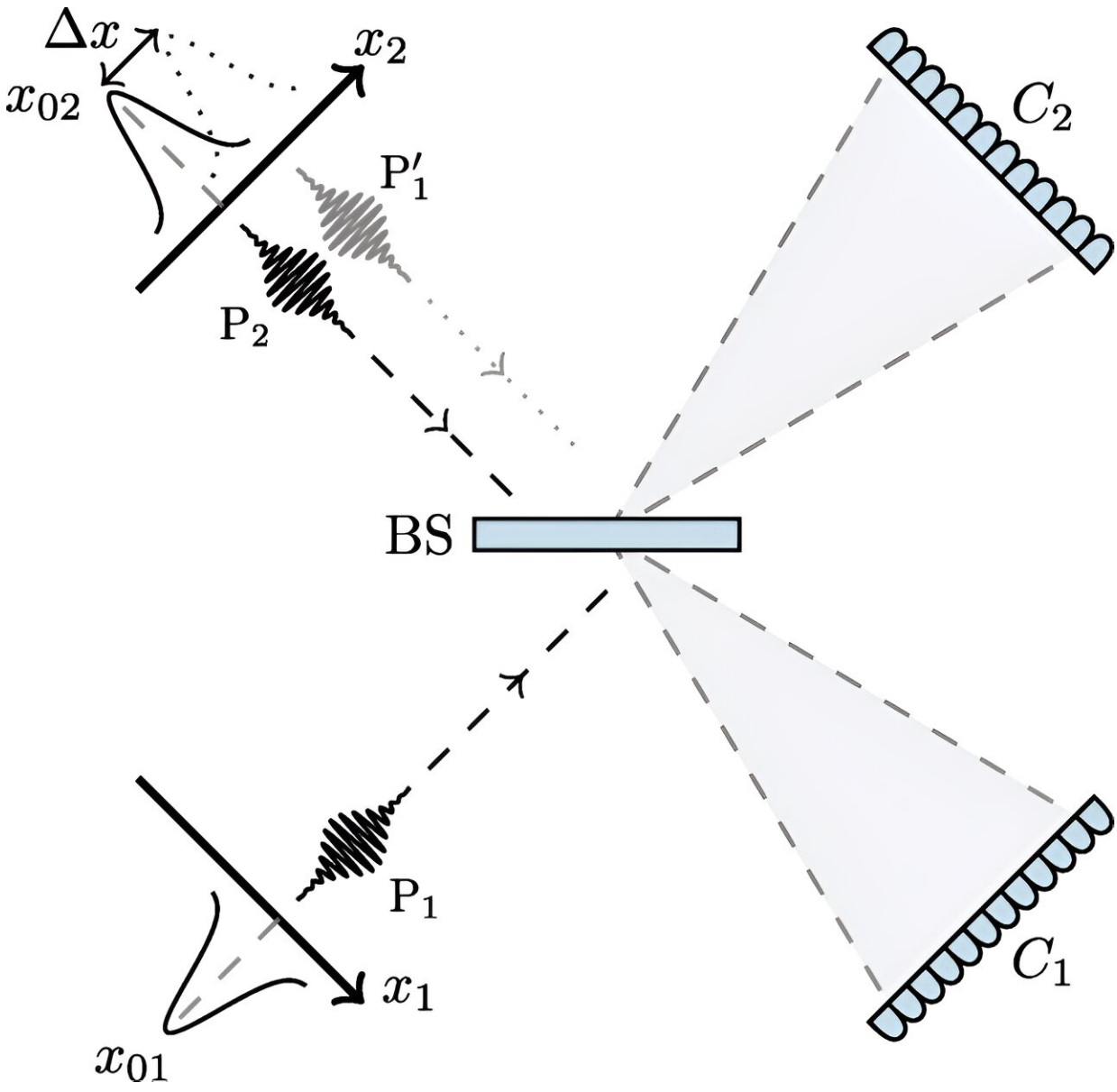
New quantum sensing scheme could lead to enhanced high-precision nanoscopic techniques

May 4 2024



Credit: *Physical Review Letters* (2024). DOI: 10.1103/PhysRevLett.132.180802

Researchers from the University of Portsmouth have unveiled a quantum sensing scheme that achieves the pinnacle of quantum sensitivity in measuring the transverse displacement between two interfering photons.

This new technique has the potential to enhance superresolution imaging techniques that already employ single-photon sources as probes for the localization and tracking of biological samples, such as single-molecule localization microscopy with quantum dots.

Traditionally, achieving ultra-high precision in nanoscopic techniques has been constrained by the limitations of standard imaging methods, such as the diffraction limit of cameras and highly magnifying objectives. However, this new quantum sensing scheme circumvents these obstacles, paving the way for unprecedented levels of precision.

At the heart of this innovation lies an interferometric technique that not only achieves unparalleled spatial precision, but also maintains its effectiveness regardless of the overlap between displaced photonic wave packets. The precision of this technique is only marginally reduced when dealing with photons differing in nonspatial degrees of freedom, marking a significant advancement in quantum-enhanced spatial sensitivity.

Study co-author Professor Vincenzo Tamma, Director of the Quantum Science and Technology Hub, said, "These results shed new light on the metrological power of two-photon spatial interference and can pave the way to new high-precision sensing techniques."

"Other potential applications for the research could be found in the development of quantum sensing techniques for high-precision refractometry and astrophysical bodies localization, as well as high-precision multi-parameter sensing schemes, including 3D quantum localization methods."

The study is published in *Physical Review Letters*.

More information: Danilo Triggiani et al, Estimation with Ultimate Quantum Precision of the Transverse Displacement between Two Photons via Two-Photon Interference Sampling Measurements, *Physical Review Letters* (2024). DOI: 10.1103/PhysRevLett.132.180802

Provided by University of Portsmouth