Quantum interference fine-tuned by Berry phase

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(Phys.org) -- A team from the University of Bristol's Centre for Quantum Photonics (CQP) has experimentally demonstrated how to use Berry's phase to accurately control quantum interference between different photons.

The effect may provide a way to implement reliable circuits for the coming generation of photonic quantum simulators, systems of photons designed to simulate other quantum systems, set to be physically realised much sooner than the universal quantum computer.

The paper, published in *Physical Review Letters*, connects one of Bristol's most celebrated results – Professor Sir Michael Berry of the School of Physics formulated the geometric phase effect nearly three decades ago – with the current wave of fundamental science exploration and quantum technologies emerging from CQP.

As described by Berry in 1984, a quantum particle that returns to its start point after a cyclic journey is found to be subtly changed: phase shifted. Among the many applications of this widely studied effect are robust methods to implement the circuits of a universal quantum computer, Berry's way of phase shifting turns out to be very reliable.

Meanwhile, in 1987, Hong Ou and Mandel (HOM) demonstrated how two photons interfere in a very peculiar way, preferring to stick together. The HOM quantum interference effect is at the core of the anticipated photonic quantum simulators that, by their very nature, are impossible to run on a conventional computer.

In this experiment, the Bristol team brought these two phenomena together to show how HOM interference can be exquisitely controlled with Berry's phase. Apart from being fundamentally interesting in its own right, connecting the computationally valuable HOM effect with the robust gates of the Berry phase paves the way for fault tolerant circuits in photonic quantum simulators.

More information: 'Observation of Quantum Interference as a Function of Berry's Phase in a Complex Hadamard Optical Network' by Anthony Laing, Thomas Lawson, Enrique Martín López, and Jeremy L. O'Brien in *Physical Review Letters*.
prl.aps.org/abstract/PRL/v108/i26/e260505

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