Multiphoton interference observed beyond coherence time

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For the first time, scientists have experimentally demonstrated how multiphoton interference with thermal light can be observed beyond the coherence time, paving the way to a possible new range of applications in high-precision sensing.

The team of researchers from Pohang University of Science and Technology, Korea, and the University of Portsmouth, UK, describe their observation as a counter-intuitive phenomenon in multi-path correlation interferometry with thermal light.

The intensity correlation between the outputs of two unbalanced Mach-Zehnder interferometers (UMZIs) with two classically correlated beams of thermal light at the input exhibits genuine second-order interference with the visibility of 1/3.

Surprisingly, the second-order interference does not degrade at all no matter how much the path length difference in each UMZI is increased beyond the coherence length of the thermal light. In addition, the second-order interference is dependent on the difference of the UMZI phases, independently of the distance between the two UMZIs, thus making this scheme appealing for possible high-precision measurements of remote phases.

These results differ substantially from those of the famous entangled-photon Franson interferometer which exhibits two-photon interference dependent on the sum of the UMZI phases and vanishing as the path

length difference in each UMZI exceeds the coherence length of the pump laser.

The research, "Second-order temporal interference with thermal light: Interference beyond the coherence time," is published in *Physical Review Letters*.

Dr. Vincenzo Tamma, one of the researchers, at the University of Portsmouth, who first predicted this effect theoretically with his student Johannes Seiler in *New Journal of Physics*, said: "This work offers deeper insight into the interplay between interference and coherence in multi-photon interferometry.

"This new and unexpected physical phenomenon demonstrated for the first time experimentally in the laboratory of Professor Yoon-Ho Kim will likely have potential use for technological applications, including in high precision metrology and imaging, particularly sensing remote distant spatial structures.

"Those working in engineering and technological development especially in metrology and imaging will be particularly interested, and the findings could inspire new technological schemes."

More information: Second-Order Temporal Interference with Thermal Light: Interference beyond the Coherence Time. *Physical Review Letters* DOI:doi.org/10.1103/PhysRevLett.119.263603

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