Cycle of lectures

When the physics behind multiphoton interference meets quantum technologies

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Abstract. The first quantum revolution brought a completely new understanding of the physics behind everything we observe and the nature itself of our universe. Phenomena like quantum superposition (the ability of a particle to be in two states at the same time), entanglement between two particles (the ability to instantaneously change the state of one particle by measuring its entangled counterpart, even at large distances) and quantum interference (in which particles interfere as waves) have been puzzling scientists around the world ever since, including Einstein.

With the advent of the second quantum revolution, these counterintuitive quantum phenomena have continued to trigger a global development of quantum technologies, with the capability of providing strategic benefits to the security, health and wellbeing of our society.

In this series of lectures, I will describe the astonishing physics behind the unique phenomena of multiphoton interference, which has led to the development of the overall field of quantum optics. Such physics underpins the counterintuitive properties of photons, the most fundamental particles of which light is composed, and the emergence of quantum correlations in the 'histories' of such photons.

I will also show the quantum metrological and computational power emerging form such fundamental physics, which is key in the development of quantum technologies. This includes the ability to achieve an exponential quantum computational speed up beyond the capacity of classical computers, as well as the ultimate precision in the measurement of physical parameters, such as time, position and colour with applications in biology, medicine, engineering, navigation, astronomy and environmental sensing.

Outline:

- From the interference of classical light to single-photon interference
- The physics behind Hong-Ou-Mandel two-photon Interference
- Interference of non-identical photons based on the photonic degrees of freedom resolved in the photonic detections
- The ultimate metrological sensitivity of two-photon interference in measuring fundamental parameters, such as time, position, and colour
- From two-photon interference to N-photon interference with N>2
- The computational power of N-photon interference and scalable boson sampling with nonidentical photons

-17/09/2025, 10.30-13.00, via Archirafi 36, aula F

-18/09/2025, 10.30-13.00, via Archirafi 36, aula E

-23/09/2025, 15.00-18.00, via Archirafi 36, aula B