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UNIVERSITÄT BERN

Seminar über Biomedizinische Photonik

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Titel: Superresolution with spatial mode demultiplexing and the method of moments

Quantum metrology offers a remarkable opportunity to enhance the sensitivity of physical parameter measurements by leveraging the quantum properties of probes and measurements. Quantum techniques have already demonstrated their effectiveness for applications such as gravitational wave detection and quantum imaging. Interestingly, even in classical scenarios, the quantum description of measurements can provide valuable insights into improving measurement sensitivity, often referred to as a quantum-inspired approach.

One significant imaging problem that serves as a model example is the estimation of the separation between two point sources. By studying this problem, we gain valuable insights into the relationship between the state of emitted light, measurement properties, and resulting resolution. Moreover, this problem finds practical applications in various fields, including astronomical observation, lidars, and fluorescent microscopy.

To analyze the problem of resolving two sources, we employ the method of moments. This approach equips us with two essential tools: the ability to predict resolution under different conditions (such as source coherence, entanglement, quantum statistics, detection noise etc.) and the availability of simple parameter estimators. These estimators eliminate the need for computationally intensive methods like maximum likelihood estimation.

Furthermore, I will present experimental results from our group. Through the use of mode demultiplexing, we achieved an impressive sensitivity of 10^(-5) of Rayleigh length for two incoherent sources separated by approximately 0.02-0.05 of Rayleigh length. The limiting factor in this achievement was primarily the noise of the photodiodes, especially in a high-flux regime. In the low-flux regime, we utilized single-photon detection to showcase resolution close to the quantum limit. This measurement demonstrated a sensitivity surpassing the maximum achievable resolution of perfect direct imaging.

Zeit: Montag 10. Juli 2023, 14:15 Uhr

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