“Communication and sensing beyond standard quantum limits”

Prof. Eugene Polzik
Niels Bohr Institute, Copenhagen University

Abstract

Quantum mechanics poses a limit on the measurement precision, the Standard Quantum Limit (SQL), through the Heisenberg uncertainty principle. Non-commuting operators, such as position and momentum, or two components of a spin cannot be determined simultaneously. There are, however, allowed operations with the precision beyond the SQL. One example is quantum teleportation. We have proposed and demonstrated a deterministic teleportation between spin states of distant material objects. The objects are macroscopic atomic ensembles at room temperature. Entanglement required for teleportation is distributed by light propagating from one ensemble to the other. We demonstrate stroboscopic teleportation of a sequence of spin states evolving in time and propose the way to simulate interaction between remote systems. The second example of an operation beyond the SQL of precision is the measurement of a disturbance applied to an atomic spin. The seemingly impossible task of the measurement of, in principle, arbitrary small disturbances of two non-commuting spin projections is achieved through entanglement of the spin with a reference system acting as an oscillator with a negative frequency.