From sub-shot-noise imaging to quantum reading and pattern recognition

Author
IVANO RUO-BERCHERA - Istituto Nazionale di ricerca metrologica (INRIM)

Abstract
The use of quantum states of light, such as entanglement and squeezing, allows surpassing the limitation of conventional optical imaging and sensing, essentially reducing the noise affecting the measurement and improving resolution. Gravitational wave detectors are the most prominent examples of the successful applications of quantum metrology but other techniques are bridging the gap between the proof of principle and real applications.

After a general introduction to the basic concepts and techniques mentioned above, we will consider more in detail the problem of photon loss estimation and the related wide field sub-shot-noise imaging task, where the goal is to estimate the transmission of a spatially structured object, with application to microscopy and spectroscopy.

A related, yet different class of problems, is the discrimination among discrete values of the parameters, which is addressed in the framework of quantum channel discrimination. An example is the readout of classical data stored in an optical memory, a collection of elementary cells each encoding a bit of information, in two possible values of a physical parameter, namely the reflectance. In this case, rather than the uncertainty used in the estimation problem, the quality of the measurement is given in terms of error probability, or directly in terms of information recovered.

We will present recent results, demonstrating theoretically and experimentally the advantage of using quantum correlation for quantum channel discrimination, in realistic context, such as quantum readout of optical digital memories and pattern recognition.