Shadow Imaging Using Quantum-Noise Detection with a Camera

E E Mikhailov[1], S L Cuozzo[1], and I Novikova[1]

[1] *Physics, William & Mary, Williamsburg VA, USA*
Contact Email: eemikh@wm.edu

Improvement of the optical measurements with non-classical states of light is an actively developed topic. Squeezed vacuum quantum states with quadrature noise suppressed below standard quantum limit already proved their use for enhancing the sensitivity of optical sensors such as interferometers, position sensors, magnetometers, atomic force microscopes, *etc.*

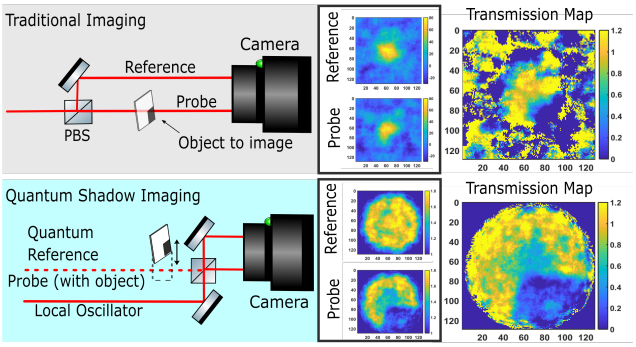

Figure 1: Traditional imaging (top) and quantum shadow imaging (bottom). The quantum noise reconstructed transmission map (bottom right) is superior in comparison to traditional shadow based map (top right)

We experimentally demonstrated an imaging technique based on quantum noise modifications after interaction with an opaque object. This approach is particularly attractive for applications requiring weak illumination. We implemented a homodyne-like detection scheme which allows us to eliminate the detrimental effects of the camera's dark noise. We illuminated the object with squeezed vacuum containing less than one photon per frame, generated in an atomic ensemble, and reconstruct the shape of the object with higher contrast than the direct intensity imaging using 1000 times more photons.

Our research will be useful in areas where illumination of an object with strong classical light is undesired, for example, in bio or medical imaging.