Novel light sources for correlated-imaging applications

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The terms ghost imaging” and “correlated imaging” are used to indicate several different imaging techniques employing two spatially correlated beams to reconstruct the image of an object [1, 2]. In the general imaging configuration, one of the correlated beams is used to illuminate the object, while the other is measured by a spatial-resolving detector without interacting with the object. The light transmitted, or reflected, by the object is collected by a single-point (bucket) detector. The “ghost” or “correlated” image is recovered by correlating the intensities measured by the bucket detector with the intensities measured by each pixel of the spatial-resolving detector.

Since the initial proposal of the ghost-imaging scheme in the late 80s, several protocols have been demonstrated in different intensity regimes and with different kinds of correlated-light sources, both quantum and classical, either monochromatic or polychromatic. More recently, as an alternative to employing physically separated beams, computational ghost imaging techniques have also been proposed and realized with spatial light modulators to deterministically prepare the field to illuminate the object.

Here we present two proof-of-principle experiments of correlated imaging in which different light sources have been used. In the first scheme [3], the correlated beams are provided by intense twin-beam states, whose spatial and spectral properties represent the resource used in the protocol. The twin-beam states are native bipartite states generated by parametric downconversion in a bulk nonlinear crystal, which are nonclassically correlated in position and frequency. To exploit these correlations simultaneously, the twin-beam states are passed through an imaging spectrometer that maps the frequency correlation into a position dependent correlation. The object to be imaged is virtually imposed on one of the parties and its image is reconstructed by evaluating intensity correlations. The quality of the image depends on the characteristics of the twin beam and can be modified by changing the pump intensity. We use the scheme to encrypt/decrypt a simple code to be transmitted between the two parties of the twin beam.

In the second scheme [4], we generated a field endowed with super-thermal statistics by performing the second harmonics of a pseudo-thermal speckle pattern. The upconverted field is then divided at a balanced beam splitter to obtain a pair of correlated beams. Since the light is super-thermal, that is it has larger intensity fluctuations than thermal light, the intensity correlations between the beams at the output of the beam splitter are larger than those obtainable from thermal light. For this reason, the expected visibility of the resulting ghost image is enhanced.

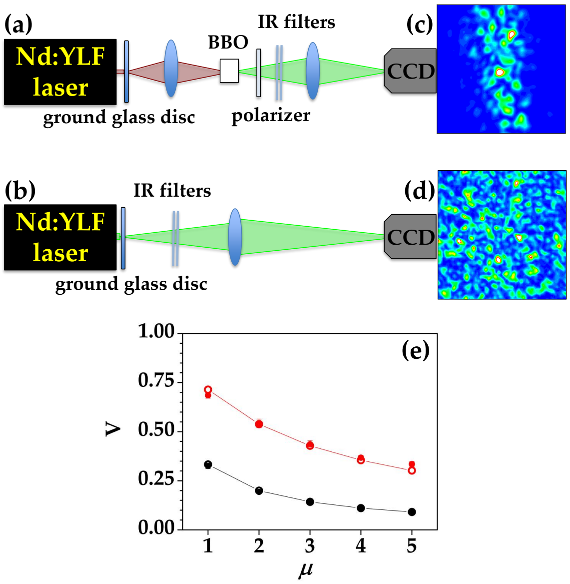

Figure 1: Sketch of the experimental setups for the application to imaging of super-thermal (a) and thermal (b) fields. Typical single-shot images of the speckle pattern exhibited by super-thermal (c) and thermal (d) lights. Visibility of the ghost image as a function of the number of modes (e). Dots: experimental data obtained by illuminating the objects with thermal (black) and superthermal (red) light. Open circles + line: theoretical expectations.

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