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Image Inversion via Quantum Ghost Imaging

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Quantum ghost imaging is one of the many unanticipated and yet wonderful peculiarities arising from quantum mechanics. The basic proposal behind it is using a pair of entangled photons, one of which strikes an arbitrary object, and being able to reconstruct an image of the object by observing the other photon. In this study we use an experimental setup involving a couple of tiers of crystals which create two pairs of entangled photons via spontaneous parametric down conversion (SPDC). A photon from each pair is combined using a beam-splitter and the entanglement is teleported between the remaining two photons by ensuring 4-way coincidences using detectors. Simultaneously, an object is created in one of the remaining arms by masking a spatial light modulator (SLM), and the measured image is observed using another SLM in the final arm. By carefully choosing the way measurements are performed, we theoretically predict the contrast inversion of the ghost image, i.e. the observed image is inverted with respect to the object mask, a most interesting result. However, strangely, it appears as though this inversion is predicated on the use of an anti-symmetric state for the beam-splitter photons; for a symmetric state, the image may or may not be inverted, depending on the object's dimensions and the way measurements are performed. Despite this, our work highlights, in a completely new context, the fundamental role measurements play in quantum theory, since in both the symmetric and anti-symmetric cases, the observed image depends greatly on the way the SLM screens are measured. We hope to confirm these theoretical predictions with experimental results in the near future.

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