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Ghost imaging with entangled photons and orbital angular momentum

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We utilise the position and orbital angular momentum (OAM) correlations between the signal and idler photons generated in the down-conversion process to obtain ghost images of a phase object. By using an OAM phase filter, which is non-local with respect to the object, the ghost images exhibit isotropic edge-enhancement. The strong spatial correlations between the signal and idler photons generated by spontaneous parametric downconversion have been widely utilised in many different imaging systems. The use of a scanning single element detector to recover the spatial information in the signal and idler beams fundamentally limits the detection efficiency of the imaging system to a maximum of 1/N where N is the number of pixels in the image. Our approach overcomes this limitation by replacing the scanning detector by an intensified CCD camera, therefore detecting all photons irrespective of their position within the image. Using a camera in this way, coupled with the OAM edge-enhancement and image reconstruction techniques allows us to obtain images of phase objects with an average of fewer than one photon per image pixel.