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Ghost Imaging with Matter Waves ROMAN KHAKIMOV, BRYCE HENSON, DAVID SHIN, SEAN HODGMAN, ROBERT DALL, KENNETH BALDWIN, ANDREW TRUSCOTT, Laser Physics Centre, Australian National University, Canberra ACT 2601, Australia — We demonstrate, for the first time, high resolution ghost imaging of a macroscopic object using atoms. Ghost imaging is a novel technique in which the image emerges from cross-correlation of particles (usually photons)in two separate beams. One beam is detected with a single-pixel (bucket detector) after passing through the object, while the other beam does not interact with the object and is registered with high spatial resolution. Neither detector can reconstruct the image independently. In our experiment, the two beams are formed by correlated pairs of ultracold metastable helium atoms originating from thecollision of two Bose-Einstein Condensates. After s-wave scattering the atoms form a spherical shell of strongly correlated pairs with opposite momenta. We extend this technique with more than a10-foldincrease in the number of correlated pairs available for eachsingle experiment run, by using higher-order Bragg scattering in the Kapitza-Dirac regime, with multiple shells generated from different diffraction orders. Using single-atom detection, we create ghost images of a target maskwith a resolution given by the width of the cross-corrrelation function of atomic momenta. Future extensions could include ghost interference and EPR tests.

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