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Neutron Super Resolution Ghost Imaging

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The concept of ghost imaging emerged from visible-light optics a little over two decades ago. Since then, its use has spread to x-ray, electron and atom optics. However, the method appears never to have been reported for neutron optics.

In a nutshell, ghost imaging enables spatial resolution multiplexing of a detector by patterning the illumination beam. Typical ghost imaging protocols are used to achieve spatial resolution using a single pixel detector. More generally however, one can use ghost imaging to increase the resolution of a pixellated detector, i.e. achieving super-resolution imaging.

In this work we present a proof of concept for a parallelised form of neutron ghost imaging that enables us to increase the resolution of a pixellated neutron-imaging detector.

Our method for neutron super-resolution ghost imaging works as follows. A spatially random mask is used, that has an intensity transmission function that has been previously measured as a function of transverse coordinates, to a specified resolution. This specified resolution, to which the mask transmission function has been measured, is higher than the resolution of a given position-sensitive detector. The random mask and low resolution position-sensitive detector can then be employed in tandem, with each pixel of the low-resolution detector working as an independent bucket detector in the ghost-imaging sense of the term. We can then take a series of low-resolution neutron images of an unknown object, with the mask in a different known transverse position for the detection of each low-resolution image. From these data we then show how a parallel form of ghost imaging protocol – similar to that which we previously developed in the x-ray domain – may be employed to obtain a neutron-optical image with significantly higher resolution than each of the low-resolution images that were taken.

Our proof-of-concept experiment, on neutron super-resolution ghost imaging, was performed using thermal neutrons at the DINGO instrument of the Australian Centre for Neutron Scattering. Our results show how the addition of single spatially random mask can turn a crude 4 x 4 pixel detector into a 128 x 128 pixel position-sensitive detector. This is both the first example of neutron ghost imaging, and a tangible example of the practical utility of ghost imaging in a neutron-optics context.

Speakers Gender

Male

Travel Funding

No

Level of Expertise

Expert

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