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X-ray ghost imaging: Line scans, radiography and tomography

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Ghost imaging is a new field of optics. Emerging from the field of quantum optics and initially believed to be underpinned by quantum-mechanical "spooky action at a distance", the field has rapidly achieved prominence in studies using classical visible light [1].

In ghost imaging, photons from a source pass through a speckle-making mask, leading to a spatially random pattern "A" being measured over the surface of a position-sensitive detector. A beam-splitter then removes a very small fraction of the photons, which pass through an object and are then recorded by a single-pixel "bucket" detector that merely records the total number "B" of photons falling upon it. This process is repeated for a number of different mask positions. While no photon that ever passes through the object is ever registered by a position-sensitive detector, and no photons measured by the position sensitive detector ever pass through the object, the *correlation* between A and B can be used to reconstruct the object [1].

Ghost imaging using x-rays was only very recently achieved, with the first proofs of concept for one-dimensional x-ray ghost imaging being published by Yu et al. [2] and Pelliccia et al. [3] in 2016. This was soon extended to x-ray ghost imaging of two-dimensional objects, by Zhang et al. [4] and Pelliccia et al. [5]. Finally, based on the theory and computer modelling of Kingston et al. [6], the first experimental realisation of ghost tomography (using potentially any form of radiation, not just x-rays) was reported by Kingston et al. [7] with x rays. The experimental setup uses the process as described above, but with the additional feature that the sample was rotated to a number of different angular orientations.

We discuss the origins of ghost imaging, explain the key principles underpinning the method, review the current state of art in x-ray ghost imaging in 1D (line scans), 2D (radiography) and 3D (tomography), consider some key drivers such as the quest for ever-reduced dose, and speculate regarding future developments. We attempt to reduce the counter-intuitive nature of the method to a retrospectively obvious simplicity, and address the obvious question of: "Why would one want to perform tomographic imaging in this peculiar manner?"

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Speakers Gender

Male

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