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Quantum Imaging: Enhanced Image Formation Using Quantum States of Light

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Image formation based on the use of quantum states of light permits significant new possibilities in the field of image science. In this contribution, we review some of the conceptual possibilities afforded by quantum imaging, and we describe recent work that displays some of these features. The underlying idea of quantum imaging is to implement ideas and techniques from the fields of quantum optics and quantum information science to perform image formation with sensitivity and resolution exceeding that available using classical techniques. Examples of improved image formation includes techniques to form images with resolution exceeding the traditional Rayleigh limit and techniques based on entangled photons to allow the formation of images using photons that have never interacted with the object to be imaged. Quantum imaging systems can also be used to detect weak phase and amplitude objects in the presence of background noise with a sensitivity that exceeds the classical shot-noise limit. Possible long term implications of quantum imaging include its implementation in systems for quantum computing and quantum teleportation, thereby greatly increasing the information capacity by exploiting the parallelism intrinsic to image-bearing optical beams.