Geometry of a cold atomic cloud as a control parameter for multiple scattering

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Abstract

The antibunching effect in quantum optics is a phenomenon where the detection of simultaneous photons is suppressed, resulting in non-classical light statistics. This effect, commonly associated with single-photon sources, was observed in light transmitted by many atoms trapped in the evanescent field of a nanofiber (1). Our team aims to demonstrate this effect in the different context of a 3D cloud of cold atoms in a magneto-optical trap (MOT). However, the high optical depth needed for antibunching could allow multiple scattering to mask the effect by randomizing the light phase. To address this, we present measurements of intensity correlation functions for light scattered by an cold atomic cloud at a small angle from the incident beam. The resulting signal reveals two characteristic decay times, allowing us to distinguish between single and multiple scattering contributions. Additionally, we demonstrate with a numerical model that a cigar-shaped atomic cloud can significantly reduce multiple scattering, making it a promising candidate for experimentally observing the antibunching effect. (1) Prasad, A.S. et al. Correlating photons using the collective nonlinear response of atoms weakly coupled to an optical mode. Nat. Photonics 14, 719–722 (2020)

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