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POS-4 - Cross-phase modulation with laser cooled atoms confined inside a hollow-core fiber

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Modulating the phase of a light field with a single photon is a requirement for many applications related to quantum information processing. Here, we predict large phase shifts induced in a meter field by a probe field at single photon levels in an off-resonant three-level ladder scheme implemented with a laser-cooled ensemble of cesium atoms. The strong optical nonlinearity arises when both photons and laser-cooled atoms are tightly confined inside a hollow-core photonic-crystal fiber (HCPCF). Compared to the previously reported experiments utilizing this scheme with room-temperature atoms [1], the use of laser-cooled atoms suppresses Doppler broadening and thus reduces the absorption of the weak probe field at a given detuning from resonance. This allows the light fields in the ladder scheme to be tuned closer to resonance where stronger nonlinearities become available. We study the effect of the detuning of probe and meter fields, the optical depth of the atomic ensemble, and the power of the meter beam on phase shifts induced by a weak probe. Experimental studies will eventually be performed in our recently built system for loading atoms into a hollow-core fiber.

[1] Venkataraman, Vivek, Kasturi Saha, and Alexander L. Gaeta. "Phase modulation at the few-photon level for weak-nonlinearity-based quantum computing." Nature Photonics 7.2 (2013): 138-141.

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