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Few-Photon Cross-Phase Modulation in Rb-Filled Photonic Bandgap Fibers VIVEK VENKATARAMAN, KASTURI SAHA, ALEXANDER GAETA, Cornell University — We produce cross-phase shifts (XPS) of a few milliradians on a meter beam with <20 signal photons, using a two-photon transition in Rb vapor confined to photonic bandgap fibers. A weak 780-nm signal beam tuned close to the $5S_{1/2} \rightarrow 5P_{3/2}$ transition of Rb-85 is used to impart a nonlinear phase shift on a strong, counter-propagating 776-nm meter beam which is tuned close to the $5P_{3/2} \rightarrow 5D_{5/2}$ transition. Using the selection rules of the relevant transitions involved, we measure the XPS as a slight polarization rotation of the meter beam. A XPS of $\sim$0.3 milliradian per signal photon is induced in our system, which, to our knowledge, represents the largest such nonlinear phase shift induced in a single-pass through a room-temperature nonlinear medium. The system response time is shown to be <5 ns, primarily determined by the transit-time of the atoms across the fiber core. Such a system offers the potential to explore novel quantum nonlinear effects at ultralow powers.

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