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Quantum State Transportation of Rubidium Atoms inside a Photonic Waveguide MINGJIE XIN, ZILONG CHEN, WUI-SENG LEONG, SHAU-YU LAN, Nanyang Technological University — Coherent interactions between electromagnetic and matter waves lie at the heart of quantum science and technology. We optically trap cold 85Rb atoms in a hollow-core photonic crystal fiber and use the waveguide elds as matter-wave beam splitter and mirror pulses to demonstrate a Mach-Zehnder interferometer. The results suggest that the coherence of a quantum superposition state of atoms can be coherently interrogated by the optical guided mode inside the hollow core fiber. We also experimentally study the ground state coherence properties of 85Rb atoms inside the hollow core fiber. We find that, the dephasing of atomic ground states is mainly due to the inhomogeneous broadening of differential ac stark shift between the ground states introduced by the optical dipole beams. We introduce vector light shift to cancel the differential ac stark shift. After the cancellation, we achive a long coherence time of T=250 ms, and able to maintain the coherence of a quantum superposition state over one centimeter distance of transportation along the optical fiber. The integration of phase coherent photonic and quantum systems here shows great promise to the advance capability of atom interferometers, compact atomic clock, quantum memory and optical fiber quantum network.

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