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A superradiant laser integrated in a hollow-core photonic-crystal fiber FERESHTEH RAJABI, University of Western Ontario, TAEHYUN YOON, JEREMY FLANNERY, SREESH VENUTURUMILLI, MICHAL BAJCSY, Institute for Quantum Computing, University of Waterloo — Superradiant lasers exhibit a high spectral purity characterized by a frequency linewidth thousand times less than that of a conventional laser. This characteristic of superradiant laser, which is due to collective effects arising in the dipole ensemble forming the gain medium, makes it an exellent candidate for high-precision metrology applications. Additionally, superradiant lasers are an interesting platform to study strongly-correlated systems. We propose a fiber-integrated superradiant laser consisting of an ensemble of cold Cs atoms coupled to a single mode of radiation field in a Fabry-Perot cavity formed in a hollow-core photonic crystal fiber (HCPCF). The Cs atoms, initially cooled using a magneto-optical trap (MOT), are guided and confined inside a short piece of HCPCF with a magic-wavelength dipole trap. The Fabry-Perot cavity is integrated into the fiber using photonic-crystal slabs acting as mirrors, which are attached to the ends of the fiber piece. A small number of photons can synchronize atomic dipoles inside the cavity and result in superradiance, while a steady-state superradiance can be achieved by re-populating the atomic excited state at a proper rate.

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