

# **High-fidelity quantum gates with Rydberg superatoms: How to count atoms in mesoscopic ensembles**

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Strong, long-range interactions between atoms in high-lying Rydberg state can block multiple Rydberg excitations in mesoscopic atomic ensembles. Such Rydberg superatoms, composed of several hundred atoms, are attractive systems for quantum information processing, storage and communication via coherent emission/absorption of single photons. But achieving these tasks with high fidelity requires knowing the number of atoms with small uncertainty.

In this talk, after quantifying the fidelities versus the atom number uncertainty, I will present an efficient adaptive protocol to assess with high precision the number of atoms within a Rydberg superatom. This is done by interrogating the atomic ensemble with resonant pulses while monitoring the resulting Rydberg excitations. A feedback from the measurement after each pulse is used to adjust the area of next pulse, which, after several steps, results in achievable gate fidelities commensurate with the fault-tolerant quantum computation.