STRONG ATOM-PHOTON COUPLING ON AN ATOM CHIP

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Atom chips combine many important features of a scalable QIP architecture, including demonstrated long coherence lifetimes (several seconds) of an atomic hyperfine qubit, and upscaling while maintaining individual addressability through microfabrication. Nevertheless, a two-qubit quantum gate still needs to be demonstrated.

The proposed collisional phase gate has become much more realistic recently with the introduction of microwave potentials that are compatible with the long-lived hyperfine qubit. A major remaining challenge is to master single atom preparation and detection in a way similar to ion traps. We have now demonstrated high-contrast qubit detection using a fiber-based, high-finesse optical cavity that realizes the strong coupling regime of cavity QED. With the same cavity, we have also been able to observe collective strong coupling of a trapped BEC to the cavity mode. This leads to record values of vacuum Rabi splitting and collective cooperativity for an atomic system, and should enable single photon generation and entanglement distribution with high success rates.