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Interaction- and measurement-free quantum information processing with single-atom and/or single-photon qubits MICHAEL MOORE, Michigan State University, YUPING HUANG, Ohio University — Interaction-free measurement (IFM) uses quantum interference to allow a single photon to detect a perfectly absorbing object without the photon interacting with the object directly. In high-efficiency IFM, the Quantum Zeno Effect is employed to increase the success probability from the original 50% to (N-a)/N, where N is the number of cycles the photon makes through the device and a 1. In principle IFM protocols allow the hyperfine state of a single atom to become entangled with the polarization of a single photon. To date, attempts to employ this entanglement to create universal atom-atom quantum logic gates, such as CNOT gates, have not succeeded in achieving (N-a)/N efficiency. In addition, they also require the detection of ancillary photons. At present, single-photon detection cannot be implemented experimentally with high efficiency. By making several key modications, we have developed a pair of complimentary Interaction-Free quantum gates that can be used to design high-efficiency atom-atom, atom-photon, and photon-photon CNOT and state-transfer protocols, which do not require the use of photodetectors or measurements of any kind. In addition, we have analyzed the effects of imperfect atomic selection rules due to tight-focussing of the photons and tight trapping of the atoms, and identified the scattering parameter on which the efficiency depends sensitively.

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