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Rapid measurement of ions for one-way quantum-computing architectures RENE STOCK, DANIEL F.V. JAMES, Department of Physics, University of Toronto — The tremendous progress achieved in the control of trapped ions has recently led to the creation of an entangled state of eight ions and the entanglement of many more ions for large-scale quantum computer seems very feasible. However, the slow entangling operation and slow readout of ions hinder fast operations and will limit the practical use of a future ion-trap quantum computer. One-way (i.e. measurement-based) quantum computing architectures offer a way out by parallelizing the slow entangling operations to create a many-body entangled state and by processing quantum information via fast readout and measurement of qubits. In this work, we investigate the challenges involved in developing a one-way quantum-computing scheme for ions. We devise an architecture for the creation of many-body entangled states and study the viability of fast rotation and readout of ions via multi-photon photoionization on a nanosecond timescale. After photoionization, the freed electron is expulsed from the ion trap by the quadrupole trap field and can be detected on a nanosecond timescale using multichannel plate detectors. We analyze the expulsion of the electron and the effect of the remaining double-ionized atom on the entangled atoms using detailed numerical calculations.

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