Towards multi-level quantum logic with trapped ions

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University of Waterloo — We report on progress developing tools to control d-
dimensional quantum systems (qudits) encoded in the hyperfine structure of trapped
atomic ions. The well-developed toolbox for manipulating ionic qubits can be mod-
ified to extend to coherent control of single- and two-qudit operations and measure-
ment capabilities to obtain full information on the qudit state. Such a system could
be useful either for quantum computing, offering potential scaling advantages, or for
quantum simulations of higher-dimensional systems such as interacting integer spin
chains.

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