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Quantum information processing with long-wavelength radiation

DAVID MURGIA, Imperial College London, SEBASTIAN WEIDT, University of Sussex, JOSEPH RANDALL, Imperial College London, BJOERN LEKITSCH, SIMON WEBSTER, TOMAS NAVICKAS, ANTON GROUNDS, ANDREA RODRIGUEZ, ANNA WEBB, EAMON STANDING, University of Sussex, STUART PEARCE, IBRAHIM SARI, KIAN KIANG, HWANJIT RATTANASONTI, MICHAEL KRAFT, University of Southampton, WINFRIED HENSINGER, University of Sussex — To this point, the entanglement of ions has predominantly been performed using lasers. Using long wavelength radiation with static magnetic field gradients provides an architecture to simplify construction of a large scale quantum computer. The use of microwave-dressed states protects against decoherence from fluctuating magnetic fields, with radio-frequency fields used for qubit manipulation. I will report the realisation of spin-motion entanglement using long-wavelength radiation, and a new method to efficiently prepare dressed-state qubits and qutrits, reducing experimental complexity of gate operations. I will also report demonstration of ground state cooling using long wavelength radiation, which may increase two-qubit entanglement fidelity. I will then report demonstration of a high-fidelity long-wavelength two-ion quantum gate using dressed states. Combining these results with microfabricated ion traps allows for scaling towards a large scale ion trap quantum computer, and provides a platform for quantum simulations of fundamental physics. I will report progress towards the operation of microchip ion traps with extremely high magnetic field gradients for multi-ion quantum gates.

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