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Quantum gates with trapped ions and optical tweezers.

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Optical tweezers offer new opportunities to control and manipulate trapped ions with applications in quantum information processing. Two techniques to implement quantum logic gates have been theoretically developed in our group. These are based on qubit state-dependent potentials delivered by optical tweezers in combination with either electric fields [1], or strong polarization gradients in the tweezer waist [2,3]. An oscillating electric field can excite the modes of ions pinned by optical tweezers [1]. The proposed gates may offer key benefits such as infrastructural simplification – the light only has to be supplied from one direction - and enhanced long-ranged interactions between the ion qubits.

We present the ongoing development to realize these gates experimentally in the lab. Specifically, the design and construction of a microfabricated ion trap and UHV setup, and the optimization of a programmable UV tweezer array. Photon scattering in the tweezer can be suppressed using Laguerre-Gaussian tweezer modes generated by our spatial light modulator.

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