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A universal gate set on a Trapped-Ion Optical Qubit using a narrow linewidth Diode laser YINNON GLICKMAN, Weizmann Institute of Science, NITZAN AKERMAN, SHLOMI KOTLER, ANNA KESSELMAN, ROEE OZERI — Optical qubit states are encoded in the $5S_{1/2}$ ground state and the metastable $4D_{5/2}$ level in a single trapped $^{88}Sr^{+}$ ion, connected by a narrow optical quadruple transition. A 674nm diode laser is frequency stabilized and narrowed to a line-width below 80 Hz. Using this laser we demonstrate a universal quantum gate-set as well as other coherent operations on the ions' internal and external degrees of freedom. Rabi flopping, Ramsey spectroscopy and ground state cooling of the qubit are performed. Using a bi-chromatic beam, two ion-qubits are entangled with a Sorenson-Molmer entangling gate scheme. The advantages and disadvantages of using a diode laser to this end are discussed. In particular, the contribution of fast phase noise, typical to diode laser systems, to off-resonance qubit excitation and gate error is analyzed.

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