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Coherent control of neutral atoms on chip traps using optical frequency combs QUDSIA QURAISHI, VLADIMIR MALINOVSKY, JASON ALEXANDER, VIOLETA PRIETO, CHRIS ROWLETT, PATRICIA LEE, Army Research Labs, Adelphi, MD — Optical frequency combs (OFCs), emitted by ultrafast modelocked pulsed lasers, are excellent tools to perform quantum coherent control. The spectral purity, large bandwidth and high pulse powers makes these sources attractive for precision control of multi-level atoms. Recent experiments have shown that an OFC can be used to coherently control and entangle trapped ion qubits by means of off-resonant Raman transitions [1]. Here, we propose to extend this technique to neutral atoms confined on an atom chip and we also propose to implement an all-optical technique for hyperfine qubit manipulation using OFCs. We envisage using pairs of OFC modes to drive stimulated Raman transitions between the two hyperfine clock states of 87Rb confined on an atom chip. The Raman transitions will be driven using a four photon technique whereby the first photon pair drives off-resonantly to the intermediate state 2S1/2 —F=2, mf=0> and then a second photon pair resonantly drives to 2S1/2 —F=2, mf=+1>. Co-propagating Raman fields impart only a spin flip whereas non-copropagating fields transfer two photon recoil momentum to the atoms, thus entangling the internal spin with the external motion of the atoms. We plan on using the frequency comb to impart state dependent forces to the atomic cloud.

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