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Synthetic gauge fields and many-body physics in an optical lattice clock[1] ANDREW P. KOLLER, MICHAEL L. WALL, SHUMING LI, XIBO ZHANG, JILA, NIST, and University of Colorado Boulder, NIGEL R. COOPER, University of Cambridge, JUN YE, ANA MARIA REY, JILA, NIST, and University of Colorado Boulder — We propose the implementation of a synthetic gauge field in a 1D optical lattice clock and explore the resulting single-particle and many-body physics. The system can realize an effective two-leg ladder by using the two clock states as a synthetic dimension, together with the tunneling-coupled 1D lattice sites. A large flux per plaquette is naturally generated because the clock laser imprints a phase that varies significantly across lattice sites. We propose to use standard spectroscopic tools – Ramsey and Rabi spectroscopy – to probe the band structure and reveal signatures of the spin-orbit coupling, including chiral edge states and the modification of single-particle physics due to s-wave and p-wave interactions. These effects can be probed in spite of the relatively high temperatures ($\sim$ micro Kelvin) and weak interactions, thanks to the exquisite precision and sensitivity of the JILA Sr optical lattice clock. We also discuss the exciting possibility of using the nuclear spin degrees of freedom to realize more exotic synthetic dimension topologies and flux patterns.

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