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Exploring spin-orbit coupling in a non-degenerate optical lattice clock.[1] MICHAEL L. WALL, ANDREW P. KOLLER, SHUMING LI, ANA MARIA REY, JILA — Optical lattice clocks have progressed in recent years to become not only precise timekeepers, but also sensitive probes of many-body physics. We consider a 1D optical lattice clock in which the wavelength of the laser that interrogates the clock transition is comparable to the optical lattice spacing. This light-matter coupling imprints a spatially dependent phase on the atomic internal state superposition, and this phase can be interpreted as a spin-orbit coupling. We show that this spin-orbit coupling manifests itself in Ramsey spectroscopy as an s-wave density shift in otherwise identically prepared fermions, even at temperatures significantly larger than the tunneling. Further, we show that Rabi spectroscopy can be mapped to a Hofstadter model on a two-leg ladder with chiral eigenstates. Using a modified Rabi procedure, we show how to extract momentum-resolved signatures of chirality solely by spectroscopic means. The effects of finite temperature, gaussian transverse confinement, and non-separability between transverse and axial degrees of freedom are discussed.

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