Abstract Submitted
for the DAMOP20 Meeting of
The American Physical Society

Interacting fermions in driven optical lattices: gauge fields and coherent control ANNE-SOPHIE WALTER, KILIAN SANDHOLZER, JOAQUIN MINGUZZI, KONRAD VIEBAHN, FREDERIK GOERG, TILMAN ESSLINGER, Institute for Quantum Electronics, ETH Zurich — Driving quantum systems out of equilibrium can generate exotic and novel phases of matter. Floquet engineering focuses on the realization of effective, static Hamiltonians by driving systems periodically in time. In the pursuit of simulating lattice gauge theories in the laboratory, we present the successful implementation of a two-frequency driving scheme in a Hubbard dimer, which explicitly breaks time-reversal symmetry and allows to engineer density-dependent Peierls phases. We demonstrate the winding structure of this phase around a Dirac point in the driving parameter space. In Floquet schemes, in general, the choice of driving frequencies for the implementation of effective Hamiltonians is limited by resonances to energetically higher-lying modes, e.g. transitions to higher Bloch bands of an optical lattice. We implement a coherent control scheme by which we overcome this frequency constraint. By adding a second drive at twice the frequency and tuning the relative phase between the two drives we achieve destructive interference of the two paths. This extends the lifetime of the spin correlations in our many-body system by more than two orders of magnitude compared to the singly-driven system.

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Date submitted: 03 Feb 2020

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