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Fast eigenstate preparation in a synthetic lattice by counter-diabatic driving[1] ERIC MEIER, University of Illinois at Urbana-Champaign, KINFUNG NGAN, The Chinese University of Hong Kong, FANGZHAO ALEX AN, University of Illinois at Urbana-Champaign, DRIES SELS, Boston University, BRYCE GADWAY, University of Illinois at Urbana-Champaign — In many experimental systems, the adiabatic theorem of quantum mechanics is used to prepare eigenstates through slow continuous changes to the Hamiltonian. Altering a Hamiltonian diabatically however, can result in coupling of the eigenstates. In some systems these diabatic terms can be calculated and exactly cancelled through the addition of counter-diabatic terms to the Hamiltonian. By applying these counter-diabatic techniques, a Hamiltonian can be changed faster than adiabatically possible with little to no coupling between eigenstates. We present the realization of this technique in a multi-state, tight-binding synthetic lattice system formed by momentum states of rubidium atoms, where complete local and time-dependent control over the Hamiltonian allows for the addition of these counter-diabatic terms. As an example of this technique, we show the fast preparation of the eigenstates of a few-site lattice with open boundaries, as well as the transport of all population from the left-most site to the right-most site of a synthetic lattice with $\sim$10 sites. This technique allows for rapid eigenstate preparation and readout, making it useful for studying critical eigenstates of topological and disordered tight-binding models, and potentially for matter-wave interferometry.

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