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Spin-orbit coupling in periodically driven optical lattices JULIAN STRUCK, Department of Physics, MIT-Harvard Center for Ultracold Atoms, and Research Laboratory of Electronics, MIT, Cambridge, Massachusetts 02139, USA, JULIETTE SIMONET, KLAUS SENGSTOCK, Institut für Laserphysik, Universität Hamburg, Luruper Chaussee 149, D-22761 Hamburg, Germany — The realization of artificial spin-orbit coupling (SOC) for the external degrees of freedom of neutral, ultracold atoms has raised considerable interest in recent years. It has been predicted that the interplay between interactions and SOC leads to a variety of many-body phases, ranging from stripe states to topological superfluids. Currently, a main experimental obstacle in the realization of these phases is the limited lifetime of the atomic ensemble. All of the experimentally implemented schemes rely on the near-resonant Raman coupling of internal states and thus suffer from the spontaneous emission of photons, leading to excitations and particle loss. Here we present a novel method for the emulation of artificial SOC for atoms trapped in a tight-binding lattice. This scheme does not involve near-resonant laser fields, avoiding the heating processes connected to spontaneous emission. In our case, the necessary spin-dependent tunnel matrix elements are generated by a rapid, spin-dependent, periodic force, which can be described in the framework of an effective, time-averaged Hamiltonian. An additional radio-frequency coupling between the spin states leads to a mixing of the spin bands. The strength of the SOC can be continuously tuned, simply by adjusting the driving amplitude.

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