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Cold atom quantum emulation of ultrafast processes[1] SHANKARI RAJAGOPAL, ZACHARY GEIGER, KURT FUJIWARA, KEVIN SINGH, RUWAN SENARATNE, DAVID WELD, Physics Department, University of California, Santa Barbara, and California Institute for Quantum Emulation — Pulsed lasers are an invaluable probe of fast electron dynamics in condensed matter systems. However, despite tremendous progress, physical limitations on lasers and a lack of exact theoretical models still limit the exploration of ultrafast processes in solids. We discuss a possible complementary approach, in which lattice-trapped cold neutral atoms driven far from equilibrium are used as a quantum emulator of ultrafast physics at sub-cycle timescales. The cold atom context is in many ways a natural choice for such experiments: equilibration timescales are more than ten orders of magnitude slower than those in solids, and strong driving forces are easily produced and manipulated. Our experimental approach uses ultracold strontium in optical traps. Multiple stable isotopes and a long-lived metastable state provide control over interaction strengths, while a narrow-linewidth transition expands the typical cold-atom toolbox of readout techniques. We discuss initial efforts in quantum emulation of tunnel ionization and development of a platform for more complicated endeavors, including the study of multiple-pulse sequences and recollision processes.

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