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Spin-orbit interaction effects in cold atomic systems TUDOR STANESCU, VICTOR GALITSKI, University of Maryland — We propose a scheme for the realization of spin-orbit interaction in cold atomic systems. We show that, in a system of trapped multi-level atoms moving in the presence of spatially modulated laser fields, the atom-laser interaction generates an emergent pseudo-spin-1/2 degree of freedom that couples to the momentum, leading to an effective spin-orbit interaction. The parameters of the spin-orbit coupling can be modified by controlling the laser fields. Atomic spin-orbit interacting systems open the possibility of studying new effects that are not usually considered, or not accessible in solid state systems. We consider explicitly the problem of strongly non-equilibrium spin dynamics by studying the evolution of an initially spin-polarized Fermi gas in a two-dimensional harmonic trap. We derive the non-equilibrium behavior of the polarization and show that it is characterized by periodic echoes with a frequency equal to the trapping frequency. We also consider a system of multi-level Bose atoms. In the presence of spin-orbit coupling, the single-particle band structure is generally anisotropic and contains two minima at finite momenta. At low temperatures, the bosons condense into these states, leading to a new type of Bose-Einstein condensate.

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