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Cavity-induced spin-orbit coupled Bose-Einstein condensation: A new approach for exploring cold atoms

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The atom-photon interaction is significantly amplified when the radiation field is confined inside a high-finesse cavity, resulting in a complex, coupled dynamics of the quantized matter and radiation fields. This coupled dynamics in turn mediates long-ranged interactions between atoms. Here we demonstrate how to simultaneously induce spin-orbit (SO) coupling and long-ranged interactions in a Bose-Einstein condensation (BEC) using two counter-propagating modes of a ring cavity. The interplay between the standard two-body and cavity-mediated interactions determines the ground state and elementary excitations of the SO-coupled BEC. The ground state is either a plane wave or stripe phase, where in the latter case the density exhibits spatial modulations along the SO coupling direction. This opens up a possible new experimental approach for exploring quantum gases by tuning cavity parameters instead of using Feshbach resonance techniques.

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