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Bose-Einstein condensate in an optical lattice with Raman-assisted two-dimensional spin-orbit coupling JIAN-SONG PAN, University of Science and Technology of China, Hefei, Anhui, 230026, China, WEI ZHANG, Renmin University of China, Beijing 100872, China, WEI YI, GUANG-CAN GUO, University of Science and Technology of China, Hefei, Anhui, 230026, China, WEI YI TEAM, WEI ZHANG TEAM — In a recent experiment by Wu *et* al., a Raman-induced two-dimensional spin-orbit coupling has been realized for a Bose-Einstein condensate in an optical lattice potential. In light of this exciting progress, we investigate key properties of the system including single-particle spectrum, many-body phase diagram, and quasi-particle excitations. As the lasers generating the spin-orbit coupling inevitably couple atoms to high-lying bands, all of these properties can be greatly affected. In particular, we show that high-band induced "roton" gaps emerge in the quasi-particle excitation spectrum, which become softened as the system approaches the stripe phase. We also calculate the topological invariants of the lowest bands in both the single-particle and the quasi-particle spectra, from which high-band induced topological boundaries are identified. These non-trivial band topologies can give rise to topological transitions in Fermi systems or to chiral edge excitations in Bose gases. Our results can be readily observed in current experiments and provide valuable insights that are helpful for future exploration of this novel two-dimensional lattice spin-orbit coupling.

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