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**Global quantum phase diagram of strongly interacting spinor bosons with generic 2 dimensional spin-orbital couplings in a square lattice**[1] FADI SUN, JINWU YE, Department of Physics and Astronomy, Mississippi State University, MS, 39762, USA, WU-MING LIU, Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China — Recently, there are ground breaking experimental advances in generating 2 dimensional spin-orbit coupling (SOC) for cold atoms in both continuum and optical lattices. One typical experiment set-up is to load spinor bosons at integer fillings in an optical lattice subject to a 2d SOC. In the strong coupling limit, it leads to the Rotated Ferromagnetic Heisenberg model (RFHM) which is a new class of quantum spin models to describe quantum magnetisms in cold atoms or some materials with strong SOC. In a previous work, we investigate various quantum phenomena of the RFHM along a solvable line in the SOC parameter space. In this talk, starting from the results achieved along the solvable line, we study the RFHM in the whole SOC parameter space. Its global phase diagram displays many novel quantum phenomena such as masses generated from "order from disorder " mechanism, quantum commensurate (C) and In-commensurate (IC) skyrmion phases, quantum Lifshitz C-IC transitions, spiral phases, metastable states, hysteresis, devil staircases and fractals, etc. Connections to the classical Frenkel-Kontorowa (FK) model are explored. Implications to cold atom systems and so called Kitaev materials with SOC are discussed. Various intriguing perspectives are outlined.

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