Unusual magnetic phases in the strong interaction limit of two-dimensional topological band insulators in transition metal oxides

MEHDI KARGARIAN, The University of Texas at Austin, ABDOLLAH LANGARI, Sharif University of Technology, GREGORY A. FIETE, The University of Texas at Austin — The expected phenomenology of non-interacting topological band insulators (TBI) is now largely theoretically understood. However, the fate of TBIs in the presence of interactions remains an active area of research with novel, interaction-driven topological states possible, as well as new exotic magnetic states. In this work we study the magnetic phases of an exchange Hamiltonian arising in the strong interaction limit of a Hubbard model on the honeycomb lattice whose non-interacting limit is a two-dimensional TBI recently proposed for the layered heavy transition metal oxide compound, (Li,Na)$_2$IrO$_3$. By a combination of analytical methods and exact diagonalization studies on finite size clusters, we map out the magnetic phase diagram of the model. We find that strong spin-orbit coupling can lead to a phase transition from an antiferromagnetic Neél state to a spiral or stripy ordered state. We also discuss the conditions under which a quantum spin liquid may appear in our model, and we compare our results with the different but related Kitaev-Heisenberg-$J_2$-$J_3$ model which has recently been studied in a similar context.

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