Mott Physics and Topological Phase Transition in Correlated Dirac Fermions

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We investigate the interplay between the strong correlation and the spin-orbital coupling in the Kane-Mele-Hubbard model and obtain the qualitative phase diagram via the variational cluster approach. We identify, through an increase of the Hubbard U, the transition from the topological band insulator(TBI) to either the spin liquid phase or the easy-plane antiferromagnetic(AF) insulating phase, depending on the strength of the spin-orbit coupling. Starting from TBI, the spin-orbit coupling gap Δ_{SO} closes first and then the Mott gap opens up but without the gapless edge states for increasing U, which is closely related to the topological properties of the system. The closing process of Δ_{SO} driven by the correlations is accompanying with a splitting of both the conduction and valence bands. In the strong spin-orbit coupling regime, the state transiting from TBI is the easy-plane AF Mott insulator. In the weak coupling regime, a spin liquid phase emerges between the TBI and the AF Mott insulators.[1]

[1]Shun-Li Yu, X. C. Xie, and Jian-Xin Li, arXiv:1101.0911 (2011).