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Exotic quantum phase transitions of 2+1d Dirac fermions, and connections to 2d and 3d topological insulators KEVIN SLAGLE, YI-ZHUANG YOU, CENKE XU, Univ of California - Santa Barbara — Using determinant quantum Monte Carlo simulations, we demonstrate that an extended Hubbard model on a bilayer honeycomb lattice has two novel quantum phase transitions, each with connections to symmetry protected topological states. 1) The first is a continuous phase transition between the weakly interacting gapless Dirac fermion phase and a strongly interacting fully gapped and symmetric trivial phase. Because there is no spontaneous symmetry breaking, this transition cannot be described by the standard Gross-Neveu model. We argue that this phase transition is related to the Z_{16} classification of the topological superconductor ^{3}He-B phase with interactions. 2) The second is a quantum critical point between a quantum spin Hall insulator with spin S^z conservation and the previously mentioned strongly interacting gapped phase. At the critical point the single particle excitations remain gapped, while spin and charge gaps close. We argue that this transition is described by a bosonic O(4) nonlinear sigma model field theory with a topological Θ-term.

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