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Topological Phase Transitions in Dirac semi-metals of distorted spinels

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Abstract:
We study quantum criticality where a Dirac point breaks into two Weyl points in the presence of instantaneous Coulomb interaction because of breaking time-reversal symmetry. We perform the renormalization group analysis for the low-energy effective theory where the interplay between the Dirac fermion, the order parameter, and Coulomb interaction gives rise an intricate universal dynamics. We find that the ratio of the velocities of the order parameter and Dirac fermion is a universal non-trivial value at the quantum critical point, and the dynamics of the system becomes exceedingly anisotropic as we approach the quantum critical point despite of Coulomb interaction which generically tends to make the system isotropic. We apply our theory to the distorted spinels and the diamond lattice, which support Dirac fermions at the high-symmetry points in Brillouin zone.

Keywords:
topological phase transition, quantum phase transition, dirac semimetal, weyl semimetal, renormalization group