Special Seminar

Theoretical Condensed Matter Physics

Monday, February 22, 2021 → Zoom → 1:30 PM

"Superconductivity in low-density Dirac materials"

The experimental observation of superconductivity in doped semimetals and semiconductors, where the Fermi energy is comparable to or smaller than the characteristic phonon frequencies, is not captured by the standard lore. In this talk, I present a mechanism for superconductivity in low-density three-dimensional Dirac materials based on the proximity to a ferroelectric quantum critical point. This mechanism implies that the Coulomb repulsion is strongly screened by the lattice polarization near the critical point even in the case of vanishing carrier density, and the renormalization group analysis demonstrates that the system flows towards strong electron-phonon coupling. Applying these results to the low-density systems, I show that the superconducting transition temperature is significantly enhanced upon approaching the quantum critical point. Furthermore, I demonstrate that at vanishing electron density the ferroelectric transition is preempted by a new antiferroelectric order, which breaks translational symmetry in addition to inversion. This new quantum critical point significantly enhances soft phonon fluctuations, suggesting that it can mediate sufficiently strong interaction and lead to superconductivity even at zero density.

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