Superconductivity in Dilute Quantum Critical Polar Metals

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Superconductivity in low carrier density metals challenges the conventional electron-phonon theory due to the absence of retardation required to overcome Coulomb repulsion. Here I will discuss how pairing mediated by energy fluctuations, ubiquitously present close to continuous phase transitions, occurs in dilute quantum critical polar metals and results in a dome-like dependence of the superconducting Tc on carrier density, characteristic of non-BCS superconductors. In quantum critical polar metals, the Coulomb repulsion is heavily screened, while the critical transverse optic phonons decouple from the electron charge. In the resulting vacuum, long-range attractive interactions emerge from the energy fluctuations of the critical phonons, resembling the gravitational interactions of a charge-neutral dark matter universe. Our estimates show that this mechanism may explain the critical temperatures observed in doped $SrTiO_3$ in the appropriate density regime. Predictions for the enhancement of superconductivity near polar quantum criticality in two- and three-dimensional materials that can be used to test our theory are provided.

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