PHYSICS AND ASTRONOMY COLLOQUIUM

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Superconductivity from repulsion

The BCS theory of superconductivity uses the electron-phonon interaction as a glue to overcome Coulomb repulsion and to bind conduction electrons into pairs that condense and superconduct. This talk reviews work that considers whether a nominally repulsive Coulomb interaction can by itself, without the electron-phonon interaction, give rise to superconductivity. This scenario was first considered in a 1965 collaboration between Nobel laureate Walter Kohn and Joachim Luttinger. Modern studies consider a number of distinct electronic mechanisms for superconductivity in the high Tc cuprates, Fe-pnictides, and doped graphene. The pairing in all three of these new classes of materials can be viewed as lattice versions of the Kohn-Luttinger scenario, despite the different symmetries of the pairing orbitals. We discuss under what conditions pairing occurs and argue for undertaking complex technical studies based on parquet renormalization-group methods. We also analyze the interplay between the instabilities due to superconductive pairing (electron-electron correlations) and density-wave pairing (electron-hole correlations).

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