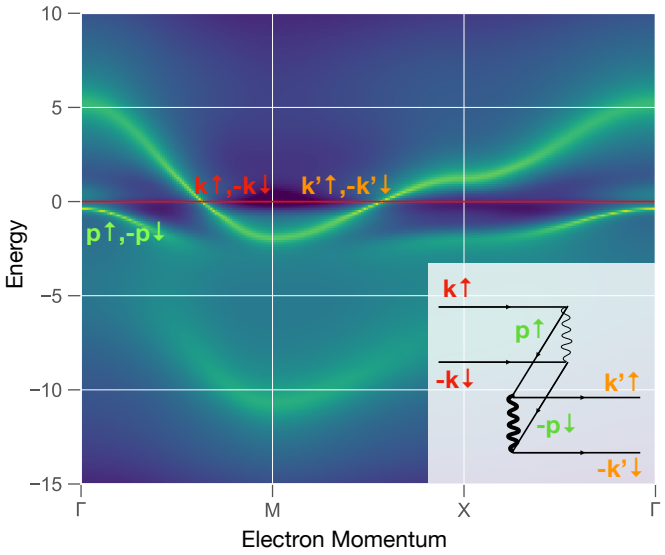
Emerging hole band spurs unconventional superconductivity



Electronic energy band structure shows an electron band at the M point that crosses the Fermi energy (red line) and an incipient hole band at Γ below the Fermi level. (inset) Spin-fluctuation scattering involving intermediate virtual pair states (p↑,-p↓) of the incipient band leads to an effective pairing interaction that scatters electron pairs (k↑,-k↓) with momenta k, -k and antiparallel spins on the Fermi surface to state (k'↑,-k'↓). This interaction can ultimately induce s-wave superconductivity.

T. A. Maier, V. Mishra, G. Balduzzi, and D. J. Scalapino, "Effective pairing interaction in a system with an incipient band," *Physical Review B* **99,** 140504(R) (2019).

Work was performed at ORNL

Scientific Achievement

Virtual scattering of electron pairs into incipient hole energy band states below the Fermi level can induce s-wave superconductivity, a phenomenon in which electrons form local coherent pairs despite their Coulomb repulsion and transmit electric current without resistance.

Significance and Impact

Understanding the role of incipient bands in the pairing mechanism that leads to superconductivity allows new insights into unconventional superconductors, such as FeSe-based materials.

Research Details

- Large scale computations of the electron-electron scattering in a bilayer Hubbard model demonstrated that pair scattering to the incipient hole band gives rise to an effective attractive interaction for the fermions on the Fermi surface.
- The retardation of this interaction gives rise to a superconducting state in which the pairs change sign as a function of frequency, a prediction that can be probed in future tunneling experiments.

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