

Lecture 21: Attraction by exchanging phonons

Electron-phonon interaction also gives rise to a mass enhancement, i.e., a change in the electron dispersion within ω_D of the Fermi energy. This phenomenon is qualitatively explained. It enhances the specific linear T coefficient from the band structure value by a factor $(1 + \lambda)$. However, it does not affect the Pauli spin susceptibility because the correction to the dispersion is tied to the spin-up and -down Fermi surface, respectively. The electron-phonon interaction gives rise to an attractive interaction among low energy electrons (those within ω_D of the Fermi energy). This is derived using a canonical transformation valid to second order in $g_{\mathbf{q}}$. This interaction is local in space but retarded in time. One can imagine the first electron set up some lattice vibration but is long gone when a second electron is attracted by the slowly varying lattice distortion. Once we add the screened Coulomb repulsion, the net interaction between electrons is still repulsive, but the effect of the attractive piece can dominate due to its retarded nature. This is important for the phenomenon of superconductivity.

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