

Current-Density Functional Theory for Superconductors

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We present a current-density functional theory (CDFT) for superconductors applied by the magnetic field. The basic variables are the electron density, paramagnetic current density and anomalous density which corresponds to the off-diagonal long-range order. In order to perform actual calculations, the exchange-correlation (xc) energy functional is the key quantity as well as the conventional DFT and CDFT. Namely, the approximate form of the xc energy functional is indispensable. We also develop an approximate xc energy functional on the basis of the vorticity expansion approximation (VEA).^{1, 2, 3} The xc energy functional is expressed as the expansion in terms of the anomalous density. The VEA formula is used as the zeroth-order term of the expansion.

The present scheme enables us to predict quantitatively both the critical temperature and critical field of superconductors.

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