Spin-Valley Half-Metal as a Prospective Material for Spin Valleytronics

Objective

To study spin-valley half-metals as prospective materials for spin valley-tronics

Summary of Research Activities

Half-metallicity (full spin polarization of the Fermi surface) usually occurs in strongly correlated electron systems. We demonstrate that doping a spin-density wave insulator in the weak-coupling regime may also stabilize half-metallic states.

In the absence of doping, the spin-density wave is formed by four nested bands [i.e., each band is characterized by charge (electron or hole) and spin (up or down) labels]. Of these four bands, only two accumulate the charge carriers introduced by doping, forming a half-metallic two-valley Fermi surface.

Depending on the parameters, the spin polarizations of the electronlike and holelike valleys may be either (i) parallel or (ii) antiparallel. The Fermi surface of (i) is fully spin polarized (similar to usual half-metals). Case (ii), referred to as "a spin-valley half-metal," corresponds to complete polarization with respect to the spin-valley operator. The properties of these states are discussed.

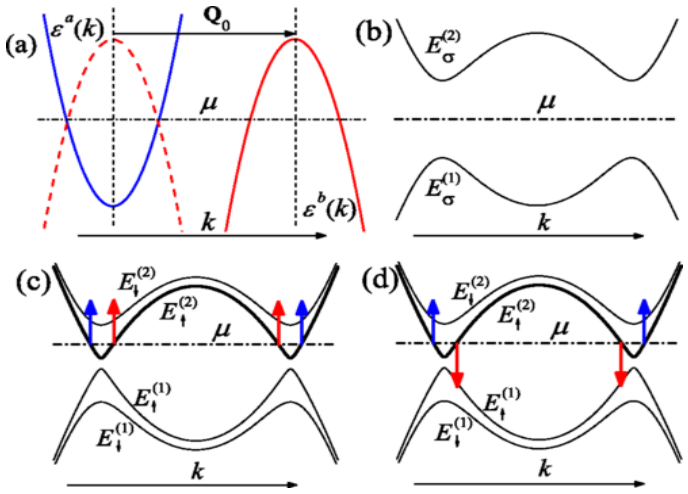

Fig. 1: The electron bands and spin structure for different dopings x [the vertical (horizontal) axis is energy (momentum), and the Fermi level μ is shown by horizontal dash-dot lines]. **(a)** Noninteracting bands at x=0. The bands are shown by solid curves; the dashed parabola is the hole band translated by the nesting vector Q_0. In (b)–(d) the interaction is accounted.
(b) If x=0, the ground state is an insulating SDW or CDW, with degenerate sectors ($\Delta\uparrow\equiv\Delta\downarrow$), with electron bands E.
(c), (d) If x>0, the sectors are no longer degenerate ($\Delta\uparrow<\mu<\Delta\downarrow\equiv\Delta 0$), with the charge accumulating in sector "↑," in which a Fermi surface opens. The spin polarizations (arrows) of the Fermi surface sheets correspond to (c) the CDW half-metal and (d) the spin-valley half-metal.

Publication

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