

Unconventional Density-Waves and Superconductivity in V-based Kagome Metals and Multilayer Nickelates

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Cascade quantum phase transitions in kagome metal AV_3Sb_5 ($A = Cs, Rb, K$) have been attracting increasing attention. Both the time-symmetry-breaking loop-current order and the superconductivity originate from the quantum fluctuations of the bond-order [1-4]. The loop-current order triggers the nonreciprocal transport effect called the electronic magneto-chiral anisotropy (eMChA) [5] and the chiral quasiparticle-interference (chiral-QPI) derived from the STM measurements [6]. Importantly, both eMChA and chiral-QPI are sensitively switched by the small magnetic field B_z .

Here we discuss the exotic superconducting state in kagome metals. We find that the loop-current in the normal state gives rise to the nematic chiral d -wave superconductivity [7]. In this mechanism, the loop-current-induced orbital magnetization stabilizes one of the chiral superconducting channels. This orbital Zeeman mechanism is generic and applies to pairing driven by either attractive or repulsive interactions. Considering the coexistence of the loop-current order and Star-of-David bond order in kagome metals, the orbital Zeeman effect is further enhanced, giving rise to the predominant nematicity even for an almost C_6 -symmetric Fermi surface. For attractive pairing, weak impurity scattering suppresses the chiral state and restores a conventional s -wave phase, as observed experimentally in kagome metals. The theory further predicts a robust 2×2 pair-density modulation consistent with experiments.

We also discuss the electronic states of multilayer nickelates superconductors [8]. We explain the origin of the double-stripe charge-density-wave (CDW) and spin-density-wave (SDW), together with the mechanism of high- T_c superconductivity.

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