Multiple quantum phases with loop-current order and nonreciprocal transport phenomena in kagome metal AV_3Ab_5 (A=Cs, Rb, K)

Hiroshi Kontani

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Rina Tazai[1], Youichi Yamakawa[2], Takahiro Morimoto[3], and Hiroshi Kontani[4]

1 Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto 606-8502, Japan \\

2 Department of Physics, Nagoya University, Nagoya 464-8602, Japan

3 Department of Applied Physics, The University of Tokyo, Tokyo 113-8656, Japan

Exotic density-wave (DW) orders in strongly correlated metals have been discovered one after another and found to be universal now [1]. The multistage unconventional DW (with non-A_{1g} symmetry) orders in frustrated kagome metal AV_3Sb_5 (A=Cs,Rb,K) and its interplay with exotic superconductivity attract increasing attention. We find that the star-of-David bond-order originates from the inter-sublattice electron correlation due to the paramagnon interference mechanism [2]. In addition, we uncover that moderate bond-order fluctuations mediate s-wave and triplet p-wave superconductivity [2]. The obtained impurity-induced change in the SC state is consistent with recent electron-irradiation measurements. Furthermore, we discovered that the time-reversal symmetry-breaking loop current order is naturally caused by the bond-order fluctuations [3].

More interestingly, the coexistence of the charge-current order and the bond-order gives rise to novel quantum states, and the coexisting state is very sensitive to the outer magnetic field and the uniaxial strain field. To understand the multiple quantum phase transitions in kagome metals, we construct the Ginzburg-Landau (GL) free-energy theory under the outer fields and explain why the loop-current order is drastically stabilized under the magnetic and strain fields[3]. We also discuss the characteristic nonreciprocal transport phenomena in the coexisting quantum phase, such as the giant electronic magnetochiral anisotropy (eMChA) reported by Guo et al, Nature 611, 461 (2022).

References:

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