Abstract Template

Unconventional superconductivity in kagome metals revealed by NQR/NMR

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Kagome lattice materials display intriguing properties resulting from the interplay of topology, correlation, and magnetism. Their electronic structures are characterized by a van Hove singularity, flat bands, and Dirac cones, presenting significant opportunities for exploring superconductivity beyond the BCS *s*-wave pairing. Here, we employed nuclear magnetic resonance (NMR) and nuclear quadrupole resonance (NQR) under extreme conditions including hydrostatic pressure, ultra-low temperatures, and high magnetic fields to elucidate a sequence of symmetry-breaking electronic orders and unconventional superconductivity in recently discovered kagome metals, CsV_3Sb_5 and $CsCr_3Sb_5$.

In the case of CsV_3Sb_5[1,2], we will demonstrate that the linewidth of the NQR spectra exhibits a Curie–Weiss temperature dependence, which tends to diverge at a pressure of $P_c \sim 1.9$ GPa. This suggests the presence of a charge-density-wave (CDW) quantum critical point (QCP) at P_c, where the transition temperature Tc reaches a maximum. Additionally, we observe that the upper critical field maintains a twofold symmetry in the *ab*-plane, even at high pressures where the CDW is completely suppressed, and the superconducting state progresses from nodal to nodeless. In contrast to CsV_3Sb_5, $CsCr_3Sb_5$ is distinguished by stronger electron correlations and magnetism [3]. At ambient pressure, this material undergoes an antiferromagnetic phase transition at 55 K, as evidenced by high-field NMR measurements. At high pressures, the density-wave-like orders are progressively suppressed, and a superconducting dome emerges within the pressure range of 3.65-8.0 GPa, which may represent an unconventional superconducting phase. These results illustrate the prevalence of unconventional kagome superconductivity that competes with charge order or magnetism, offering unique insights into the nature of the Cooper pair state.

[1] J. Luo, et al., npj Quantum Materials, 7,30 (2022).
[2] X.-Y. Feng, et al., npj Quantum Materials, 8,23 (2023).
[3] Y. Liu, et al., arXiv: 2309.13514v2.