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Signatures of unconventional superconductivity in the kagome superconductors Cs(V1-xTix)3Sb5

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CsV3Sb5 exhibits several emergent phenomena, including superconductivity (TC ˜ 3.2 K), charge-density wave (TCDW ˜ 98 K), and nematicity (Tnem ˜ 36 K). Despite tremendous investigations for several years, the nature of the superconductivity and multiple electronic orders, as well as the relationship among them, remain elusive. In this study, we have investigated nematic susceptibility and thermal conductivity in a broad doping and temperature range in high-quality single crystals of Cs(V1-xTix)3Sb5 (x = 0 –0.06) where a double-dome superconducting phase diagram is realized. In most doping ranges, the nematic susceptibility exhibits the Curie–Weiss behavior above Tnem and Ti doping systematically suppresses the Curie–Weiss temperature from ˜30 K for x = 0 to ˜4 K for x=0.0075, resulting in a sign change at x = ˜0.009, where the first superconducting dome exists. Furthermore, the Curie constant reaches a maximum at x = 0.01, suggesting a drastic enhancement of the nematic susceptibility near a putative nematic quantum critical point (NQCP) at x = ˜0.009. Furthermore, we have investigated the temperature (T)- and magnetic field (H)-dependent thermal conductivity k of the Ti-substituted kagome superconductor Cs(V1-xTix)3Sb5 (x=0.0, 0.01, 0.015, and 0.06). In the samples belonging to the first superconducting dome (0.0 ≤ x ≤ 0.015), k(T) revealed a set of excitations that indicated the existence of a small full gap and monotonic suppression of the gap minimum with increasing x. In the same sample set, most quasiparticles, as inferred from k(H) were easily excited and delocalized when small H ≤ ˜100 mT were applied along the c-axis, and the increasing behaviour of k(H) was similar to that of the nodal superconductors. Moreover, the electronic k reached the normal state values under H well below the upper critical fields, uncovering anomalous gapless superconducting states under H. All these results strongly support the presence of unconventional chiral d + i d pairing inside the first superconducting dome, which develops a full gap that is quite fragile under time reversal symmetry breaking potential.

[1] Y. Sur at al Nat. Commun. 14, 3899 (2023)
[2] K. Nam et al. submitted (2024)

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