Emergence of Multiple Resistance States and Quantum Criticality in Ga-Irradiated Kagome Superconductor

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This work discusses the emergence of a disorder-driven superconductor–insulator transition (SIT) and current-induced switching phenomena in a CsV_3Sb_5 micron size Hall bar fabricated by Ga-ion focused ion beam (FIB). While pristine crystals exhibit metallic behavior with a charge density wave (CDW) transition near 94 K and superconductivity below 3 K [1], the micron size Hall bar fabricated by Ga-ion FIB displays an insulating ground state as well as intermediate SIT depending on the channel that we measure. The SIT is associated with a temperature independent quantum critical resistance ($\sim$ 3.5 kΩ per kagome layer). Interestingly, the SIT state shows current dependent high and low resistance states. Furthermore, both resistance states jump to an intermediate resistance state in a temperature window between 130 K and 280 K during the warming cycle. Additionally, negative resistance is observed at low temperatures, suggesting the presence of non-equilibrium quasiparticle dynamics. These findings reveal multiple metastable resistance states and signatures of quantum critical fluctuations, which we think originates from the disorder induced during the FIB fabrication and resulting in competing electronic phases in kagome superconductors.

[1] Yu et al., Phys. Rev. B (2021), DOI : https://doi.org/10.1103/PhysRevB.104.L041103.