

15th International Conference on Muon Spin Rotation, Relaxation and Resonance



Contribution ID: 275

Type: Oral

Complex nature of charge order and superconductivity interplay in correlated kagome superconductor CsV_3Sb_5

Thursday, 1 September 2022 12:20 (20 minutes)

Recent family of Kagome superconductors AV_3Sb_5 ($A = \text{Rb}, \text{K}, \text{Cs}$) offers a natural playground to study the interplay between different electronic states such as non-trivial chiral charge order (CO) and unconventional superconductivity [1-5]. This is because of its unique crystal structure that results in flat bands across the Brillouin zone, crossing of linear bands at K-corner, appearance of van Hove singularities at M-edges of the Brillouin zone. CsV_3Sb_5 is of particular interest compared to Rb and K counterparts due to distinct M-dome shaped two peak behaviors in its superconducting transition temperature T_c vs. pressure phase diagram. The phase diagram is however drawn through transport measurements accessing only macroscopic nature of interplay between CO and SC [6]. Thus, microscopic nature and theoretical understanding of their correlation remains unanswered. We have carried out muon spin relaxation/rotation (μSR) experiments under hydrostatic pressure up to 1.9 GPa. Nearly threefold enhancement in T_c and superfluid density n_s at 1.74 GPa compared to their respective ambient pressure values has been observed. Interestingly, n_s also displays two peak like feature with pressure. Three different regions of phase diagram manifest distinct linear relationship between T_c and n_s . The μSR results and DFT calculations conjointly suggest possible evolution of CO from a superimposed tri-hexagonal Star-of-David phase at low pressures to the staggered tri-hexagonal phase at intermediate pressures [7]. Our studies thus uncover different regions of phase diagram with CO showing varying degree of interplay with SC.

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Session Classification: Oral contributions

Track Classification: Superconductivity