Contribution ID: **137** Contribution code: **O-6** Type: **Oral**

Time-reversal symmetry-breaking charge order in a kagome superconductor

Monday, 29 August 2022 14:40 (20 minutes)

The kagome lattice, the most prominent structural motif in quantum physics, benefits from inherent nontrivial geometry to host diverse quantum phases, ranging from spin-liquid phases, topological matter to intertwined orders, and most rarely unconventional superconductivity. Recently, charge sensitive probes have suggested that the kagome superconductors AV3Sb5 (A = K, Rb, Cs) [1] exhibit unconventional chiral charge order. However, direct evidence for the time-reversal symmetry-breaking of the charge order remained elusive. We utilized muon spin relaxation to probe the kagome charge order and superconductivity in (K,Rb)V3Sb5 [2,3]. We observe a striking enhancement of the internal field width sensed by the muon ensemble, which takes place just below the charge ordering temperature and persists into the superconducting state. Remarkably, the muon spin relaxation rate below the charge ordering temperature is substantially enhanced by applying an external magnetic field. We further show [3] that the superconducting state displays a reduced superfluid density, which can be attributed to the competition with the novel charge order. Upon applying pressure, the charge-order transitions are suppressed, the superfluid density increases, and the superconducting state progressively evolves from nodal to nodeless. Our results point to the rich interplay and accessible tunability between unconventional superconductivity and time-reversal symmetry-breaking charge orders in the correlated kagome lattice, offering new insights into the microscopic mechanisms involved in both orders.

[1] Y.-X. Jiang et. al., Nature Materials 20, 1353 (2021).

[2] C. Mielke et. al., and Z. Guguchia, Nature 602, 245-250 (2022).

[3] Z. Guguchia et. al., arXiv:2202.07713v1 (2022).

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Session Classification: Oral contributions

Track Classification: Superconductivity