

Interweaving electronic orders and Collective Quantum Effects in Kagome Materials

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Abstract

Electron interactions can strongly shape quantum materials, producing competing states and unusual effects. The recently discovered AV₃Sb₅ Kagome superconductors are a striking example. They host a fragile electronic ground state in which one order can switch or tune another. This strong coupling makes them a rich platform for exploring quantum phenomena, but also makes them extremely sensitive to external perturbations. As a result, small changes in experimental conditions can lead to very different outcomes, explaining many seemingly contradictory reports in the field.

To address this, we developed a membrane-mount microdevice platform based on focused-ion-beam fabrication [1]. Its soft, meander-shaped silicon nitride springs mechanically isolate the device from its frame, minimizing unwanted strain. With this approach, we showed that the apparent contradictions in Kagome experiments arise naturally from the material's exceptional tunability. Using this platform, we uncovered unusual transport effects linked to **electronic chirality**, a fundamental geometric property. Unlike structural chirality, which is fixed, the electronic chirality in CsV₃Sb₅ can be switched by small magnetic fields [2]. This previously unseen switchable chirality could enable new functionalities. More recently, we discovered a new collective quantum effect in Kagome metals: flux-quantized, h/e-periodic magnetoresistance oscillations in mesoscopic structures [3]. These results show that Kagome metals can sustain long-range coherent charge transport and that their quantum behavior can be shaped through geometry. Together, these studies establish Kagome materials as a promising platform for future quantum technologies.

References

- [1] CG et al., Nat. Phys. 20, 579 (2024).
- [2] CG et al., Nature 611, 461 (2022).
- [3] CG et al., Nature 647, 68 (2025).

