The unusual electron transport in metallic Kagome nets

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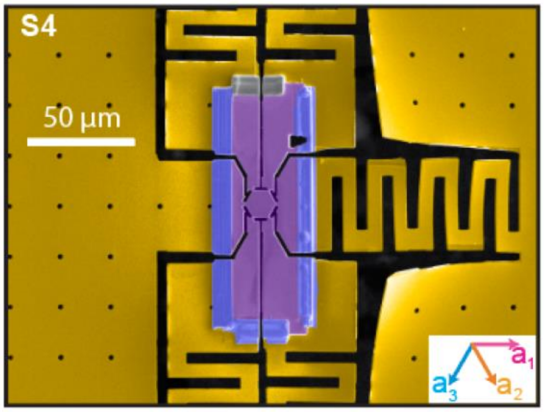
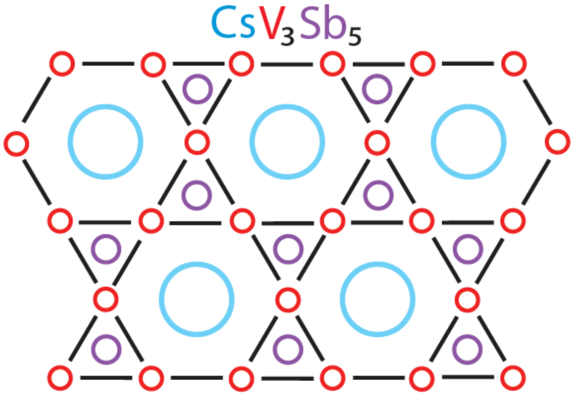
Materials that can host different states of electronic order form a recurring theme in physics and materials science, and they are of particular interest if they are coupled strongly. A famous example are ferroelectrics, in which electric polarization and magnetism not only coexist but are strongly linked. This both unveils a rich physics of correlated states, and also opens unexpected application avenues as the coupling promises to manipulate one state by a stimulus that primarily acts on another – say switching magnetism using electric fields.

Recently, materials based on the structural motif of the Kagome web have attracted significant attention for their tendency to host such strongly coupled phases. In particular, the centro-symmetric layered Kagome metal (K,Cs)V_3Sb_5 have entered the focus of experimental and theoretical research. They host a charge-density-wave type transition at elevated temperatures ~100K, followed by a superconducting transition at 3K (exact values depend on composition). Yet there is another type of electronic order which thus far eludes exact microscopic identification. A series of experimental probes detects the onset of anomalous behavior around T'~30-40K, including thermal Hall, μSR, NMR, magnetic torque, Kerr rotation. The anomalous low-temperature state carries the characteristics of a chiral, nematic and time-reversal-symmetry breaking fluid (all of which are under most active debate currently).

Yet what crystallizes out of the current state of experimental data is a highly entangled system which is extraordinarily responsive to external perturbations. This materials main strength is equally its weakness, the unusual degree of coupling between states can hinder its systematic investigation. However, it is already clear that it provides a platform to explore strongly coupled correlated phases, and as a result it displays a thus-far unknown electromagnetic response, a diode in which the forward direction can be switched by the application of a magnetic field. I will review the current state of the field, and discuss ongoing projects in my department.





[1] C. Guo et al., Nature 611, 461-466 (2022)
[2] X. Huang et al., PRB 106, 064510 (2022)