Abstract for IAS Focused Program on Reticular Quantum Matter (Nov 30 - Dec 4, 2026)

Yu-Shiba-Rusinov Bands in a Self-Assembled Kagome Lattice of Magnetic Molecules

Laëtitia Farinacci

Experimental Physics II, Julius-Maximilians-Universität Würzburg, Germany

Email: laetitia.farinacci@uni-wuerzburg.de

Kagome lattices, built from corner-sharing triangles, are versatile platforms for studying correlated phases of matter: their band structure features strongly dispersive Dirac cones alongside a flat band. However, investigating purely 2D kagome physics remains challenging, as most kagome materials are intrinsically three-dimensional. Molecular self-assembly offers a promising alternative, but typically relies on metallic substrates whose hybridization with the adsorbates modifies electron-electron correlations.

Here, we use a Pb(111) superconducting substrate to study the self-assembly of magnetic Fe-porphine-chloride (FeP-Cl) molecules [1]. The interaction between the Cooper pairs of the substrate and the magnetic centers of the FeP molecules leads to the presence of magnetic bound states, called Yu-Shiba-Rusinov (YSR) states, inside the superconducting gap. By controlling the sample temperature during and after molecular deposition, we are able to control the formation of small kagome precursors and of long-range kagome islands (Fig1a). We can thereby track the formation of kagome-derived bands at the interface due to exchange coupling between neighbouring YSR states (Fig1b). This approach offers us unique insight into YSR-band formation and paves the way for future studies to possibly resolve spin-liquid or Kondo-lattice-type behaviours.

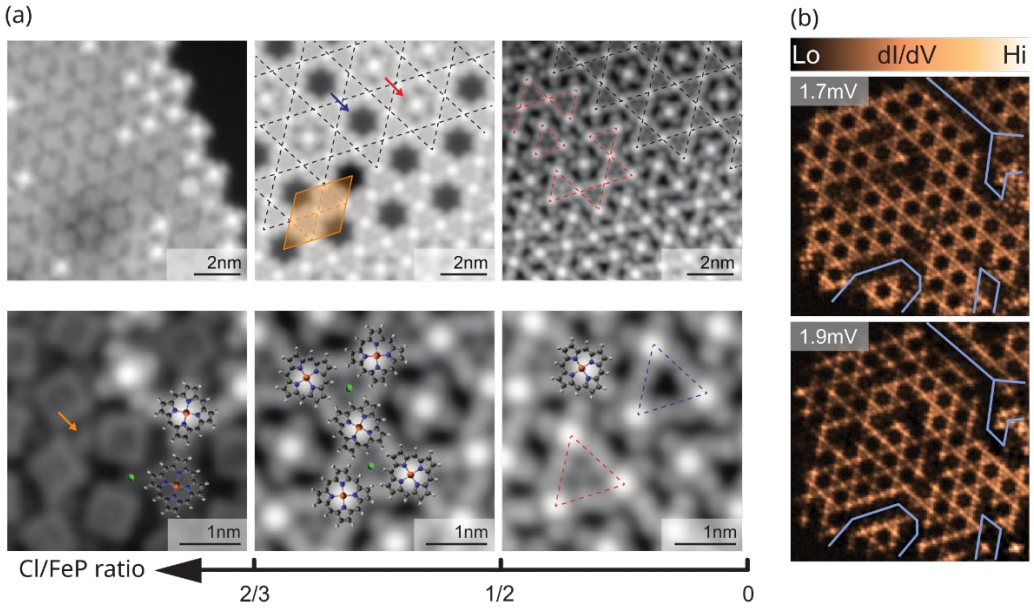


Figure 1. (a) Formation of a kagome lattice and kagome precursors by means of molecular self-assembly. (b) Observation of YSR bands inside kagome domains. Adapted from [1].

References:

[1] L. Farinacci, G. Reecht, F. von Oppen and K.J. Franke. Nat. Comm. 15 6474 (2024).