Emergent flat band and topological Kondo semimetal driven by orbital selective correlations

Lei Chen[1], Fang Xie[1], Shouvik Sur[1], Haoyu Hu[2], Silke Paschen[3,1], Jennifer Cano[4,5], Qimiao Si[1],

[1] *Department of Physics and Astronomy, Rice Center for Quantum Materials, Rice University, Houston, Texas*

[2] *Donostia International Physics Center, P. Manuel de Lardizabal 4, 20018 Donostia-San Sebastian, Spain*

[3] *Institute of Solid State Physics, Vienna University of Technology, Wiedner Hauptstr. 8-10, 1040 Vienna, Austria*

[4] *Department of Physics and Astronomy, Stony Brook University, Stony Brook, NY 11794, USA*

[5] *Center for Computational Quantum Physics, Flatiron Institute, New York, NY 10010, USA*

Flat electronic bands are expected to show proportionally enhanced electron correlations, which may generate a plethora of novel quantum phases and unusual low-energy excitations. They are increasingly being explored in d-electron-based systems with crystalline lattices that feature destructive electronic interference, where they are often topological. Such flat bands, though, are generically located far away from the Fermi energy, which limits their capacity to partake in the low-energy physics. Here [1,2], we show that electron correlations produce emergent flat bands that are pinned to the Fermi energy. We demonstrate this effect within a Hubbard model, in the regime described by Wannier orbitals where an effective Kondo description arises through orbital-selective Mott correlations. Moreover, the correlation effect cooperates with symmetry constraints to produce a topological Kondo semimetal. Our results motivate a novel design principle for Weyl Kondo semimetals in a new setting, viz. d-electron-based materials on suitable crystal lattices and uncover interconnections among seemingly disparate systems that may inspire fresh understandings and realizations of correlated topological effects in quantum materials and beyond. Finally, we analyze the loss of quasiparticles and the concomitant strange metallicity in terms of a Kondo destruction quantum critical point.

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[1] H. Hu, et al., arXiv: 2209.10396 (2022).

[2] L. Chen, et al., arXiv: 2212.08017 (2022).