Sonderforschungsbereich 1277

Emergent Relativistic Effects in Condensed Matter -
From Fundamental Aspects to Electronic Functionality

SFB – Colloquium

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Date: Tuesday, 02.07.2024, 14:15, H34

Topic: Nematic versus triplet superconductivity in twisted bilayer graphene

Abstract:

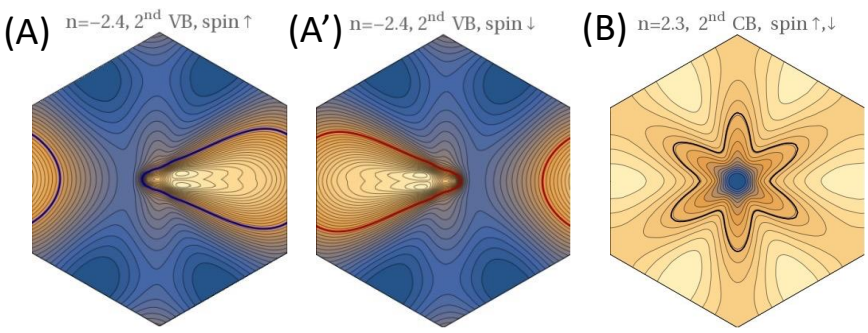
Typical moiré systems consist of 10,000 atoms per unit cell, however, as mainly the emerging flat bands determine the novel correlated and topological phases, an effectiv density-matrix related to the flat bands usually suffices to describe the main physics. And within the continuum model for twisted bilayer graphene, the correlated insulator phases of magic angle bilayer graphene at even integer filling factor can be characterized by an emergent U(4)-ferromagnet. However, this approximate symmetry is broken in real samples and the way how it is broken may lead to the yet unexplained asymmetry between the superconducting phases for electronic and hole doping.

In order to address the phase diagram of realistic moiré systems, I will thus start from a microscopic tight-binding model for twisted bilayer graphene within the Hartree-Fock approximation and present two ways how to reduce the full density matrix to a density matrix based on a SU(4)-symmetry [1,2]. We find that at charge neutrality, also the reduced density matrix is described by a pure (valley coherent) state. We further find nematic superconductivity with valley polarization for hole doping and triplet superconductivity with intervalley coherence for electron doping, see Fig. 1.

Finally, I outline our theory of Ising superconductivity of twisted trilayer graphene [3] and show how real-space chirality can be measured in linear transport experiments [4].

Host: Prof. Dr. Jaroslav Fabian

[1] M. Sánchez Sánchez, T. Stauber, Phys. Rev. B **109**, 195167 (2024) [2] M. Sánchez Sánchez, *et al*., arXiv: 2403.03140
[3] J. González, T. Stauber, Nat. Commun. **14**, 2746 (2023) [4] D. A. Bahamon, *et al*., Nano Lett. **24**, 4478 (2024)



Energy contour maps showing the Fermi lines in the second valence band for (A) spin-up and (A') spin-down electrons in the moiré Brillouin zone of TBG for filling fraction of 2.4 holes per moiré unit cell. Contiguous contour lines differ by a constant step of 0.02 meV, from lower energies in blue to higher energies in light color. (B) Energy contour maps showing the Fermi line in the second conduction band at filling fraction of 2.3 electrons per moiré unit cell.