Correlations and spins in 2D materials

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Electronic correlations in few-layer graphene systems, such as rhombohedral ABC graphene or Bernal AB graphene, enable novel Stoner- and intervalley-coherence-correlated states. The corresponding order parameters are typically meV in magnitude, similar to the strength of spin proximity effects–spin-orbit coupling and exchange interactions–induced by proximity to transition-metal dichalcogenides and van der Waals magnetic semiconductors. I will present several examples [1,2] of this interplay and outline our theoretical approach, which is based on realistic DFT-based effective single-particle Hamiltonians [3] and generalized RPA susceptibility. In particular, I will demonstrate that valley-Zeeman spin-orbit coupling in graphene gives rise to new spin-valley coherence phases in the presence of electron interactions.

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[1] Y. Zhumagulov et al, Phys. Rev. Lett. 132, 186401 (2024).

[2] Y. Zhumagulov et al, Physical Review B 110, 045427 (2024).

[3] K. Zollner et al, Nature Reviews Physics 7, 255 (2025).