Striped Spin Density Wave in a Graphene/Black Phosphorous Heterostructure

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A bilayer formed by stacking two distinct materials creates a moiré lattice, which can serve as a platform for novel electronic phases. In this work we study a unique example of such a system: the Graphene/Black Phosphorus heterostructure (G/BP), which has been suggested to have an intricate band structure. Most notably, the valence band hosts a quasi-one-dimensional region in the Brillouin zone featuring a high density of states, suggesting that various many-body electronic phases are likely to emerge. We derive an effective tight-binding model that reproduces this band structure, and explore the emergent broken-symmetry phases when interactions are introduced. Employing a Mean-Field analysis, we find that the favored ground-state exhibits a striped Spin Density Wave (s-SDW) order, characterized by either one of two-fold degenerate wave-vectors that are tunable by gating. Further exploring the phase-diagram controlled by gate voltage and the interaction strength, we find that the SDW-ordered state undergoes a metal to insulator transition via an intermediate metallic phase which supports striped SDW correlations. Possible experimental signatures are discussed, in particular a unique dispersion of the collective excitations.

[1] Dolev Haddad, H. A. Fertig and Efrat Shimshoni, Phys. Rev. B 111, 155153 (2025)