## Visualizing complex electronic states in van der Waals materials

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Conventional materials hosting exotic quantum phases typically have complex atomic structures, inhomogeneities from defects, impurities, and dopants making it difficult to rationally engineer their electronic properties. This can be overcome using van der Waals (vdW) materials and their heterostructures that allow an almost arbitrary selection of the heterostructure building blocks. In a vdW heterostructure, proximity effects cause properties to "leak" between the adjacent layers and allow creating exotic quantum mechanical phases that arise from the interactions between the layers. These key features have recently made it possible to realize exotic quantum phases by design and engineer responses that do not readily occur in natural materials.I will highlight these concepts through our recent results on monolayer multiferroic materials and vdW heterostructures realizing artificial heavy fermion states [1–4]. In general, these examples highlight the versatility of vdW heterostructures in realizing quantum states that are difficult to find and control in naturally occurring materials.

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