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Unconventional Superlattice Ordering in Intercalated Transition Metal Dichalcogenide $V_{1/3}NbS_2$

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The interplay between symmetry and topology in Magnetic materials enables the design of exotic phases and technologically useful properties. A team from UC Berkeley showed that $V_{1/3}NbS_2$ can crystallize in two distinct superlattices defined by the stacking periodicity of magnetic intercalants. One structure is metallic and exhibits key signatures of altermagnetism, while the other superlattice, which has not been isolated before in this family of materials, is a semimetallic noncollinear antiferro-magnet with potential topologically nontrivial properties.

This discovery provides a route to systematically engineer the magnetic and electronic behaviors of the broader intercalated transition metal dichalcogenide family, advancing their prospects for low-power spintronic and topological quantum devices. Moreover, the possibility of reversible switching between these intercalant orders via external stimuli suggests opportunities for functional phase-change devices that exploit tunable magnetic and topological states.

This work was made possible by the low-dose imaging and spectroscopy in PARADIM's high-brightness Spectra "Kraken" STEM required to achieve atomic resolution visualization and elemental mapping of the sensitive V intercalants which are rapidly damaged under more conventional experimental conditions.

S.S. Fender, *et al.* [*J. Am. Chem. Soc.* **147**, 32315-32320 (2025)].

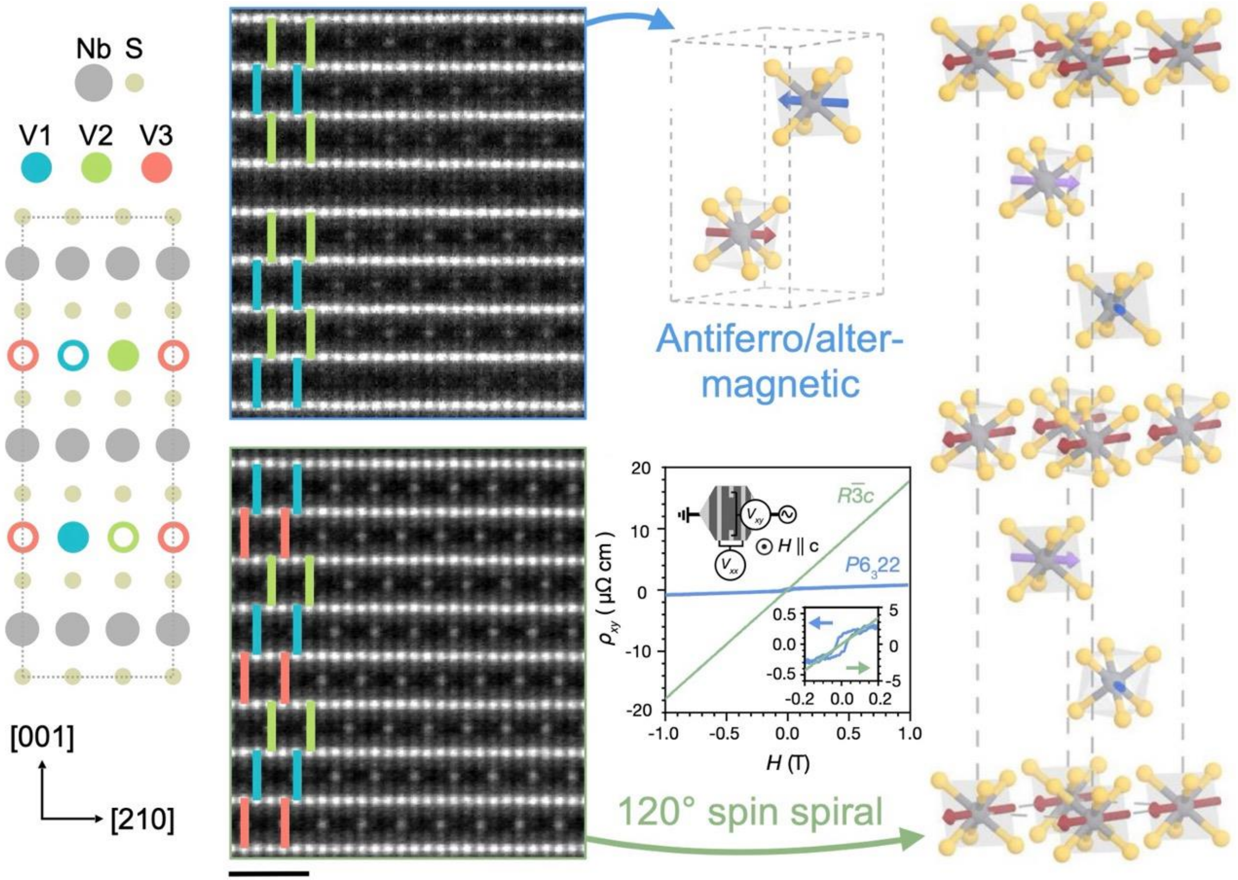

Figure. Different vanadium ion intercalant ordering in NbS_2, characterized by ABAB (top) and ABC (bottom) stacking, identified by color overlays (scale bar 1 nm). The two crystal structures exhibit distinct magnetic and electronic properties.