

# Bulk Moiré Crystals Reveal a Higher-Dimensional World for Electrons

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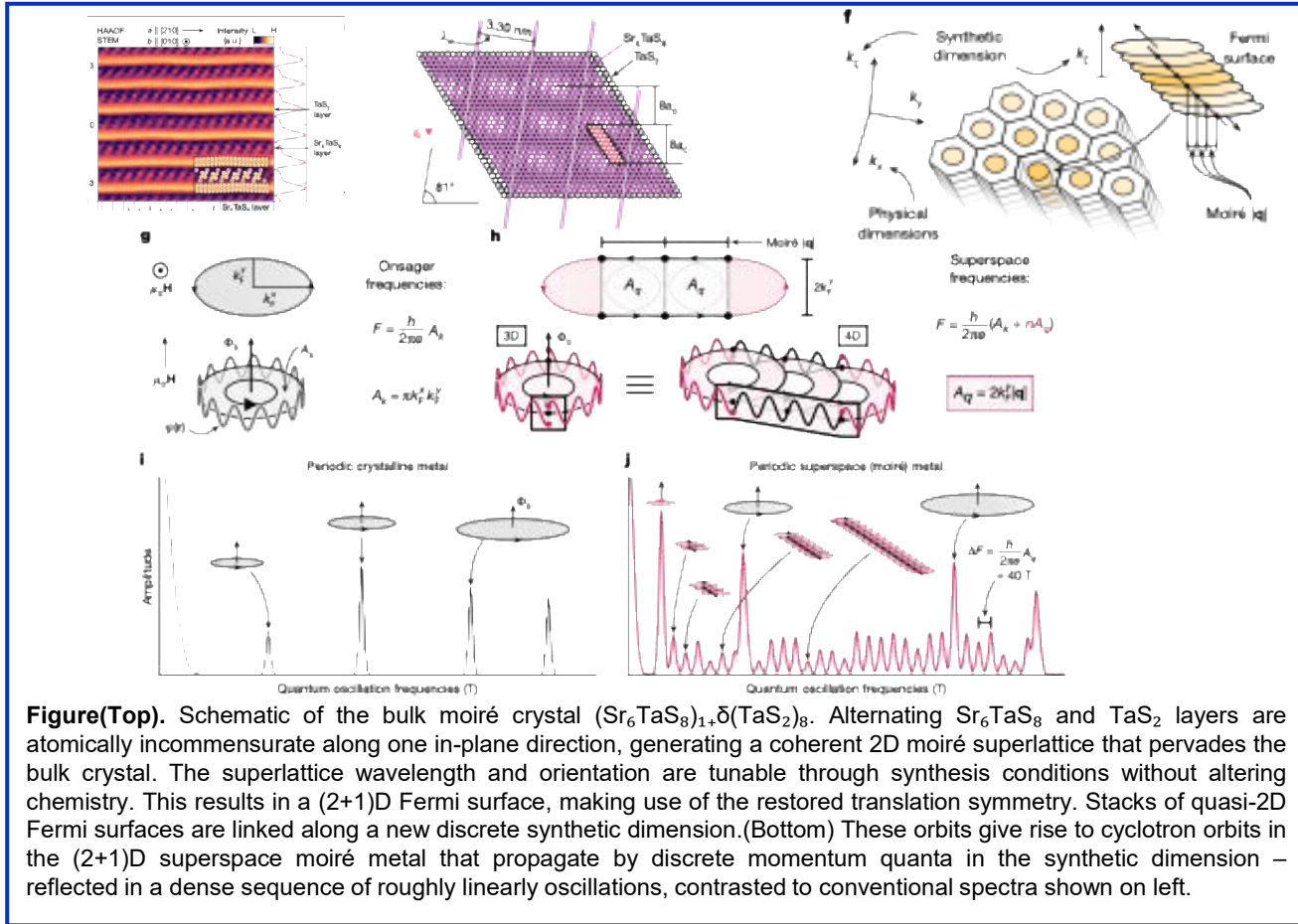
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Moiré materials — formed by stacking atomically thin layers with slightly mismatched lattices — have transformed how researchers engineer quantum phases of matter, hosting tunable superconductivity, ferroelectricity, and topological states. But every moiré platform to date has required laborious hand-assembly of individual van der Waals flakes, limiting quality and scalability. Whether the same physics could emerge in equilibrium-grown bulk crystals remained open.

Here, the authors report a new family of bulk moiré materials,  $(\text{Sr}_6\text{TaS}_8)_{1+\delta}(\text{TaS}_2)_8$ , grown in equilibrium without hand-stacking. The lattice mismatch between alternating  $\text{Sr}_6\text{TaS}_8$  and  $\text{TaS}_2$  layers generates a coherent moiré superlattice throughout the bulk, tunable through synthesis conditions. High-field torque magnetometry (Cell 9, 31.5 T) and magnetotransport (Cell 6) at the MagLab's DC-Field Facility revealed a de Haas–van Alphen spectrum mapping more than 40 distinct Fermi-surface cross-sections — far more than any conventional three-dimensional metal.

This dense Fermiology is naturally explained by treating these bulk moiré metals as projections of higher-dimensional "superspace" crystals — a long-standing framework in incommensurate crystallography never before applied as an electronic platform. Electrons effectively access a synthetic fourth dimension generated by the moiré superlattice, opening an experimental route to higher-dimensional topological and superconducting phases previously confined to theory. Because these are robust bulk crystals rather than hand-stacked flakes, the approach is inherently scalable toward wafer-scale moiré electronics.



**Facilities and instrumentation used:** DCFF Cell 9 (torque magnetometry up to 31.5T) and Cell 6 (torque magnetometry and magnetotransport)

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