Correlated quantum materials design with magnetic twisted van der Waals heterostructures

Jose Lado

Department of Applied Physics, Aalto University, Espoo, Finland
jose.lado@aalto.fi

Twisted van der Waals heterostructures provide an outstanding platform to create emergent physics, due to the possibility of combining materials with genuinely different electronic orders and the ability to enter controllable correlated states through twist engineering. Two-dimensional magnetic materials add a whole new set of opportunities, bringing up the unique ability to exploit exchange proximity effects to tailor the internal spin structure of an electronic state. Here we show that twisted heterostructures based on graphene, transition metal dichalcogenides, and two-dimensional magnetic materials provide a unique platform to create controllable correlated states. We will show how ferromagnetic two-dimensional materials allow designing new correlated states of matter in twisted graphene bilayers [1] and control symmetry breaking in twisted Janus dichalcogenide bilayers [2]. Furthermore, we will show how specifically designed twisted van der Waals heterostructures give rise to emergent heavy fermion physics [3,4], bringing to the twisted van der Waals world the physics of rare-earth compounds. These results put forward magnetic twisted two-dimensional materials as a rising knob to engineer and control a whole new family of correlated physics in moire van der Waals heterostructures.

References

[1] T. M. R. Wolf, O. Zilberberg, G. Blatter, and J. L. Lado, Phys. Rev. Lett. 126, 056803 (2021)
[2] D. Soriano and J. L. Lado, New J. Phys. 23, 073038 (2021)
[3] A. Ramires and J. L. Lado, Phys. Rev. Lett. 127, 026401 (2021)
[4] V. Vaňo, M. Amini, S. C. Ganguli, G. Chen, J. L. Lado, S. Kezilebieke, P. Liljeroth, arXiv:2103.11989 (2021)

Figures