Quantum Sensing of Moiré Magnetism

Chunhui Rita Du

School of Physics, Georgia Institute of Technology, Atlanta, Georgia, USA

Moiré magnetism featured by stacking engineered atomic registry and lattice interactions has recently emerged as an appealing quantum state of matter at the forefront of condensed matter physics research [1]. Nanoscale imaging of moiré magnets is highly desirable and serves as a prerequisite to investigate a broad range of intriguing physics underlying the interplay between topology, electronic correlations, and unconventional magnetism. In this talk, I will present our recent work on using nitrogen-vacancy (NV) centers to perform nanoscale quantum sensing and imaging of magnetic domains and spin fluctuations in twisted double trilayer (tDT) chromium triiodide CrI_3. We show that intrinsic moiré domains of opposite magnetizations appear over arrays of moiré supercells in low-twist-angle tDT CrI_3 [2]. In addition, spin fluctuations measured in tDT CrI_3 reveal two distinct magnetic phase transitions with separate critical temperatures within a moiré supercell [3]. Our results enrich the current understanding of exotic magnetic phases sustained by moiré magnetism and highlight the opportunities provided by quantum spin sensors in probing microscopic spin related phenomena on two-dimensional flatland.

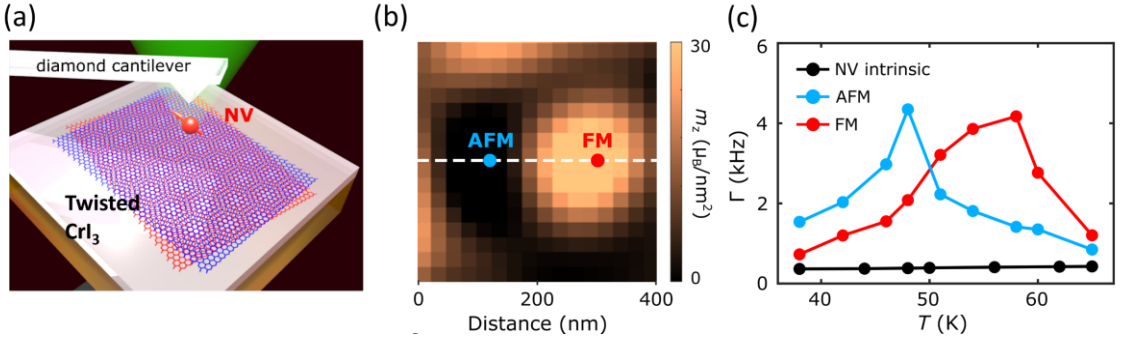

Figure 1. (a) Schematic illustration of scanning NV measurements of twisted CrI_3. (b) Magnetization map measured on a selected sample area (400 nm × 400 nm) of the 0.15° twisted double trilayer (tDT) CrI_3 device, showing co-existing ferromagnetic (FM) and antiferromagnetic (AFM) domains. (c) Temperature dependence of NV spin relaxation rate Γ measured when the NV center is positioned right above the FM and AFM domains formed in the 0.15° tDT sample, revealing two distinct magnetic phase transitions with separate critical temperatures (~10 K) within moiré supercells.

[1] T. Song et al., Science **374**, 1140 (2021).
[2] M. Huang et al., Nat. Commun. **14**, 5259 (2023).
[3] S. Li et al., Nat. Commun. **15**, 5712 (2024).