A microscopic approach to studying the topological bands of twisted molybdenium di-telluride

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The physics of 2D layers can be engineered by creating a moiré, arising when two layers are twisted on top of each other. As a striking example, fractional quantum anomalous Hall states can be engineered in twisted Molibdenium ditelluride (tMoTe2) close to 3 degrees [1,2]. The moiré creates flat bands in the system, thereby enhancing electronic interactions. Not only that, but in the context of tMoTe2 the moiré also engineers berry curvature, that is at the roots of the apparition of a quantized resistance in the abscence of a magnetic field. I will present how scanning tunneling microscopy/spectrocopy (STM/S) is a good probe that gives access to the the flat bands as well as provides information on the non-trivial character of the bands. I will explain how we perform reliable STM/S measurements on this semiconductor. Our measurements of the energy-dependent polarization of the wavefunctions is well understood only when using a complete modelling of the system that takes into account atomic-scale relaxation effects. It allows us to confirm the role of ferroelectricity and piezoelectricity in the system, that determine the sub-moiré layer pseudospin texture, at the origin of the non-trivial topology of the bands.

References

[1] Joon, H. et al, Observation of fractionally quantized anomalous Hall effect, Nature 622, 74-79 (2023)
[2] Xu, F. et. al., Observation of integer and fractional quantum anomalous Hall states in twisted bilayer MoTe2, Phys. Rev. X 13, 031037 (2023)

Figures

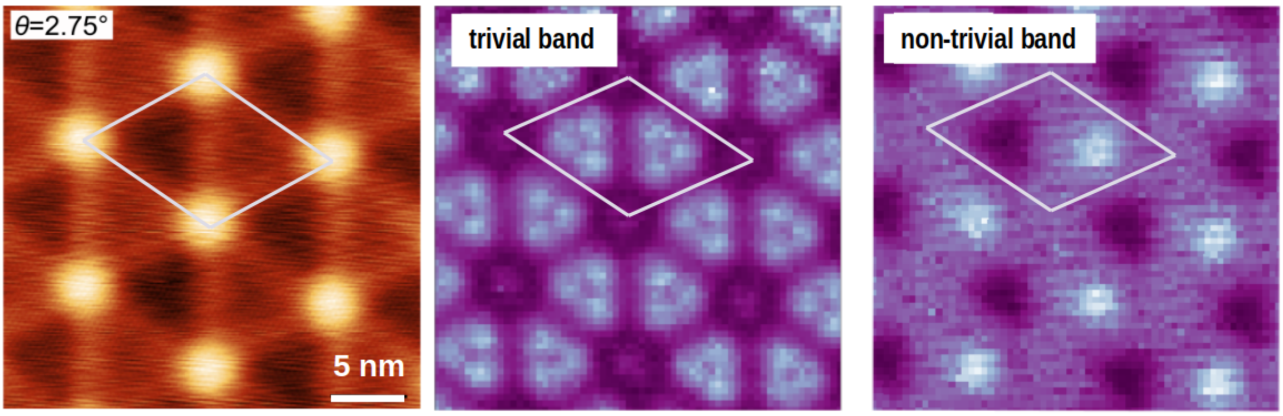

Figure 1: Left : topography of the tMoTe2 moiré. Right : local density of states for two different bands. The moiré period is highlighted in white.