THE PHYSICS COLLOQUIUM

Thursday 16 January 2025, 4:00 p.m.
Nijenborgh 4, Lecture Hall 5111.0080

Probing and controlling collective states of 2D quantum materials

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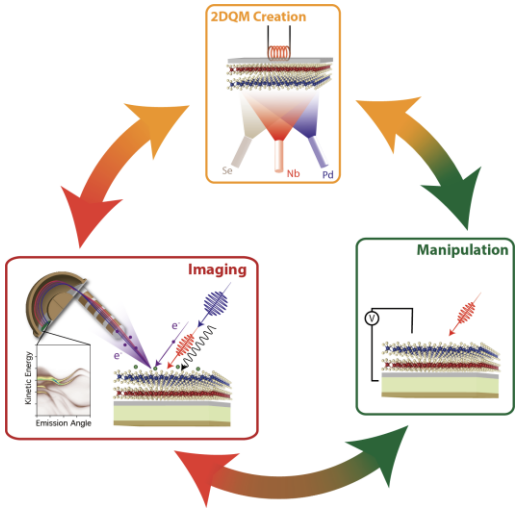
Control over materials thickness down to the single-atom scale has emerged as a powerful tuning parameter for manipulating not only the single-particle band structures of solids, but increasingly also their interacting electronic states and phases. A particularly attractive materials system in which to explore this is the transition-metal dichalcogenides (TMDs), both because of their naturally-layered van der Waals structures and the wide variety of materials properties which they are known to host. Yet, how the intricate correlated motion of the electrons that gives rise to many of these materials properties evolves when the compound is thinned to the single-layer limit remains – in many cases – a controversial question.

Here, I will discuss our work attempting to address this by integrating monolayer materials growth by molecular-beam epitaxy with electronic structure studies via *in situ* angle-resolved photoemission (ARPES) and ARPES-based microscopy. I will introduce a new method for achieving enhanced nucleation in monolayer TMD growth, which leads to a step-change in the quality and uniformity of our fabricated samples [1].



I will discuss the resulting electronic structures that we can observe in these systems, with a particular focus on the controversial charge-density wave phase of monolayer $TiSe_2$ [2-5], and the insights we can obtain from controlling the chemical and electrostatic environment and from ultrafast optical excitation.

This work was performed in close collaboration with A. Rajan, S. Buchberger, T. Antonelli, M.D. Watson, and colleagues from the Universities of St Andrews, Elettra, Keil, Diamond, and SOLEIL.

[1] Rajan *et al.*, Advanced Materials 36, 2402254 (2024).
[2] Watson *et al.*, 2D Materials 8, 015004 (2021)
[3] Antonelli *et al.*, npj Quantum Materials 7, 98 (2022)
[4] Antonelli *et al.*, Nano Lett. 24, 215 (2024)
[5] Buchberger *et al.*, unpublished

Join us for coffee starting 3:30 p.m. Refreshments will be served after the lecture.
For more information contact the host: Antonija Grubisic-Cabo (a.grubisic-cabo@rug.nl)
Website: http://www.rug.nl/research/vsi/colloquia/