

THE PHYSICS COLLOQUIUM

Thursday 18 April 2024, 4:00 p.m.
Nijenborgh 4, Lecture Hall 5111.0080

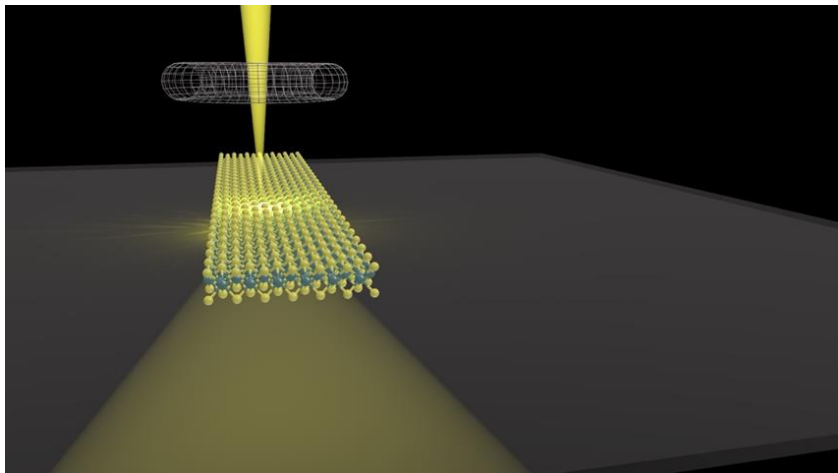
Towards a New Generation of van der Waals Materials for Quantum Technologies

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Engineered van der Waals (vdW) materials hold tremendous promise for revolutionizing condensed matter science and driving innovation in nanoelectronics, nanophotonics, quantum communication and sensing. These materials can be assembled into a variety of homo- and heterostructures, where strain fields, material combination, and twist-angle manipulation generate new crystal lattice periodicities (moiré patterns) that underline phenomena such as unconventional superconductivity.

In this talk, I present recent progress on the fabrication, analysis, and theoretical interpretation of vdW materials in non-trivial configurations beyond the planar ones. For this, we exploit advanced Transmission Electron Microscopy (TEM) and related techniques such as four-dimensional (4D) Scanning Transmission Electron Microscopy



(STEM) and Electron Energy Loss Spectroscopy (EELS) combined with machine learning algorithms. The latter include supervised and unsupervised ML techniques originally developed in high-energy particle physics, and then deployed for TEM data analysis within our open-source codes, EELSfitter. Our strategy enables us to precisely control lattice reconstruction, strain- and defect-engineering, and electrostatic field distributions down to the nanoscale. I highlight representative results obtained this way, such as the onset of modulated bandgaps and exciton localisation in MoS₂ nanotubes, strain-driven bandgap variations in twisted WS₂, and enhanced non-linear optical emission in large scale arrays of Mo/MoS₂ core-shell nanopillars.

Our results illustrate how developing novel material configurations unlocks unique functionalities in vdW homo- and heterostructures, when combined with cutting-edge data processing and interpretation algorithms, paving the way for pioneering new platforms advancing applications from light sources for quantum communication to low-power electronics.

Join us for coffee starting 3:30 p.m. Refreshments will be served after the lecture.

For more information contact the host: Marcos Guimarães (m.h.guimaraes@rug.nl)
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