CENIDE & WIN Seminar Series on 2D-MATURE

DFG IRTG 2803 & NSERC CREATE



Bruno Schuler

Empa
Swiss Federal Laboratories for Materials Science and Technology

"Probing Excitons in 2D Semiconductors at the Atomic Scale"

Date November 26th, 2026
10:00 a.m. ET / 04:00 p.m. CET

Bruno Schuler leads the 2D Quantum Materials Group at the Swiss Federal Laboratories for Materials Science and Technology (Empa). His research focuses on atomic-scale light-matter interactions and ultrafast quantum dynamics in 2D materials, using light-coupled scanning probe microscopy.

He studied Physics at ETH Zurich and received his PhD from the University of Regensburg after conducting his doctoral research at IBM Research Zurich. His work has been recognized with the Swiss Physical Society Award in Applied Physics, two IBM Research Division Awards, and an ERC Starting Grant.

Two-dimensional (2D) semiconductors like monolayer transition metal dichalcogenides (TMDs) provide an exciting platform for strong and tunable light-matter interactions. This talk explores the intriguing atomic-scale photophysics of TMDs probed by scanning tunneling luminescence (STML), photocurrent spectroscopy (pc-STM), and their ultrafast analogues using time-resolved THz-STM.

Using ultrathin hBN decoupling layers, we demonstrate electrically driven luminescence from pristine regions alongside localized band-to-defect recombination at single charged impurities. Furthermore, we show exciton-assisted tunneling that manifests as an additional transport resonance, independent of the laser excitation wavelength. In the second part, I will present our recent advances in time-resolved THz-STM [2,3] enabling the investigation of exciton dynamics with atomic spatial, millielectronvolt energy, and picosecond temporal resolution. [4].

By combining the structural and electronic properties accessible by conventional scanning probe microscopy with the optical fingerprint from STML and the excited-state dynamics revealed through pump-probe THz-STM, we gain a comprehensive microscopic understanding of localized quantum states in low-dimensional materials.

References:

[1] L. Huberich et al. Nature Nanotechnol. (in press) (2026)
[2] L. Bobzien et al. APL Mater. 12, 051110 (2024)
[3] J. Allerbeck et al. Nat. Commun. 16, 10806 (2025)
[4] L. Bobzien et al. (in preparation)