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Progress in TEM-EELS of low-D materials combining high energy and momentum resolution

Professor Thomas Pichler

Electronic properties of Materials, Faculty of Physics, University of Vienna

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Venue: Faculty of Engineering Bldg. 2, Room 31A

Abstract:

A major mission of condensed-matter physics is to understand material properties via the knowledge of the energy vs. momentum (q) dispersion and lifetime of fundamental excitations. Recent developments of EELS in TEM with a combined high energy & q-resolution is a perfect tool to determine them. This opens the so-far unexplored possibility to investigate dispersion and lifetime of phonons, plasmons & excitons in nanomaterials including molecules, 1D & 2D materials and heterostructures with few nm of lateral resolution on samples as thin as an atomic monolayer. In this presentation I give an overview on our recent progress in analysing fundamental excitations such as phonons, excitons, and plasmons in 2D materials such as graphene, h-BN and transition metal dichalcegonides (TMDC) using EELS with complementary high energy and momentum resolution in comparison to previous results. I will show how we can understand the full phonon dispersion of an apolar material like graphene [1] and use the ultrahigh momentum resolution to make the link to surface phonon polaritons close to the optical limits in h-BN. For graphene we also show new results on the plasmon dispersion including the gap opening close to the optical limit unravelling the Dirac cone in the excitation spectrum [2]. For monolayer TMDC using ultra high q resolution we determined the exciton dispersion and deciphered the intense postgap absorptions and disentangling plasmon from excitons from their different momentum dependence [3-5].

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References

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[2] A. Guandalini, R. Senga, Y.C. Lin, K. Suenaga, A. Ferretti, D. Varsano, A. Recchia, P. Barone, F. Mauri, T. Pichler, C. Kramberger, *Nanoletters* **23**, 11835 (2023)

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主催: 東京大学大学院工学系研究科専攻間横断型教育プログラム 機械システム・イノベーション（GMSI）
未来社会協創国際卓越大学院（WINGS CFS）
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本件連絡先: 東京大学大学院工学系研究科機械工学専攻 教授 丸山 茂夫
GMSI事務局 E-mail: office@gmsi.t.u-tokyo.ac.jp Phone: 03-5841-0696