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Seminar

Quantitative phase imaging of 2D and 3D materials through ptychography

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Abstract

The use of fast pixelated detectors optimized for four-dimensional scanning transmission electron microscopy (4D-STEM) experiments has revolutionized the type and amount of data that can nowadays be acquired at an electron microscope. In combination with the development of new computational hardware and reconstruction algorithms, microscopy techniques, such as ptychography, are about to replace conventional STEM imaging methods due to their superior image resolution of electron radiation-sensitive materials [1,2]. Ptychography in particular has already become a mature electron microscopy technique and has experienced immense advances in the last years [3-5]. The current research to further improve this technique is driven by the desire to investigate thick samples as well as to measure with a low electron dose.

Here, we will discuss the advances in ptychography during the last couple of years. We will examine the measures that have been taken to generate high resolution 3D images of thicker samples. We will discuss possible improvements of the conditioning of the 3D reconstruction problem in order to extent the depth resolution and we will compare the results to those of other STEM techniques. Finally, we will outline future research directions and unresolved problems for ptychography.

[1] Jiang, Yi, et al. ”Electron ptychography of 2D materials to deep sub-ångström resolution.” Nature 559.7714 (2018): 343-349.

[2] Chen, Zhen, et al. ”Electron ptychography achieves atomic-resolution limits set by lattice vibrations.” Science 372.6544 (2021): 826-831.

[3] Wakonig, Klaus, et al. ”PtychoShelves, a versatile high-level framework for high-performance analysis of ptychographic data.” Journal of applied crystallography 53.2 (2020): 574-586.

[4] Schloz, Marcel, et al. ”Overcoming information reduced data and experimentally uncertain parameters in ptychography with regularized optimization.” Optics Express 28.19 (2020): 28306-28323.

[5] Pelz, Philipp M., et al. ”Solving Complex Nanostructures With Ptychographic Atomic Electron Tomography.” arXiv preprint arXiv:2206.08958 (2022).

The Presenter

Marcel Schloz is a final-year PhD student in the group of Prof. Christoph Koch at Humboldt-Universität zu Berlin.