MONASH University

Monash Centre for Electron Microscopy

Monash Centre for Electron Microscopy Seminar

Quantitative off-axis electron holography of two-dimensional transition metal dichalcogenides and magnetic skyrmions

MONDAY 4 DECEMBER, 2017

9.00AM

Lecture Theatre S10
16 Rainforest Walk (Bldg 25)
Monash University, Clayton

Presenter

Rafal Dunin-Borkowski

Peter Gruenberg Institute, Research Centre, Juelich

Abstract

Off-axis electron holography is a powerful technique for recording the phase shift of a high-energy electron wave that has passed through an electron-transparent specimen in the transmission electron microscope. The phase shift is, in turn, sensitive to the electrostatic potential and magnetic induction in the specimen, projected in the electron beam direction. We are currently working on several model-based approaches that can be used to provide quantitative interpretations of phase images recorded using off-axis electron holography.

I will first show how iterative fitting of specimen thickness, specimen tilt, absorption, image spread and electron optical aberrations can be performed by comparing experimental high-resolution phase and amplitude images of two-dimensional WSe2 with simulations on an absolute scale. The simulations are based on scattering potentials derived from density functional theory and include bonding effects, which are found to be necessary to achieve quantitative agreement. By removing residual aberrations from the experimental phase and amplitude images and comparing them with simulations, a quantitative description of the atomic structure of the material, including the detection of changes in electrostatic potential associated with individual structural defects and dopant atoms, becomes possible.

I will then describe a model-based approach to magnetic vector field tomography, which involves using an iterative reconstruction algorithm to recover the three-dimensional magnetization distribution in a specimen from a series of magnetic phase images recorded using off-axis electron holography as a function of sample tilt angle. The initially ill-posed problem is replaced by a least-squares minimization problem. First order Tikhonov regularization is applied and a mask is used to localize magnetized objects. All measures are combined into a cost function, whose minimization is facilitated by conjugate gradient methods. Sources of magnetization outside the field of view are accounted for by introducing buffer pixels and a confidence array is used to exclude other identifiable artefacts from the reconstruction. Encouraging experimental results have been obtained from studies of magnetic skyrmions *

About the Presenter

Rafal Dunin-Borkowski is Director of the Institute for Microstructure Research and the Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons in Forschungszentrum Jülich. Between 2007 and 2010, he led the establishment of the Center for Electron Nanoscopy in the Technical University of Denmark. From 2000 to 2006 he held a Royal Society University Research Fellowship in the University of Cambridge. He specializes in advanced transmission electron microscopy. In 2009 he was awarded the Ernst Ruska Prize of the German Society for Electron Microscopy. In 2012 he was awarded an Advanced Grant by the European Research Council.

* The research leading to these results has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013)/ ERC grant agreement number 320832. We are grateful to Z.-A. Li, M. Riese, M. Farle, N. Kiselev and S. Blügel for ongoing cooperations and contributions to this work.

Convenor: Professor Joanne Etheridge
Email: mcem@monash.edu
Tel: 9905 5563

Visitors are most welcome. Please not that there are designated visitor car parks and tickets, at a cost of $2.00 per hour or $10.00 all day are available from parking meters. Payment is by coin, credit card, or phone app. Further details can be found at the following links: http://www.monash.edu/people/transport-parking/permits/metered-free and http://www.monash.edu/__data/assets/pdf_file/0010/71686/16P-0006-T2-Clayton-map_final.pdf