Electron holography, tomography

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Magnetic fields impose a phase shift on beam electrons traversing a magnetic material. Phase contrast techniques and holography in the TEM can reveal that so-called Aharonov-Bohm phase with nanometer resolution, providing insight into the magnetism of the material. This lecture will introduce electron holography from fundamentals to applications. We discuss the most prominent holographic setups and their pertinent reconstruction principles – namely focal series holography, transport of intensity holography and off-axis holography. Finally, we combine holography and tomography to reconstruct the 3D distribution of electric and magnetic fields and show which magnetic properties can be derived from these.

Lecture topics:

1. Fundamentals of electron scattering
    a. Axial scattering
    b. Magnetic and electric Ehrenberg–Siday–Aharonov–Bohm effect
2. Fundamentals of Electron Holography and Tomography
    a. Holographic Principle (interference, reconstruction)
    b. Holographic Setups (inline, off-axis) and instrumental requirements (coherence, focus calibration, biprism)
    c. Separation of electrostatic and magnetic contributions
    d. Tomographic reconstruction of 3D electric potential and magnetic induction vector field from tilt series of projections
3. Magnetic fields and textures in solids
    a. Magnetization, Magnetic induction, Magnetic field
    b. Magnetostatics
    c. Micromagnetics
    d. Vortices, Skyrmions and more

Recommended reading:

1. H Lichte et al., Electron holography for fields in solids: Problems and progress, Ultramicroscopy 134, 126-134.
2. Introduction to Electron Holography (Ed. E. Völkl, L.F. Allard, D.C. Joy,), Plenum Press (1999).