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## **Fundamentals of cryo-EM image processing**

This lecture covers the fundamental principles underlying electron cryo-microscopy (cryo-EM), starting with an introduction to Fourier transforms and the principles of image formation. Fourier transforms are a fundamental mathematical tool for the analysis of periodic signals in which arbitrary functions are expanded into a combination of simple waves. We will introduce the basic principles of Fourier transforms and reciprocal space, discuss their properties and illustrate their use in diffraction experiments and cryo-EM image processing. We will address sampling and Nyquist limit, treat the convolution theorem and its relationship to correlation and look at fundamental filtering operations. We further explore the process of image formation in the electron microscope, starting at the interaction of electrons with matter and different forms of image contrast, the effect of electromagnetic lenses, contrast transfer function (CTF) and defocus, and briefly introduce the central-section (or projection-slice) theorem.

Selection of recommended reading:

1. Harburn, G., Taylor, C. A. & Welberry, T. R. *Atlas of Optical Transforms*. (Bell Publishing, 1975).
2. Stewart, M. Introduction to the computer image processing of electron micrographs of two-dimensionally ordered biological structures. *J. Elec. Microsc. Tech.* **9**, 301–324 (1988).
3. Glaeser, R. M., Downing, K. H., DeRosier, D., Chiu, W. & Frank, J. *Electron Crystallography of Biological Macromolecules*. (Oxford University Press, 2007).
4. Steward, E. G. *Fourier Optics: An Introduction*. (Halsted Press, 2004)