MSE 675  
Advanced Structural Analysis by Scattering


Synopsis:

The purpose of this course is to introduce graduate students in materials science, physics, chemistry and biochemistry to modern methods of structural characterization using x-rays and neutrons. In the last two decades synchrotron based radiation sources (synchrotron radiation sources and spallation neutron sources) have revolutionized the scattering methods to characterize static and dynamic atomic structure in solids and liquids, including surfaces. Starting from the basics, this course covers theories and practices necessary to carry out and utilize these advanced techniques.

Outline:

1. Introduction  
   Bragg’s law, reciprocal space, diffraction vector.
2. Tools of analysis  
   2.1 X-ray diffraction  
      Generation of x-rays, detection of x-rays, interaction of x-rays with matter  
   2.2 Neutron scattering  
      Generation of neutrons, detection of neutrons, interaction of neutrons with matter
3. Introduction to diffraction theory  
   Wave interference, structure factor
4. Small angle scattering  
   Theory and practice
5. Crystallographic analysis  
   Powder and single crystal analysis
6. Local structure by pair-density function (PDF) analysis  
   Fourier-transform of structure function
7. Inelastic scattering of neutrons and x-rays  
   Dynamic structure factor, methods of inelastic scattering experiment
8. Dynamical theory of scattering  
   Coherent multiple scattering, Laue and Bormann effect, total scattering
9. Surface scattering  
   Truncation rod, thin films
10. X-ray absorption spectroscopy  
    XANES and EXAFS
11. Anomalous x-ray scattering  
    Combining spectroscopy and scattering