

Physics 594 and MSE 576 X-ray and Neutron Scattering

Logistics

Instructor: Dr. Michael Fitzsimmons

Office: South College, Room 209

Telephone: 505 901 0534

Email: mfitzsi1@utk.edu

Lecture time and location: T-R, 11:10-12:25, Nielsen 512

Office Hours: Immediately after class or by appointment

Target Audience

The course is designed for upper division undergraduate and graduate science and engineering students. Lectures will provide students with a theoretical understanding of x-ray and neutron scattering. In addition, students will receive a hands-on practical education using the department's x-ray machine and one field trip to the High Flux Isotope Reactor (HFIR) neutron source at Oak Ridge National Lab.

Prerequisites: None

Expected previous knowledge: A working knowledge of geometry, trigonometry, differentiation, integration and complex arithmetic is expected.

Course objectives:

At the conclusion of the course students should be able to:

Understand the production and use of x-rays and neutrons to probe structure.

Be able to describe different scattering tools, to know the strengths and weaknesses of the tools, and to choose the right tool for a problem.

Demonstrate the ability to collect and interpret x-ray and neutron scattering and spectroscopy data.

Textbook:

X-ray Diffraction by B.E. Warren (1990) (available as an e-book).

Minimal material covered:

Properties of neutrons and x-rays and sources to produce neutron and x-ray beams.

Kinematical diffraction (Born Approximation) theory: Correlation functions, Fourier transforms, neutron and x-ray cross-sections.

Crystals, the reciprocal lattice, point and space groups

Applications of diffraction: Coherence, obtaining crystal structures from powder and single crystal diffraction data, properties of “real” crystals including thermal and static diffuse scattering, finite size effects, and defects.

Beyond diffraction: Scattering from nanostructures, assemblies of nanostructures (mesoscale), non-crystalline materials (amorphous matter and liquids), thin films and interfaces, concepts of refraction, reflection and dynamical scattering.

Applications of x-ray and neutron spectroscopies, including absorption probes (x-rays) and inelastic scattering (primarily neutrons).

X-ray and neutron scattering from magnetic materials, polarized beams.

How to write an effective x-ray or neutron scattering proposal.

Contacting the Instructor

I encourage students to approach me during office hours, or schedule an appointment.

Grading

Homework 40%

Midterm + Final 40%

Presentation 20% (Students will discuss scientific papers describing an application of x-ray or neutron scattering. Depending upon class size, the expectation is that each student will discuss, or lead a discussion of a publication for ~10 minutes.)

For students with disabilities

Any student who feels s/he may need an accommodation based on the impact of a disability should contact me privately to discuss specific needs. I will then contact the Office of Disability Services to coordinate reasonable accommodations for students with document disabilities.