22.51 Interactions of Radiation with Matter

Fall 2001, WF9:30-11 (24-115)

Basic principles of interaction of electromagnetic radiation, thermal neutrons, and charged particles with matter. Introduces classical electrodynamics, quantum theory of radiation, time-dependent perturbation theory, transition probabilities and cross sections describing interaction of various radiations with atomic systems. Applications include theory of nuclear magnetic resonance; Rayleigh, Raman, and Compton scattering; photoelectric effect; and use of thermal neutron scattering as a tool in condensed matter research.

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Weekly problem set: 40%
Three closed-book exams, each 20%

Book:
Sow-Hsin Chen, Michael Kotlarchyk, *Interaction of Photons and Neutrons with Matter: An Introduction*, World Scientific Publishing, 1997. ISBN: 981022026X.

You don't need other books to solve problems, but you must read *this* book very very thoroughly and understand every sentence, and can reproduce the derivations!

Problem sets and solutions will be dispensed on class, and will also be available at *http://web.mit.edu/22.51/www/*

Ju Li's office hour: 24-212A, after each lecture.

Hongyu Jiang's office hour: NW14-2222, Friday 3-5.

22.51 Tentative Schedule

Wed, Sept. 5	2. Classical Mechanics	Ps1 out
Mon, Sept. 10	3.1 Dirac Formulation	
Wed, Sept. 12	3.2 Quantum Postulates	Ps1 in, Ps 2 out
Fri, Sept. 14		**No classes**
Wed, Sept. 19	3.3 Schrodinger Equation 3.4 Position-space Representation	Ps 2 in, ps 3 out
Fri, Sept. 21	3.5 Momentum-space Representation 3.6.1 Angular Momentum Operator	
Wed, Sept. 26	3.6.2 Quantization of Angular Momentum	Ps3 in, ps 4 out
Fri, Sept. 28	3.6.3 Spherical Harmonics	
Wed, Oct. 3	4.1 Maxwell's Equations	Ps 4 in, Ps5 out
Fri, Oct. 5	4.2 Electromagnetic Potentials	
Wed, Oct. 10		Exam 1
Fri, Oct. 12	4.3 Field due to Polarization	Ps 5 in, ps 6 out
Wed, Oct. 17	4.4 Light Scattering	
Fri, Oct. 19	5.1 Canonical Radiation Field 5.2 Quantization of Radiation	Ps 6 in, ps 7 out
Wed, Oct. 24	6.1 Interaction Picture 6.2 Time-evolution Expansion	
Fri, Oct. 26	6.3 Fermi's Golden Rule	Ps7 in, ps8 out
Wed, Oct. 31	6.4 Double-differential Cross-sections	
Fri, Nov. 2	7.1 Mixed States & Density Operator	Ps 8 in, ps 9 out
Wed, Nov. 7	8.1 Photon Emission & Absorption	
Fri, Nov. 9	8.2 Origin of Linewidth	
Wed, Nov. 14		Exam 2
Fri, Nov. 16	8.3 Photoelectric Effect 9.1.1 Classical Electron-phonon Scattering	Ps 9 in, ps 10 out
Wed, Nov. 21	9.1.2 Quantum Electron-phonon Scattering	Ps 10 in, ps 11 out; Drop Date
Fri, Nov. 23		**No classes**
Wed, Nov. 28	9.2.1 X-ray scattering 9.2.2 Light scattering	
Fri, Nov. 30	12.1 Dynamic Structure Factors	Ps 11 in, ps 12 out
Wed, Dec. 5	12.2 Inelastic Neutron Scattering	
Fri, Dec. 7	12.3 General Properties of Dynamic Structure Factor	Ps 12 in
Wed, Dec. 12		Exam 3