Angular Momentum Theory and Applications in Chemistry and Physics

Fall A 2017

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No set office hours, but I will be happy to answer questions whenever they arise.

Meeting times: Tuesday, Wednesday, Friday 2:55-4:00 pm, in HEB 2002

Text: Angular Momentum: Understanding Spatial Aspects in Chemistry and Physics,
by Richard N. Zare.

This little book is a gem, providing all the details you need to know about angular momentum in a much more readable format than its predecessors. You can study this book for a long time, and still find new things that you can learn. If you buy any text to supplement my lectures, this should be it.

Angular momentum is the basis for selection rules in spectroscopy, and the angular momentum operators are intimately related to rotations and rotational transformations of coordinate systems. This text provides a concise description of the theory of angular momentum and rotation operators, and their use in chemistry and physics. It is strongly recommended for those interested in pursuing theory, spectroscopy (both gas-phase and condensed-phase spectroscopy, including NMR), and chemical dynamics.

Recommended Texts:

1. Spectra of Atoms and Molecules, by P. F. Bernath (a copy has been requested to be placed on reserve in Marriott Library)
   A good introduction to spectroscopy, which everyone who took Chemistry 7020 or 7030 should already have. This will be used as a background text, but will not be frequently referenced in the course.

2. Molecular Symmetry and Group Theory, by Alan Vincent (a copy has been requested to be placed on reserve in Marriott Library)
   For those of you who do not fully remember your group theory, this is an excellent little book to help you re-learn the mechanics of how to use point group theory. It does not cover the underlying mathematical theory at all. An excellent textbook on the application of group theory to chemistry is by F. A. Cotton, Chemical Applications of Group Theory (a copy has been requested to be placed on reserve in Marriott Library). This does cover some of the underlying mathematical foundations of group theory.

3. Hélène Lefebvre-Brion and Robert W. Field, The Spectra and Dynamics of Diatomic Molecules, (Elsevier Academic Press, Amsterdam, 2004). (a copy has been requested to be placed on reserve in Marriott Library)

   I will also make copies of my lecture notes available, and these will probably be the most useful reference material.

Topics: Angular Momentum Operators and Eigenfunctions (Spherical Harmonics)
   Coupling of Two Angular Momenta (Clebsch-Gordan coefficients and 3-j symbols)
   Point group theory for finite groups and for the sphere. Wigner rotation matrices.
   Interaction of radiation with matter; electric dipole transitions; magnetic dipole transitions
   The Hamiltonian of a diatomic molecule: Hund’s coupling cases; spin-orbit interaction
   Electronic spectroscopy of diatomic molecules
   Irreducible spherical tensors and the Wigner-Eckardt theorem
   Multiphoton Processes
   The Quantum Theory of Radiation

Grading: Grading will be on the basis of assigned problem sets. There will be no exams in this course.