CHEM 550: Special topics in chemical physics

(Focus on: magnetic resonance spectroscopy)

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Office Hours Tu 1-2 pm; LJS 152

Lecture MWF 9:00 – 9:50 am; GFS 202

Course Description

Magnetic resonance such as nuclear magnetic resonance (NMR) and electron spin resonance (ESR) can probe the local structure and dynamic properties of various compounds in liquids and solids, making them the most powerful and versatile analytical methods available today. This special topic course will cover principles of magnetic resonance, simulation of ESR spectra of paramagnetic species, spin dynamics in solid and liquid. Various magnetic resonance techniques will be presented: coherent manipulation of spin quantum bits, pulsed ESR to study structure of macrobiological molecule and the next-generation high-field ESR techniques.

Course Outline

1. Introduction
    - An overview: electromagnetic radiation and spectroscopy in general
    - Spin states in atoms and molecules
    - From NMR to ESR
2. Angular momentum, spin properties and magnetic resonance
    - Zeeman energy, Landé g-factor and two-level system
    - Transition probability and spin relaxations
    - Bloch equation, ESR lineshape and saturation
3. Spin interaction and ESR spectra
    - Hyperfine coupling
    - Hydrogen atoms and ESR spectrum
    - Dipole interaction
    - Singlet-triplet mixing and forbidden transitions
    - ESR in crystal, powder and solution
4. Pulsed magnetic resonance
    - Free-induction decay
    - Spin echo
    - Advanced pulse techniques
5. Topics of current interests in physics and biochemistry
    - Quantum computing using electron spins
    - Decoherence
    - ESR spectroscopy to probe macro-biological molecules
    - High-frequency/field ESR spectroscopy and THz technology
    - Demonstration of ESR spectroscopy

Textbook No required textbook

The following reference books are useful.

1. Abragram, The Principles of Nuclear Magnetism
2. Abragram and Bleaney, Electron Paramagnetic Resonance of Transition Ions
3. Atherton, Electron Spin Resonance, Theory and Applications
4. Atkins and Friedman, Molecular Quantum Mechanics
5. Schweiger and Jeschke, Principles of pulse electron paramagnetic resonance
6. Slichter, Principles of magnetic Resonance

Website **http://singlespin.usc.edu/teaching/2012-chem550/index.html**

Homework Bi-weekly

Grade Homework: 40%, midterm: 20%, final project: 40 %

Academic Integrity: USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *SCampus*, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: http://www.usc.edu/scampus/. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The review process can be found at: http://www.usc.edu/student-affairs/SJACS/.

Holidays (No class)

Martin Luther King's Birthday: January 16
Presidents' Day: February 20
Spring Recess: March 12-17