Electron Spin Resonance

University of Chicago, July 14–16, 2017

(This is ONE of the THREE experiments that each participant is to perform.)

Mentor

Van Bistrow (B.A., 1966, University of Wisconsin; M.A.T. 1973, M.S. in Physics, 1974, University of Chicago) is Director of Instructional Laboratories at the University of Chicago. He teaches, develops lab exercises, writes lab manuals, trains TAs and is a member of the Physics Department's Teaching Activities Committee. With the American Association of Physics Teachers, he has led workshops on Advanced and Intermediate Instructional Labs, served on and was spokesman for the AAPT Advanced Labs Task Force, and helped with the design of AAPT's Advanced Labs website. He was co-organizer and presenter at the Conference on Instructional Labs "Beyond the First Year" at the University of Michigan, Ann Arbor. He is a member of the Advanced Labs Physics Association, ALPhA, co-presenting an ALPhA Immersion on Single-Photon Interference at the University of Chicago. In 2016, Van was presented with the Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction by the American Physical Society.

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We will study how a classical “particle” having magnetic dipole moment and angular momentum responds to an external magnetic field. We will relate these findings to quantum mechanical properties of electrons. We will study energy and angular momentum transfer from rotating fields to the particle. Use of a classical analog helps the student develop a model to better understand the quantum mechanical electron spin resonance.

The apparatus: Teachspin Magnetic Torque apparatus, Daedelon Electron Spin apparatus, and digital oscilloscope. (Click on photo for a higher resolution view.)

Skills that will be acquired include: measuring spin frequency using a strobe light; use of a digital oscilloscope for careful measurements of resonance conditions; building a classical theoretical model and applying it to a quantum system.

This experiment will be performed on one day of the three-day immersion. In the classical system measurements will be made of the magnetic dipole moment and angular momentum of a ball riding on an air bearing. The relation among magnetic moment, angular momentum, magnetic field and precession frequency will be determined. This relation will be used to understand similar relations for electron spin resonance.

Participants should bring a lab notebook. A laptop computer would be useful but is not required.

Safety considerations: none.

The cost to implement the experiment is roughly $6000.

Please note that the Jonathan F. Reichert Foundation has established a grant program (ALPhA webpage; Foundation website) to help purchase apparatus used in Laboratory Immersions. Limitations and exlusions apply, but generally speaking the foundation may support up to 40% of the cost of the required equipment.
