Exp. P- 2 Electron Spin Resonance

References:

- You may start by reading the short section in Halliday, Resnick, Walker "Fundamentals of Physics" on Magnetic Resonance, which introduces the closely related Nuclear Magnetic Resonance (NMR or MRI) effect
- http://en.wikipedia.org/wiki/Electron_spin_resonance
- http://hyperphysics.phy-astr.gsu.edu/hbase/molecule/esr.html
- Melissinos, "Experiments in Modern Physics", 2nd ed., Ch. 6 &7 (in particular sections 7.4 & 7.5). Note, however, that the details of the experimental ESR apparatus in our lab are different from the one described in 7.5.
- Lab manual on Electron Spin Resonance (ESR) and instruction sheet on ESR basic unit and ESR adapter by Leybold-Heraeus Co. (equipment manufacturer)

Objective:

To determine g_S, the gyromagnetic ratio of spin and magnetic dipole moment for the electron.

Equipment:

Leybold ESR base unit, ESR adapter, DC and AC power supplies (+12 V DC, -12V DC, and 0-40 V AC, 2A), Helmholtz coils, passive resonance absorption circuit, dual-channel oscilloscope, digital multimeter (microammeter), DPPH sample vile.

CAUTION:

Make sure you understand exactly how to properly set up the 2-channel power supply to provide the two +12V and -12V voltages to the ESR adapter. If you are not 100% sure, please first consult with your instructor BEFORE turning on the power. Note that each of the two sets of +/- terminal on the power supply provides ONE potential difference. You need to provide TWO such pot. differences (0 to +12V and 0 to -12V) and you need to make sure that they use the same COMMON reference ("0").

Basic Instructions:

1. Read the reference and set up the electron spin resonance as shown in Fig. 2.1.1 of Exp. 2.1. Observe resonance absorption from a high-frequency oscillator using the passive resonance circuit box. Monitor the high-frequency voltage signal received by the passive resonance circuit box with a scope. At the same time monitor the current in the transmitter with the DVM set in microammeter mode and the transmitter frequency/1000. Check with a scope that the frequency meter is correctly measuring the f/1000 output. Then measure voltage amplitude at the receiver as a function of frequency, i.e. a resonance curve. This is intended to check out your set-up before the determination of the electron's g-factor. Plot voltage vs. frequency to obtain a resonance curve.

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2. Set up the apparatus as shown in Exp. 2.2 of the reference. Be sure an AC power supply is used for the Helmholtz coils and that the field in the two coils points in the same direction. Follow the instructions given in the reference and observe the electron spin resonance of Diphenyl-picryl-hydrazine (DPPH) on the oscilloscope. Record the magnetic fields for various resonance frequencies and determine g_S from those data. It is recommended to calculate g_S from the first few measurement you are taking to see if your value is in the right ballpark before taking larger data sets for a precision measurement,

<u>Notes:</u>

1. The value for μ_0 in some of the Leybold notes is wrong! It is $\mu_0 = 1.\mathbf{2}56\ 10^{-6}$ Vs/Am (not $1.\underline{3}56\ 10^{-6}$ Vs/Am).

2. With current flowing continuously through the “1 Ohm” resistor, it heats up over time, which can change its resistance. Measure the resistance directly while you are performing your measurements and correct your data for any deviations from 1.00 Ω.

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