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://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, two dual-channel oscilloscopes, digital multimeter (microammeter), DPPH sample vile.

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 the resonance absorption from a high frequency oscillator using the passive resonance circuit box. Monitor the high frequency 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 with another scope. Simultaneously measure voltage amplitude for the receiver and current for the transmitter 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.

2. Set up the apparatus as shown in Exp. 2.2 of the reference. Substitute a scope for the frequency counter. Be sure an AC power supply is used for the Helmholtz coils. 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 the data. It is recommended to calculate \( g_s \) from the first few measurements you are taking to see if your value is in the right ballpark before taking larger data sets for a precision measurement.

Note: The value for \( \mu_0 \) in the Leybold notes is wrong! It is \( \mu_0 = 1.256 \times 10^{-6} \text{ Vs/Am} \) (not \( 1.356 \times 10^{-6} \text{ Vs/Am} \)).

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