Melissinos Experiments In Modern Physics Pdf Download

Pulsed Nuclear Magnetic Resonance

Experiment NMR

University of Florida — Department of Physics
PHY4803L — Advanced Physics Laboratory

References

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Introduction

To observe nuclear magnetic resonance, the sample nuclei are first aligned in a strong magnetic field. In this experiment, you will learn the techniques used in a pulsed nuclear magnetic resonance apparatus (a) to perturb the nuclei out of alignment with the field and (b) to measure the small return signal as the misaligned nuclei precess in the field.

Because the return signal carries information about the nuclear environment, the technique has become widely used for material analysis. Initially, you will study the behavior of hydrogen nuclei in glycerin because the signal is easy to find and interpret. Samples involving other nuclei and other nuclear environments can also be investigated.

Theory

Recall that the hydrogen nucleus consists of a single proton and no neutrons. The precession of a bare proton in a magnetic field is a simple consequence of the proton's intrinsic angular momentum and associated magnetic dipole moment. A classical analog would be a gyroscope having a bar magnet along its rotational axis. Having a magnetic moment, the proton experiences a torque in a static magnetic field. Having angular momentum, it responds to the torque by precessing about the field direction. This behavior is called *Larmor precession*.

The model of a proton as a spinning positive charge predicts a proton magnetic dipole moment $\boldsymbol{\mu}$ that is aligned with and proportional to its spin angular momentum $\mathbf{s}$

$$\boldsymbol{\mu} = \gamma \mathbf{s} \tag{1}$$

where γ, called the gyromagnetic ratio, would depend on how the mass and charge is distributed within the proton. Determined by various magnetic resonance experiments to better than 1 ppm, to four figures $\gamma = 2.675 \times 10^8$ rad/(sec tesla).

Note that different nuclei will have different spin angular momentum, different magnetic moments, and different gyromagnetic ratios. The gyromagnetic ratio given above is only for the hydrogen nucleus. In NMR, the word proton generally only refers to the nucleus of the