Z8 - Pulsed Nuclear Magnetic Resonance (NMR) Spectrometer. Fourier Spectroscopy and Relaxometry

Physics Laboratory II
Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University

The goal of exercise is exploring pulse methods of NMR:

- Pulsed detection technique of NMR signals in time domain
- Relaxation time measurement technique
- Fourier analysis of signals

The exercise covers maintenance of PS15 spectrometer, free induction detection (FID) registration in and off the resonance, Fourier analysis of signals and measurement spin–spin and spin–net relaxation times.

Preparatory questions

- Basics of NMR – classical and quantum description [1]
- Pulsed method of NMR [1]
- Relaxation of nuclear magnetization, free induction detection, spin echo [1]
- Measurement of spin–net and spin–spin relaxation times [1]
- Fourier analysis for performing NMR spectra [1]

It is necessary to know [1]:

- To describe a motion of nuclear spin in a constant magnetic field, to describe a motion of ensemble of spins (magnetization), adding a weak varying magnetic field, to describe magnetization in a constant and weak varying magnetic field, transfer to rotating frame
- To describe relaxation for both component of magnetization (Bloch equation)
- To describe the pulse method of NMR, FID and spin echo and to explain the role of π and $\pi/2$ pulses
- To compare orders of magnitude of constant varying and earth magnetic fields

Computational assignments

Calculate magnetic nuclear resonance of hydrogen, deuterium and helium in a field of induction 2T

Apparatus and materials

The set-up (Fig. 1) consists of:

- Pulse spectrometer (3)of NMR PS15 with controller (2)
- PC with software (1)

Experiment

1. Principle of operation and maintenance of PS15 spectrometer
2. Detecting FID
3. Fourier analysis
4. Relaxation times measurements (spin-net, spin-spin)

Data analysis

- To show the FID signals and their Fourier transforms
- To calculate relaxation times
- To compare the relaxation times measured by different pulse methods

References

[1] J.P.Hornak, The Basics of NMR

Figure 1: Experimental set-up