

Workshop 5 - Questions

1. Consider the problem of extracting T_1 times from inversion-recovery data described by:

$$\mu(t) = \mu_{\text{eq}} \left(1 - 2 \exp \left[-\frac{t}{T_1} \right] \right)$$

where μ_{eq} is a known quantity. Transform this equation into a form suitable for obtaining a linear plot and specify the quantities to be used for X and Y axes.

2. If the first pulse in an inversion recovery experiment is $180^\circ - \varepsilon$ instead of 180° , derive the expression for the modified signal $\mu(t)$ and explain how the curve shifts relative to the ideal case. What modifications may be necessary in the fitting procedure to account for the possible imperfections in the 180° pulse?
3. The ^1H NMR spectrum of ethanol contains three distinct signals, with the following spin-lattice relaxation times: CH_3 : 5 s, CH_2 : 4 s, OH : 0.5 s. The sample is inserted into the NMR magnet and allowed to equilibrate. Then, two consecutive spectra are acquired, each with a 90-degree pulse, with a delay of 3 s between them. CH_3 and CH_2 signals appear diminished in the second spectrum.
- Explain why signal intensities are different in the second spectrum.
 - For each of the signals, determine by what factor it is reduced in the second spectrum.
 - How long would the delay have to be to ensure that no signal loses more than 10% of the amplitude in the second spectrum?
4. Starting from Bloch equations with relaxation, obtain the equation of motion for the complex magnetisation $\mu_+(t) = \mu_x(t) + i\mu_y(t)$.
5. The phenomenon of auto-decoupling occurs when a spin randomly reorients much faster than the rate of its particular interaction, leading to the effective disappearance of the interaction from the Hamiltonian. If the interaction amplitude is J Hz, estimate the T_1 time below which the spin would effectively decouple its partners from that interaction.