

January 15, 2015

Modern Techniques in Biophysics

Topic: Nuclear magnetic resonance

Exercise 1: Chemical shift

A reference sample containing certain nuclei was placed in a 9.4 T magnet and was found to resonate at 400 MHz. An unknown sample containing the same type of nuclei displays a resonance that is +20,000 Hz relative to the reference sample.

- (i) What is the nucleus being investigated? Explain.
- (ii) Draw a simple diagram containing the locations of the NMR signals from the two samples. Calculate the chemical shift of the unknown sample in ppm.

Exercise 2: Larmor frequency and nuclear polarization

A bottle of water (mainly protons, ^1H $\gamma=42.6$ MHz/T) was studied by NMR at ambient conditions at Earth's magnetic field ($B_0=5$ G) and $T=298$ K.

- (a) At what frequency do you expect to see the NMR signal?
- (b) Calculate the nuclear polarization in % of the sample under those conditions.
- (c) Assuming there are 10^{25} proton spins in that bottle of water, what is the difference between the spin populations between the upper and lower Zeeman energy levels?