NMR - Nuclear Magnetic Resonance

Signature Sheet

Student's Name _____ Partner's Name _____

Suggested reading to start with (see the end of the manual for more):

1. 111B NMR Manual
2. About Lock-In Amplifiers: Application Note # 3" **About Lock-ins**
3. Bloch, Felix. "**Nuclear Induction**". *Physical Review 70.* 1946. Bloch's two-coil method is used in this experiment.
4. Yuan, L and Wu, C.S. ***Methods of Experimental Physics***. Part B, Vol. 5. Academic Press. 1963. pp. 104-123 (Section 2.4.1.4). This reference discusses all the ideas necessary to do the experiment, which uses the two-coil Bloch method.
5. 111B NMR Experiment Videos **CW NMR** and **Pulsed NMR**. Note: In order to view the private Youtube videos hosted by the university, you must be signed into your berkeley.edu Google account.

Pre-Lab Discussion Questions

It is your responsibility to discuss this lab with an instructor before your first day of your scheduled lab period. This signed sheet must be included as the first page of your report. Without it you will lose grade points. You should be prepared to discuss at least the following before you come to lab:

1. What is nuclear magnetic resonance? What is Larmor precession? What magnetic fields do we apply to our sample and what are their functions
2. Referring to NMR Head of this lab manual, in what directions are the DC field, the modulating (60 Hz) field, and the RF field? What do these fields do? How do these fields relate to question 1? When you arrive in lab, examine how these fields are actually oriented in space.
3. How can you tell when you have found the resonance condition in this continuous wave mode? Should there be any symmetry?
4. Calculate the expected resonance frequencies of the glycerin and manganese samples.
5. What are T1 and T2?
6. What are the working principles of the lock-in amplifier? How is it used to produce a derivative waveform in this lab?
7. How does pulsed NMR work? How does the setup differ from CW?
8. What is "free nuclear induction"?
9. What is a "spin echo"?

Staff Signature _____ Date _____

Completed before the first day of lab? (Circle one) Yes / No

Mid-Lab Discussion Questions

1. On day 2 of this lab, you should have successfully produced an H2O absorption resonance picture, with a calibrated frequency axis. What is the Larmor Frequency in MHz? Show them to a GSI and get a signature.

Staff Signature _____ Date _____

Completed by day 3 of lab? (Circle one) Yes / No

1. On day 7 of this lab, you should have successfully observed the spin echo on the scope. Show it to an instructor and ask for a signature.

Staff Signature _____ Date _____

Completed by day 7 of lab? (Circle one) Yes / No

Other Questions to answer about this experiment as you go along

1. **Quantum Mechanics and E and M:** Classical absorption and dispersion curves for light going through matter (covered in any 110 text). In the NMR lab you will encounter similar absorption and dispersion curves. Why should optical absorption and dispersion be so similar to NMR absorption and dispersion? [Hint: think of the relevant Hamiltonians!]
2. **E and M:** The experiment relies on the induced voltage generated in a "pickup" coil surrounding your sample (in more than one way). Study the sample NMR head apparatus and understand how a magnetization induced in your sample can be "picked up" by the coil (which is basically just an RLC circuit). Does the frequency of the RF field affect the pickup coil's response?

Checkpoint Signatures

1. CW Set-Up

   Staff Signature _____

2. Glycerin Line Width

   Staff Signature _____

3. Mn Sample Traces

   Staff Signature _____

4. Setup Pulsed

   Staff Signature _____