Determination of spin-lattice relaxation times of ^{7}Li doped with various concentrations of Mn(II)

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Introduction

The flux regulation system for the 36T SCH magnet uses a field frequency lock to reduce low frequency temporal field fluxuations that adversely affect NMR experiments.

The first aim of this work is to prepare ^{7}Li lock samples with different spin-lattice relaxation times T_1 by varying the concentration of a Mn(II) dopant. T_1 values are measured using an inversion recovery pulse sequence.

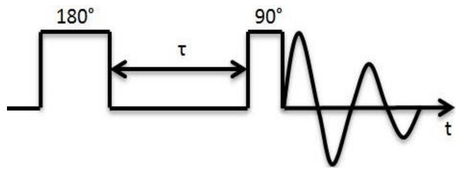
The second aim is to determine how the value of T_1 affects the SNR of the field frequency lock signal. For each ^{7}Li sample, a steady- state free precession signal (SSFP) is generated using a sequence of 90° pulses spaced by 25ms.

Methods and Materials

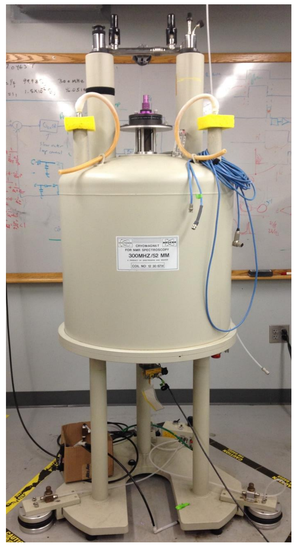
The concentration of ^{7}Li is fixed at 6.84M in each sample. This concentration is chosen to give the widest range of temperatures at which the sample remains a liquid.

The value of T_1 is estimated from the recovery time τ that nulls the FID following the 90° pulse

$$T_1 = {}^{\tau_{null}}/_{ln2}$$



Data was acquired using a 300 MHz superconducting magnet and a Tecmag NTNMR console.



Results

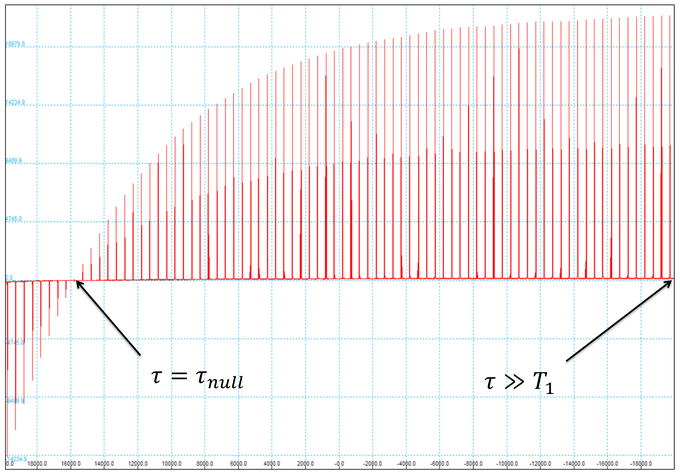


Figure 1. FID magnitude spectra as a function of inversion time τ.

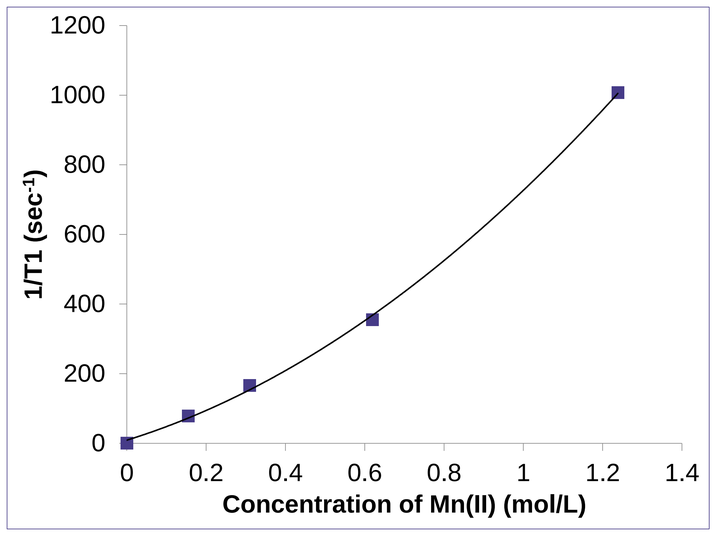
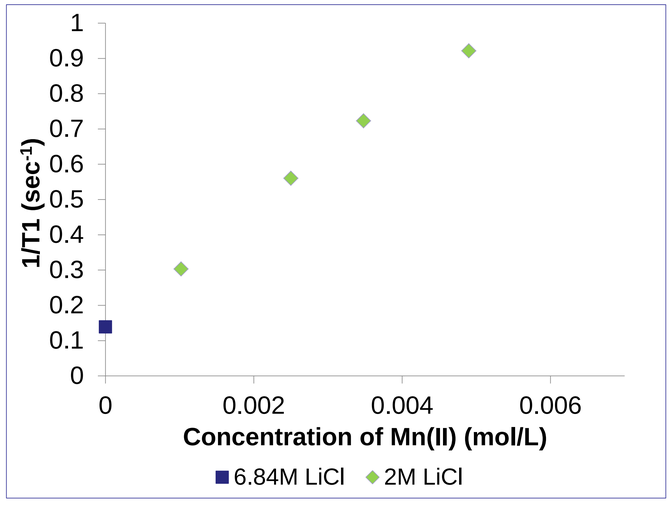


Figure 2. Relaxation rate dependence on Mn(II) concentration.

Figure 3. Relaxation rate dependence previously reported at much lower concentrations of ^{7}Li and Mn(II).[2] These values are consistent with the results in Figure 2 at low concentration levels.



Conclusion

Figure 4 shows the SSFP responses from ^{7}Li samples with values of T_1 that differ by four orders of magnitude. With respect to measurement SNR, the undoped sample which has the largest T_1 value, is a better candidate for the field frequency lock as it yields a high SNR across the entire 2 ms acquisition window. In contrast, the SNR of the doped sample significantly decreases at the end of the acquisition window.

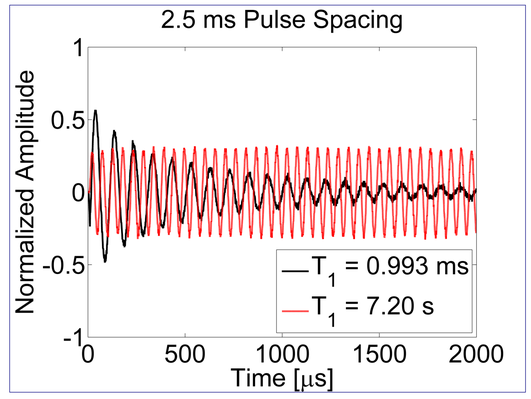


Figure 4. SSFP responses for ^{7}Li samples with different T_1 values.

Literature

[1] Joseph P. Hornak, Ph.D.. (1998). *The Basics of NMR.* Available:https://www.cis.rit.edu/htbooks/nmr/bnmr.htm. Last accessed 24th Jul 2015.

[2] Dinesen, T., Wagner, S., & Bryant, R. (1997.). Magnetic Relaxation Dispersion of 7 Li: Interaction with Mn(II) in the Aqueous Solvent Cage. J. Am. Chem. Soc. Journal of the American Chemical Society, 7004-7009.

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