

HYPERPOLARIZED ^1H NMR EMPLOYING LOW γ NUCLEUS AS A SPIN ORDER STORAGE

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The PASADENA (parahydrogen and synthesis allow dramatically enhanced nuclear alignment) and Dynamic Nuclear Polarization efficiently hyperpolarize biologically relevant nuclei such as ^1H , ^{31}P , ^{13}C , ^{15}N , etc. Recently, multiple groups have demonstrated the utility of hyperpolarized MR in medicine using hyperpolarized ^{13}C biomarkers with relatively long spin lattice relaxation time T_1 on the order of tens of seconds. However, as NMR receptivity scales as γ^3 for spin $\frac{1}{2}$ nuclei, NMR detection of low γ nuclei results in lower signal-to-noise ratio. While protons are ideal nuclei for detection, short spin lattice relaxation time T_1 prevents direct ^1H hyperpolarized MR in biomedical applications.

Here, we demonstrate the utility of ^{13}C for spin storage of hyperpolarization followed by ^1H detection, which theoretically can provide up to $\sim(\gamma_{1\text{H}}/\gamma_{\text{X}})^2$ gain in sensitivity in hyperpolarized biomedical MR. We hyperpolarized the ^{13}C site of 2-hydroxyethyl 1- ^{13}C -2,3,3- ^2H -propionate by PASADENA. The spin order was then stored on ^{13}C for 48 s while the sample was transferred from a low magnetic field polarizer operating at 1.8 mT to a 4.7 T animal MR scanner. Spin order on ^{13}C decayed from 10% to 6% during the sample transfer, after which the refocused INEPT pulse sequence was used to transfer polarization from ^{13}C to protons within HEP. The ^{13}C nucleus with $T_1 = 70$ s acts as an efficient spin order storage, while ^1H nuclei nearby are ideal for detection.

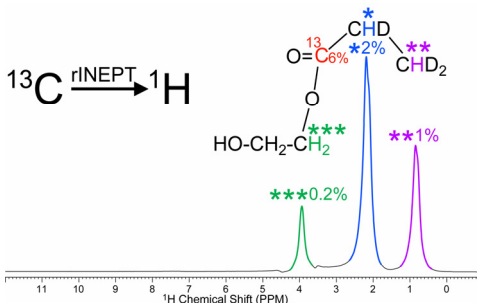


Figure 1. ^1H spectrum of hyperpolarized 2-hydroxyethyl 1- ^{13}C -2,3,3- ^2H -propionate (HEP). The experimental polarization percentage is shown for each proton site. The spectrum is acquired using the refocused INEPT sequence.