VANDERBILT UNIVERSITY

CTTC Center for Technology Transfer & Commercialization

PANORAMIC: Precession and Nutation for Observing Rotation at Multiple Intervals about the Carrier

Summary

Methods of hyperpolarization based on parahydrogen have been expanding recently from the early applications in hydrogenation chemistry to biomedical imaging where they are expected to yield similar information as the competing technology, dynamic nuclear polarization, (DNP). These hyperpolarization experiments have already enabled the measurement of metabolism in vivo at temporal resolutions of seconds. When infused into organisms harboring tumor cells, molecules such as pyruvate and lactate have been shown to be sufficiently long-lived to infiltrate cellular metabolic cycles and be converted at different rates in cancer versus normal tissue. DNP has been used most frequently in these early studies, owing to commercial availability and the flexibility to polarize small molecules such as pyruvate and lactate. Techniques based on chemical addition or exchange of parahydrogen have also shown promise for generating metabolic contrast in vivo at similar levels of signal enhancement and at lower costs.

In biomedical applications of parahydrogen induced polarization (PHIP), the initial proton spin-order must be transferred to nuclei with more favorable longitudinal relaxation rates so that the highly polarized states can be preserved and subsequently detected in vivo. However, pulsed PHIP has previously required more expensive and more complex multinuclear spectrometers.

The present invention provides a solution to this problem that enables a single channel spectrometer to perform multinuclear NMR experiments at low field. The primary anticipated application is polarization transfer from parahydrogen to coupled heteronuclei with the PASADENA or SABRE techniques. This enhancement simplifies the required instrumentation and translates to less expensive and more reliable equipment. Because the pulses utilize a central carrier to rotate hetero-nuclear magnetization over a wide field of view, we refer to the technique as PANORAMIC (Precession and Nutation for Observing Rotation At Multiple Intervals about the Carrier). These waveforms are ideally suited to low-field applications and can be tailored to specific applications.

The technique has been demonstrated by refocusing transverse components of 13C and 1H magnetization at 12 mT using a central carrier frequency. The 13C and 1H resonances were separated by 382 kHz and refocusing efficiency was equivalent to block pulse analogs on the individual channels. In addition to being efficient, magnetization in the untargeted band was minimally disturbed without additional constraints in the design algorithm

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