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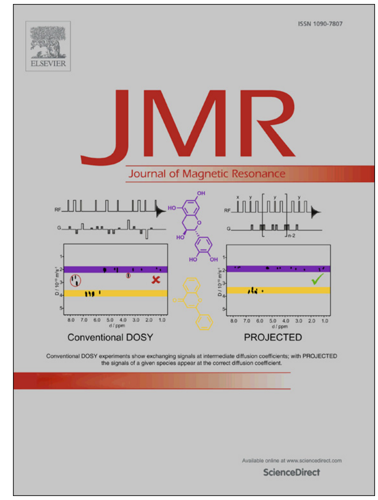

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Evgeny Nimerovsky, Andrew J. Ilott, Alexej Jerschow

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Low-power Suppression of Fast-Motion Spin 3/2 Signals

Evgeny Nimerovsky[1], Andrew J Ilott[1] and Alexej Jerschow[1]*

[1]Department of Chemistry, New York University, New York, NY 10003, USA

*corresponding author:email: alexej.jerschow@nyu.edu; Phone: 1-212-998-8451
Department of Chemistry, New York University, 100 Washington Square East, New York, NY 10003, USA

Abstract

Triple Quantum Filters (TQFs) are frequently used for the selection of bi-exponentially relaxing spin 3/2 nuclei (in particular ^{23}Na) in ordered environments, such as biological tissues. These methods provide an excellent selection of slow-motion spins, but their sensitivity is generally low, and coherence selection requirements may lead to long experiments when applied in vivo. Alternative methods, such as 2P DIM, have demonstrated that the sensitivities of the signals from bi-exponentially relaxing sodium can be significantly increased using strategies other than TQFs. A shortcoming of this method in particular is its strong dependence on B_0 inhomogeneities. We describe here a method, which is sensitive to the slow-motion regime, whereas the signal from spins in the fast-motion regime is suppressed. This method is shown to be more effective than TQFs, requires minimal phase cycling for the suppression of the influence of rf inhomogeneity, and has less dependence on resonance offsets and B_0-inhomogeneity than 2P DIM.

Introduction

Nuclear spins larger than ½ experience a quadrupolar interaction, which can be used for characterizing the electric field gradient around them. In semi-solids, the interaction often fluctuates and leads to relaxation. In spins 3/2, this process manifests itself in a bi-exponential relaxation mechanism[1], wherein two T_1 and two T_2 time constants can be observed. Triple Quantum Filters (TQFs) have long been used for the separation between mono- and bi-exponential behaviors due to their ability to provide, in principle, a clean separation of signals. Despite their adequate performance in a spectroscopy setting, they suffer from drawbacks which make them less desirable for imaging, especially *in vivo*: their sensitivity is generally low, and longer phase cycles frequently need to be used, which add a significant overhead to the implementation. Pulsed field gradients for coherence selection are not a viable option in vivo. Here we show a simple alternative, which provides a more sensitive selection of the slow-motion relaxation regime. Our focus is in particular on rf power limited applications, which are relevant in the context of *in vivo* MRI and *ex situ* NMR experiments.

Specifically, we demonstrate the methodology on sodium spins. Sodium ions represent the most important abundant cations in the body, and perform essential physiological functions. It tissues, both fast-motion and slow-motion sodium pools are present, with the former often attributed to the extra-cellular environment, and the latter to the intra-cellular compartment.[2,3] Certain extracellular environments have also been shown to exhibit a slow-motion regime, for example in the heart[4]. In cartilage, because of attraction of sodium to polyanions, sodium shows in addition a residual quadrupolar splitting. Optimal sequences for the case of selecting signals from compartments with such splittings have been described recently with a low-power pulse sequence.[5]