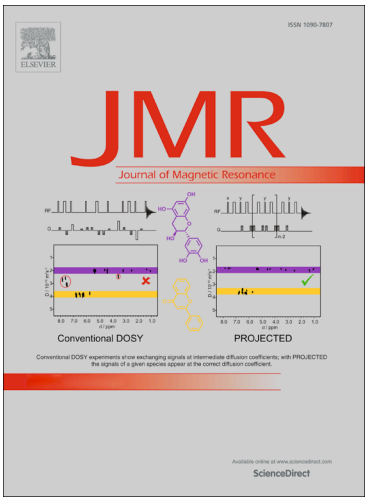
Accepted Manuscript



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PII: S1090-7807(18)30103-4
DOI: https://doi.org/10.1016/j.jmr.2018.04.001
Reference: YJMRE 6279

To appear in: *Journal of Magnetic Resonance*

Received Date: 22 December 2017
Revised Date: 26 February 2018
Accepted Date: 4 April 2018

Please cite this article as: A. Burant, M. Antonacci, D. McCallister, L. Zhang, R. Tamara Branca, Effects of Superparamagnetic Iron Oxide Nanoparticles on the Longitudinal and Transverse Relaxation of Hyperpolarized Xenon Gas, *Journal of Magnetic Resonance* (2018), doi: https://doi.org/10.1016/j.jmr.2018.04.001

Effects of Superparamagnetic Iron Oxide Nanoparticles on the Longitudinal and Transverse Relaxation of Hyperpolarized Xenon Gas

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Abstract

SuperParamagnetic Iron Oxide Nanoparticles (SPIONs) are often used in magnetic resonance imaging experiments to enhance Magnetic Resonance (MR) sensitivity and specificity. While the effect of SPIONs on the longitudinal and transverse relaxation time of ^{1}H spins has been well characterized, their effect on highly diffusive spins, like those of hyperpolarized gases, has not. For spins diffusing in linear magnetic field gradients, the behavior of the magnetization is characterized by the relative size of three length scales: the diffusion length, the structural length, and the dephasing length. However, for spins diffusing in non-linear gradients, such as those generated by iron oxide nanoparticles, that is no longer the case, particularly if the diffusing spins experience the non-linearity of the gradient. To this end, 3D Monte Carlo simulations are used to simulate the signal decay and the resulting image contrast of hyperpolarized xenon gas near SPIONs. These simulations reveal that signal loss near SPIONs is dominated by transverse relaxation, with little contribution from T_1 relaxation, while simulated image contrast and experiments show that diffusion provides no appreciable sensitivity enhancement to SPIONs.

Keywords: Superparamagnetic iron oxide nanoparticles, Hyperpolarized ^{129}Xe, Longitudinal relaxation, Transverse relaxation, Restricted diffusion

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