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Discussions

Interactive comment on "Nuclear spin noise tomography in three dimensions" *by* Stephan J. Ginthör et al.

Anonymous Referee #2

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Authors properly applied the spin noise phenomena in 3D tomography of specific object immersed in the solvent. The remarkable beauty of spin noise lays in naturally performing NMR experiments without disturbance to spins by gently listening what spins can reveal about themselves and not using RF pulses which they normally act as brute force. Spin noise coherence does not need to be created by pulses as such already exists being created by the nature of the spin fluctuations statistic. Presented manuscript is continuation of previous work done on the spin-noise-detected NMR imaging in two-dimensions published in 2006. Since then authors, made an excellent progress in researching the spin noise phenomena in several aspects not limited to imaging as well as in an optimization of associated hardware and software. This allowed to demonstrate much better visual quality images of phantom thanks to introducing of a new

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Discussion paper

kind of SART-based iterative image reconstruction technique.

I would like to suggest a few minor comments for consideration.

Since sensitivity of the spin noise is closely related to the magnitude of radiation damping, I would like to suggest some comment on this issue. It would be helpful to know the radiation damping constant of the H2O/D2O system and compare it to the T2 spin-spin relaxation time. Since radiation damping is involved in providing a coupling between spin system and RF coil this has a very significant impact on practicability, efficiency and successful application of spin noise.

160 pg.7 "In a first approximation, noise acquisition can be modeled as analogous to the simplest conventional 1DNMR experiment 160(Fig. 3a), with a very short random phase excitation pulse." This is not accurate enough statement. Simplification could be misleading. By no any means one can perform NMR experiment with comparable number of excitation pulses to the number of spins. Therefore the statistic in both cases will be very different. Each spin posses its own phase and typically contributes to the magnetization and overall statistic gives M$\sim$square root[N]. Simplest conventional NMR with very short random pulses will not yield such relation.

160 pg.7 "For each angle φM angles for θ", I would suggest considering a different character for M as in NMR this symbol is generally reserved for the magnetization.

165. pg.7 "Due to the non-deterministic nature of the spin noise phase, it is not possible to accumulate the raw phase sensitive data directly in the time-domain (as it is usually done), as this would lead to signal cancellation." The statement "Non-deterministic" needs future explanation. Is non-deterministic nature because of uncertainty principle or simple due to the phase time dependence and lack of possibility to acquire enough signal to be observed at the unique phase value at the acquisition time adequate to the linewidth? In physics, the statement "non-deterministic nature" rises often a lot of ambiguity.

170 pg.7 “Relaxation not being an issue any recycling delay can be omitted” This is too generic statement especially when later in the manuscript the relaxation factor in eq.(3) is used with different meaning. I would suggest being more specific and add spin-lattice relaxation. On the other hand spin-spin relaxation is still relevant and important.

Significant part of the manuscript is devoted to SART-based iterative image reconstruction technique. However, this does not have explicit reflection in the title of the article. I would suggest considering including in the title the statement “SART” so this could better reflect the scope of the work as well as improve search-ability of the article.

315 pg.13 “unique properties of spin noise, in particular that it does not decay and has no defined starting point in time”. “Spin noise does not decay”, is not an accurate statement. Spin noise originates by spin fluctuations which they exist all of the time. By the property of such fluctuations they will never disappear and at the same time they will decay. Autocorrelation of fluctuations exhibits an exponential behavior which mirrors the free induction decay. On the other hand the linewidth of spin noise spectrum is related to T2 relaxation that is associated with FID which always involves loosing the phase coherence and magnetization decay. If spin noise does not decay, this naturally requires T2 relaxation time being infinitely long and linewidth should approach 0.0 Hz which is beyond objective reality.

The manuscript is revealing a significant progress in 3D spin noise tomography and I am recommending it for publishing after considering these minor issues.

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