Spin Noise in NMR

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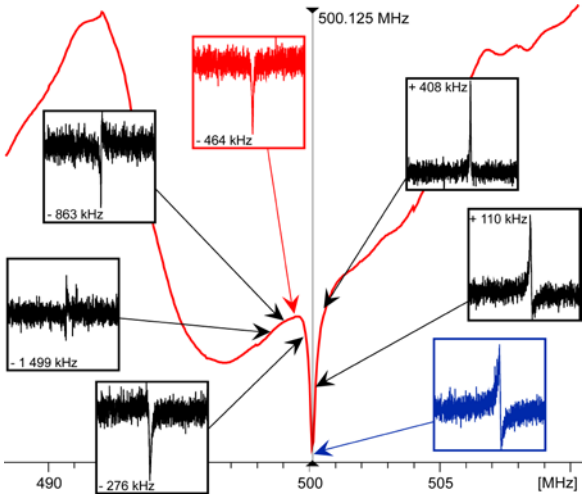
Already predicted in 1946 by Bloch[1] nuclear spin noise, stemming from incomplete cancellation of transverse magnetization components, could not be detected before 1985, when detection of NQR noise was first reported[2]. With state-of-the-art high-resolution NMR spectrometers, in particular when using cryogenically cooled probes, spin noise observation is fairly straightforward today. It has been used previously to generate images of proton spin density without radio frequency excitation[3]. Our current research focuses on the fundamentals of spin noise in NMR spectroscopy and systematic assessment of experimental manifestation of spin noise phenomena. Quantification of spin noise amplitudes and line shapes are complicated due the effects of radiation damping. Only if radiation damping is quenched, e.g. by a static field gradient, linear dependence between the power spectral amplitude and the number of spins can be observed as was the case in our earlier study[3].



Of particular interest is the dependence of spin noise line shape on the tuning of the receiving resonance circuit illustrated in the Figure to the left. The large offset of -464 kHz between the tuning optimum and the "spin noise dip tuning", deviates significantly from what is intuitively expected and in important aspects also from what is predicted by a formalism based on Nyquist noise introduced by Ernst and McCoy[4]. This tuning dependence may be used to optimise tuning and as a guide for the design of resonance circuits in magnetic resonance probes.

References

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