OPM-based ultra-low field NMR relaxometry

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Nuclear magnetic resonance at ultra-low magnetic fields (ULF-NMR) offers an especially high contrast in the longitudinal relaxation time T_1 between different types of tissue, which for instance enables to distinguish between healthy and cancerogenous tissue [1].

Today's best commercial zero-field OPMs offer a sensitivity below $10\,\mathrm{fT}/\sqrt{\mathrm{Hz}}$, entering the sensitivity range of SQUID-systems typically employed for ULF-NMR. It would be a large benefit for in-vivo ULF-NMR to gain from the flexibility and small size of these miniaturized OPMs, to access regions of the subjects body which are otherwise not accessible, as e.g. for the investigation of prostate cancer. Furthermore, medical realizations would profit from much lower effort in terms of costs and maintenance.

We present measurements of the relaxation of the nuclear spin of benzene in a finite but small detection field with a commercial zero field OPM (Quspin QZFM-gen-2). So far, we considered the nuclear Larmor frequency range from 5,5 Hz to 9 Hz, which corresponds to a detection field amplitude of 130 nT to 200 nT. We achieved a relaxation linewidth below 200 mHz for benzene, when proper care was taken to reduce the influence of the field produced by the OPM itself.

[1] S. Bush et al., Magnetic Resonance in Medicine, **67**, 1138 (2012).