Applications for Atomic and Diamond Sensors

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Abstract:
The detection of feeble biomagnetic fields requires sensitive and robust magnetic field sensors deployable in a clinical environment. Ensembles of nitrogen-vacancy (NV) centers in diamond or, even more sensitive, vapor cell-based sensors, are widely utilized for magnetometry, magnetic field imaging and magnetic-resonance detection.

I will give an overview of the quantum sensing activities in the Matter-Antimatter Asymmetry section of the Helmholtz Institut Mainz focusing on our efforts to deploy vapor-cell based magnetometers in various applications and our efforts to come up with novel magnetometry methods in diamond. This includes microwave-free vector measurements with diamonds [1], a demonstration on how to detect the conductivity of a material using diamonds [2] and results of our efforts to extend the measurement range of NV centers into the zero-field regime [3]. Especially the last result might become important to allow diamonds to sense biomagnetic DC fields in a shielded environment. Commonly NV center magnetometers are deployed with a background magnetic field of several millitesla, which is not trivial within a magnetic shield and can also result in substantial technical noise.

Ultimately our hope is to deploy the developed sensors and techniques in a miniaturized endoscope allowing minimal distance to the biomagnetic source and therefore improved signal-to-noise as a novel tool in clinical diagnostics.

References

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[2] G. Chatzidrosos et al., Phys. Rev. Applied **11**, 024005 (2019)
[3] H. Zheng et al., Phys. Rev. Applied **11**, 064068 (2019)