Unshielded Atomic Magnetometry – Building a Portable, Compact Device

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The field of optically-pumped magnetometry has seen rapid progress in the past decade. In order to move from well established lab-based experiments to field-ready instruments we are developing an unshielded, portable Mx magnetometer for use in a range of environments, from medical, (e.g. magnetocardiography, magnetoencephalography) to maritime defence and geophysical applications, (e.g. geology, archaeology). The double resonance technique presented here uses a single laser beam to pump thermal caesium vapour as well as phase sensitively probe its coherent precession in the presence of an RF field [1].

We aim to minimise hardware while prioritising sub-picoTesla sensitivities. Component miniaturisation is key – optimisation and characterisation of micro-fabricated alkali vapour cells is reported, and the effects of operation temperature and buffer gas pressure discussed. We introduce a novel feed-forward noise suppression technique for operation in magnetically noisy environments, in particular those dominated by 50 Hz noise.

We have achieved signal resolution in the parts per million against a background comparable to the Earth's field, observing noise suppression of 20 dB. Here we present the techniques used to achieve this, as well as potential applications.

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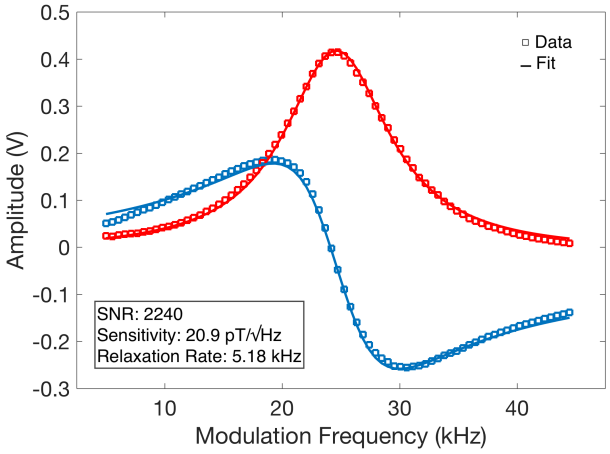

Fig. 1: Measured data and fits to the in-phase and quadrature components of the magnetic resonance signal. A 300 nT RF modulation field is applied across a range of frequencies and a resonant response observed in the presence of a 7 μT static field.

References

[1] S. J. Ingleby, P. F. Griffin, A. S. Arnold, M. Chouliara, E. Riis, *High-precision control of static magnetic field magnitude, orientation, and gradient using optically pumped vapour cell magnetometry*, Review of Scientific Instruments. **88**, (2017).

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