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Magnetometry using Four Wave Mixing of Sodium Vapour

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Four wave mixing is a popular spectroscopic technique with limited examples of use for magnetometry. As an all optical, heterodyne technique, it allows for high sensitivity measurement, without the challenges associated with using RF.

All alkali vapours could be used for four wave mixing, however we selected sodium due to having the vapour cell and dye laser readily available in our lab. A high power, linearly polarised pump beam, is mixed with a small left circularly polarised probe beam. When the probe beam is resonant with the magnetic field, a right circularly polarised conjugate beam is generated at an opposite angle to the probe beam.

The conjugate and probe beams are beat together at the photodetector, with the beat frequency twice that of the magnetic field splitting. The estimated sensitivity for four wave mixing with sodium vapour is on the order of $1 \text{ pT/Hz}^{-1/2}$. This is without magnetic shielding, unlike many conventional OPM experiments.

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