# An accurate magnetometer based on Ramsey-style interrogation

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We implement an interrogation mode analogous to Ramsey spectroscopy [1], enabling observation of spin dynamics unperturbed by optical fields. Similar readout methods have been employed previously to measure ground state coherences [2]. The basic principle involves optically pumping an atomic ensemble into a well-defined quantum state that subsequently evolves during a dark period. This is succeeded by a time-delayed probe pulse that measures the spin phase at the instant readout began. The intrinsic spin dynamics can then be reconstructed by superimposing the signals observed at various delay times, manifesting as precession and partial relaxation experienced during the dark interval.

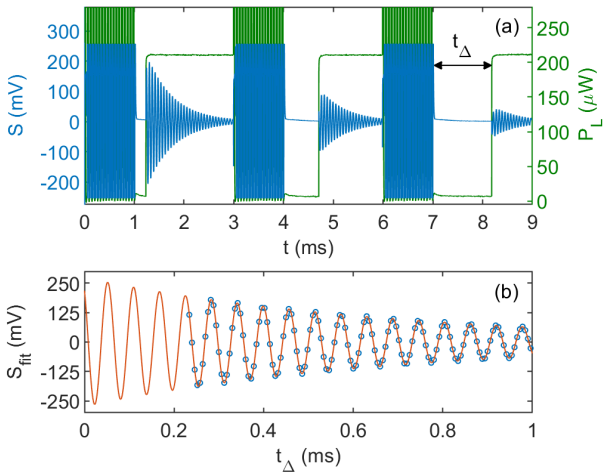


Figure 1: (a) FID signal train subsection, and corresponding laser power prior to illuminating the vapor cell which is set close to zero for a time, $\mathrm{t}_\Delta$, after optical pumping. (b) Reconstructed precession signal exhibiting spin dynamics unperturbed by the $210\,\mu\mathrm{W}$ readout field.

This phase-sensitive measurement enables accurate magnetic field tracking as AC Stark shifts are effectively suppressed. Additionally, reduction in power broadening introduced by residual optical pumping provides a platform for assessing the intrinsic relaxation properties of the vapor cell. This method is highly favourable compared to previously adopted techniques that extrapolate to zero-light power [3], as elevated laser intensities can be used to significantly improve SNR.

# References

[1] N. F. Ramsey, Phys. Rev. **78**, 695 (1950).
[2] W. Franzen, Phys. Rev. **115**, 850 (1959).
[3] T. Scholtes *et al.*, Appl. Phys. B **117**, 211 (2014).