

Direct magnetic gradiometer with multi-pass cells

Michael Romalis, Vito Giovanni Lucivero, Wonjae Lee, Nezih Dural

Physics Department, Princeton University, Princeton NJ, 08544

Sensitive magnetometry in unshielded environment requires robust subtraction of common mode magnetic noise. We describe operation of a direct magnetic gradiometer that subtracts optical rotation signals from two measurement regions. We use a V-shaped multi-pass cell to uniformly sample two distinct regions of Rb atoms. The two regions are initially polarized in opposite directions, so their optical rotation signals largely cancel. This avoids the complication of signal wrap-around when the optical rotation exceeds $\pi/4$ radians. The amplitude of the difference signal is directly proportional to the magnetic field gradient. We have developed analysis methods to reduce sensitivity to any initial spin polarization imbalance and extract a measurement of the magnetic field gradient.

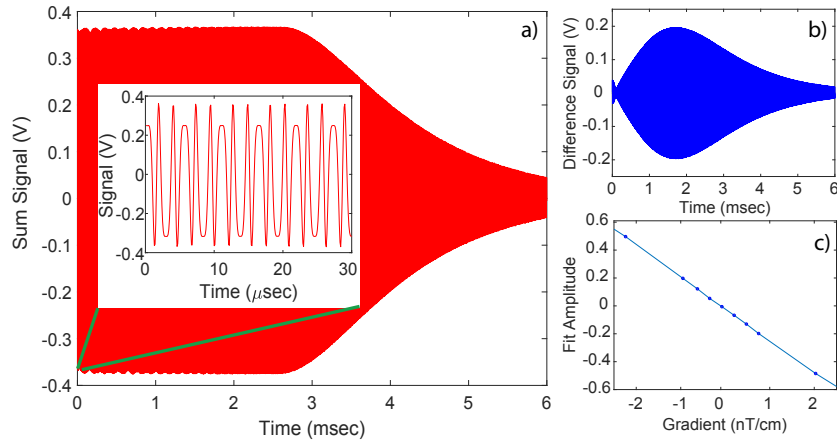


Figure 1. Examples of optical rotation signals. a) Sum signal with both regions polarized in the same direction. The inset shows a zoom on the signal oscillations, indicating multiple rotations. b) Difference signal for a small magnetic gradient. c) Calibration of the difference signal amplitude as a function of gradient.