Optical Beat Note Readout of a Magnetic Gradient

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Typical gradient measurements using optically pumped magnetometers consist of making two independent measurements and then subtracting the results electronically. We present a technique where the gradient of the magnetic field is derived directly from the optical signal [1]. Using two ^{87}Rb vapor cells, the atoms are pumped into the $|F = 2, m_F = 2\rangle$ stretched state. Then, a resonant microwave pulse is applied to make a superposition between the $|2,2\rangle$ and $|1,1\rangle$ levels, and a resonant 780-nm probe beam is passed through the two vapor cells. With the atomic superposition precessing at the hyperfine splitting frequency, the probe laser will be modulated, parametrically generating an optical sideband [2]. If there is a magnetic field gradient between the two vapor cells, the sidebands will have a frequency difference and generate a beat note. Thus, the beat note frequency will be proportional the magnetic gradient. We will present an experimental implementation of this technique and describe efforts to improve the sensitivity and to eliminate dead zones of the gradiometer.

References

[1] Vishal Shah, System and Method for Measuring a Magnetic Gradient Field. Patent. US10088535 (2018).

[2] Tang, H. Parametric Frequency Conversion of Resonance Radiation in Optically Pumped Rb^{87} Vapor. Phys. Rev. A, **7**, 2010–2032 (1973).