A pulsed dead-zone free gradiometer in Earth's field

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Measuring ambient (without shielding) magnetic field gradients from a single optical signal is an important problem in atomic magnetometry. We report on the development of an atomic gradiometer based on the hyperfine splitting in two vapor cells of warm ^{87}Rb atoms [2]. A pulsed microwave field resonant with the hyperfine ground state splitting prepares an atomic coherence and generates sidebands offset from a weak (carrier) beam incident on two vapor cells [1]. From the sidebands, a single optical beat note is produced, with the frequency of the beat determining the magnetic field gradient between the two cells. For a practical gradiometer, it is important to be able to measure the gradient regardless of the direction of the ambient magnetic field, either perpendicular or parallel to the laser beam propagation axis. Operation of the gradiometer in these multiple field orientations is discussed, along with current research investigating the feasibility of single laser operation, where one beam acts as both a pump and carrier. Applications of this research, including Magnetoencephalography (MEG), where multiple sensor channels are positioned around the human skull, would benefit from the compactness and simplicity of a single laser setup.

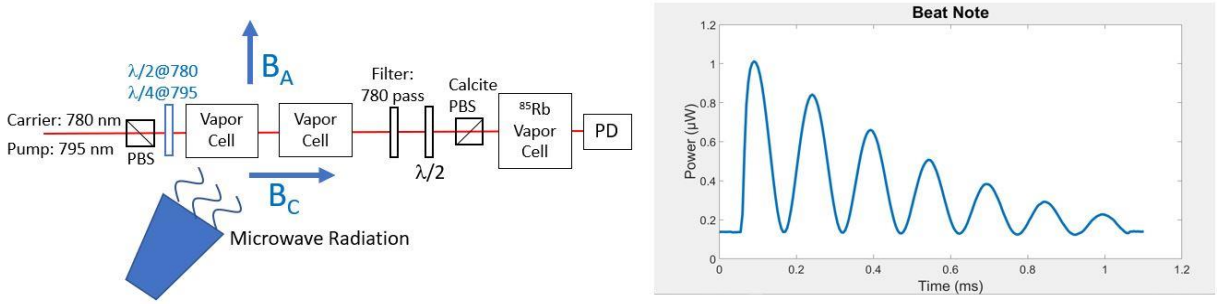

Fig. 1 (Left) Experimental gradiometer setup with collinear Pump and Carrier beams [2]. For this case, we assume the ambient field, B_A, is perpendicular to the Carrier direction. The sideband is orthogonally polarized to the carrier, so the beat note can be picked off using a polarizing beam splitter (PBS). (Right) An example of the beat note data.

References

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

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