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Sensitivity Improvement of a 4He Optically Pumped Magnetometer in the RF band

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Sensitivity Improvement of a ^{4}He Optically Pumped Magnetometer in the RF band

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High-sensitivity detection of radio-frequency (RF) magnetic fields is critical for various applications, from radio communication to fundamental physics experiments. Ultra-low field MRI (ULF-MRI) with the static magnetic field less than 10 mT, in particular, demands sensors capable of operating with high sensitivity in the 100 kHz to 400 kHz range 1. Optically pumped magnetometers (OPMs) are promising candidates for high-sensitivity RF magnetic field detection. Previous studies have shown that the OPMs using alkali metal atoms exhibit high sensitivity for RF magnetic field detection, but their operation typically requires heating and careful management of spin-exchange relaxation in static magnetic fields [2]. Our research focuses on OPM using ^{4}He (^{4}He-OPM), which operates without heating and offers a broad frequency range. While our previous work achieved a noise floor of 90 fT/Hz$^{1/2}$ at 100 kHz, sensitivity decreased at higher frequencies [3]. In this study, through adjustments in the magnetic field configuration, we improved the sensitivity of ^{4}He-OPM for higher frequencies. Specifically, we achieved a noise floor of 13 fT/Hz$^{1/2}$ at 300 kHz. In addition, we will show the potential of ^{4}He-OPM for high-sensitivity detection at higher frequencies for applications such as ULF-MRI.

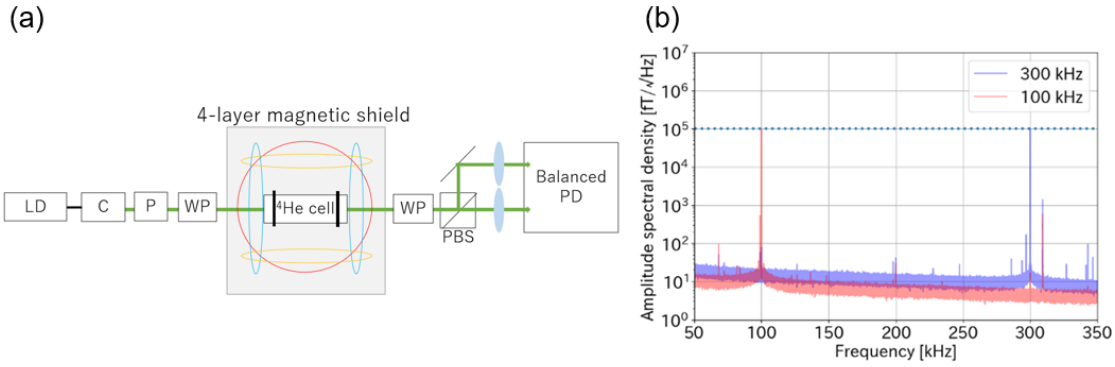

Figure 1: fig.1

Figure 1: (a) Schematic diagram of ^{4}He-OPM experimental setup. LD: laser diode; C: collimator; P: polarizer; WP: half-wave plate; PD: photo diode. (b) Amplitude spectral density for 100 pT$_{\mathrm{rms}}$ sinusoidal signals applied at 300 kHz and 100 kHz.

References

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