An all-optical self-oscillating ^{4}He atomic mangnetometer with liquid-crystal polarization rotation instead of phase-shift circuits

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Self-oscillating atomic magnetometers [1], which have simple structure and fast response, have been realized in cesium, rubidium, potassium and helium atoms. The research of the light-modulated self-oscillating atomic magnetometer indicates a new direction [2]. The optical-phase shift realized by using double beams has taken place of the phase-shift circuits and further has reduced the systematic errors caused by the circuits [3]. We also use this method to realize all-optical self-oscillating ^{4}He atomic magnetometers [4], which are suitable for applications within the range of geomagnetic field without nonlinear Zeeman effect. The separated pump and probe lights are linear polarized whose initial polarizations are parallel to each other, and the propagation directions are perpendicular. An acousto-optic modulator is used to modulated the intensity of pump light, while the probe light is non-modulation. A photoelectric detector is used for detecting the absorption for probe light. The external magnetic field and the propagation of probe light are in the same direction. In order to solve the problem of phase shift, a liquid crystal is added to compensate the phase. As shown in Fig.1, the liquid crystal is modulated with 13 Hz for tracking the phase shift and ensure self oscillation of loop. After close loop, it is found that the magnetic field sensitivity (noise spectral density) of the high-frequency part is equivalent to that without phase compensation. The low-frequency part is raised, mainly because the modulation with 13 Hz for liquid crystal has an impact on the magnetic field measurement. The follow-up researches mainly aim at improving the modulation frequency of liquid crystal and reduce its impact on the low-frequency magnetic field. Details and more results will be show in the future.

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