Bell-Bloom magnetometer driven by pump beams off-resonant with the atomic transitions

Q.-Q. Yu[1], S.-Q. Liu[1], D. Sheng[1]

[1] Hefei National Laboratory of Physical Sciences at the Microscale, and Department of Precision Machinery and Precision Instrumentation, University of Science and Technology of China, Hefei 230026, China

When the pump beam is modulated at frequencies close to the atomic Larmor frequency, a substantial atomic polarization can be built up even when the pump beam is orthogonal to the bias field, and this leads to the Bell-Bloom magnetometers. In this work, we present the results of the Bell-Bloom magnetometers when the pump beams are detuned from the atomic transitions, which has been largely neglected before. We study such effects in two different operation modes of the magnetometers. For the two-beam mode of the magnetometer, as shown in Fig. 1(a), we focused on the relation between the phase of the demodulated probe signal and the orientation of the bias field. Such a relation is strongly dependent on the pump beam detuning, and we can such an effect to improve the vector magnetometer sensitivity to the bias field orientation. For the single-beam mode of the magnetometer, as shown in Fig. 1(b), we studied the line shapes of the magnetometer response as a function of the modulation frequencies. Such a response is always symmetrical when the pump beam are resonant, however, it become asymmetrical when the pump beams are off-resonant from the atomic transitions, and non-orthogonal to the bias field. This effect is an important source of the heading error for the scalar magnetometers in the practical use, and we present an experimental solution to such a problem.

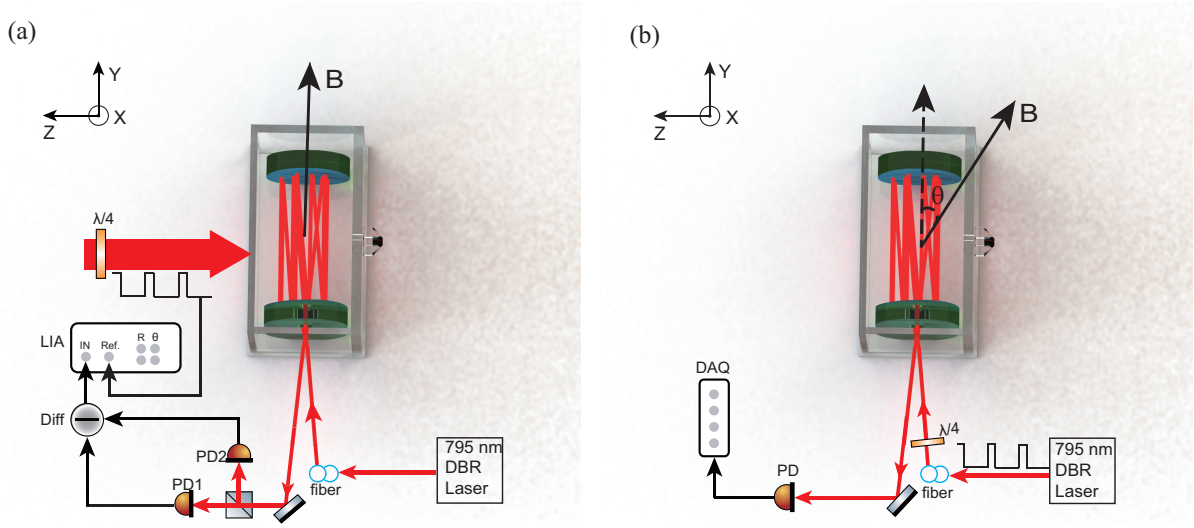

Figure 1. The two operation modes of the Bell-Bloom magnetometer.