An all-optical atomic vector magnetometer using multipass cells and dual Bell-Bloom optical pumping

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We will report the work on an all-optical vector magnetometer using the dual Bell-Bloom optical pumping method. The magnetometer setup is shown in Fig. 1(a). In order to improve its sensitivity, we develop a standardized procedure to fabricate an atomic cell containing a Herriott cavity as shown in Fig. 1(b). Together with a printed platform, we could get rid of all optical adjustments for the cavity beam. We apply two perpendicular pumping beams into two separated regions of the cell, assisted by a printed mask. These two beams are amplitude modulated at the Larmor frequencies of ^{85}Rb and ^{87}Rb, respectively.

The probe beam signal contains both modulation components excited by the two pumping beams. We demodulate the probe signal using two lock-in amplifiers, and focus on the phase shift between each frequency component and the reference frequency. Each phase shift is a function of ψ, the angle between the magnetic field direction and the corresponding pumping beam direction,and θ, the azimuthal angle of the magnetic field direction in the plane perpendicular to the pumping beam direction. Therefore, each phase shift output could define a curve on the spherical coordinate, and the magnetic field direction is determined by the cross point of the two curves extracted from the magnetometer signal, as shown in Fig. 1(c).

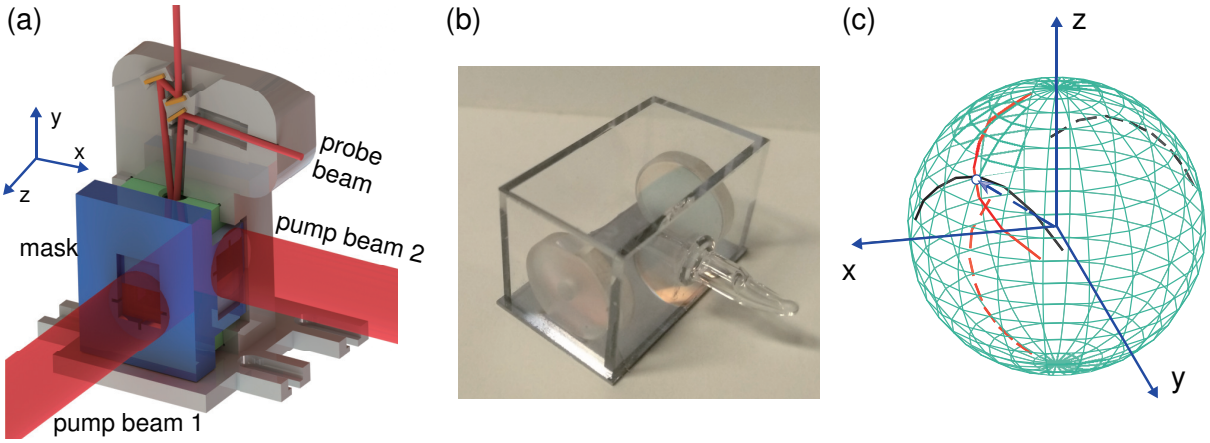

Figure 1. (a) The magnetometer setup. (b) The atomic cell with a Herriott cavity bonded inside. (c) The cross point of two curves, defined by the demoulated phase information, determines the magnetic field direction.