SUB-DOPPLER SPECTROSCOPY OF ^{39}K FOR MAGNETIC FIELD MEASUREMENTS

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Alkali atoms are commonly used in atomic physics for a number of reasons, the main one being the simplicity of their electronic structure. Relatively cheap lasers are available for the main optical transitions (D lines) of most alkali atoms making them convenient to study experimentally, mainly in the domain of magnetometry[1 2]. Potassium 39 (^{39}K) is an interesting candidate for such experiments, since it has the smallest characteristic value $B_0 = A_{^2S_{1/2}}/\mu_B \approx 170$ G (where $A_{^2S_{1/2}}$ is the ground state's magnetic dipole interaction constant) characterizing the decoupling of **J** and **I** and therefore the establishment of hyperfine Paschen-Back (HPB) regime[3 4]. Probing a ^{39}K vapor with a circularly polarized laser while applying a strong enough (> 200 G) magnetic field oriented along the propagation direction of laser allows to record an absorption spectrum in which only 8 spectrally resolved Zeeman transitions (4 for each circular polarization $\sigma^{\pm}$) are visible, while the probabilities of the 16 remaining transitions tend to zero. Complete spectral resolution is obtained thanks to the thickness of the vapor cell (of the order of the transition wavelength), allowing almost complete cancellation of the Doppler broadening[5]. We present a method that allows to measure the magnetic field with micrometer spatial resolution based on the recorded spectra in the range $0.1-10$ kG with a cell of thickness $L = 120\pm5-390\pm 5$ nm, which is relevant in particular for the determination of magnetic fields with a large gradient (up to 3 G/μm). The experimental results are verified by theoretical calculations.

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