Study of atomic transitions of ^{39}K isotope on D_1 line in strong magnetic fields

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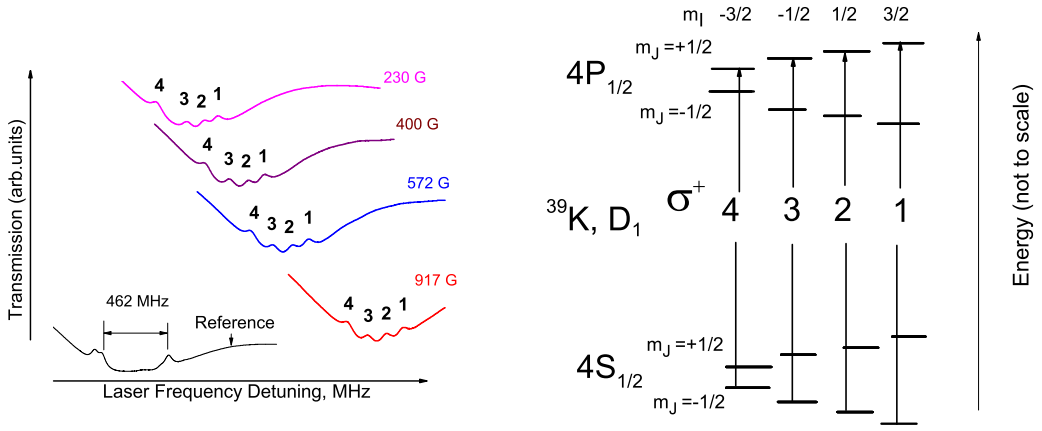
The magnetic field required to decouple the electronic total angular momentum J and the nuclear magnetic momentum I is given by $B \gg B_0 = A_{hfs}/\mu_B$,where A_{hfs} is the ground-state hyperfine coupling coefficient and μ_B is the Bohr magneton. For such strong magnetic fields when I and J are decoupled (Hyperfine Paschen Back (HPB) regime) the eigenstates of the Hamiltonian are described in the uncoupled basis of J and I projections $(m_J; m_I)$.

Among all the alkali metals, ^{39}K atom has the smallest value of the ground state hyperfine coupling coefficient: $A_{hfs}(^{39}\mathrm{K}) = 231\hbar$ MHz. Consequently, the magnetic field required to decouple total electronic angular momentum J and nuclear spin momentum I (HPB regime) is $B \gg B_0(^{39}\mathrm{K}) = 160$ G. Note that $B_0(^{85}\mathrm{Rb}) \simeq 0.7$ kG and $B_0(^{87}\mathrm{Rb}) \simeq 2.4$ kG. Thus, $B_0(^{39}\mathrm{K})$ value is more than 4 times smaller than that for ^{85}Rb and 15 times smaller than that for ^{87}Rb. This means that complete HPB regime for ^{39}K can be observed for much smaller external magnetic fields [1]. It is demonstrated that the use of recently developed setup based on nano-cell filled with K metal (L = 770 nm) allows us to study behavior of atomic transition of ^{39}K atoms D_1 line in a wide range of magnetic fields.



(a) **(b)**

Figure 1: *(a) Transmission spectrum of ^{39}K vapor contained in the nano-cell with L = 770 nm for $B = 230, 400, 572$ and 917 G and σ^+ excitation. (b) The diagram of the hyperfine structure of the D_1 line of the ^{39}K HPB regime, the selection rules are $\Delta m_J = 1, \Delta m_I = 0$.*

It is experimentally demonstrated that from 12 Zeeman transitions allowed at low B-field only 4 transitions remain in absorption spectra at $B > 200$ G (Fig. 1a). A complete HPB regime for relatively low magnetic fields $B \simeq 1.6$ kG has been observed. The theoretical model very well describes the experiment.

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References

[1] A. Sargsyan, A. Tonoyan, G. Hakhumyan, etc., `http://www.arxiv.org/abs/1502.07564v1`