Behaviour of atomic transitions of Rb D_2 line in strong magnetic fields

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It is well known that the energy levels of atoms in external magnetic fields undergo splitting into a large number of a Zeeman sublevels which are strongly frequency shifted. Simultaneously, external magnetic fields cause changes in atomic transition probabilities. There is a huge number of applications of magneto-optical processes in atomic vapor of alkali metals [1, 2]. An efficient "$\lambda/2$-method" (is the resonant wavelength of laser radiation) based on nanometric-thin cell filled with Rb is implemented to study the splitting of hyperfine transitions of ^{85}Rb and ^{87}Rb D_2 line in an external magnetic field in the range of $B = 3$ kG - 7 kG. It is experimentally demonstrated that from 38 (22) Zeeman transitions allowed at low B-field in ^{85}Rb (^{87}Rb) spectra in the case of σ^+ polarized laser radiation, only 12 (8) remain at $B > 5$ kG, caused by decoupling of the total electronic momentum J and the nuclear spin momentum I (hyperfine Paschen-Back (HPB) regime) (Fig. 1a). In particular, the $\lambda/2$-method has allowed us to resolve 20 atomic transitions (which are regrouped in two separate groups of 10 atomic transitions each) and to determine their frequency positions, fixed (within each group) frequency slopes, as well as the probability characteristics of the transitions (Fig. 1b). The experiment agrees well with the theory. Possible applications are described.

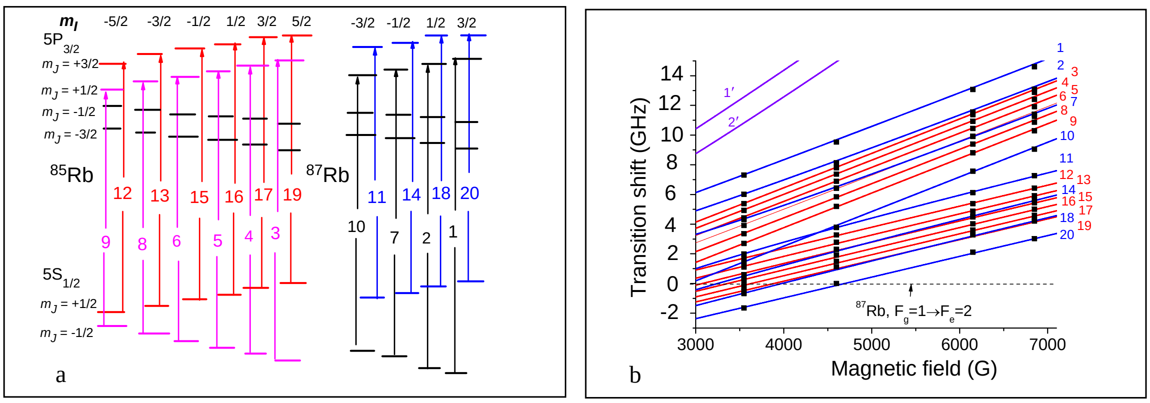

Figure 1: *a) Diagram of ^{85}Rb (left side) ($I = 5/2$), and ^{87}Rb (right side) ($I = 3/2$) D_2 line transitions for σ^+ laser excitation in HPB regime. The selection rules: $\Delta m_J = +1$; $\Delta m_I = 0$. For ^{85}Rb there are 12 transitions marked by the respective numbers $3-6, 8, 9, 12, 13, 15, 16, 17$ and 19; for ^{87}Rb there are 8 transitions marked by the respective numbers $1, 2, 7, 10, 11, 14, 18,$ and 20. b) Frequency positions of the Rb D_2 line atomic transitions $1-20$ versus the magnetic field. Solid lines are the calculated curves and black squares are the experimental results (with an error of 3%). At $B > 4.5$ kG the transitions are regrouped to form two groups of ten transitions each.*

References

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