Alkali atoms in a strong transverse magnetic field: "guiding" transitions foretell behavior of all transitions of D_1 line

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We report the existence of so-called "guiding" atomic transitions (GTs) in the system of transitions between magnetic sublevels of the hyperfine structure of D_1 lines of all alkali metal atoms in the case of linear (π) polarization. They allow predicting the probabilities of all atomic transitions in their group in strong transverse magnetic fields, as well as their frequency shifts with respect to magnetic field. In the case of the D_2 lines, GTs are absent. This effect was experimentally observed in rubidium vapor with the use of a half-wavelength cell ($\lambda/2$-method) [1].

An experiment with a nanocell filled with Rb atomic vapor with a thickness of half the wavelength $L = \lambda/2 = 398$ nm for ensuring a sub-Doppler spectral resolution has completely confirmed the presence of guiding transitions shown in Fig.1. Two groups of six transitions for ^{85}Rb and two groups of four transitions for ^{87}Rb have been detected in the transmission spectra in magnetic fields above 4 kG. A guiding transition has been identified in each of four groups. Four transitions forbidden at $B = 0$ have been detected too; also their probabilities approach the probabilities of the guiding transitions with an increase in the magnetic field.

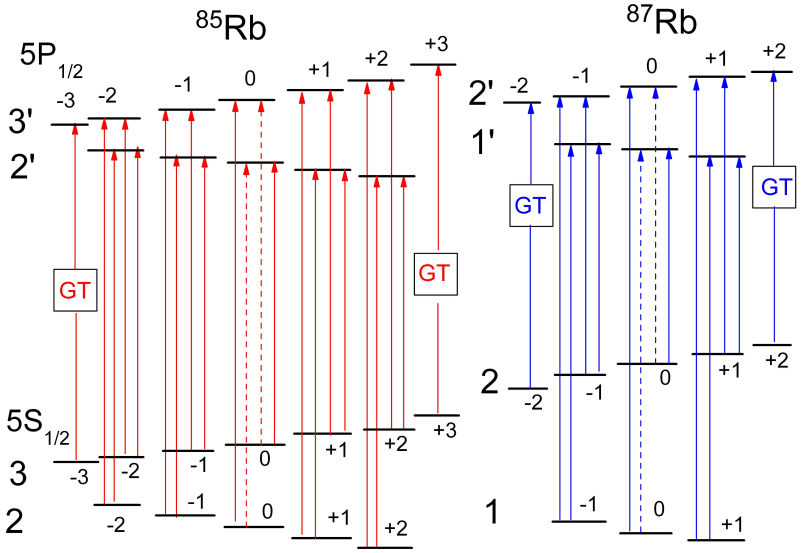

Figure 1: *Diagram of the atomic transitions of D_1 line in ^{85}Rb (22 transitions) and in ^{87}Rb (14 transitions) in magnetic field $B << B_0$ ($B_0 = A_{hfs}/\mu_B \cong 0.7$ and 2 kG for ^{85}Rb and ^{87}Rb, respectively) in the case of π-polarized radiation ($\Delta F = 0,\pm 1$, $m_F = 0$, the dashed arrows indicate forbidden transitions). Squares mark GTs.*

The good agreement of the experimentally measured spectra with the theoretical predictions proves that the $\lambda/2$-method makes it possible to quantitatively trace the behavior of each individual atomic transition in the magnetic field. GTs exist for the D_1 lines of all alkali metal atoms.

References

[1] A. Sargsyan, G. Akhumyan, A. Papoyan, D. Sarkisyan, JETP Lett. **101**, 303-307 (2015).