Spectroscopy of $5D_{3/2}$ and $5D_{5/2}$ levels of ultracold rubidium atoms in an external electric field.

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An accurate experimental determination of atomic level polarizabilities in an electric field remains an important issue in modern spectroscopy as it allows to improve the accuracy of atomic clocks [1, 2] and stimulates progress in the theoretical modelling of atoms in an external field. In order to verify theoretical models, it is desirable to be able to compare calculation results with experimentally determined polarizabilities of various atomic levels. The major challenge, from both experimental and theoretical viewpoints, is to determine the polarizability of atomic states that are rather highly excited but do not lie in the Rydberg spectrum (where one can use asymptotic models).

In particular, it is interesting to measure the polarizability of the $5D_{3/2}$ and $5D_{5/2}$ levels of Rb atoms as there are very different theoretical predictions depending on the model [3, 4]. The polarisability of a level can be determined from its Stark shift in an external electric field.

In this contribution we represent our measurements of the scalar and tensor polarizabilities of the $5D_{3/2}$ and $5D_{5/2}$ levels of the Rb atoms as well as the research on efficient coherent excitation of the 5D level of ultracold rubidium atoms with short laser pulses with reversed pulse sequence (Stimulated Raman Adiabatic Passage).

In order to obtain efficient excitation to 5D level and to avoid Rabi splitting we used Stimulated Raman Adiabatic Passage [5]. We achieved 80% population of 5D level with this technique.

We studied Stark shift of the $5P_{3/2}$-$5D_{5/2}$ and $5P_{3/2}$-$5D_{3/2}$ transitions of Rb atoms in a magneto-optical trap [6]. Measurement errors were less than 1% that allowed us to detect differences in the Stark shift for different polarization of the exciting laser pulses and hyperfine levels and therefore to determine not only scalar but also tensor polarizability of this levels. Measured polarizabilities were compared to the theoretical predictions.

References:

[1] S. Ulzega, A. Hofer, P. Moroshkin, A. Weis, Eur. Phys. Lett. **76**, 1074 (2006).
[2] K. Beloy, U.I. Safronova, A. Derevianko, Phys. Rev. Lett. **97**, 040801 (2006).
[3] A.A. Kamenski, V.D. Ovsiannikov, J. Phys. B. At. Mol. Opt. Phys., **39**, 2247 (2006).
[4] D.A. Kondrat'ev, I.L. Beigman, L.A. Vainshtein, Kratk. Soobshch. Fiz., **12**, 3 (2008).
[5] S.A. Snigirev, A.A. Golovizin, G.A. Vishnyakova et al, Quantum Electronics, **8**, 42 (2012).
[6] A.V. Akimov, E.O. Tereshchenko, S.A. Snigirev et al, Zh. Eksp. Teor. Fiz., **136**, 419 (2009).