SPECTROSCOPY OF ATOM PAIRS AND COLD COLLISIONS

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By the recent developments on cold atomic ensembles, cold atomic collisions, Feshbach resonances at zero kinetic energy and finally cold molecules, the need for precise spectroscopy on diatomic alkalis gained a high importance. Most researchers discovered that the spectroscopic effort on such species stopped some time ago and moreover, just before that energy range where the interest of the community for ultracold atoms starts. During the last years we used laser fluorescence excitation in combination with high resolution Fourier transform spectroscopy to study the complete energy interval of binding potentials for the coupled system of singlet-triplet states of the atomic ground state asymptote. We will report in this talk the wide application on homo and hetero nuclear molecules(e.g. $NaRb$, $NaCs$, and $LiCs$ [a]) to derive precise data which are able to model ultra cold collisions reliably including resonance structure.
The spectra show clearly hyperfine structure and the singlet-triplet coupling by hyperfine interaction, which is taken into account by coupled channels calculations during the evaluation. In recent developments we included also in our fitting process the observed Feshbach resonances, for which we give the well developed example of KRb.
The next steps of experimental development will be the application of molecular beams to increase the accuracy of the modeling. First positive results using Franck-Condon pumping to reach the molecular levels located directly at the atomic ground state asymptote were obtained for Na_2 [b] some years ago. Recently, we succeeded in observing NaK in the beam.

[a] example NaCs: O. Docenko, M. Tamanis, J. Zaharova, R. Ferber, A. Pashov, H. Knöckel, E. Tiemann *J. Phys. B: At. Mol. Opt. Phys.* 39, S929-S943, 2006

[b] Chr. Samuelis, E. Tiesinga, T. Laue, M. Elbs, H. Knöckel, E. Tiemann *Phys. Rev. A* 63, 012710, 2001