Photodetachment thresholds to highly excited states in Na

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Lindahl et al. recently showed that the observed photodetachment cross section in the 5^2G channel in K^- was strongly supressed in the region just above its threshold. This behaviour could not be explained by existing models [1]. In contrast to many other states, it was found that the 5^2G state has a large negative polarizability [2]. A new qualitative model to describe detachment in a repulsive potential was developed. However, an unambiguous test of the model was not possible due to the presence of a competing resonant process which, in the region of interest, dominated over the non-resonant process.

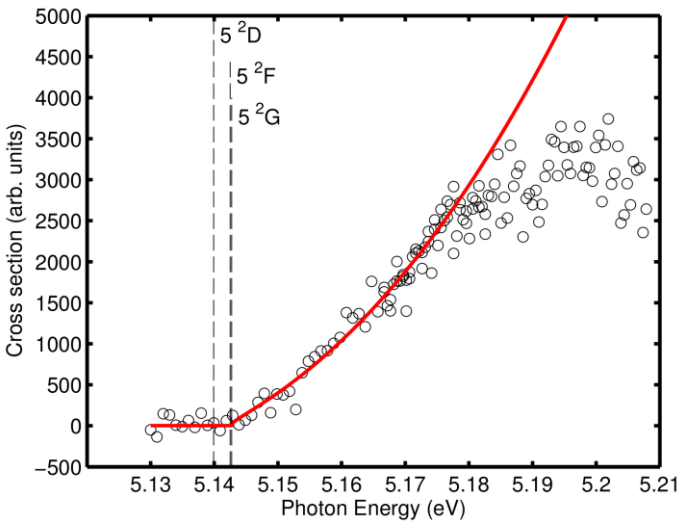

Fig1. *Photodetachment cross section for the reaction $Na^-(3^1S) + \gamma \rightarrow Na(5^2G)$. The red line represents a fit of the model to the*

We here report on an experiment on Na^- in which we identified a photodetachment threshold of a state with large negative polarizability with no competing resonant process. In the experiment, a 6 keV beam of Na^- was overlapped collinearly with a tuneable UV laser. Photodetachment by absorption of a UV photon resulted in a distribution of Na atoms occupying all energetically available states. State selectivity was achieved by using a two step resonant ionization scheme with the help of a second tuneable laser and electric field ionization. Dispersion in the field ionizer was used together with a position sensitive detector to reduce unwanted contributions to the measured signals.

Photodetachment cross sections of Na^- resulting in the final states Na(5^2D), Na(5^2F) and Na(5^2G) have been measured. The cross section for the Na(5^2G) channel is shown in Fig 1. Similar to K^-, the cross section is greatly suppressed due to the state's large negative polarizability. For Na^-, however, there are no interfering resonances and the model of Lindahl et al. is applied directly as the only contribution to the form of the cross section. A fit of the model to these data is shown in Fig. 1. Photodetachment cross sections of the two channels Na(5^2D) and Na(5^2F) show threshold behaviour similar to those reported previously by Sandström et al. [3] for Li^- and K^- due to the large positive polarizabilities of the states.

Development is under way to modify the detection system to extend further the measurement technique. Future experiments include doubly excited states in Li^- and double photodetachment of e.g. K^-.

References:
[1] A. O. Lindahl, J. Rohlén, H. Hultgren, I. Kiyan, et al. Phys. Rev. Let. **108**, 33004 (2012)
[2] C. N. Liu, Phys. Rev. A **64**, 052715 (2001)
[3] J. Sandström, G. Haeffler, I. Kiyan, U. Berzinsh et al. Phys. Rev. A **70**, 052707 (2004)