Radiative lifetimes in atomic negative ions

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Abstract

The first new scientific output from the Double ElectroStatic Ion Ring ExpEriment (DESIREE) was a measurement of the lifetime of the metastable $^2P^o_{1/2}$ level in $^{32}S^-$ [1]. Since then, the lifetimes of excited states in several atomic negative ions have been measured. The method has also been applied at the Cryogenic Storage Ring (CSR) in Heidelberg where Si^- was investigated [2].

Transitions between bound states in atomic negative ions are in most cases forbidden. This leads to very long lifetimes of the excited states, which only can be investiated if the ions can be stored for long times. The lifetimes are measured using the laser photodetachment spectroscopy technique where an OPO laser is used to photodetach only the excited state(s) in the ion. The ions are produced in a sputtering process which yields very high populations in excited states. The lifetime can be probed measuring the population of the excited state as a function of the time after injection into the ring. These experimental results can be used to benchmark theoretical methods that go beyond the independent particle model, since such models break down in the case of negative ions.

Some of the ions that have been studied are Ir^-, Bi^-, Rh^-, Sb^- and W^-. One of the ions that has been studied recently is $^{75}As^-$, where two excited states were observed. The preliminary results indicate a $^3P_1$ state with a lifetime of 43.1(11) s shown in figure 1.

I will in this work present the experimental method and the give a brief overview of the work done so far.

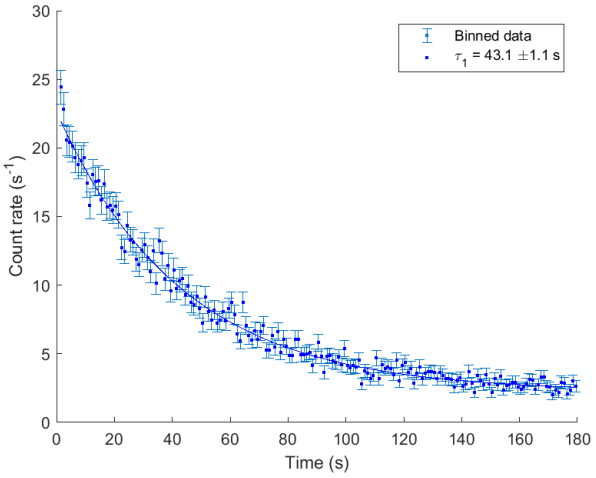

Figure 1: Preliminary results for the lifetime measurements of one of the $^3P_1$ in $^{75}As^-$.

References

[1] E. Bäckström et al. *Physical Review Letters*, 114(14), 4 2015.

[2] D. Müll et al. *Physical Review A*, 104(3), 9 2021.