Towards laser cooling of atomic negative ions

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Synopsis Laser cooling of La^- ions is prepared both with spectroscopy and trapping experiments.

The research project aims to directly laser cool a negatively charged atom species. Achieving this goal would open up the possibility to perform a wide range of low-temperature experiments with anions, including precision gravity measurement on antimatter [1].

Among the few atoms predicted to have a dipole allowed bound transition [2] we concentrate our experimental studies on La^-. This atom was identified as the most promising candidate among all the others for a successful application of Doppler laser cooling [3,4].

Negative ions are produced in our experiments as a beam in a Cs sputtering source. On the one hand the atomic transitions and energy states are investigated directly on the beam in a mixed collinear and transversal spectroscopy set up. Internal states are probed via a two-step excitation process. A first photon drives the bound transition from the ground state and a second photon detaches the excess electron. This scheme generates a neutral component in the beam which is used as signal during the measurement.

On the other hand to reach longer interaction time between atoms and the light field a double trap experiment is being commissioned. Successful slow down and confinement of Au^- particles was achieved in a Penning trap. After capture ions will be transferred to a radiofrequency trap where laser cooling will take place.

References

[1] A. Kellerbauer, J. Walz, 2006 *New Journal of Physics* **8**, 45

[2] S. M. O'Malley, D. R. Beck, 2010 *Phys. Rev. A* **81**, 032503

[3] C. W. Walter, N. D. Gibson, D. J. Matyas, C. Crocker, K. A. Dungan, B. R. Matola, and J. Rohlén, 2014 Phys. Rev. Lett. **113**, 063001

[4] E. Jordan, G. Cerchiari, S. Fritzsche, A. Kellerbauer, 2015 *Phys. Rev. Lett.* **115**, 113001

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