GÖTEBORGS UNIVERSITET

Two-Electron Excitations in Negative Ions

Fil. lic. Anton O. Lindahl
Institutionen för Fysik
Naturvetenskapliga fakulteten

Akademisk avhandling för filosofie doktorsexamen i Fysik, som med tillstånd från Naturvetenskapliga fakulteten kommer att offentligt försvaras fredagen den 28 oktober 2011 kl. 09:15 i Kollektorn, Institutionen för fysik, Kemivägen 9, Göteborg.

ISBN: 978-91-628-8363-8

Two-Electron Excitations in Negative Ions

Anton O. Lindahl

Department of Physics
University of Gothenburg
Göteborg, Sweden

Abstract

The main goal of this work has been to increase the knowledge of electron-electron correlation through experimental studies of negative ions. Negative ions are atoms or molecules to which an extra electron has been attached. Due to the energy sharing between the electrons, the effects of electron interactions, and thus electron-electron correlation, are relatively large in these systems. Comparisons of experimental data and results from *ab initio* many-body calculations can therefore serve as sensitive tests of our knowledge of these correlation effects.

This thesis describes experimental investigations of fundamental properties of atomic negative ions. Photodetachment experiments have been performed with collinearly merged laser- and ion-beams. A new threshold behaviour have been observed in photodetachment of K^- into the $K(5\,^2G)$ channel. A semi-classical model has been developed, which qualitatively describes the behaviour as a result of the large and negative polarisability of the $5\,^2G$ state. Partial cross sections for K^- and Cs^- photodetachment to highly excited states in the residual atom have been measured. Two previously unobserved resonances have been identified in K^- below the $K(7\,^2P)$ channel opening, while a rich spectrum of resonances was observed in Cs^- below the $Cs(10\,^2P_{1/2,3/2})$ thresholds.

Improved values for the electron affinities of W and P and the fine structure intervals of P^- are presented. Moreover, the binding energy of the previously unobserved $^2S_{1/2}$ state in Pt^- has been determined, and photodetachment from a previously unknown bound state in W^- has been observed.

The experiments were made possible by extensive development of the experimental facility at GUNILLA (Göteborg University Negative Ion Laser LAboratory). A state-selective detection scheme utilizing resonance ionisation has been developed. It is based on excitation to a Rydberg state, which is field-ionised in an inhomogeneous field. The produced positive ion is subsequently detected with a position-sensitive detector. The resolution of the mass spectrometer has been substantially improved, which proved important in the W^- and Pt^- measurements.