LASER PHOTODETACHMENT OF NEGATIVE IONS

FUNDAMENTAL RESEARCH AND APPLICATIONS

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Laser Photodetachment of Negative Ions - Fundamental Research and Applications

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ABSTRACT

Photodetachment studies of atomic and molecular negative ions in the gas phase are presented. Negative ions are loosely bound quantum systems whose existence is strongly dependent on the correlations between the electrons. This makes sophisticated calculations of the structure and dynamics for these systems complex and experimental data are needed for verification. Negative ions are also important in applications such as plasma etching and atmospheric studies. One of the most important applications for negative ions is as the state of matter for injection in tandem accelerators used in Accelerator Mass Spectrometry (AMS), the most sensitive method for ultra trace isotope analysis. Using negative ions in the injection stage provides isobar suppression in cases where the contaminating isobar does not form stable negative ions. Several experiments on laser interaction with a beam of mass-selected negative ions are presented. The objective for these studies can be divided into three subgroups: structure studies, dynamic studies, and proof-of-principle experiments for applications of negative ions. In the first group, the value for the electron affinity and the fine structure splitting of phosphorus is refined. The value of the electron affinity of tungsten is improved and the origin of the photodetachment signal below threshold is discussed. Resonant structure in the cross section and the electron affinity of cerium is treated. Finally, a predicted excited state in platinum is observed experimentally for the first time. The second group consists of the lifetime measurements of metastable excited states for tellurium, selenium and silicon. These measurements were made at the magnetic heavy ion storage ring CRYRING at Manne Siegbahn Laboratories in Stockholm. The third and last group are proof-of-principle experiments of isobar and neighboring isotope suppression by laser interaction. Suppression of up to four orders of magnitude is reached and the implementation into mass spectrometric systems are discussed.

Keywords: Negative Ions, Laser Spectroscopy, Photodetachment, Electron Affinity, Mass Spectrometry, Radiative Lifetimes, Storage Rings.
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