

# PROPOSED NEGATIVE ION BEAM ACCELERATOR FACILITY FOR PHOTODETACHMENT AND PHOTOIONIZATION EXPERIMENTS AT THE SRC

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A compact, low energy, (< 50keV) negative ion accelerator end station is proposed in order to perform state-selective, high resolution photodetachment and photoionization experiments. Its research program will have two primary foci. The first focus involves the measurement of photodetachment cross sections in the negative ion continuum energy region using synchrotron photons in the 10 - 100 eV photon energy range. The predicted continuum state structure (energy locations, widths, and magnitudes) are very sensitive to specific atomic structure theory approximations, and experimental measurements such as the ones currently proposed will provide stringent tests of our understanding of the electron-electron and electron-nucleus interactions that occur in atoms and ions.

The second primary focus is to use the negative ion beam as a source to produce a pure-state, energetic neutral beam in order to perform photoionization experiments [1]. This would involve photodetaching the negative ion beam with low energy photons (< 3 eV) by an intense laser prior to the photoionization event. The photodetachment of a negative ion beam has several distinct advantages over the other process of electron capture neutralization of a positive ion beam in the generation of an energetic neutral beam. The photodetachment process can ensure a pure state neutral beam whereas the electron capture process in many situations can populate metastable states, resulting in a mixed initial state for the experiment. The other advantage is that the photodetachment process preserves the initial trajectories of the ion beam, whereas the electron capture process naturally involves heavy body collisions.

The first series of experiments that are proposed will probe the photon energy region from 4eV to 20 eV in a variety of relatively light elements. Gribakin, *et al.* [2] predicted the photodetachment cross sections for the outer np and nearby ns subshells of C<sup>-</sup> (2p<sup>3</sup>) <sup>4</sup>S, Si<sup>-</sup> (3p<sup>3</sup>) <sup>4</sup>S, and Ge<sup>-</sup> (4p<sup>3</sup>) <sup>4</sup>S. The np photodetachment cross sections have minima around 5eV above the negative ion ground states and then rise to maxima at around 8 eV before gradually falling again. The minima have widths of order of 0.5 eV, whereas the maxima have widths of several eV. By contrast, most of the predicted [3] resonances in Be<sup>-</sup> (<sup>4</sup>P<sup>o</sup>, <sup>4</sup>D<sup>o</sup>, and <sup>4</sup>S<sup>o</sup>) have widths of order of 10-50 meV. These proposed experiments complement previous photodetachment experiments of the authors at lower photon energies.

An apparatus is proposed for conducting these ion/neutral - photon experiments. Briefly, it will consist of a 0 - 50kV negative ion accelerator; a dodecapole energy analyzer for merging the ion and synchrotron photon beams; an interaction chamber for the ion/synchrotron photon interactions as well as the option for a crossed laser beam for photodetachment to produce a neutral beam; and data acquisition chamber which includes: a magnetic analyzer for de-merging the positive, neutral, and negative ion beams; and a hemispherical energy analyzer to perform energy analysis on the photoejected electrons.

## References

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