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Accelerator-Based Atomic Physics Experiments
with Photon and Ion Beams*

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Accelerator-based atomic physics experiments at Brookhaven presently use heavy-ion beams from the Dual MP Tandem Van de Graaff Accelerator Facility for atomic physics experiments of several types. Work is presently in progress to develop experiments which will use the intense photon beams which will be available in the near future from the ultraviolet (UV) and x-ray rings of the National Synchrotron Light Source (NSLS). In this abstract we describe plans for experiments at the NSLS and then summarize an exciting development in instrumentation for heavy-ion experiments.

A new phase of our program[1] which is now being implemented is the use of the National Synchrotron Light Source for atomic physics experiments. We plan to start the experimental work by putting together ion source assemblies which produce positive and negative heavy-ion beams of any desired element for use in crossed or merged ion-photon beam experiments. The first experiments will probably be done on the UV ring with later work at the x-ray ring when it is operational. A dedicated beam line for atomic physics experiments is now being fabricated for the X-26 port on the NSLS x-ray ring. It is planned to start work at the x-ray ring with experiments that can be done with the white radiation that will be available at the onset of machine operation. In particular, we ultimately plan to do experiments that will utilize the new PHOBIS[2] concept for production and storage of multiply charged ions at very low energies. Work for about the next year will be devoted to testing and development of the basic trapping technology.

At the Tandem Facility study of electron impact excitation and ionization of heavy ions is of substantial importance for experimental substantiation of theoretical calculations, to provide experimental data which can be used to interpret plasma processes and as input data to be used for design of plasma production devices. Such experiments have been very difficult because of the low particle densities in the electron beams.

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In order to circumvent some of these problems, we have used[3] a hollow cathode plasma source 1 m long as a source of electrons. It is estimated that it will be possible to obtain electron densities of at least 10^{13} cm^{-3} when the plasma has been fully tuned. This represents an increase in effective target density of several orders of magnitude when compared to the target density obtainable with electron beams. The plasma is electrically neutral, of course, and suitable allowance must be made for the Coulomb ionization produced by the H^+ ions present. This is not a great problem since these cross sections are relatively small. Variation of relative energies can be accomplished to some degree by changing the energy of the heavy ion beam. The major experimental difficult encountered thus far is to provide sufficient diagnostics for the plasma so that the geometries for a true merged beam experiment can be attained. A first experiment[3] has been carried out to study neutralization efficiency for beams of heavy negative ions that can be considered for neutral beam heating of tokamak plasmas. The results demonstrate the usefulness of the plasma targets. Modifications of the set-up to optimize conditions for crossed beams are under consideration.

The extensive use of the new plasma target at the Tandem Facility and the implementation of new experiments at the NSLS will make it possible to ask and answer sophisticated questions concerning ion/photon-atom interactions which have previously been closed to experimental verification.

References

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