Photoionization Cross Sections of Atoms and Ions Related to Astrophysical Problems

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A project of calculation for the photoionization cross sections of atoms and ions of astrophysical interest has been initiated. The project envisions three principle goals: To provide cross sections as input for modelling of various astrophysical problems; To develop methodologies to calculate such photoionization cross sections which provide results of known accuracy; To offer a check on the accuracy of the extensive (but unassessed) Opacity Project data base[1]. The most difficult systems to deal with are those with a high degree of correlation (many-body interactions) among the target electrons. To test methodologies on such systems, we concentrate, to begin with, upon transition metal atoms and ions, where the open 3d shell opens a Pandora's Box of many-body correlations, and negative ion photoabsorption, where many-body interactions are required even for binding the ground state. Among the theoretical methodologies which are being brought to bear on these problems, often with in tandem and with modifications to enhance accuracy, are many-body perturbation theory (MBPT), multiconfiguration Hartree-Fock (MCHF), relativistic random phase approximation (RRPA), R-matrix with pseudostates (RMP), eigenchannel R-matrix (ERM), multichannel quantum defect theory (MQDT), and Fano continuum configration interaction (FCCI), among others.

Prelimimary results of this research program have been most encouraging. We have studied photoionization of the ground states of Sc and Sc^{++} among the transition metal atoms and ions [2,3] using a modified MBPT in conjunction with MCHF and a coupled channel matrix diagonalization technique. Investigation of the excited metastable 1s2s2p ^4P state of He^- employing MCHF in a FCCI formalism has also taken place [4,5]. The Ne isoelectronic sequence has also been scrutinized using a combination of RRPA and MQDT, along with some new enhancements we have introduced [6]. A selection of these and other results will be presented for a number of cases to give a flavor of the success of this program to date.

References:

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