Theoretical Approaches to Electron-Impact Ionization

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Electron-impact ionization cross sections are one of the fundamental constituents of the myriad sets of atomic data required for plasma modeling. A short review will be given of the various theoretical approaches to computing such ionization cross sections. Examples include perturbative approaches based on distorted-wave theory, and non-perturbative approaches based on close-coupling expansions. Non-relativistic, semi-relativistic, and fully-relativistic versions of these methods are generally available. The availability of computing packages to generate such cross sections is also discussed. For example, ionization cross sections may be obtained using distorted-wave (and/or scaled hydrogenic) methods using the Los Alamos suite of atomic structure and collision codes [1], available online [2]. Such methods are relatively computationally inexpensive, and increase in accuracy as the charge of the target ion increases.

Close-coupling approaches to electron-impact ionization include the convergent close-coupling method [3], R-matrix approaches [4], and time-dependent close-coupling methods [5]. These approaches have, for the most part, been applied to neutral and near-neutral systems, where differences with perturbative methods can become significant. However, all of these calculations are normally quite computationally expensive.

This talk will provide some examples of the ionization cross sections for a selection of atoms and ions, and present comparison with measurements, where available. We will also start a discussion of how the uncertainty of these cross sections can be determined, and what calculations are most needed for future fusion modeling efforts.

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