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Known and unknown in electron-atom and molecule scattering

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The variety of atomic and molecular processes in fusion plasmas requires detailed knowledge and/or prediction of numerous cross sections, both for scattering on neutral as well on ionized species. A brief outline of the state of data from experiments, theories, semi-empirical methods and existing databases will be given. Our recent work on electron-CH_4 [1] will be used as an exemplary case.

The state of knowledge on cross sections will be classified according the level of certainty that can be ascribed to every process (and class of targets).

• Elastic cross sections are pretty well known for small targets, like CH_4 but experiments and theories lack and/or disagree on polar targets (including H_2O), and heavier targets (like C_6H_6).

• The level of agreement between elastic and momentum transfer cross sections is still poor for molecular targets. Re-analysis of existing swarm , cross-check of different modeling codes (two-term Boltzmann, multi-term, Monte Carlo) and new beam measurements at low energies are needed.

• Born approximation works pretty well for IR-active vibrational cross sections but not for Raman modes; various theories generally disagree, especially at resonances

• Rotational excitation, especially on polar molecules, could be also described by Born approximation, but even for water [2] the picture could be more complicated

• Ionization cross sections (integral and differential) cross sections can be described by Born-Bethe Binary Encounter Model (BEB), and agrees well with experiments as we analysed the case of series CH_4-CH_3F…-CF_4 [3]. That model operates only two parameters – the kinetic and potential energy of electrons at a given molecular orbital. However, we are not able to predict *partial* ionization cross sections: work is in progress.

• Electronic excitation cross sections present the biggest challenge: recent calculations [4] in CH4 agree with experiments on dissociation cross sections but direct electronic excitation measurements seem unreliable.

A tentative map of "white spots" in knowledge of cross sections for scattering on ions, radical and molecules in species relevant to fusion plasmas will be discussed.

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