GEC08-2008-000347

Abstract for an Invited Paper
for the GEC08 Meeting of
the American Physical Society

The role of atomic and molecular collision processes in plasmas - and vice versa[1]

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A broad base of accurate data of atomic and molecular collision processes is essential for reliable modelling, simulation, and diagnostics of plasmas. This is particularly important for plasmas at elevated pressures close to atmosphere. This regime attracts rapidly growing attention due to both - promising innovative technological applications as well as new fundamental scientific phenomena. The collision dominated environment and decreasing dimensions down to microscale plasmas with extremely high surface to volume ratios significantly increase the demand for collisional deactivation and surface interaction processes. Cross sections for collisional deactivation can be determined from the effective lifetime of excited states. Direct excitation using short pulse laser systems are most reliable however limited by optical selection rules and available photon energies. Recently improved understanding of the dynamics of electron impact excitation in radio-frequency discharges allows alternative strategies using space and phase resolved optical emission spectroscopy measurements coupled with careful modelling of the population dynamics of excited states. This method based on electron impact excitation is not limited by optical selection rules and also provides access to high energetic electronic states which are not accessible with common laser systems. Data for surface interactions is inherently delicate since it strongly depends on surface properties such as coverage and temperature. Nevertheless, reliable data for recombination of radicals and metastable states, and coefficients for secondary electron emission are highly desirable for consistent modelling and simulation. An alternative approach is the active implementation of experimentally measured surface sensitive parameters such as atomic radical densities and excitation structures caused by secondary electrons. These experimentally accessible quantities can be used as fixed input parameters in improved self-consistent modelling.

[1]Supported by: DFG and EPSRC