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Line Shapes of Fast Hydrogen Atoms in a Low Density Gas Discharge: Challenges and Applications

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For many years plasma spectroscopy established itself as one the most powerful and robust technique to deliver information on the plasma parameters such as gas pressure, electron density and tempera-ture or the electric field in the plasma sheath. But could the emission spectroscopy go beyond these limits and provide the answers on new challenges of low-temperature plasma physics? One of them is to determine the optical properties of the surface exposed to a plasma. In this talk I demonstrate that in Ar-H low density gas discharges (p¡1Pa) the emission of fast hydrogen or deuterium atoms in the energy range of 80-300 eV at plasma-solid interfaces replaces to a certain extent the conventional mirror laboratory. The Doppler effect observed for the Balmer-lines transfers the time-resolved measurements in the laboratory to in-situ measurements in the velocity domain. Fast atoms originate from neutralization of ions accelerated in the sheath at the surface of interest. The light emission is stimulated by collisions between these fast atoms and argon atoms. The measurements of total reflectance, polarization properties of the surface, real-time evolution of reflectance such as a transition between the specular and diffusive type and the modification of the surface morphology during the surface cleaning are only a few examples of this powerful technique which emerged recently. In contrast to the expectations based on the atomic data set for the emission cross-sections of Balmer-lines, the signal of fast atoms in other noble gases remains extremely weak. The excitation of H atoms by collisions with Kr is, for instance, a factor of five weaker than the excitation by Ar atoms although the measured cross-sections are within 20% in the energy range of interest. It is proposed that the metastable fraction of Ar could play the dominant role in the excitation channel of Balmer-lines via an endothermal excitation transfer reaction.