Publ. Astron. Obs. Belgrade No. 84 (2008), 14 *Invited Lecture*

MODELING OF ANOMALOUS DOPPLER BROADENED LINES, THERMALIZATION OF ELECTRONS AND THE ROLE OF RADICALS IN DISCHARGES AT HIGH E/N

Z. Lj. PETROVIĆ, Ž. NIKITOVIĆ and V. D. STOJANOVIĆ
Institute of Physics, Pregrevica 118, 11080 Zemun, Serbia
E–mail: stoyanov@phy.bg.ac.yu

Abstract. Observations of anomalously broadened hydrogen lines in gas discharges were made in 60s and the explanations that followed were mainly based on dissociative processes. However, some observations, especially those of Benesch and Li (1984) could not be explained without evoking the directionality of the motion of ions. First full explanation of the effect and observations of energies exceeding few tens of eV were made on the basis of a swarm experiment carried out by Petrović et al. (1992) which revealed the need to include a new effect, that of the reflection of fast neutrals from the cathode with sufficient energies to produce hydrogen radiation. The model that was developed although having a correct physical phenomenology was based on approximate treatment of non-hydrodynamic transport, i.e. essentially on a beam like treatment of energy distribution functions with the mean energy calculated from the energy balance. In the meantime the set of pertinent atomic collisions has become much more complex and we have based the calculations on a Monte Carlo simulation which gives exact energy distributions. We will present the results on all details of kinetics of relevant particles, from electrons to ions, molecules and atoms. We will also stress the need to model more accurately the heavy particle collisions, especially the angular anisotropy of scattering.

Thermalization of electrons produced by cosmic rays from very high energies and the resulting emission of nitrogen radiation has been proposed as a means to detect properties of extremely high energy elementary particles. The process is exactly the opposite to that taking place in high E/N discharges and may be treated exactly by a similar Monte Carlo code if the applied cross sections are correct.

Finally we will discuss how dissociated fragments affect the transport properties of electrons having in mind applications such as plasma etching of SiO_2 where abundances of radicals of CF_x are of the order of several percent. The principal effect of radicals on electron transport in pure CF_4 or in CF_4/Ar mixtures is through very different attachment rates which leads to orders of magnitude different effective attachment rate for the mixture with radicals as compared to the properties of pristine buffer gas. Thus one may conclude that even the electronegative nature of the plasma may be changed due to the presence of different radicals, especially of CF_2.

References

Benesch, W., Li, E.: 1984, *Opt. Lett.*, **9**, 338.
Petrović, Z. Lj., Jelenković, B. M., Phelps, A. V. : 1992, *Phys. Rev. Lett.*, **68**, 325.