Non-local kinetic effects in excitation rate profile formation in DC glow plasmas at middle and high pressures.

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The spatial electron fluxes, which arise in inhomogeneous plasmas in external fields play important role in low-temperature plasma. They result in a redistribution of particles and energy in the plasma volume, loss and generation of plasma. Moreover, these differential fluxes can be directed both inward and outward producing nontrivial behavior of spatial plasma characteristics in non-local plasmas [1].

In this paper modeling of discharge column gas plasma is proceeded to reveal phenomena which result from their complicated structure at moderate and high pressures when EDF is formed by energy exchange in elastic collisions (Dryuvestein–Davydov EDF).

Computational simulation for argon gas consisted of Ar atoms, metastable atoms Ar*, radiating Ar**, positive ions Ar+, and electrons have been performed. The model involves direct ionization, electronic excitation from ground-state atoms, step-wise ionization from metastables, Penning ionization, and de-excitation. To provide simulations COMSOL MULTIPHYSICS TM modules which are iterated to a converged solution have been used. The calculations have been performed in the wide range of pressures from 3 to 40 Torr for the different energy dependences of elastic electron cross sections $\sigma_{el}(w)$.

It is shown, that the radial profile of excitation rate are very sensitive to the choice of $\sigma_{el}(w)$. The position of maximum shifts to the periphery and takes place only when elastic cross section increase with energy. Thus, this fundamental fact illustrates that paradoxical excitation rate profiles arise from processes which determined by group of electrons rather than total electron ensemble.