ELECTRON TEMPERATURE RELAXATION IN THE CLUSTERIZED ULTRACOLD PLASMAS

Dumin Yu. V.,*[1,2] ***Lukashenko A. T.***[3]

[1]*MSU, SAI, Moscow, Russia,* [2]*IKI RAS, Moscow, Russia,* [3]*MSU, SINP, Moscow, Russia*

**dumin@yahoo.com*

The ultracold plasmas are a promising candidate for the creation of strongly-coupled Coulomb systems. Unfortunately, values of the electron coupling parameter Γ_e actually achieved after photoionization of the neutral atoms usually remain relatively small because of the considerable "intrinsic" heating of the electrons. A conceivable way to get around this obstacle might be to utilize a spontaneous ionization of the ultracold Rydberg gas, where the initial kinetic energies could be much less. However, the spontaneous avalanche ionization will result in a very inhomogeneous distribution (clusterization) of the ions, which can change the efficiency of the electron relaxation in the vicinity of such clusters substantially. In the present work, this hypothesis is tested by an extensive set of numerical simulations.

As a result, it is found that despite a less initial kinetic energy, the subsequent relaxation of the electron velocities in the clusterized plasmas proceeds much more violently than in the case of the statistically-uniform ionic distribution. The electron temperature, first, experiences a sharp initial jump (presumably caused by the "virialization" of energies of the charged particles) and, second, exhibits a gradual subsequent increase (presumably associated with a multi-particle recombination of the electrons at the ionic clusters).

As a possible tool to reduce the anomalous temperature increase, we consider also a two-step plasma formation, involving the blockaded Rydberg states. This leads to a suppression of the clusterization due to a quasi-regular distribution of ions. In such a case, according to our numerical simulations, the subsequent evolution of the electron temperature proceeds more gently, approximately with the same rate as in the statistically-uniform ionic distribution.

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