SPONTANEOUS TEMPERATURE INCREASE IN THE ULTRACOLD PLASMAS: DISORDER-INDUCED HEATING VS. VIRIALIZATION

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A well-known property of the ultracold plasmas is a very sharp jump of the electron temperature immediately after ionization of ultracold atoms (at the time scale about the inverse plasma frequency). Although this phenomenon was discovered already in the first experiments with ultracold plasmas, its clear interpretation is still missing. The most popular explanation is the so-called "disorder-induced heating" [1], but there is no detailed theory of this mechanism, and its conceptual basis is quite vague. Yet another explanation, put forward, in fact, even before the first laboratory experiments with ultracold plasmas, is the effect of "virialization" of the velocities of electrons moving in the strong microfields of the nearby ions [2, 3].

To discriminate between the two above-mentioned options, we recently performed the high-accuracy numerical simulations of the electron motion against the background of ions with different arrangement, ranging from an almost perfect lattice to the completely disordered system. Surprisingly, the relaxation of electron velocities was found to proceed exactly by the same way in all the cases of ionic background, characterized by the absolutely different degrees of their ordering. This fact enforces us to conclude that the "disorder-induced heating" cannot be a viable explanation of the experimental data.

On the other hand, as follows from the results of our simulations, a virial distribution of the electron energies is really established—at least, on the order of magnitude—in the course of the initial relaxation of the electron motion. Therefore, the mechanism of virialization should be a much better explanation of the performed experiments.

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1. Killian T. C., Pattard T., Pohl T., Rost J. M. // Phys. Rep. 2007. V. 449. P. 77.
2. Dumin Yu. V. // Prikladnaya Fizika. 1999. No. 5. P. 18. (In Russian)
3. Dumin Yu. V. // J. Low Temp. Phys. 2000. V. 119. P. 377.