SMOOTH DECREASE OF SPECTRAL SERIES LINES INTENSITY WHEN APPROACHING THE IONIZATION THRESHOLD IN A DENSE EQUILIBRIUM PLASMA. PART I. THEORY.

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I will consider the damping of spectral lines in dense plasma. That is, a decrease in the intensity of spectral lines of spectral series transitions as the transition energy increases.

This problem is related to the issue of limiting the statistical sum and statistical weight of the atom level. Studies of limiting the number of excited atoms appeared long ago and were considered by Bohr, Fermi, Planck, Larkin and others. The Planck-Larkin approach [1] is a solution for the two-body problem. However, such a description is not enough for plasma, because it represents a system of many bodies.

In dense plasma, the key limiter of states in the statistical sum is the transition from two-particle to multiparticle interactions. Molecular dynamics modeling was applied to account for these multiparticle interactions. The code for determining paired states, described in [2], was also used. At each step of the simulation, a search for the nearest ion was performed. If the energy of an electron and a proton is less than zero, then we consider them to be bound pairs.

As a result, graphs of the distribution of the concentration of pairs by energy were constructed. They were compared with experimental results on the occupancy levels.

The experimental points fit well on the theoretical dependence for d levels and poorly on the theoretical dependence for s levels. It has been suggested that the s level is poorly described by any classical modeling. For example, the orbital moment s of the electron level is 0, while the classical thermodynamic average angular momentum of electron motion is nonzero.

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1. M. Planck, Zur Quantenstatistik des Bohrschen Atommodels, Ann. Physik, 75, 673-684 (1924).
2. A. V. Lankin, G. E. Norman, Crossover from bound to free states in plasmas, Journal of Physics A: Mathematical and Theoretical, 42, 214032 (2009).