TO temperature dependence of shell eFFECTS contribution IN Plasma characteristics

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In the papers [1], [2] one of the authors reviewed the modern semiclassical ETF (extended Thomas-Fermi) method for describing properties of an electronic subsystem of the matter. The method employs the TF statistical model and includes the shell and other physical effects. It was shown that in spite of significant extension of the ETF method applicability area to a classical plasma, the method nevertheless corresponds to extreme matter states, i.e., to high temperatures and/or to high compressions.

Recently the attempts were activated both to improve the TF model calculations [3] and to modify it [4] taking into account shell effects nearly approach [1], [2]. Purpose of the paper is to attract attention to some restraints, which one may be confronted with when using the approach.

The method [1], [2] substantially uses smallness (in comparison with TF-term) and additivity of corrections. For high temperatures the smallness of shell correction and efficiency of its application were verified in the calculations of plasma ionicity and equation of state. However, when obtaining the simple formula for the shell correction some additional assumptions were made. The assump­tions were confirmed at high temperatures, but they require proving or change when temperature decreasing. They include:

* reducing of integration for the spectrum to efficient expressions, depending only on the value of chemical potential,
* quadratic dependency assumption of the radial action on the orbital angular momentum,
* neglect the orbital quantum number *l* discreteness.

The last assumption means that a summation over *l* is substituted by integration. There was shown in the recent paper of authors [5], that refusal of this approximation, namely the precise calculation of sum over *l*, substantially increases the accuracy of the semiclassical method when calculating ionization potentials of the free ions. However, it turned out that a plasma situation is much more complex and requires a more thorough study.

In the present report we discuss the correctness of assumptions enumerated above when a temperature decreasing and analyze results of their refusal by the example of calculating a number of single-particle states in a classical plasma.

References

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