The calculations of thermophysical properties of Pb plasma

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The thermophysical properties of metals have been studied for more than a century in different areas of phase diagram. Among these properties we will consider the equations of states and electronic transport coefficients (electrical conductivity, thermal conductivity and thermal power). The region of relatively high temperatures - approximately more than 5kK, where the plasma of metals is located - presents especial challenge both for measurements and theory [1]. It is the problem itself to penetrate into this area, without any other measurements. For instance, it is almost impossible to measure directly the temperature in corresponding experiments [2]. Nevertheless, during last two decades new measurements and calculations have appeared [3]. These studies have allowed one to shed light on the thermophysical properties of many metals in plasma state. However, for some metals there is still the shortage of data. For instance, for Pb there are measurements and calculations in plasma at relatively high temperatures and densities, for instance in the states of compressed warm dense matter [4]. But the data at expansion rarely reach even the critical density [5]. So present study is aimed to fill this gap.

Earlier we have developed a model for calculations of the considered thermophysical properties based on the chemical approach. Namely a substance is considered as a mixture of electrons positive ions, atoms. The free energy of this mixture can be minimized with respect to the particle densities of separate components. It allows one to find the ionic composition and thermodynamics values as the pressure, internal energy etc. Then the ionic composition is used to calculate the electronic transport coefficients within the relaxation time approximation. The chemical model has also some approximations for the free energy. They limits the considered approach by the density from above. Nevertheless our model was successfully applied to the plasma of gases, metals and semiconductors (see [6,7] and references therein). In present investigation we have applied our model to Pb plasma. We have calculated the pressure, internal energy, conductivity, thermal conductivity, thermal power at the densities less than 1 g/cm^3 and the temperatures 10 - 100 kK.

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