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Study of the influence of local field correction on the transport characteristics of hydrogen dense plasma

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The study of matter at high densities in astrophysical objects and modern experiments with high-intensity lasers is of great interest for many applications. Confirmation of the existence of liquid metallic hydrogen under high pressure will allow the development of theories about new states of matter. This, in turn, can find application in describing the state of matter in extreme conditions, such as the cores of planets and stars at different stages of their evolution. Metallic hydrogen can potentially be used as a fuel cell, since the transition of metallic hydrogen to the usual molecular state is accompanied by the release of energy 20 times greater than when burning a mixture of oxygen and hydrogen.

Also, many theoretical models predict the presence of superconductivity in metallic hydrogen, which has a very high critical temperature [1]. Thus, the transport and optical properties of the hydrogen medium at high pressures are important for a number of areas, including astrophysics [2-5]. In addition, the dense hydrogen medium at various temperatures is actively studied experimentally, where knowledge of the transport and optical properties is important for understanding the experimental results [6-8]. Hydrogen under such extreme conditions is characterized by moderately bound and partially degenerate electrons, as well as strongly bound ions.

This work is aimed at studying the transport and properties of hydrogen at high pressures, taking into account electron exchange-correlation effects. These properties of plasma can be calculated accurately taking into account the correction of the local field, obtained from the simulation by the quantum Monte Carlo method. The local field function (LFC) contains all the exchange-correlation effects in a wide range of densities and temperatures. The local field factor represents the degree of influence of particle interactions on the exchange and correlation properties of a system of homogeneous electron gas, and it is associated with the exchange-correlation factor. Using the local field correction approach, we have computed diffusion, viscosity, thermal conductivity and electrical conductivity. The potential to take into account quantum nonlocality in electron screening leads to a significant improvement in agreement with experiments and calculations (Fig.1). The studies conducted in this paper showed that the thermal conductivity values taking into account the local field correction are in good agreement with the results of other authors (Fig.2) [9].

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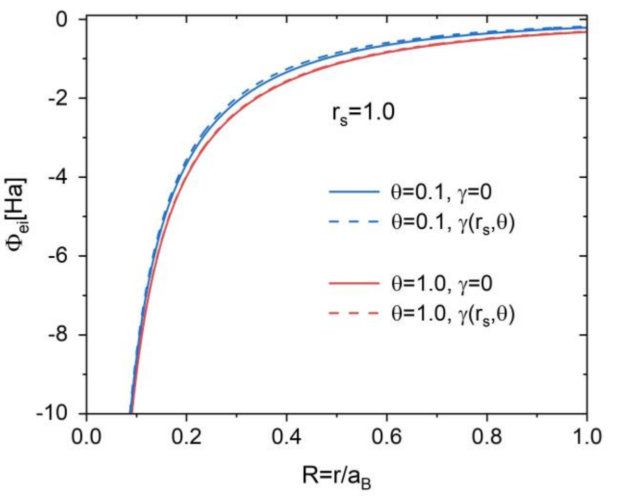

Figure 1. Effective potential of interaction of an electron with a hydrogen ion with and without the local field correction.

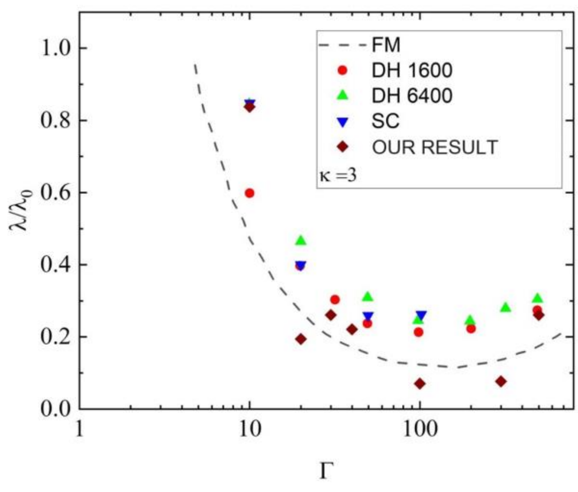

Figure 2. Reduced thermal conductivity at k=3. Salin and Caillol (SC) Faussurier and Murillo (FM) and Donko´ and Harmann (DH).