Effective Proton-Proton Interaction and Metallization of Hydrogen and Helium

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The effective proton-proton interaction in metallic hydrogen has been calculated for various densities. In the potential of this interaction, which can be represented in the form of a series of perturbation theory in the electron-proton interaction, the second and third order terms are taken into account. The second order term gives a comparatively shallow potential well with one minimum. The position of the minimum corresponds to the equilibrium mutual position of protons in metallic hydrogen. When the third order term is additionally taken into account, the potential has two characteristic minimums; the position of the one of them corresponds to the distance between the protons in a hydrogen molecule. The depth of these potential wells depends on the density of the system. At fairly high densities, only the potential well corresponding to the equilibrium position of protons in the metallic phase holds in the proton-proton potential. Owing to the presence of two minimums in the effective proton-proton potential, the density of hydrogen at the point of transition to the metallic state can be estimated. Analysis of the effective proton-proton interaction makes it also possible to estimate the possibility of the existence of metallic hydrogen in a stable state at quite low temperatures. Similarly, we've learned the pair effective ion-ion interaction in metallic helium