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Proton crystallization and quantum melting of proton crystals in a dense hydrogen plasma PAVEL LEVASHOV, VLADIMIR FORTOV, VLADIMIR FILINOV, Joint Institute for High Temperatures RAS, Moscow, Russia, HOLGER FEHSKE , Institut fur Physik, EMAU Greifswald, Germany, MICHAEL BONITZ, Institute for Theoretical Physics and Astrophysics, Kiel University, — We present extensive new simulation results which allow to predict the temperature and density range for proton crystallization. We simulate a macroscopic spatially homogeneous fully ionized two-component electron-proton plasma in thermodynamic equilibrium from first principles using direct fermionic path integral Monte Carlo simulations. Our results for the phase diagram differ substantially from the previous predictions based on the one-component plasma (OCP) model: In the classical part of the phase diagram the crystal appears to be stabilized compared to the OCP predition. In contrast, in the quantum part of the phase diagram the crystal appears to be de-stabilized and vanishes at lower densities compared to the OCP prediction. Finally, the maximum temperature for the proton crystal is found to be around 40 000K, slightly below the previous prediction. Our results indicate that the OCP treatment of the liquid-solid transition in a two-component plasma has to be questioned. The OCP-assumption of a homogeneous rigid neutralizing background gives rise to substantial deviations of the critical parameters.

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