Thermodynamic limit of non-degenerate hydrogen plasma using quasi-classical molecular dynamics

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In this study, we perform a quasi-classical molecular simulation of a hydrogen plasma in the weak degeneracy regime over a wide range of coupling parameters. The simulations utilize the improved Kelbg pseudopotential [1], which incorporates the quantum uncertainty principle, provides an accurate treatment of bound state formation, and enforces the Pauli exclusion principle to prevent same-spin electrons from occupying identical states. Furthermore, we employ the improved Kelbg-AAE pseudopotential using KelbgLIP [2], which accurately accounts for interactions with all periodic images.

Our findings are compared with Path Integral Monte Carlo simulations by Filinov and Bonitz [3]. We analyze the stability of hydrogen plasma, addressing the challenge of cluster formation at temperatures below 50 kK [1], and explore the dependence of equilibrium energy on the number of particles. The results confirm the effectiveness of the pseudopotential approach in describing systems with strong long-range interactions.

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[1] Filinov A V, Golubnychiy V O, Bonitz M, Ebeling W and Dufty J W 2004 *Phys. Rev. E* **70**(4) 046411 URL `https://link.aps.org/doi/10.1103/PhysRevE.70.046411`

[2] Demyanov G and Levashov P 2024 *Computer Physics Communications* **305** 109326

[3] Filinov A and Bonitz M 2023 *Physical Review E* **108** 055212