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Nuclear quantum effects on structure and transport properties of dense liquid helium DONGDONG KANG, JIAYU DAI, JIANMIN YUAN, National University of Defense Technology — Transport properties of dense liquid helium under the conditions of planet's core and cool atmosphere of white dwarfs are important for determining the structure and evolution of these astrophysical objects. We have investigated these properties of dense liquid helium by using the improved centroid path-integral simulations combined with density functional theory. The results show that with the inclusion of nuclear quantum effects (NQEs), the self-diffusion is largely higher while the shear viscosity is notably lower than the results of without the inclusion of NQEs due to the lower collision cross sections even when the NQEs have little effects on the static structures. The potential surface of helium atom along the simulation trajectory is quite different between MD and PIMD simulations. We have shown that the quantum nuclear character induces complex behaviors for ionic transport properties of dense liquid helium. NQEs bring more fluctuations of local electronic density of states than the classical treatment. Therefore, in order to construct more reasonable structure and evolution model for the planets and WDs, NQEs must be reconsidered when calculating the transport properties at certain temperature and density conditions.

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