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Ab Initio Plasmon Dispersion of the Warm Dense Electron Gas

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The plasmon dispersion $\omega(q)$ and damping $\gamma(q)$ contain important information on the state of warm dense matter. On the other hand, x-ray Thomson scattering (XRTS) experiments provide accurate data for the dynamic structure factor $S(q,\omega)$ that is directly linked to the plasmon spectrum [Glenzer et al., Phys. Rev. Lett. 98, 065002 (2007)]. However, details of this link depend on the quality of the theoretical model for the dielectric function. Here we present the first ab initio data for the dielectric function that is obtained by quantum Monte Carlo simulations [Dornheim et al. Phys. Rev. Lett. 121, 255001 (2018)]. This allows us to obtain high quality results for $\omega(q)$ and $\gamma(q)$ of the electron component at warm dense matter conditions that differ significantly from previous models. Second, we critically analyze the commonly used weak damping approximation for the dispersion and improve it by performing the analytic continuation of the retarded dielectric function. This yields results that apply at strong damping and large wave numbers as well, which is the basis for a more accurate comparison with XRTS experiments [Hamann et al., submitted for publication].

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