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Density Correlations in Ultracold Neutral Plasmas[1] NATHANIEL SHAFFER, SANAT KUMAR TIWARI, SCOTT D. BAALRUD, University of Iowa
— We present a model for the radial distribution functions (RDFs) in an ultracold plasma with two temperatures. If the temperature relaxation is slow, the RDFs can be approximated using methods of equilibrium statistical mechanics. Under various ansatzes for the cross temperature T_{ie}, we compute RDFs using the hypernetted chain approximation. To prevent Coulomb collapse, we model the electron-ion interaction using a Deutsch potential. Here we focus on the semiclassical regime. The strongly coupled ions arrange themselves similarly to a Yukawa OCP, with a Coulomb hole and long-range density oscillations. This can cause the electron-ion RDF to also display long-range order. Nontrivial electron-ion density correlations are significant because OCP theories seek to bundle all the electron physics into a single screening parameter κ in a modified ion-ion interaction. We compare our two-component model to a YOCP on two fronts: (1) We compare our ion-ion RDFs to those from YOCP calculations, treating κ as a fitting parameter to test the usual screening model. (2) We compute the electron-ion temperature relaxation rate in the effective potential theory using both two-component and YOCP effective potentials. Results are compared with molecular dynamics simulations.

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