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ELECTRIC MICROFIELD DISTRIBUTIONS IN STRONGLY COUPLED PLASMAS FROM INTEGRAL EQUATION SOLUTIONS

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Ions radiating from a dense plasma reveal important information about plasma conditions through the detailed structure of their spectral lineshapes (Griem, 1974). This coupling of lineshape and plasma conditions is brought about by the local electric microfield distribution at the radiating ion due to all other charges in the plasma, a quantity first studied by Holtsmark (1919) by neglecting all correlations between plasma particles. More recently, Iglesias (1983) has shown that the calculation of the electric microfield distribution in a plasma is equivalent to the determination of the structure of a fictitious "fluid" whose intermolecular potential has both real and imaginary parts. This new formulation of the problem is the point of departure for the work presented below, which is based on the application of a straightforward generalization of the standard methods of liquid state theory coupled with a novel representation of the generalized bridge function.

The model to be studied is the one-component-plasma (OCP), consisting of N+1 ions, labeled 0 through N, each of charge e and all contained in a volume V at temperature T; a uniform background of opposite charge serves to neutralize the collection. The goal is to determine the distribution of electric field magnitudes at ion 0 due to the other N charges and the background. For a particular configuration, the field at $\vec{r}_0$ is

$$\vec{E}(\vec{r}^{N+1}) = \sum_{j=1}^{N} \frac{e}{r_{j0}^2}\hat{r}_{j0} - e\rho \int d\vec{r}\, \frac{\vec{r}_0-\vec{r}}{|\vec{r}_0-\vec{r}|^3}\,, \tag{1}$$

where $\rho = N/V$ and the integral term is the background contribution. The probability density for finding the value $\vec{\varepsilon}$ for $\vec{E}(\vec{r}^{N+1})$ is then

$$W(\varepsilon) = (2\pi^2\varepsilon)^{-1} \int_0^\infty dK\, KT(K)\sin(K\varepsilon), \tag{2}$$

where

$$T(K) = \langle \exp[i\vec{K}\cdot\vec{E}(\vec{r}^{N+1})]\rangle \tag{3}$$

is the characteristic function corresponding to ε. The angular brackets denote a canonical ensemble average with the OCP potential.

Iglesias (1983) has shown Eq. (3) to be formally equivalent to