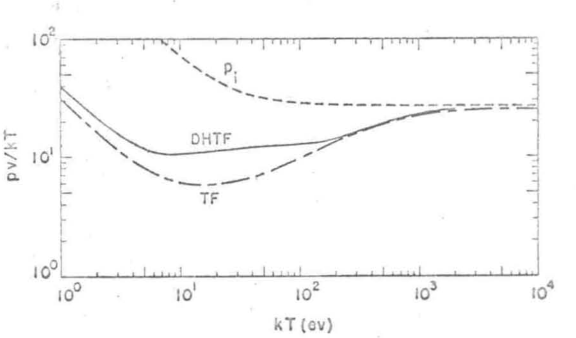

FIG. 3. Variation of pressure with temperature for iron at normal solid density ($\rho = 7.85$ g/cc).

At low temperatures and densities, the DHTF curves differ qualitatively from the corresponding TF curves, the former possessing distinct plateaus in Figs. 3 and 4. This effect is strongly Z- and (density-) dependent, as confirmed by numerical results (not shown here) for $Z=6$ and 92. It is not immediately obvious whether the large DHTF pressure calculated in the plateau region should be considered physically meaningful. One might conjecture that this reflects ionization resulting from collisions of neighboring atoms due to the thermal motion of the nuclei, which is absent in the TF picture. However, for reasons which will be discussed, the authors feel that these large pressures may be spurious (at least in part) and that the DHTF results should not be given too much weight at low temperatures and densities.

At sufficiently low densities, the zero-temperature pressure becomes negative (Figs. 1 and 4), unlike the TF theory where p becomes zero only in the limit of zero density. This is probably related to the lowering of energy due to electron correlation, which is not present in the TF theory. The DHTF pressure seems to become zero at a slightly higher density than in the TFD theory; this is reasonable since at the low electron densities at which correlation effects are important, the correlation energy in the present theory is greater than the exchange energy of the TFD theory (see reference 4 and Sec. 4c following).

The high-temperature regions in which the DHTF results may be considered reliable are pertinent to the following two problems, among others.

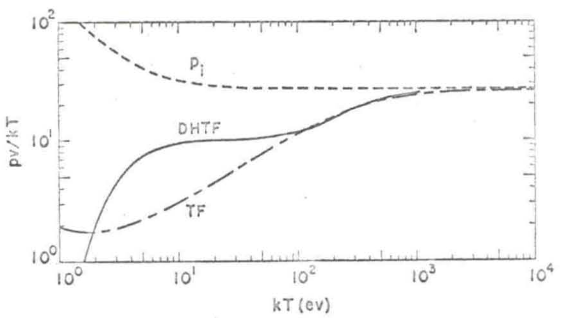

FIG. 4. Variation of pressure with temperature for iron at one-tenth normal density ($\rho = 0.785$ g/cc).

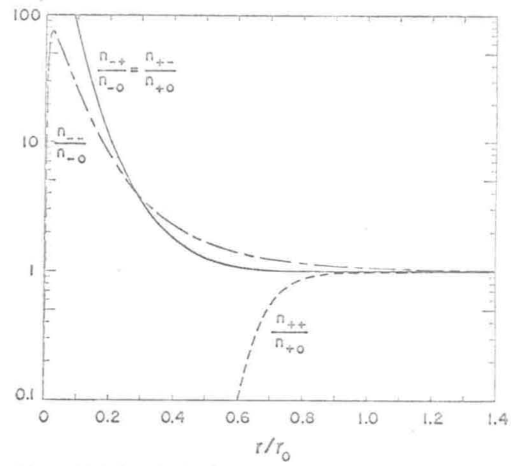

FIG. 5. The radial distribution functions for iron at normal density, $\lambda = 1$, and $kT = 100$ ev.

(1) Current efforts at achieving thermonuclear reactions are aimed at producing temperatures well above 100 volts in deuterium at gaseous densities. Since both high temperature and low density reduce the importance of electrostatic interactions between the nuclei and electrons, it is evident from Fig. 1 that electrostatic effects are completely negligible under the above conditions.

(2) In the early years of the Debye-Hückel theory, several attempts were made to apply the theory (primarily in its linearized form and using Boltzmann statistics for all particles) to the problem of ionized material in stellar interiors. Thus for iron at a density of 156 g/cc and a temperature of 26.36×10^{6}°K ($kT = 2271$ ev), Fowler and Guggenheim[13] calculated the electrostatic effects to reduce the pressure by 21.9%, while Eddington[14] corrected the theory in some respects

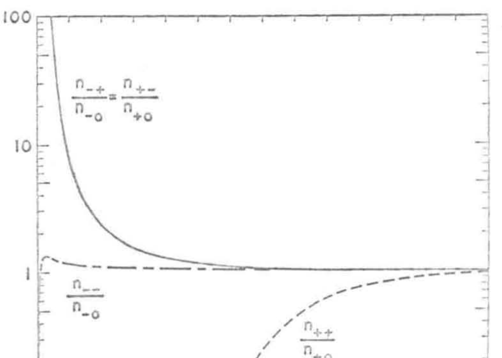

FIG. 6. The radial distribution functions for iron at normal density, $\lambda = 1$, and $kT = 1000$ ev. The n_{--} curve lies above the n_{-+} curve for $r/r_0 > 0.892$.

[13] R. H. Fowler and E. A. Guggenheim, Monthly Notices Roy. Astron. Soc. 85, 939 (1925).

[14] A. S. Eddington, Monthly Notices Roy. Astron. Soc. 86, 2 (1926).