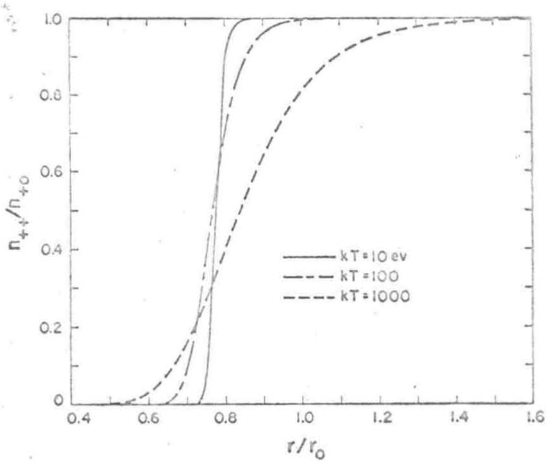

FIG. 7. The distribution of nuclei about a given nucleus for iron at ten times normal density and $\lambda=1$.

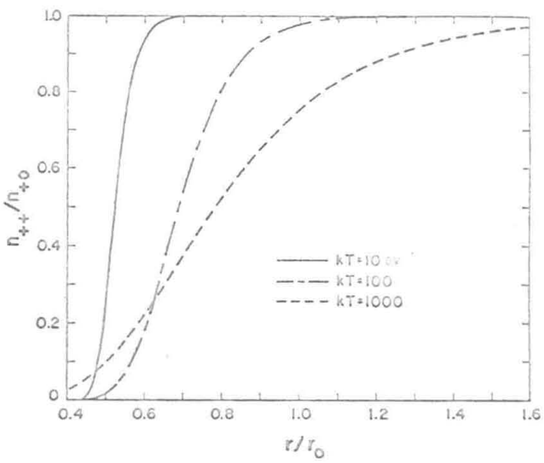

FIG. 9. The distribution of nuclei about a given nucleus for iron at one-tenth normal density and $\lambda=1$.

and found an effect of only 6.8%. The present DHTF theory gives for iron under these conditions $pv/kT=24.0$, and thus a pressure only 4% less than the perfect-gas value for the 24-fold ionized atoms assumed by Eddington.

b. Radial Distribution Functions

In Figs. 5 and 6 are shown the radial distribution functions (5), (24), and (26) for iron at normal density, $\lambda=1$, and $kT=100$ and 1000 ev.

For small r, the density of electrons about a nucleus (n_{-+}) becomes infinite as $r^{-\frac{3}{2}}$, just as in the Thomas-Fermi theory of the atom. As a result of the high electron density near a nucleus (of not too low Z), the distribution of electrons about a typical electron (n_{--}) shows a maximum for relatively small r, and at some larger r, n_{--} even becomes greater than n_{+-}. This behavior is particularly pronounced for low temperature and density and for high Z. For $Z=1$, no maximum in n_{--} has been observed; this is to be expected since in this case, there is only one electron per nucleus and consequently no strong bunching of several electrons about each nucleus.

The distribution of nuclei about a given nucleus (n_{++}) is shown in greater detail in Figs. 7 to 9, which correspond to the cases pictured in Figs. 2 to 4, respectively. For a given density, the effect of an increase in temperature is qualitatively what one would expect—an increase in n_{++} at small r and a decrease at large r. However, at low density (Fig. 9), the effect is quantitatively abnormal; on the scale of the figure, the only perceptible change in n_{++} on increasing kT from 10 to 100 ev is a decrease everywhere. This behavior is more pronounced the lower the density and the higher the value of Z. It is closely related to the fact that in the zero-temperature limit, n_{++} tends to a step function with the step at a radius r_1 which is less than r_0, this last being the radius of a sphere whose volume is the average volume per atom ($4\pi r_0^3/3=n_{+0}^{-1}$).

The reason why r_1 is less than r_0 is easily seen. At zero temperature, the normalization condition (19), (20) reduces to

$$Z=4\pi\int_0^{r_1} n_{-+}r^2dr.$$

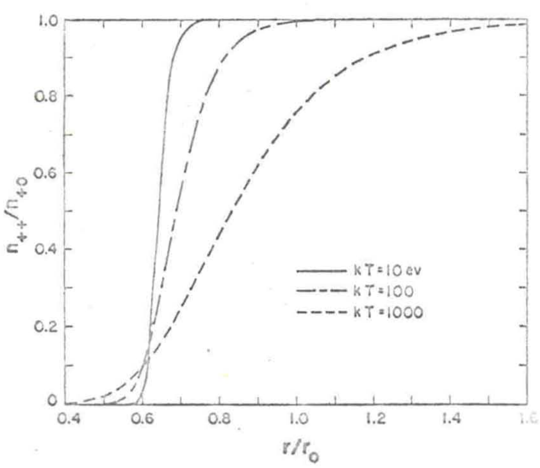

FIG. 8. The distribution of nuclei about a given nucleus for iron at normal solid density and $\lambda=1$.

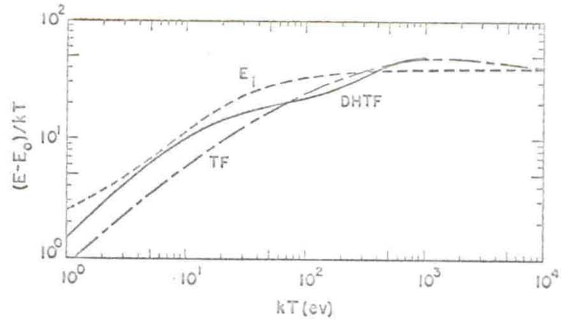

FIG. 10. Temperature dependence of energy for iron at normal density ($\rho=7.85$ g/cc). The dotted curve is for a mixture of nuclei and electrons without electrostatic interactions.