Letters to the Editor.

Note on the Limiting Density, Mass and Temperature of Condensed Stars.*

IN a previous note[1] it has been shown that with electrons degenerate stellar matter is completely ionised for number density ~ 10 and temperature ~ 10. Thus the stability of highly condensed stars is maintained by the equilibrium between the gravitational pressure (or energy) and material kinetic and radiational pressure (or energy). Besides these, electrostatic energy is also to be introduced. While Fowler and Frenkel[2] neglect this last factor, Kothari[3] holds that this causes an appreciable increase in the limiting density. The kinetic energy of the positive ions has also been neglected by most workers. We propose to reconsider the effects of the electrostatic energy, kinetic energy of the positive ions and the radiational energy on the limiting density, and temperature of Stars.

Electrostatic Correction.—In the case of completely ionised atoms electrostatic energy corresponds to the total ionisation potential which has been calculated by Sommerfeld[4] for a Fermi atom. Taking the total number of atoms $n = \frac{M}{2 \cdot 5 m_H}$; M being stellar mass and 2·5 the average mol. wt. For iron atoms $E_S = 1 \cdot 597 \times 10^{14} M$. Introducing this value in the equation of equilibrium: $2T = W_S + W_G$ the kinetic energy of electrons for the non-relativistic degenerate case being taken we find that electrostatic correction is negligible as suggested by Fowler. The results are tabulated below :—

Star	M/M	$n \times 10^{29}$	$n_0 \times 10^{29}$	%correction
Sun ..	1	9·588	9·561	0·28
Sirius B ..	1·18	6·474	6·59	0·25
Eridani ..	2·27	1·744	1·726	1·04

Effect of the Kinetic Energy of Positive ions.—K.E. of positive ions $= \frac{3}{2}$ NkT = 4·955×10 T.M. Thus this is comparable to that of electrons even for n. If, however, equilibrium be considered at absolute zero then it is zero. Modified values of n due to this are entered below :—

Star	Temp.	$n \times 10^{29}$	$n_0 \times 10^{29}$	%correction
Sun ..	10^6	9·594	9·561	0·34
Eridani ..	10^8	2·733	1·726	36·4
Sirius B ..	10^8	8·106	6·459	12·5

Effect of Radiation Pressure.—As pointed by Jeans radiation pressure exerts a marked influence on the hydrostatic equilibrium especially for a condensed star. If we consider the following condition for stability $P_G + P_R \ngtr \frac{3}{8\pi} \times \frac{GM^2}{R}$ we can calculate the modification in the limiting density.

Relativistic Case.—For the relativistic case which is valid for $n >> 5 \cdot 932 \times 10^{29}$ the K.E. of electrons is $7 \cdot 243 \times 10^{-17} n^{4/3}$. On introducing this into the equation we obtain a critical mass $\frac{M}{M_S} = 0 \cdot 2787$ above which equation is not valid. Frenkel introduces the K.E. of positive ions and obtains the limiting density ~10^{21}. His method is, however, faulty as he assumes a maximum pressure p'_0 for the statistical distribution of positive ions given by the relation $\frac{p_0}{p'_0} = \left(\frac{n}{n'}\right)^{1/3} = Z^{1/3}$ where p_0 is the maximum pressure for electron distribution according to Fermi statistics. He thus tacitly assumes positive ions to be degenerate.

Modifications in the limiting density for a given star due to the K.E. of positive ions and radiation pressure can be calculated. One can also calculate the maximum temperature for a given star with given density and mass by introducing the K.E. of electrons alone or by taking into consideration the K.E. of the positive ions as well.

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1 Ganguli, *Curr. Sci.*, Dec. 1932, **1**; 1934, **2**, 294.

2 Fowler, *M.N.*, 1926, **87**, 114; Frenkel, *Z. Phys.*, 1929, **55**.

3 Kothari, *Phil. Mag.*, 1931, **12**, 672; see also Stoner, *M.N.*, 1932, **92**, 651.

4 Sommerfeld, *Z. Phys.*, 1933, **78**.

Formation of Hydrates and Diamagnetism.

A STUDY of the diamagnetic susceptibilities of liquid mixtures has shown that magnetic measurements are not sensitive to interaction