It might appear surprising that the local fluctuations of the currents (1) should sum up to yield a resultant magnetic momentum which is approximately parallel to the earth's axis. The reason for this is found in the action of the *Coriolis force* upon the mechanical motions of the fluid mass. A glance at the hydrodynamic equations will show that for small values of the viscosity the Coriolis force is vastly preponderant as compared to all other dynamical effects. This causes a peculiar east-westerly asymmetry of the temperature variations at a given level. The latter variations are, in the usual way, produced by the vertical component of the convective motions.

For the further considerations, we shall confine ourselves to the second term on the right-hand side of equation (1), which presumably contributes the major part of the magnetic momentum. The discussion of the first term is closely analogous. It is readily seen that the magnetic dipole momentum vanishes, if, for a given depth, B is a constant. This means that in a homogeneous mass no temperature fluctuations would produce a magnetic momentum. In addition to the hypothesis of convective motions, we must therefore admit the existence of *inhomogeneities* in the earth's core. Since any particle of the mass undergoes large pressure changes during vertical displacements, the inhomogeneities are best accounted for by phase transformations induced by the pressure changes which are a frequent occurrence at high pressures[3]. Perhaps there are also considerable chemical inhomogeneities present in the core, and while there would be a regular stratification in a state of rest, the distribution of the phases will become irregular under the constant stirring action of the convection.

No additional assumptions have been found necessary. An attempt has been made to estimate roughly the order of magnitude of the thermo-electric currents. Using some simple results of the theory of metallic conductivity, values of σ and B were estimated for iron under the physical conditions of the core. It was found that with temperature differences so low as 10° the current density is of the order of 10^{-6} amp./cm.^{2}. This is enough to explain the observed magnetic field as the result of a small one-sided excess in a current system of irregular distribution.

A full account of this investigation will appear shortly in the *Physical Review*.

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[1] Jeffreys, H., "The Earth" (2nd ed., 1927, ch. vii).
[2] Jeffreys, *Mon. Not. Roy. Astro. Soc., Geophys.* Suppl., 1, 371, 416 (1926).
[3] Bridgman, P. W., "The Physics of High Pressures" (London, 1931, ch. viii).

The Expanding Universe and the Origin of the Great Nebulæ

SIR JAMES JEANS[1], commenting on our recent letter[2], criticizes the numerical relation between the distances between nebulæ and their radii following from our point of view on the formation of nebulæ. We should like to emphasize here that, owing to the uncertainty of the observational data, the values used by us can only be taken as representing orders of magnitude.

For the diameter of nebulæ we used the value (2,000 light-years) corresponding to spherical nebulæ ($E0$) which seemingly represent the theoretically simplest case. If, however, one uses the most elongated nebulæ the *average* diameter will be larger only by a factor 2·5 not seriously affecting the general agreement.

The numerical discrepancy of a factor $8\pi^2/9 \simeq 9$ between the exact formula of gravitational unstability as developed by Jeans and the simplified one used by ourselves, is due to the fact that Jeans identifies the square of the critical wave-length λ_0, as given in his book, with the square of the *radius* of condensing matter as given by us. This wave-length should be, however, equal to, or larger than, the *diameter* of the condensing sphere; the discrepancy thus becomes less than a factor of two.

The only important modification proposed by Jeans is that instead of Hubble's value $0{\cdot}8 \times 10^{-30}$ gm./cm.^{3} for mean density of matter, he suggests that a larger value $2{\cdot}5 \times 10^{-29}$ gm./cm.^{3} obtained by Sinclair-Smith and others should be used. It should be indicated, however, that whereas Hubble's value for the average mass of nebulæ as used by us was derived from the nebular rotation on the assumption that *the nebulæ themselves are in a state of equilibrium*, the proposed new value is based on the somewhat arbitrary assumption that the so-called clusters of nebulæ are stable. The question as to the status of such clusters is in fact a rather difficult one, and we hope to discuss it in a later publication. Thus it seems more plausible to use Hubble's value which leads to the velocity of particles of the order 100 km./sec. rather than 20 km./sec.

Assuming particles of mass at least equal to that of the hydrogen atom, a temperature of at least $0{\cdot}4 \times 10^6$ degrees C. is obtained. Of course, a pure gas of free electrons could not be responsible for the formation of nebulæ; an equal mixture of free electrons and protons (necessary to secure the neutrality of matter) reduces the temperature only by a factor of two.

A more detailed statement of our point of view and its relation to relativistic cosmology is contained in our longer article soon to be published in the *Physical Review*.

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E. TELLER.
George Washington University,
Washington, D.C.
Feb. 7.

[1] Jeans, Sir James, NATURE, 143, 158 (1939).
[2] Gamow, G., and Teller, E., NATURE, 143, 116 (1939). Owing to a manuscript error, a phrase was omitted from this letter. After the word "distances" in the eleventh line from the end, the following phrase should be inserted: "which after correction for reddening becomes an apparent increase in density at great distances".

Crystal Structure of Methane at the Transition Point, 20·4° K.

WE have made a detailed X-ray investigation of the crystal structure of methane in the transition region, and find, in accordance with previous results[1], that the lattice of methane above and below the transition point is a face centred cube.

In the neighbourhood of the transition point, new lines appear on the photographs apart from those belonging to the face centred cube. We observed as many as five. Some of these lines are quite strong and comparable in intensity with those of the normal lattice. Mooy (*loc. cit.*) has already found evidence of additional lines which he calls parasitic lines.