volume expansion from room temperature to just below the transition point is about 10·2 per cent, which is comparable with the density decrease of 9 per cent suggested by Robertson and Brockway as likely to occur if the triclinic crystal had taken a monoclinic structure by a slight rearrangement. The abrupt volume change at the transition point is 3·65 c.c./mole, corresponding to about 2·4 per cent of the volume at room temperatures. After passing through the transition point, the volume still increases to a conspicuous maximum value (178·5 c.c./mole) at about 130° C. and then decreases to a minimum value (160·5 c.c./mole), showing negative thermal expansion, melting finally at 165·5° C. The volume change at the melting point is about 30 c.c./mole, corresponding to 8 per cent of the volume at room temperatures.

The ratio of entropy changes at the transition and melting points measured by Parks and others is nearly equal to the ratio of the corresponding volume changes given above. Examples of similar unusual negative thermal expansion are known in the cases of ammonium iodide[4] (− 60° C. ∼ − 40° C.), deutero-ammonium bromide (ND_4Br)[5] (− 70° C. ∼ − 58° C.), ice[6] under the pressures of about 1,500 kgm./cm.² (− 10° C. ∼ − 2° C.), and a few other substances in the neighbourhood of their transition points. We are now making an X-ray analysis of the structure in the region between the transition and the melting points. The examination of the effect of substitution of the methyl groups by chlorine atoms will also be interesting in connexion with the dielectric study by White and Bishop[7].

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Nitrogen Afterglow

IN a recent communication in Nature, L. Herman and R. Herman[1] have given an account of their spectroscopic study of the complex afterglow in nitrogen immediately after the discharge is stopped. These short-lived afterglows have also been extensively studied by Kaplan[2]. In this connexion, Herman and Herman remark that it seems difficult to explain the characteristics of the complex afterglow as recorded by them with the help of the theory of active nitrogen proposed by me[3]. It appears, however, that these authors have missed the very important point that my theory was developed for the long-lived Lewis – Rayleigh afterglow, and not for the short-lived Kaplan afterglow, which is quite a distinct phenomenon. According to my hypothesis, the Lewis – Rayleigh afterglow phenomena, for example, the long life, the rate of decay, ionization, the characteristic spectrum (selected bands from the first positive group), etc., can be very satisfactorily explained if it is assumed that the active substance in the glow is $N_2^+(X')$ ions. The Kaplan afterglows, however, contain besides $N_2^+(X')$ ions other particles such as $N_2^+(A')$, N, N' which are responsible for the complex nature of the short-lived spectrum. It may, however, be mentioned in this connexion that in some of his experiments Kaplan has observed the persistence of the first negative bands for several seconds after the discharge is stopped. This provides a direct proof of the presence of N_2^+ ions, at least in the first stage of the afterglow. According to my hypothesis, the N_2^+ ions continue their existence even after the short-lived afterglows have died out and produce the phenomena associated with the Lewis – Rayleigh afterglow.

For explaining the afterglow characteristics M. and Mme. Herman prefer the Cario – Kaplan mechanism[4]. This necessitates the presence of atomic nitrogen. There is no doubt that nitrogen molecules (N_2) are dissociated in the strong discharge and excited nitrogen atoms are produced. This, indeed, is proved by some of Kaplan's spectrograms[5]. But the presence of such atoms when the discharge is on, or for a very short time thereafter, is a different matter from their persistence for several hours producing the Lewis – Rayleigh afterglow, remembering that atomic nitrogen is known to have very short life.

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Evolution of the Universe

IN checking the results presented by Gamow in his recent article on "The Evolution of the Universe" [Nature of October 30, p. 680], we found that his expression for matter-density suffers from the following errors: (1) an error of not taking into account the magnetic moments in Eq. (7) for the capture cross-section, (2) an error in estimating the value of α by integrating the equations for deuteron formation (the use of an electronic analogue computer leads to α = 1), and (3) an arithmetical error in evaluating ρ_0 from Eq. (9). In addition, the coefficient in Eq. (3) is 1·52 rather than 2·14. Correcting for these errors, we find

$$\rho_{mat.} = \frac{4·83 \times 10^{-4}}{t^{3/2}}.$$

The condensation-mass obtained from this corrected density comes out not much different from Gamow's original estimate. However, the intersection point $\rho_{mat.} = \rho_{rad.}$ occurs at $t = 8·6 \times 10^{17}$ sec. $\cong 3 \times 10^{10}$ years (that is, about ten times the present age of the universe). This indicates that, in finding the intersection, one should not neglect the curvature term in the general equation of the expanding universe. In other words, the formation of condensations must have taken place when the expansion was becoming linear with time.

Accordingly, we have integrated analytically the exact expression[1]:

$$\frac{dl}{dt} = \left[\frac{8\pi G}{3} \left(\frac{aT^4}{c^2} + \rho_{mat.} \right) l^2 - \frac{c^2 l_0^2}{R_0^2} \right]^{1/2},$$