reticulatus, where the male is the heterogametic sex, shows that a whole series of colour factors may be carried in the *Y*-chromosome.

On the other hand, I feel rather sceptical as to the existence of a series of multiple allelomorphs for egg-colour and pattern such as Mr. Wynne-Edwards postulates. Recent work on the domestic hen[4], also highly polymorphic for egg-colour, has shown that the series depends upon several factors which exhibit neither sex-linkage nor linkage with one another. Of course, it is hazardous in the matter of sex-linked characters to argue from one species of birds to another; for a character which exhibits sex-linked inheritance in one species may exhibit normal inheritance in a second. Silky plumage in pigeons[5] and fowls[6] is a case in point.

Nevertheless, I feel that what is known of the genetics of egg-colour in other species must cause us to hesitate before we can accept the ingenious suggestion of Mr. Wynne-Edwards, with its necessary corollary of the existence of a series of multiple allelomorphs for egg-colour and pattern.

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[1] NATURE, **132**, 822, Nov. 25, 1933.
[2] *J. Genetics*, **11**, 52; 1921.
[3] *J. Genetics*, **18**, 1; 1927.
[4] R. C. Punnett, "The Blue Egg", *J. Genetics*, **27**, 465; 1933.
[5] D. G. Steele, *J. Heredity*, **16**, 321; 1925.
[6] R. C. Punnett, "Heredity in Poultry", London, 1923, p. 99.

Atomic Transmutation and Stellar Temperatures

GAMOW and Landau[1] suggest either that lithium of mass 7 can be present only occasionally on a star's surface, or that no regions with temperatures of more than several millions of degrees can exist in the interior of a star; their argument is that at higher temperatures lithium could not find its way by diffusion from "the internal regions of the star, where the production of different elements takes place" to the surface, before being disintegrated. Eddington[2] has replied by noticing that the presence of ascending currents may decrease the time required for the ascent of the lithium, so as to remove the difficulty in accepting the central temperatures of the order of 2×10^7 found for his models, "whilst negativing any suggestion of considerably higher temperatures".

Most will agree with Eddington that temperatures of only some few millions of degrees are too low for the liberation of sufficient energy; his central temperatures are about the lowest which will yield the correct rates of liberation. But it appears from our present knowledge of disintegrations that an Eddington star would be violently over-stable, unless there were some other important source of energy than transmutations. Stellar matter at his central temperatures would behave not merely like gunpowder, but like gunpowder at just so high a temperature as to be deteriorating steadily, with any decrease in temperature stopping its liberation of energy, and any increase causing it to explode! Eddington shows[3] that one of his stars will be over-stable if the rate ε of liberation of energy increases more rapidly than about T^3, unless there is a delay of the order of months or years between an increase in T and the resulting change in ε. The most important contribution to the total energy liberated by transmutations comes from the disappearance of hydrogen because of its large packing fraction, and the rate at which the speed of disappearance of hydrogen increases with the energy of the collisions can be calculated by Gamow's theory[4] of the nucleus. Except for a constant factor, the calculated speeds appear to be in satisfactory agreement with the observed speeds[5]; the factor does not particularly concern us because we are interested in the exponent, s say, of T for that temperature at which ε is of the right order of magnitude to agree with L/M. One can calculate s, considering the statistical distribution over all energies of collision at a temperature T, and it is found[6] that s lies between 9 and 30. There is no delay, and an Eddington star with ε varying like T^{15} would be violently over-stable. These figures refer to the disintegration of lithium; s is increased, and matters are made considerably worse, if elements other than lithium are being disintegrated. The possibility that there may be another important source of sub-atomic energy, "annihilation", cannot be disproved, but there is not the least experimental evidence for the occurrence of any kind of annihilation that could supply useful energy to a star. The creation and disappearance of positive electrons would serve merely to increase the specific heat of the material, while at Eddington's temperatures even this increase would probably be trivial.

It is difficult to see how more than traces of elements like lithium could be formed at temperatures no higher than Eddington's, but if the temperatures are considerably higher than his, then the lithium can be made[7] as well as disintegrated, and by the aid of ascending currents some of it could perhaps appear on the surface. Since it would not be subjected to disintegration *alone* throughout the trip to the surface, for a time the abundance might even increase. If elements are being made as well as being disintegrated, the difficulty of over-stability is avoided, for there is no longer an ε which increases rapidly with T, but merely an ε which depends upon the rate of loss of energy by radiation into space.

There is still another way out of the difficulty raised by Gamow and Landau, and that is that lithium may have been present from the beginning in the star's atmosphere, while diffusion and currents may not yet have carried all of it into the far interior where transmutations occur. This is consistent with Eddington's calculations[8], for the vertical current of 60 metres a year which he found was an upper limit which applied to the neighbourhood of the surface only; at a place where ε and the mean value of ε interior to this are nearly equal (as presumably they are in regions where transmutations occur frequently) the vertical velocity by Eddington's calculations is considerably less. In this case the internal temperatures could well be as high as Eddington's, or higher. The considerations of over-stability suggest the higher temperatures.

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[1] NATURE, **132**, 567, Oct. 7, 1933.
[2] NATURE, **132**, 639, Oct. 21, 1933.
[3] "Internal Constitution of the Stars", § 136.
[4] *Z. Phys.*, **52**, 510; 1928.
[5] Lawrence and others, *Phys. Rev.*, **42**, 150; 1932. Henderson, *Phys. Rev.*, **43**, 98; 1933.
[6] A paper of the author's on this and allied topics is published in the *Mon. Not. R.A.S.*, **93**, No. 9; Oct. 1933.
[7] A paper of the author's on the equilibrium of transmutations is in the *Mon. Not. R.A.S.*, **93**, No. 9; Oct. 1933.
[8] *Mon. Not. R.A.S.*, **90**, 54; 1929.