gas will remain degenerate and a non-degenerate gas will remain non-degenerate, the value of A_0 remaining constant during the process.

In the case of *non-degeneracy*, the Joule-Thomson effect is given by the relation

$$\left(\frac{\partial T}{\partial p}\right)_i \doteqdot -\frac{\beta A_0}{2^{5/2}nk} = -\frac{\beta h^3}{2^{5/2}g(2\pi m)^{3/2}k^{5/2}T^{3/2}} \quad . \quad . \quad . \quad (2)$$

where β is to be taken as $+1$ for a gas obeying Fermi-Dirac statistics and as -1 for a gas obeying Bose-Einstein statistics. It is of interest to note that the *Joule-Thomson effect is independent of the pressure, and further it vanishes only when* $T \to \infty$.

In order to illustrate the order of magnitude of this effect, let us take the case of helium at 5° K. Helium obeys Bose-Einstein statistics and hence, taking $\beta = -1$ and substituting numerical values for the quantities involved, we find

$$\left(\frac{\partial T}{\partial p}\right)_i = 0{\cdot}076°/\text{atmos.}$$

However, this will not represent the thermal effect actually observed, which will depend largely upon the Van der Waals' type of deviations from the *classical* perfect gas. It is difficult to estimate exactly the contribution due to Van der Waals' deviations, but if we use the ordinary formula[1] to obtain some idea of it, we find (taking Van der Waals' $a = 0{\cdot}034 \times 10^6$ atmos., $b = 23{\cdot}7$ cm.^{3}) a value of 0·7°/atmos. for helium at 5° K. The Van der Waals effect is much the larger, but the statistical effect is still 10 per cent of it. It therefore seems possible that the Joule-Thomson effect under suitable conditions may provide an experimental test of the statistics obeyed by gases, say, helium.

D. S. KOTHARI.
B. N. SRIVASAVA.

Physics Department,
University, Delhi.
Oct. 14.

[1] Saha and Srivasava, "A Treatise on Heat", 476 (1935). We use the approximate equation in which the term $\frac{2a}{RTV}$ is supposed small compared to unity.

Interpretations of Atomic Constitutions

PROF. ANDRADE has had the great courtesy to attempt to answer my two questions in NATURE of November 20, they are:

(1) Whether the theory of the electrical composition of matter now fails.

(2) The difficulty of the nucleus tightly packed with protons.

Prof. Andrade avoids my first question in the most accomplished parliamentary form, telling me that in future I must not look on electricity as a fluid, and ask for a pot, pint, or firkin thereof. Interesting and informative, but the position is that the physicists announced to the world the electrical composition of matter. I did not do it. Why should I be lectured? Now when the non-electrical neutron is established I ask a simple question: Have they been talking nonsense or not? The general impression I get from Prof. Andrade is that they have. If so, the sooner they announce it the better.

Now as to the nucleus.

Prof. Andrade, when I get him into a difficulty over the protons packed together, answers with the readiness of a cash register, "No charge". But I notice the charge, with its defensive field, is still there to account for the superior penetration of the neutron over the proton in hitting and disintegrating the nucleus in bombardment.

Apparently the physicist changes the conditions at any time he likes to suit his convenience, but you cannot have it both ways. The quotation from Rutherford seems to me extremely sane, to the point, and logical. Referring to the nucleus he says it is "held together by very powerful unknown forces". If everyone was as frank as that and confessed to difficulties instead of riding round them, the popular explanation of modern physics would be no less attractive and a good deal clearer.

I hope these somewhat harsh words in debunking the physicists will not be construed as an attack on Prof. Andrade. Alone, valiantly he has come forth to break a lance with me and I respect and admire him for it. In his concluding paragraph he asks me for information on one of my subjects, namely, foreign policy, over the last ten years. It being near Christmas time, mutual help seems only seasonable.

Macroscopic events, ethnical considerations, and crowd psychology are subjects that the simple physicists will not understand, therefore I will try to tell the story in their own language.

Europe may be looked upon as a nucleus composed of individual protons, not however all of the same size or power, mixed up with a few neutrons with no charge and little mass. This is kept together by a strong force which prevents them flying apart, known as geography. This nucleus is not symmetrical as, included on its western edge, is a particularly powerful proton[1] that has "wave characteristics" of a definite type peculiar to itself. In the south there is what might be called a neutrino[2]. This has, some think, also wave mechanic aspirations. It is peculiar in this respect that its core is eternal[3] but its surround, some think, is ephemeral.

Now the real trouble is that just as in the atom there are electrons in their orbits far away from the nucleus, so in this case there are colonies also revolving. These used to be attached, so to speak, to separate protons, but some years ago the nucleus was subjected to a terrific bombardment which shifted these electrons from belonging to one proton to another. One very powerful proton, in mathematical language generally designated thus 卐, suffered severely in this respect, with the result that the nucleus as such is no longer stable. It has been found, however, that if the western proton adds to its charge[4], although a state of strain between the two protons is introduced, the nucleus qua nucleus becomes more stable.

I hope I have put this very difficult problem in simple terms for the physicists. I would have liked to have said a word on Newton's laws of gravity, as Prof. Andrade mentions them, but I feel that you, sir, must have your own laws on the same subject and that I am straining them.

J. T. C. MOORE-BRABAZON.

70 Pall Mall,
London, S.W.1.
Nov. 22.

[1] Britain.
[2] Italy.
[3] Rome.
[4] By re-arming.