mass of Bed V and the overlying steppe-lime were formed, that is, the skeleton appears to have been buried at the time of the existence of the old land surface connected with the steppe-lime at the base of Bed V.

It so happens that there is other and independent evidence which supports this view. On this old land surface, and also in the basal deposits of Bed V, there was found an industry which has very close affinities with the phase C of the Upper Kenya Aurignacian. From the work at Gamble's Cave in 1929, we know that the men of this culture-stage buried their dead in the contracted position, as was the case with the Oldoway skeleton. It seems likely, therefore, that the Oldoway man was one of the race which made the tools that are found on the old land surface and in the basal deposits of Bed V.

The above views accord with those of Mr. E. J. Wayland, director of the Uganda Geological Survey, summarised in letters to Nature (October 15, 1932) and *East Africa* after his visit to Oldoway last August.

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Heights of Nuclear Potential Barriers and Nuclear Structure

I recently pointed out in these columns[1] that experimental evidence indicates that the heights of the potential barriers of the light nuclei are proportional to the atomic number. This simple relation can be shown to fit in with Heisenberg's suggestion[2] that nuclei are composed of protons and neutrons and that there is an attractive force $J(r)$ between neutron and proton at close distances, and between neutron and neutron $K(r)$, the former being the greater. An α-particle contains two neutrons and two protons, a nucleus contains n_1 neutrons and n_2 protons; there will therefore be an attractive force between nuclear neutrons and α-particle protons *and* nuclear protons and α-particle neutrons, superposed on the Coulomb repulsion between protons. Thus we have (neglecting the neutron-neutron force $K(r)$, since it is less than $J(r)$):

$$V = \frac{2n_2e^2}{r} - \frac{2n_1k}{r^p} - \frac{2n_2k}{r^p}$$

for the potential at a distance r. I have assumed a law of force of the form $\frac{k.\ n_1.\ \text{no. of protons}}{r^p}$ to represent $J(r)$.

This gives

$$V = \frac{2n_2e^2}{r} - \frac{2k(n_1+n_2).}{r^p}$$

It happens that for the light elements n_1 is very nearly equal to n_2, never differing by more than one unit. Thus we have approximately,

$$V = \frac{2n_2e^2}{r} - \frac{4kn_2,}{r^p}$$

This gives for V_c the maximum when $dv/dr = 0$ the value

$$V_c = \frac{2n_2e^2}{(2pk/e_2)^{1/(p-1)}}\left[1 - \frac{1}{p}\right]$$

If p is constant, that is, if the law of force is the same from element to element, we have that V_c is a straight line function of n_2, which is what is found experimentally.

The critical radius for the height of the barrier is $(2pk/e_2)^{1/(p-1)}$ and has, for elements for which n_1 is approximately the same as n_2, a constant value; this would be expected, because both repulsive and attractive forces increase linearly with the nuclear charge. This critical radius does not necessarily govern the volume of the nucleus. An accurate measurement of the barrier heights would afford a means of testing the truth of the assumption made by Heisenberg (and necessary to his theory of nuclear stability) that the neutron-neutron force is less than the neutron-proton force; since if it were not so, the attractive force would depend on n_1 alone, giving different values for those elements (such as lithium and beryllium) for which n_1 does not equal n_2.

The heights calculated for these two elements (both subject to considerable error) do fit in better with an attraction proportional to $n_1 + n_2$ than to n_1. It is interesting to note that the attractive force in the case of a proton does depend on n_1 alone, so that the barrier height to a proton should be rather higher than half that to an α-particle for light elements: for heavy elements, where the number of neutrons is roughly twice the number of protons, the barrier will not rise so rapidly; perhaps this accounts for the relative ease of penetration of heavy nuclei by fast hydrogen ions.

Since the slope of the line relating height and nuclear charge depends on p, the index power of the law of force, it should be determinable from this relation.

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Feb. 2.

[1] E. C. Pollard, Nature, **131**, 97, Jan. 21, 1933.
[2] W. Heisenberg, *Z. Phys.*, **77**, 1; 1932.

Arc Spectrum of Iodine

The analysis of the spectrum of the normal iodine atom has proved relatively difficult, partly because of the wide multiplet separations, and partly because of the transitional nature of the coupling characteristics. Some constant intervals, due to Turner[1], have long been known, and S. F. Evans[2] in 1931 presented a partial analysis which included most of the stronger lines in the region 4700–10000 A. Recently S. C. Deb[3] has published a more extensive analysis, which differs very materially from that of Evans. As he dismisses the latter's results rather summarily, with the remark that they are "mainly incorrect", some observations on his paper may be of assistance in forming a just appreciation of the present position in regard to this question.

In the first place, it may be noted that of the 160 wave-lengths listed by Deb, 75 are identical with those given by Bloch[4] and 19 with those of Evans, although the text implies that they are his own determinations. Further, Bloch classifies all but 9 of these 75 as spark lines, and Evans's observations (unpublished), together with those of Wood and Kimura[5], are in good general agreement. The multiplets proposed take no account of this heterogeneity of the data, including arc and spark lines on an equal footing. It is therefore not surprising that the multiplet intervals show much wider discrepancies than should be permissible by reason of wave-length inaccuracies. As one instance we may take the interval 1459·3 cm.$^{-1}$ which was well established by