Constitution of Dysprosium, Holmium, Erbium, Thulium, Ytterbium and Lutecium

CONTINUING the examination of the rare earth elements by the method of anode rays as already reported[1], I have now been able to complete the analyses of the group.

Dysprosium (66) gave poor spectra but sufficient to indicate that it consists of mass numbers 161, 162, 163, 164 not differing much in relative abundance.

Holmium (67) is quite definitely simple 165.

Erbium is not so complex as it was at first supposed to be. The early samples used were evidently contaminated. A pure sample gave three strong lines, 166, 167, 168 and a weak fourth 170.

Thulium (69) is simple 169.

Ytterbium (70) appears to contain mass numbers 171, 172, 173, 174, 176, of which 174 is the strongest.

Lutecium (71) is simple 175.

It will be seen that these six elements fill all the numbers from 161 to 176 and show no isobares.

A full account of this work will be published in due course with estimates of relative abundance and the atomic weights so deduced. It is already evident that the international values for several of the rare earths are in need of revision. That of holmium (163·5) is particularly bad.

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Value of e/m

SIR ARTHUR EDDINGTON[1] has developed theories according to which

$$hc/2\pi e^2 = 137,$$

and the ratio of the mass of the proton to that of the electron is

$$M/m = 1847 \cdot 6.$$

I have shown[2] that these theories and most experimental data are in extremely good mutual agreement. The only experimental evidence against them[3] is that given by recent determinations of the specific electronic charge[4], which may be summarised as

$$e/m = (1 \cdot 759 \pm 0 \cdot 000_5) \times 10^7 \text{ E.M.U.}$$

These measurements disagree with the value deduced[5] from $M/m = 1847 \cdot 6$, namely,

$$e/m = (1 \cdot 77031 \pm 0 \cdot 00014) \times 10^7.$$

However, Sir Arthur Eddington pointed out[6] that his work and the discovery of the neutron made it seem likely that the equations used in deducing the spectroscopic estimates of e/m are in error.

I am writing to suggest that some (or possibly all) of the experimental determinations of e/m are really measurements of

$$\frac{136}{137} (1 \cdot 77031 \pm 0 \cdot 00014) \times 10^7;$$

that is to say, of $(1 \cdot 757,4 \pm 0 \cdot 000,14) \times 10^7$ E.M.U. This is in reasonable accord with the $1 \cdot 759 \pm 0 \cdot 000_5$

recently obtained experimentally (being smaller than some and larger than other of the experimental results).

If this supposition proves to be correct, the only evidence against Sir Arthur's 137 and 1847·6 would vanish.

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[1] Eddington, *Proc. Roy. Soc.*, A, **143**, 327, and earlier papers.
[2] Bond, *Proc. Phys. Soc.*, **44**, 374 ; 1932.
[3] Birge, *Phys. Rev.*, **40**, 319 ; 1932.
[4] Dunnington, *Phys. Rev.*, **43**, 404 ; 1933. Kretschmar, *Phys. Rev.*, **43**, 418 ; 1933. Robinson, Andrews and Irons, *Proc. Roy. Soc.*, A, **143**, 48 ; 1933.
[5] Birge, loc. cit.
[6] Bond, *Phys. Rev.*, **41**, 368 ; 1932.

Reaction of Heavy Water with Metallic Sodium

MESSRS. C. O. DAVIS and H. L. JOHNSTON report[1] that when metallic sodium is dissolved in heavy water, the diplogen content of the evolved hydrogen is reduced and the diplogen content of the solution correspondingly increased. We wish to put forward the results of similar experiments, which have been carried out in a somewhat different way and seem to lead to a more precise interpretation of this reaction.

Metallic sodium was introduced into an evacuated glass bulb by electrolysis, and heavy water was then distilled into the vessel. In two experiments an excess of water was taken, in two other runs there was an excess of sodium metal. In all experiments the quantity of hydrogen evolved was found to be 0·5 mol. per mol. of decomposed water. The original water contained 1·81 parts of diplogen to 100 parts of hydrogen + diplogen.

1. Water excess, room temp.	0·96	per cent
2. Sodium ,, ,, ,,	0·99	D in
3. ,, ,, −10° C.	1·01	$H_2 + HD$
4. Water excess, room temp.	1·03	formed.

These values are in agreement with the 'separation factor' reported by Davis and Johnston.

Since in presence of an excess of sodium the whole of the water was decomposed, the shift in the diplogen content of the hydrogen produced cannot be accounted for by a difference in the rate of reaction of H_2O and HDO with sodium. The case is therefore different from the shift observed in the reaction between iron and water[3].

The correct description of the phenomenon appears to be this : Decomposition of HDO by metallic sodium can lead alternatively to the formation of NaOH or NaOD, the latter alternative being preferred. Or, putting it in a different way : when HDO comes into contact with sodium, the H-atom escapes with greater ease to combine with an H-atom released by a neighbouring pair of reacting particles $(Na + H_2O)$, than does the D-atom.

The greater ease of reaction of H as compared with D was predicted by Cremer and Polanyi[2] on account of : (1) the lower zero point energy of D-compounds[4] ; (2) the stronger leakage of H through energy barriers.

In the present case of a single compound entering into two alternative reactions, the zero point energies of the initial states are identical. However, at the top of the activation barrier the two alternative