Designation of Heavy Hydrogen

THE frank acknowledgement of Prof. Urey and his colleagues in NATURE of February 3, p. 173, that the nomenclature of heavy hydrogen should not be decided by the wishes of the discoverers, but by the convenience of physicists and chemists in general, encourages me to say something in reply to their arguments.

To physicists the most important point is perhaps the name to be given to the nucleus. More than one physicist who was at Chicago last summer found it difficult to distinguish the spoken words 'neutron' and 'deuton' or 'deuteron'. The difficulty may be greater in England than in America; all good Americans will realise that in England it always rains and everyone has a cold; but in this country at least the danger of confusion seems to me to be serious, and it is entirely avoided by using 'diplon'.

The names to be employed in chemistry will not be nearly so unpleasant as Prof. Urey and his colleagues suggest. They say that we should call $NH^1H^2_2$ 'di-diplogen mono-hydrogen nitride'; they would presumably say 'di-deuterium mono-protium nitride'. But the chemist would call it 'di-diplo-ammonia', just as he calls $C_6H_4Cl_2$ dichlorobenzene and not di-chlorine tetrahydrogen cyclohexacarbide. 'Di-diple-' is no more cacophonous than 'di-deutero-'; didymium was accepted for many years as a satisfactory chemical name. Moreover, the compounds of H^2 will not always contain two atoms of it in the molecule.

The objection that 'diplogen' means 'making double' is not really valid; it means 'making diplon', just as oxygen does not mean making sharp, but making acids. Diplon is 'the double thing', just as proton is 'the first thing', and is used in no other sense than as meaning the H^2 nucleus. Deuterium or deutium means the second substance, and deuteron or deuton the second particle; and it may be argued that the second particle after the proton is the neutron, whereas there is no doubt what particle is the double of the proton.

The adoption of a new name to distinguish pure H^1 from the isotopic mixture does not seem likely to be widespread, but if one is needed, the obvious correlative to diplogen is haplogen, as Prof. Urey suggests, and this seems to be a harmless word.

Whatever decision may be reached on this question, we can at least all agree to use the symbol D for H^2.

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Nuclear Spins and Magnetic Moments

A COMPARISON of the two lines of spectroscopic evidence bearing on the properties of the atomic nucleus raises some interesting questions and suggests new directions of research. The magnetic moment of the nucleus can only be evaluated from hyperfine structure observations, and then only in favourable circumstances. The spin quantum number I can sometimes be obtained by both methods: by the hyperfine structure method if the magnetic moment and its interaction with the optical electrons is sufficiently large, and by the band spectrum method if the atom is one which forms an elementary diatomic molecule, provided also that this gives rise to a band spectrum of which the rotation structure can be analysed. Although each method is thus restricted in the scope of its application, there are a number of cases in which both are applicable; for example, Li^7, F^{19} and Na^{23}, for each of which the two values obtained for I are in agreement. On the other hand, P^{31}, Cl^{35} and K^{39} are amenable only to the band spectrum method, the magnetic moment being presumably too small to give observable hyperfine structure, whereas for many other nuclei (for example, $Cu^{63,\,65}$, $Cd^{111,\,113}$, Cs^{133}, $Hg^{199,\,201}$, etc.) the latter method only is applicable since no diatomic molecules giving rise to band spectra are known.

The case of nuclei of even mass number is of particular interest. No hyperfine structure has been detected for any of these, although N^{14} shows some slight indications, and such band spectrum observations as are available all give zero values for I with the exception of H^2 and N^{14}, for which $I = 1$. (I is half integral or zero in every other known case.) It would therefore be natural to assume, as has generally been done, that all nuclei of even mass number have $I = 0$, except H^2, N^{14} and possibly also Li^6 and B^{10}, these four being the only nuclei of even mass number but odd atomic number.

Such an assumption would, however, be quite unjustified on the basis of the present experimental evidence. A zero value for I can only be established by band spectrum methods, since the absence of hyperfine structure might alternatively be due to a small magnetic moment. It is therefore unfortunate that the number of nuclei of even mass number for which diatomic band spectra are known is very small. There are in fact only six, four of which, He^4, C^{12}, O^{16} and S^{32}, have mass numbers of the type $4n$, where n is integral, and zero spins. The other two, H^2 and N^{14}, have been referred to above. They have $I = 1$, but may very well be anomalous. There are no others having mass numbers $4n + 2$ for which the band spectrum method is practicable at present. The most promising appears to be Li^6, the difficulty here being the weakness of the Li^6_2 bands in comparison with those of Li^7_2 and $Li^6 Li^7$, among which they lie. The highest possible dispersion, applied in a carefully selected region, might offer some prospect of success.

A survey of the remaining elements of this type shows that in every case one or more of the following obstacles bars further progress:

(1) The isotope in question is too rare (for example, O^{18}).

(2) There are too many isotopes (for example, $Te^{126,\,130}$), giving rise to extreme complexity of band structure.

(3) No suitable bands are known (for example, Zn^{66}, Se^{78}).

(4) No bands at all are known (for example, B^{10}, Ne^{22}, Ni^{58}, Zr^{90}, Ba^{138}).

(1) and (2) would seem to be insuperable unless the technique of isotope separation can be greatly improved. As to (3) and (4), the great variety of methods of excitation now available and the wide spectral range now open to photographic investigation give ground for hope that some of these band spectra may yet be discovered. Whether or not an exhaustive search for them would be worth undertaking, it is at least very desirable that spectroscopists working with such elements and their compounds should be on the look-out for new band systems, and should endeavour to ascertain the origin of any which may be found.

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