Neutrons and Protons in Atomic Nuclei

By PROF. H. S. ALLEN, F.R.S.

HEISENBERG has discussed the hypothesis that the nucleus of an atom is composed of neutrons and protons only, the neutron being regarded as a fundamental entity and *not* as a combination of an electron and a proton. On this view, the nucleus is formed of n neutrons and p protons, and p is also the number of planetary electrons required to form an electrically neutral atom. Thus p, the charge number, is identical with Moseley's atomic number, Z, which determines the position of the element in the periodic table. The mass number, A, is the sum of n and p. For example, the nucleus of an ordinary hydrogen atom consists of a single proton, while that of the hydrogen isotope of mass 2 consists of one proton and one neutron. The helium nucleus or α-particle, which may form a constituent of heavier nuclei, is composed of two protons and two neutrons.

Importance is attached to the value of the *ratio* of n to p, which is supposed to determine disruption of a radioactive nucleus. The question as to whether these numbers are odd or even is also of moment. For light elements, n is very nearly equal to p, never differing from it by more than one or two units. E. C. Pollard[1] concludes that the height of the potential barrier of a light nucleus is proportional to the atomic number, and claims that this is in agreement with Heisenberg's suggestions.

The accompanying table gives the values of p and n and the mass number A for hydrogen and the elements in the two short periods at the beginning of the periodic table. The more abundant isotopes are printed in heavy type. A study of the table brings out several interesting points with regard to their distribution. In the first period, helium with its single isotope is followed by three elements, Li, Be, B, for which the more abundant isotope has $n = p + 1$. Then come three elements, C, N, O, for which the condition for abundance is that $n = p$. The period ends with fluorine, F, having only one known isotope. In the second period there is another type of symmetry, and there is a well defined alternation in the position of the more abundant isotope as we pass from group 0 to group VII. The figures in the table are also of interest in connexion with the artificial disintegration of the atomic nucleus.

There is no difficulty in extending the table so as to include other periods, but the results tend to become more complicated as the atomic number increases.

HYPOTHETICAL NUCLEAR STRUCTURE OF LIGHT ELEMENTS

showing the number of protons (p) and neutrons (n).

H 1p, $A = 1$ **0n** 1p, $A = 2$ 1n

0	I	II	III	IV	V	VI	VII
He 2p **4 2n**	**Li** 3p 6 3n **7 4n**	**Be** 4p 8 4n **9 5n**	**B** 5p 10 5n **11 6n**	**C** 6p **12 6n** 13 7n	**N** 7p **14 7n** 15 8n	**O** 8p **16 8n** 17 9n 18 10n	**F** 9p **19 10n**
Ne 10p **20 10n** 21 11n 22 12n 23 13n	**Na** 11p **23 12n**	**Mg** 12p **24 12n** 25 13n 26 14n	**Al** 13p **27 14n**	**Si** 14p **28 14n** 29 15n 30 16n	**P** 15p **31 16n**	**S** 16p **32 16n** 33 17n 34 18n	**Cl** 17p **35 18n** 37 20n 39 22n

[1] NATURE, **131**, 97, 398; 1933.

Forestry Practice

SIR FRANCIS D. ACLAND, a forestry commissioner, has undertaken a most timely piece of work in publishing a small brochure on "Forestry Practice—A Summary of Methods of Establishing Forest Nurseries and Plantations with Advice on other Forestry Questions for Owners and Agents" (Forestry Commission, Bulletin No. 74, H.M. Stationery Office, 1933). This little book, replete with practical advice, should prove of the greatest value to proprietors of land who are engaged in planting, and should give encouragement to, and provide knowledge for, those who hesitate to improve their properties by this form of monetary outlay.

After referring to the results given in the "Census of Woodlands", published by the Commission in 1928, it is pointed out that the existing reserves of mature coniferous timber in Great Britain are equivalent to less than a six months' consumption. The younger crops, though well distributed through the various age-classes, are on the same small scale. Oak planting in particular has gone out of fashion and future supplies of home-grown oak are endangered. The total area of woodlands tends to diminish and the productiveness of the area under coppice and coppice-with-standards will probably be reduced. There is thus plenty of room for improvement, and those who plant for the future should not be deterred by present unfavourable prices. As regards the decrease in area of existing coppice-with-standards woods, when the standards consist chiefly of oak, there is unfortunately little doubt that they are in some counties disappearing at an alarming rate under the ruthless operations of the timber lumberer.

The author's advice to the landowner is strongly supported by the opinion expressed by Lord Clinton, when chairman of the Forestry Commission. Speaking at an annual meeting of the Scottish Arboricultural Society, he said : "I am not at all confident that the State can properly undertake the full duties of afforestation" (NATURE, 122, 231, August 18, 1928).

It is impossible here to discuss the treatment of the brochure at length. It follows well-known lines and is divided into five parts: nursery work; formation and establishment of plantations; utilisation and markets, including a note on timber conversion by Sir George Courthope, and timber preservation; financial questions; and practical experience of private owners, being an interesting summary of replies by landowners to a questionnaire on forestry matters.

Two small points merit notice. On the subject of establishing oak crops Sir Francis correctly says that "it is essential to plant densely; it is, therefore, specially desirable to choose the cheapest suitable plants and the cheapest satisfactory planting method. One year seedlings have proved entirely satisfactory". A caution is however required. If the area is infested, even to a small extent, with cockchafer grubs, it will be found that a percentage of the young plants will be cut and killed either in the first or second year after planting; whilst transplants, apparently, to a great extent escape.

The second point is on the subject of 'firming'. Sir Francis points out the importance of firming and packing the soil round the roots of the planted plants. The percentage of plants annually lost owing to a failure to attend to this important matter must be high. He recommends the use of the heel of the foot instead of the sole in firming. In the majority of cases this is true. It has been observed, however, that in a heavy clay soil, if the plants are rammed home with the heel and a few dry weeks supervene, the pressed soil becomes a compact block into which moisture cannot penetrate, and the plants so treated die. The summer of 1929 and the prolonged east winds of 1932 provided numerous examples which appeared to support this contention.

Sounding the Ionosphere

DR. LAL C. VERMAN, Department of Electrical Technology, Indian Institute of Science, Bangalore, describes in a communication to the Editor a new system for continuous recording, by cathode ray oscillograph, of the equivalent heights at which radio signals are reflected by the ionosphere. The required radio signal pulses, with a duration of 100 μ, are produced by a generator using a cold-cathode neon-discharge tube (Verman, Paper No. 10 Math. and Physics Section, Indian Science Congress, Patna, Jan. 1933). The sending and receiving stations are 5 km. apart, and the pulse-emission and linear-time-base frequency of 125 per sec. are derived by locking at each station to a 62·5 cycle per sec. electricity supply network.

In the systems already described, the received ground-ray pulses and the ionospheric echo-pulses are applied, after amplification, to the vertically deflecting plates in the cathode ray oscillograph, the linear time-base sweeping horizontally. Ratcliffe and White limit the vertical excursion by an appropriately adjusted valve circuit, and record through a slit coinciding with the level of limitation. Appleton, Builder, and the other workers in the King's College, Radio Research Station, and Tromsö network record through a slit coinciding with the undeflected base-line. Thus one set of workers photographs the bright images of the artificially flattened tops of the echo components, the other photographs the dark gaps produced by echo-departures from the undeflected bright base-line.

Dr. Verman does not utilise the vertically-deflecting plates but applies the echo-pulses, after high-gain amplification, to the Wehnelt cylinder used for focusing the electron jet of the oscillograph. The bright image of the linear time-base is thus interrupted by dark gaps which result from defocusing of the electron jet by the amplified echo e.m.f.'s. By the provision of a suitable time-constant in the audio-frequency amplifier the duration of the interval of defocusing, and thence the width of the dark gap, is made to indicate the approximate intensity of the corresponding echo. As in the other systems, the equivalent path-differences are measured by the distance, on the time-base scale, between the beginnings of ground-ray and echo pulses.

The system, in this form, shares with those already mentioned the disadvantage that when, as is done in all these systems, the time-constant is adjusted to give some measure of echo-intensity by the interval between the steep initial rise and some convenient reference level on the relatively slow exponential decay of the output e.m.f., the separating power of the system in respect of closely adjacent echoes, and in particular of close magneto-ionic doublets, is impaired.

Dr. Verman proposes to modify his system by using an amplifier of very small time-constant in association with a cathode ray oscillograph, of the type which is suitable for television, providing for quantitative modulation of the light-intensity. The separating power of the system will then depend only on the duration of the received echo pulses, and the intensity of the echoes will be measured by the photographic density of the base-line image. Details and a discussion of possibilities are promised in a later communication.

Leverhulme Research Fellowships

ANNOUNCEMENT was made in NATURE of June 3, p. 795, intimating the establishment of a scheme of research fellowships, in accordance with a direction in the will of the first Lord Leverhulme that the income arising from part of his estate should be devoted to the granting of scholarships for research and education.

A notice inviting applications under the scheme was published, and by the closing date, June 19, a large number had been received. Application was invited from 'experienced workers' and especially from men and women prevented from carrying out research either by pressure of routine duties or by any other cause. From the applications received, seventeen selections have been made by the Advisory Committee and approved by the Trustees, and are for varying periods up to two years. The names of the fellows and the subjects of the researches are:

Dr. E. C. Bullard, demonstrator in geodesy in the University of Cambridge: gravity and magnetic measurements in the Great Rift Valley, East Africa.

Mr. C. R. Burch, physicist, Metropolitan-Vickers