ABSTRACTS

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The neutrons from the disintegration of fluorine by deuterons. By T. W. BONNER. (*Communicated by J. D. Cockcroft, F.R.S.—Received* 16 *October* 1939.)

The neutrons from the disintegration of fluorine by deuterons have been investigated by the method of observing helium or hydrogen recoils in a high pressure cloud-chamber. When targets containing fluorine were bombarded with 950 kV deuterons, several groups of neutrons were observed. The disintegration Q values computed from the energies of the neutron groups are 10·80, 9·33, 6·62, 5·39, 3·53, 1·84 and 0·74 MeV. The nuclear reaction appears to be (F^{19}, H^2, Ne^{20}, n^1). The disintegration value $Q = 10·80 \pm 0·20$ MeV corresponds to a transition to the ground state of Ne^{20} and smaller Q values indicate excited states in Ne^{20} at 1·5, 4·2, 5·4, 7·3, 9·0 and 10·1 MeV. Only a small fraction of the neutrons belong to the group of maximum energy. The excited states in Ne^{20} at 5·4, 7·3, 9·0 and 10·1 MeV are unstable against alpha-particle emission and so they may break up into O^{16} and an alpha-particle. The experimental width of the level in Ne^{20} at 10·1 MeV appears to be not greater than about 0·2 or 0·3 MeV.

On aspects of animal locomotion. (Croonian Lecture.) By J. GRAY, F.R.S. (*Received* 17 *October* 1939.)

The available facts appear to establish five main points: (i) To a surprising degree, normal locomotion is independent of the higher nervous centres, although in vertebrates the integrity of the medulla oblongata is essential for a display of full locomotory activity. In some vertebrates the role of the medulla can be replaced by appropriate electrical stimuli applied to the nerve cord. (ii) The type of locomotion

displayed by an animal can frequently be shown to depend upon the presence of a particular pattern of exteroceptive stimulation: one pattern is essential for ambulation, another for swimming or for flight. (iii) Few if any animals display co-ordinated motion when their central nervous systems are completely isolated from those patterns of peripheral stimulation which reach them under conditions of normal progression. It is, however, possible to restrict the receipt of this stimulation to a comparatively small amount of the total musculature taking part in the process of locomotion. (iv) When a vertebrate limb responds by flexion to passive stretch, each of the other three limbs respond by movements which bear an unmistakable resemblance to normal locomotory co-ordination—although these latter limbs may be completely deafferentated. Reflex activity in one limb thus induces a wide spread of postural pattern within the central nervous system. These phenomena are not restricted to tetrapod vertebrates: they occur in fish, and in a variety of invertebrates. (v) Strong support is available for the conclusion that peripheral reflexes play a fundamental role in normal locomotion. Against this theory are certain facts which require further consideration.

Statistical thermodynamics of superlattices. By R. H. FOWLER, F.R.S. and E. A. GUGGENHEIM. (*Received* 19 *October* 1939.)

This paper establishes the precise statistical basis of Bethe's method of discussing order-disorder phenomena in superlattices in Bethe's first approximation. It shows that for cubic lattices of the type here considered, in which all points of one superlattice have as nearest neighbours points of the other superlattice only, Bethe's first approximation is equivalent to the use of a method which we here call the quasi-chemical method. The quasi-chemical method is an approximation which proceeds by assuming that the bond between any pair of nearest neighbours may be treated as if it were a chemical molecule, and the number of arrangements with given numbers of bonds as if the bonds did not interfere with each other.

In the simple case considered, all the details of Bethe's method and the quasi-chemical method and the approximation on which they are based, and the relationship between them, can be made perfectly explicit. There seems reason to hope that the greater power of these explicit methods may enable them to be applied successfully for more complicated lattices, to which at present only the much rougher approximation of Bragg and Williams can be carried through.

An experimental study of the transfer of excitation energy in solution. By A. H. CARTER and J. WEISS. (*Communicated by G. R. Clemo, F.R.S.*—*Received* 23 *October* 1939.)

The transfer of electronic excitation energy in solution (primarily adsorbed from an external light source) has been investigated in the case of the photosensitized decomposition of oxalic acid by uranium salts. More detailed information about the mechanism of the energy transfer in this reaction has been obtained by studying it in the presence of substances (I^-, Br^-) which can act as acceptors for the excitation energy of the excited uranium ions.

New experimental facts are presented which cannot be explained by any of the previously advanced theories. In particular there has been observed a change in the relative amounts of the decomposition products with varying concentrations of quenching substances and hydrogen ions present in the solution. In fact the net process of the photosensitized decomposition of oxalic acid cannot be represented by the equation: $H_2C_2O_4 = CO + CO_2 + H_2O$ as has been assumed often in the past. The experiments show the formation of formic acid and the oxidation of a certain amount of the oxalic acid to carbon dioxide, which must be taken into account. Under the most favourable conditions not more than about 50 % of the oxalic acid is decomposed into carbon monoxide (according to the above reaction), whereas up to 72 % of the oxalic acid is decomposed into formic acid under suitable conditions ($pH\sim5$).

A theory is discussed based on the non-adiabatic electron transfer process between excited uranium ions and oxalate ions. This process constitutes the elementary process of quenching of fluorescence which is identical with the primary process in the photosensitized reaction. The complex formation between the reacting ions is interpreted as a result of quantum mechanical resonance in this primary process.

In connexion with the above investigation, the quenching of the uranium fluorescence by iodide ions and the elementary processes involved have been investigated experimentally and discussed on a similar theoretical basis.

Theory of the vibrations of the sodium chloride lattice. By E. W. KELLERMAN. (*Communicated by M. Born, F.R.S.—Received* 26 *October* 1939.)

According to Born's treatment of polar crystals the frequency equation for a vibrating crystal contains in its coefficients lattice sums which are due to long-range Coulomb forces. Using a method developed by Ewald it has been possible to find a quickly convergent form of those sums. The general formulae for the coefficients have been developed and a special application has been made to the case of sodium chloride. The coefficients and also the frequencies themselves have been calculated for forty-eight different states of vibration of the crystal which are chosen in such a way as to make possible a fair survey over the whole frequency spectrum of the crystal. It appears that the purely electrostatic derivation of the general formulae for the coefficients does not give information about the case of the residual rays. This can only be obtained by taking account of the electrodynamic boundary conditions, namely that the crystal as a whole must not emit radiation, which leads to the correct solution for the frequency of the residual rays. The formulae for the coefficients have also been used for the calculation of the elastic constants of sodium chloride.

The torsional flexibility of aliphatic chain molecules. By A. MÜLLER. (*Communicated by Sir William Bragg, P.R.S.—Received* 26 *October* 1939.)

The dielectric polarization of two diketones is measured in a temperature range including the melting points of the substances. The material under observation consists essentially of aliphatic chain molecules carrying two dipoles. In one sub-

stance, $C_{10}H_{18}O_2$, these dipoles are situated on opposite sides of the chain axis and thus neutralize each other. In the other substance, $C_{11}H_{20}O_2$, the dipoles lie on the same side and therefore increase the dipole strength. From the polarization experiments it is concluded that in both cases considerable distortion of the chain molecules occurs in the temperature range near the melting points.

Cytological studies in *Oenothera* with special reference to the relation of chromosomes to nucleoli. By P. N. BHADURI. (*Communicated by R. R. Gates, F.R.S.—Received* 27 *October* 1939.)

A comparative study of the relation of chromosomes to nucleoli has been made in nine species and one hybrid of *Oenothera*. The distinction between a satellited chromosome and one with secondary constriction breaks down in *Oenothera*. Both the constricted region and the appendage are well marked in most of the species. The filament, like the appendage, is Feulgen positive.

The chromosomes have been classified in some of the species according to their sizes, the situation of the primary constriction and the presence of secondary constrictions. An exact correspondence between the number of secondary constrictions and the number of nucleoli has been established in each case. This number is four in all the species except *O. angustissima* var. *quebecensis* where it is five. Determination of the position of nucleolar chromosomes in the ring is important as a means of identifying chromosomes in the two complexes of a species. The presence of four nucleoli corresponding to four secondary constrictions in (*a*) heterozygous species with high chromosome catenation, such as *O. Lamarckiana*, *O. Hazelae* and *O. biformiflora* and (*b*) homozygous species with seven free pairs, such as *O. Hookeri* and *O. missouriensis*, proves that the presence of four nucleolar chromosomes is an older character than chromosome linkage. This supports the view that ring formation in *Oenothera* has evolved in the genus. That morphological changes of chromosomes can be brought about by segmental interchange is evidenced by the fact that at least one heteromorphic pair of Sat-chromosomes in *O. Lamarckiana* has become homomorphic in its mutant *O. blandina*. There is variation in the sizes of the nucleoli in species and hybrids of *Oenothera*. *O. Lamarckiana* has one very small, one quite big and two intermediate nucleoli, whereas in the homozygous *O. blandina* and *O. Hookeri* there are two distinct pairs of nucleoli. An unpaired condition of nucleoli in *Oenothera* therefore indicates heterozygosity of the species. Prochromosomes, which are Feulgen positive, have been observed in somatic cells of some species. The catenation of three species and nine interspecific hybrids has been determined. In a narrow-leaved trisomic mutation of *O. Hazelae* the fifteen chromosomes showed irregularities in catenation.

The presence of four nucleoli corresponding to four secondary constrictions, the frequent presence of multivalent chromosomes in the pollen mother cells of haploid and diploid plants, as well as the fact that no common basic number is found in the family Onagraceae, indicates that the haploid number 7 in *Oenothera* is a derived number. On this assumption *Oenothera* species cannot, therefore, be looked upon as true diploids.

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