Both processes are interdependent to a high degree: no differentiation and no notable growth is possible without the loosening of the old inexpansible cuticle. On the other hand, feeding at the beginning of the instar provides the impulse not only for growth but also for the production of the moulting hormone. The mutual dependence is still more complicated in the Diptera Cyclorrapha, where both juvenile hormone and moulting hormone are produced by the same organ, the ring gland. Hence the confusion between the moulting and 'growth and differentiation' functions of the moulting hormone in the papers of Vogt[17], Bodenstein[14], Scharrer[7,18], Williams[8,19], etc. By the succession of moulting processes larval growth and metamorphosis are divided into a series of well-defined instars with periodically inhibited growth.

As a certain minimum concentration of the juvenile hormone in the blood is necessary to induce the growth of larval cells, there is a period in each instar before this minimum level is reached, during which only the cells containing the gradient factor, that is, imaginal cells, are able to grow. This is the period of allometric growth; hence the relative increase of the imaginal parts (the wing pads in *Oncopeltus*, the imaginal buds in Holometabola) in the later larval stages. The relative length of this period is determined by the time required for the production of the juvenile hormone to reach a certain minimum level, and this depends on the productivity of the corpora allata. As this productivity, *ceteris paribus*, is in direct proportion to the ratio of surface to volume in the gland (there are no blood capillaries inside the organ) and the surface increases with the square of the radius whereas the volume increases with the cube, there must be a decrease in the productivity of the corpora allata, and thus an increase of the allometric growth period with each succeeding instar. (The relation may be illustrated by the formula $P = c\,\frac{S_a V_a}{V_b}$, where P is the volume-independent productivity (the quantity of juvenile hormone in unit blood volume produced in unit time), c is a constant, S_a is the surface of the corpora allata, V_a is the volume of the corpora allata, and V_b is the volume of the blood.) Sooner or later, according to the species, an instar must be reached, during which the minimum level of the juvenile hormone is not attained before growth is inhibited by the newly deposited cuticle. This will therefore be the last larval instar, and metamorphosis will occur. It is this mechanism which determines the number of instars. The production of juvenile hormone by the corpora allata continues in the adult insect, but the productivity or rate of production decreases still further. There is morphological evidence of this in *Oncopeltus*. In the 4th stage nymph, the maximum volume of the corpus allatum is reached in about two days, in the 5th or last stage the increase is much smaller and the maximum is reached in about four days; in the adult insect the maximum is reached in eight to twelve days.

This theory, based on experiments with the heterometabolous *Oncopeltus*, may also be applied to the metamorphosis of Holometabola including Diptera, as a subsequent analysis of the results of different workers has shown. By means of this theory a simple causal explanation has been achieved of the nature of histolysis, the development of the pupal stage, hypermetamorphosis, regression metamorphosis and some other not yet fully understood phenomena. It leads further to some interesting generalizations enabling a deeper insight to be gained into the problems of growth and differentiation[20].

I wish to thank Dr. V. B. Wigglesworth, in whose department most of this work was carried out, for his continued interest and for much helpful discussion.

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SPECTROSCOPY AT RADIO-FREQUENCIES

AMSTERDAM CONFERENCE

THE Amsterdam Conference on Spectroscopy at Radio-Frequencies (September 18–23) was the third of three biennial conferences organized by the Netherlands Physical Society in co-operation with the International Union of Pure and Applied Physics. The previous meetings were the Zeeman Congress (1946) chiefly on optical spectroscopy, and the Conference on the Physics of Metals (1948). Those who had attended either of these previous events looked forward with pleasurable anticipation to the Conference of 1950, knowing that none could be more delightfully organized. The achievements of our Dutch friends in this respect might well be taken as a model in other countries, where an over-crowded programme is apt to straggle belatedly to a close before a jaded audience.

The development of radio-frequency spectroscopy in the past five years has been prodigious, and owes not a little to the fact that many physicists had their attention forcibly directed to radio and radar techniques during the Second World War. Previously the resonant absorption of energy (as distinct from non-resonant absorption in electrically polar or paramagnetic liquids and solids) had been detected only by molecular beam techniques, and applied to the precise determination of nuclear moments by Rabi and his school. These methods constituted a major experimental *tour de force* and involve the detection of resonance through its effect on the path of an atomic beam. The several branches of radio-frequency spectroscopy developed after the War are more akin to optical spectroscopy in that the actual absorption of energy from the radiation is measured. In 1946, at the Zeeman Congress, one paper on one aspect of these new methods was included; in 1950 a whole conference was devoted to this subject.

The scope of the Conference may be summarized by the sectional headings of the official programme. These were: paramagnetic resonance, ferromagnetic resonance, nuclear resonance, atomic and molecular spectra and nuclear properties. The latter took the form of an exposition of the present theory of nuclear shell structure by Prof. L. Rosenfeld ; its inclusion in this Conference underlined the fact that the several fields of research discussed (with the exception of ferromagnetic resonance) each contained notable contributions to nuclear data. In particular, the methods which have determined nuclear constants with an accuracy exceeding that of many atomic constants were well represented, as these without exception make use of radio-frequencies. In the following notes, a number of the novel and interesting results revealed at the meetings will be briefly discussed. Inevitably, this discussion must be inadequate, and many important papers omitted—in particular, Prof. Rosenfeld's survey, the session on experimental methods, and the excellent introductory talk with which Prof. C. J. Gorter opened the Conference.

A session of outstanding interest was that in which the chief two protagonists of nuclear induction and nuclear resonance diverted their audience with the most recent achievements of their laboratories. Prof. F. Bloch contrasted the smallest cyclotron in the world (8 cm. in diameter) at Stanford University, in which protons are being slowed down, with the machines under construction "by his friends across the bay". With this novel cyclotron and a nuclear induction experiment in the same magnetic field, the ratio of the proton magnetic moment to the nuclear magneton is determined from the ratio of the resonant frequency for the proton spin to the cyclotron frequency. The retarded protons finally take a considerable fraction of a radio-frequency period to cross between the 'dees', so that little energy is given up to the radio-frequency field ; thus they make many revolutions, and high accuracy is attained, which is further enhanced by the use of radio-frequencies which are odd harmonics of the fundamental cyclotron frequency. The interim value of the ratio μ_p/μ_n is $2\cdot79245 \pm 0\cdot0002$. Other work at Stanford included the determination of a large number of nuclear moments by Proctor and Wu, using a recording spectrometer. The importance of chemical effects, such as a 1·3 per cent shift in the cobalt resonance between different compounds, was emphasized. The splitting into five components of the antimony resonance from each of the antimony isotopes in a solution of potassium fluorantimonate points to a quasi-crystalline structure in the liquid state.

Prof. E. M. Purcell's paper was concerned with nuclear relaxation effects in crystals. After considering the effect of molecular and ionic rotations on the relaxation time and line width, he described an experiment of Pound where, by use of the saturation phenomenon, it was shown that the spin-lattice relaxation is due to interaction between the nuclear electric quadrupole moment and the fluctuating electric field set up by vibrations within the crystal lattice. The theory of this process, adapted from that of Waller, led to relaxation times in reasonable agreement with experiment. The discovery of a fluoride crystal with a relaxation time of many minutes made possible several ingenious and fascinating experiments. By the use of a condenser discharge, the magnetic field could be reversed in a time short compared with the nuclear precession frequency ; the polarization is then in the opposite direction to the field, with more nuclei in the state of higher energy than in the state of lower energy. This corresponds to a 'negative temperature', for which concept thermodynamic justification was claimed. Here it should be noted that the nuclei 'cool off' from negative temperatures to positive temperatures by passing through infinite temperature (equal populations of the two levels), not through the absolute zero. By observing the emission from such a crystal in fields less than the internal field, the answers to some interesting questions about the state of such a system can be obtained.

In a short communication Prof. H. Kopfermann gave details of the nuclear absorption lines observed by Kruger in zero magnetic field in solid compounds of iodine and chlorine. The frequencies of these lines are determined by the large electric quadrupole interaction and involve searching over a wide range of frequencies, up to 300 Mc./s. The ratio of the quadrupole moments of the two chlorine isotopes (35 and 37) obtained by this method is 1·2667, compared with 1·270 (Townes, microwave gas spectroscopy) and 1·280 (Zacharias, molecular beams). It is thought that the probable error in the last-quoted figure is greater than previously assumed ; the ratio of the magnetic dipole moments obtained by Zacharias (1·2027) is also at variance with the nuclear induction result (1·2014) of Proctor and Wu.

A survey of recent advances in atomic beam techniques was given by Prof. P. Kusch, beginning with an account of the methods used by Zacharias to determine the spins and moments of several radioactive nuclei. Very precise measurements of the hyperfine structure of hydrogen, deuterium and tritium at Columbia University were outlined. The ratio of the hyperfine splitting of hydrogen and deuterium differs from the ratio calculated from the nuclear moments by $(1\cdot703 \pm 0\cdot007) \times 10^{-4}$; this is due to the effect of the internal nuclear motions in deuterium, a theoretical estimate of which gives $(1\cdot83 \pm 0\cdot22) \times 10^{-4}$ for the discrepancy. Prof. N. F. Ramsey described a method of using two radio-frequency fields to enhance the precision of molecular beam methods by a method analogous to the Michelson stellar interferometer.

The use of the isotope shift in rotational lines in microwave molecular spectra to determine nuclear masses was outlined by Prof. C. H. Townes. Frequencies can be measured to one part in 5×10^6 ; but a correction must be made for the change in the equilibrium distance between the atoms due to the different zero-point energy of different isotopes. Where several isotopes are available this correction can be calibrated from the masses of two isotopes, and the masses of the others determined with an accuracy exceeding that of the mass spectrograph. In this way it has been shown that neither for selenium nor germanium is there any anomaly in the mass where the closed neutron shell at $N = 40$ occurs. The spins of a number of nuclei, including several radioactive isotopes, have been established by means of the quadrupole interaction, and very small quantities were required (10^{-10} gm. in the case of sulphur-36). Using the Zeeman effect, Dr. C. K. Jen has determined the magnetic moment of sulphur-33 as $0\cdot63 \pm 0\cdot02$ nuclear magneton, together with the magnetic moment associated with molecular rotation of a number of compounds.

The study of paramagnetism by means of the resonance phenomenon at centimetre wave-lengths was reviewed by Dr. B. Bleaney. The presence of hyperfine structure in paramagnetic ions in the solid state was first suggested by Prof. C. J. Gorter, and verified by the late Dr. R. P. Penrose at Leyden at the end of 1948. Following measurements at Oxford on copper, cobalt, manganese and vanadium salts, the principal features of the phenomenon have been reconciled with theory by the work of Abragam and Pryce. The spins of the two odd isotopes of neodymium (143 and 145) have been established as 7/2 and the ratio of their magnetic moments is 1·61. In the field of ferromagnetic resonance, the state of the theory was outlined by Prof. J. H. Van Vleck; the principal features which remain unexplained are the departure of the spectroscopic splitting factor from 2 in materials where the gyromagnetic ratio is very close to 2, and the cause of the width of the resonance lines. On the experimental side, Dr. J. H. E. Griffiths showed how, with the help of a new type of magnetometer, anomalous results with thin nickel films have been established as due to strain.

During the week, members of the Conference had opportunities of visiting the laboratories in Amsterdam, Delft, Utrecht and Leyden. The visit to Leyden coincided with the presentation of the first Kamerlingh Onnes Medal of the Nederlandsche Vereeniging voor Koeltechniek to Prof. F. E. Simon, of Oxford, in recognition of his outstanding contributions in the field of low-temperature research (see *Nature*, June 24, p. 1001). The occasion was marked by a dinner, and a reception by the British Council in Amsterdam on the following day. This was an addition to the many other social functions. This note cannot end without a tribute to the hospitality of the Netherlands Physical Society and the work of its Conference committee, in particular, the president, Prof. C. J. Gorter, and the secretary, Prof. J. de Boer.

B. BLEANEY

OBITUARIES

Prof. J. F. Spencer

PROF. JAMES FREDERICK SPENCER, emeritus professor of chemistry in the University of London (Bedford College), who died on December 31 on the eve of his seventieth birthday, will be remembered by his former colleagues and by a large number of his students as a very human personality. One of his great pleasures was in university committee or examination work, when he met and worked with a body of other people. He enjoyed being in a laboratory full of students, with whom he discussed any topic that seemed to him appropriate. His popularity among his students at Bedford College was shown by the attendance at his farewell party in 1946. His colleagues recognized him as a man who had exerted all his powers to advance the academic prestige of the College, and they too, when he retired, felt that a real human link had been sundered.

Spencer took first-class honours in Liverpool in 1901 and, with the aid of an 1851 Exhibition, went to Breslau, where he worked for two years on a physico-chemical problem under Abegg and took the degree of Ph.D. The third year (1905–6) of the Exhibition he spent at University College, London, and was then appointed demonstrator in the Department of Chemistry at Bedford College, Mr. Holland Crompton then being the head of the Department. Here, as was customary in those spacious days, Spencer lectured on both organic and physical chemistry. As a result of Mr. Crompton's periodical absences through illness, the running of the department devolved from time to time on Dr. Spencer, and he became successively assistant lecturer and university reader in physical chemistry. In 1919 the Department of Chemistry was subdivided and he became head of the Department of Inorganic and Physical Chemistry. Eight years later he was granted the title of professor in the University of London and, in 1928, when a new head of the Department of Organic Chemistry was appointed, he also became director of the Chemical Laboratories. In 1929 he entered into occupation of the new Inorganic and Physical Laboratories, which are a living witness to his energy and foresight.

Spencer served Bedford College with whole-hearted zeal. He also did much to advance the study of magneto-chemistry, for which subject, particularly in collaboration with Dr. V. C. G. Trew, once a student and later a colleague, he acquired international recognition. He also wrote good books on practical physical chemistry and on the rare earths. In his spare time, he was an enthusiastic philatelist.

Miss W. S. Blackman

MISS WINIFRED SUSAN BLACKMAN, who died on December 12, was one of the first women to adopt anthropology as a profession. After taking the diploma in anthropology in the University of Oxford, she worked for a time as assistant to Henry Balfour, then curator of the Pitt Rivers Museum, Oxford, where she is remembered for her careful cataloguing, especially of the large series of amulets and charms. This gave her an informed interest in magico-religious ideas and practices which she retained throughout her life, and put to practical use in her field-work.

In 1920–21 Miss Blackman worked in Egypt as research student to the Oxford Committee for Anthropology, returning for further periods during 1922–26 in charge of the Percy Sladen Expedition and again during 1927–31 under the auspices of the Wellcome Historical Medical Museum, for which she made extensive collections. Her main object was to study the daily life, beliefs and customs of the Egyptian peasantry, among whom she lived and whom she knew and understood as no one else has done. Her book, "The Fellāhīn of Upper Egypt", published in 1927, is still the most authoritative work on the subject, and has the rare quality of appealing alike to the specialist and to the layman. In the chapter on ancient Egyptian analogies, she had the advantage of the specialized knowledge of her brother, the distinguished Egyptologist, Prof. A. M. Blackman. It was a source of great satisfaction to her that by her researches into modern customs she was able to throw light on points hitherto obscure to students of ancient Egypt.

Her other publications, dealing with special aspects of her work in Egypt, are in the form of articles in various scientific journals, including the *Journal of Egyptian Archæology*, *Folk-Lore*, *Man*, and the *Journal of the Royal Anthropological Institute*. Although small in quantity, her published contribution to anthropology is valuable for its careful and detailed recording and scientific interpretation of data in a field where specialists are few. It is greatly to be regretted that circumstances prevented her from fulfilling the ambition recorded in the preface to her book, "to produce a large and strictly scientific volume on the beliefs and practices and the social and industrial life of the modern Egyptians".

BEATRICE BLACKWOOD