number of weaker components of both kinds—truly a formidably complicated system. In general, the longitudinal components appear to be unpolarised, although Miss Howell has found some anomalies with lithium and calcium. In some cases the components are unsymmetrical both in position and in intensity. Of all the other elements investigated, mercury alone shows a slight broadening. It might be expected that the great nuclear charges of heavy atoms would diminish the effect of an external field. The inverse absorption effect has so far not been observed.

Long before the Stark effect was observed Voigt showed that such results might be expected from quasi-elastic forces in the atom and the stresses produced by the field. Schwarzschild has attempted to explain it by the ordinary laws of electrodynamics, and Warburg, Gehrcke, Garbasso and Bohr by Bohr's theory. Each attempt was successful in some respects, but each failed to account fully for all the components, their displacements and their state of polarisation, and all the theories assign the same number of components to each line of a series, whereas one of the most significant features is the progressive difference in number of components, displacements and relative intensities in passing from one line to another. Stark not only rejects them all, but is led by his study of the phenomenon to abandon finally the quantum and light-cell theories, because he considers that he has proved that the greatest possible energy which an electron can acquire in its orbit falls far short of one energy quantum. Moreover, he argues that it seems impossible to explain the phenomenon in terms of Bohr's one electron. He concludes that a number of electrons must take part in the emission of a single line, each having the same frequency under ordinary conditions or in a magnetic field, but different frequencies when displaced unsymmetrically in an electric field. It is difficult, however, to understand why hydrogen has only one detachable electron if Stark's view is correct.

It has already been mentioned that at low pressures the width of lines may be ascribed entirely to the Doppler effect. The great broadening at higher pressures has never been explained, but it has been assumed that damping, collisions and rotations all play a part. Stark suggests that it may be largely due to atomic electric fields, which may exercise a large influence when the atoms are crowded together. It seems significant that the broadening increases with the ordinal number of a line in a series, is often unsymmetrical, and diminishes with increasing atomic weight in most cases, quite in harmony with the effects of an electric field. Nicholson and Merton have found that the broadening of hydrogen lines is in quantitative agreement with Stark's suggestion.

With changes in vapour density, pressure, temperature or the mode of excitation lines belonging to one series may weaken or disappear, other lines may be strengthened, and new lines may appear. We must assume that different groups of lines are due to different emission centres. These differences must depend upon the size of the particles, or upon the number and arrangement of electrons. Any theory must take account of the molecular or atomic state or the electrical charge of the emission centres. In some cases we have rather definite information on these points.

A number of elements emit band spectra under some conditions, line spectra under others. One conclusion which seems to be well established is that band spectra are emitted by molecules, line spectra by atoms. Universally, we find that compounds give band spectra, never line spectra. If a compound is dissociated by the discharge the line spectrum of one or both constituents appears. Elements give band spectra with feeble excitation, line spectra when the discharge is so intense as to cause dissociation. It seems reasonable to infer that the band spectra of elements is likewise associated with the molecular condition. In the case of monatomic elements which give both band and line spectra electrical conditions must determine the nature of the radiation.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE war has brought women students into prominence in Germany. They form a third of the actual number of students in residence at the twenty-two universities of the Empire, and one-tenth of the total number of registered students. During the winter of 1916–17 there were more women than men at several German universities, *e.g.* Marburg and Münster; in Bonn, Frankfurt, Munich, Heidelberg, and Jena the women formed half the students, while they were in a minority at Strassburg, Leipzig, Breslau, and Giessen. Altogether, there were 5757 women undergraduates at the German universities during the last term, distributed as follows:—Literature and history, 2789; mathematics and science, 1036; medicine, 1479; dentistry, 64; economics and agriculture, 225; law, 116; Protestant theology, 18; and pharmacy, 30.

THE committee appointed to consider arrangements for post-graduate teaching in the Calcutta University has, we learn from the *Pioneer Mail*, presented a report dealing exhaustively with that subject. In summing up the recommendations the committee states that the proposals, in the main, amount to the acceptance of two fundamental principles: (*a*) an intimate association and co-operation between the college and the university staffs is imperative in the interest of all concerned and of the development of higher teaching; (*b*) it is necessary to constitute a suitable organisation within which the teachers will be enabled by discussion among themselves efficiently to conduct the teaching and examination of graduates. Beyond this, says the report, the committee has been unable to go and has refrained from commenting on the wider problems which confront the University.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society. March 22.—Sir J. J. Thomson, president, in the chair.—J. C. **Mottram** and Dr. S. **Russ**: Observations and experiments on the susceptibility and immunity of rats towards Jensen's rat sarcoma. Observations have been made upon the modes of growth of Jensen's rat sarcoma following inoculation. There is a gradual transition from those cases in which the tumours spontaneously disappear to those in which they grow in a uniformly progressive manner. The experimental production of the immune condition can be brought about in several ways. Animals made refractory to the growth of the tumour have been given various doses of X-rays; the effect of such irradiation upon the blood was to cause a marked reduction in the number of lymphocytes. Over suitable conditions of exposure it has been possible to destroy the immune condition and thus convert refractory into tumour-bearing animals. There is a tendency for the immune condition to be restored. Histological and other evidence is brought forward which indicates that the failure of sarcoma cells to grow in an immune animal is due to an active resistance thereto on the part of the host.—S. **Pickering**: Problems bearing on residual affinity. It has been ascertained that the

alkali metals, like the other metals previously examined, form metallo compounds isomeric with normal salts, and that, therefore, these metals may assume a valency higher than that usually exhibited by them. A class of compounds intermediate between the metallo and normal salts also exists. These are termed metallato compounds. The possibility of most metals, other than carbon and hydrogen, assuming a valency value higher than that usually exhibited by them is shown to explain (i) the constancy in the heat of substitution of CH_3 for H as contrasted with want of constancy in the case of the substitution of OH or Cl for H; (ii) the fact that the heat of neutralisation of organic acids is lower than that of inorganic acids, and exhibits certain distinctive features when only partially effected; (iii) that all true acids must contain a doubly linked oxygen atom, and that the apparent exceptions to the constancy of the heat of neutralisation are due to the acid not being a true acid; (iv) that the so-called normal salts of the alkali metals with organic acids are strongly alkaline, and that those with inorganic acids are feebly so; (v) that the usual method of titration of an acid by an alkali, as well as the precipitation of the acid or base by usual methods, fails in the presence of an organic acid; (vi) that the actual value of the heat of neutralisation constant can be explained.—Prof. E. **Wilson** and Prof. J. W. **Nicholson**: Residual magnetism in relation to magnetic shielding. (i) The paper contains a further contribution to the study of the problems presented by the necessity for constructing a magnetic shield capable of reducing the earth's field to an order as low as 0·001 C.G.S. unit in a large space. The main problem not treated in earlier papers is that of residual magnetism in the various shells of the shield, and this problem is discussed in connection with exhaustive experiments in the present paper. (ii) It is found that the ordinary process of demagnetisation of a mass of iron fails to be completely effective if, during the operation of the current which is diminished by steps and continually reversed, a constant magnetic field such as that of the earth is present at the same time. This phenomenon has escaped notice hitherto, probably on account of the smallness of the earth's field, but it becomes prominent in experimental work involving the measurement of fields so small as that specified in (i). (iii) This effect of the steady magnetic field is shown to be associated with a reversal of the residual effects of hysteresis in iron when tested in the earth's field by currents lying within a certain range in which they approximately annul the field. (iv) It has been found possible to ensure complete removal of irregular polarisation or previous magnetic history of the shells, provided that during the preliminary demagnetisation of the shells the earth's steady field on them is annulled by a steady current of suitable amount enclosing the whole shield. (v) The well-known fact that iron, polarised by a large force, and afterwards tested for permeability at a lower force shows diminished permeability at the lower force, gives, in combination with these results, an interpretation of the increase of permeability manifested by iron when tested within a magnetic shield.—Dr. S. **Chapman**: The solar and lunar diurnal variations of terrestrial magnetism.

Zoological Society, March 20.—Dr. A. Smith Woodward, vice-president, in the chair.—E. P. **Allis, Jr.**: The prechordal portion of the chondrocranium of *Chimaera colliei*.—D. M. S. **Watson**: A sketch-classification of the pre-Jurassic Tetrapod vertebrates. The classification introduced in this paper is founded on a detailed consideration of all parts of the skeleton of such old amphibia and reptiles as are at all well known. In previous papers the author has analysed the features presented by many of these forms, distinguishing between those which are common to all early reptiles and those which are restricted to definite stocks, the latter being divided into those dependent on "adaptive radiation" and the more fundamental characters, especially those of the brain-case and ear, which are not to be correlated with any special mode of life. These non-adaptive characters, which appear in typical forms even in early members of a stock, serve for the ordinal and superordinal grouping, adaptive changes being used for groups of lower order and the gradual loss of primitive structures giving horizontal dividing lines.

DUBLIN.

Royal Dublin Society, March 27.—Prof Hugh Ryan in the chair.—Prof. W. **Brown**: The change in Young's modulus of nickel with magnetic fields. The change is smaller for alternating than for direct longitudinal magnetic fields. With transverse magnetic fields, both direct and alternating, the Young's modulus first increases, then decreases; and the magnetic field in which the maximum value occurs is smaller the greater the constant load on the nickel wire.

PARIS.

Academy of Sciences, February 26.—M. A. d'Arsonval in the chair.—E. **Ariès**: The entropy of perfect gases at the absolute zero of temperature. The entropy at the absolute temperature is not $-\infty$, but is in the indeterminate form of two infinite quantities of opposite signs. It is shown that for a gram-molecule of a solid, the increase in the entropy, when vaporising entirely at a low temperature as a perfect gas, tends towards the gas constant R, as the temperature approaches the absolute zero.—P. **Vuillemin**: *Eurotium amstelodami,* supposed parasite of man.—Henri Lecomte was elected a member of the section of botany, in the place of the late Ed. Prillieux.—G. **Julia**: Binary forms of any degree.—P. **Gaubert**: A new property of sphærolites.—L. **Gentil**: The Upper Marine Miocene of West Algeria.—M. **Stuart-Menteath**: The interior basins of the Pyrenees.—M. **Miège**: New attempts at the disinfection of the soil. The antiseptics used included toluene, carbon bisulphide, hydrogen peroxide, lysol, formol, potassium permanganate, copper sulphate, sulphur, bleaching powder, and wood charcoal. In large-scale experiments, toluene and carbon bisulphide proved the most efficacious, as regards both increased yield and the health of the plants.—M. **Weinberg** and P. **Séguin**: Study on gas gangrene. *B. oedematiens* and anti-*oedematiens* serum.

March 5.—M. A. d'Arsonval in the chair.—A. **Lacroix**: The phonolitic rocks of Auvergne. A delicate case of interpretation of the chemical composition of felspathoid rocks.—G. **Bigourdan**: Some seventeenth-century observatories in the provinces. Historical details are given of La Fleche, Le Maurier, Loudun, and Arles.—G. **Giraud**: Hyperfuchsian functions and systems of total differential equations.—E. **Cotton**: Characteristic number and radius of convergence.—R. de Montessus de **Ballore**: Left algebraic curves.—E. **Belot**: The possible *rôle* of volcanoes in the production of meteorites.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the fourth quarter of 1916. Observations were made on sixty-four days during the quarter, and the results are given in tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—A. **Berget**: A differential refractometer for measuring the salinity of sea-water. The two liquids to be compared are placed in a rectangular box separated into two parts by a diagonal glass partition. An image of a slit, after passage through this double prism, is focussed in a microscope, and the

displacement of the image measured by a micrometer eyepiece. Densities can be indirectly determined by this refractometer to the fifth decimal figure with great rapidity.—L. **Abonnenc**: The laws of flow of liquids by drops in cylindrical tubes. Vaillant has shown that when a liquid falls in drops from the orifice of a cylindrical tube the weight of a drop is a parabolic function of the frequency of fall. An extension of these experiments to tubes of less than 2 mm. external diameter is given.—P. **Gaubert**: The rotatory power of liquid crystals.—A. **Guilliermond**: Vital observations of the chondriome of the flower of the tulip.—C. **Vincent**: The forms of phosphorus in Breton granitic soils. The amount of phosphorus found in these soils will be underestimated if the method of extraction by strong mineral acids is used in the analysis. The organic phosphorus present in the humus may amount to 50 per cent. of the total phosphorus, and this explains the effects of liming these soils. From these results a rational method of manuring is deduced.—M. **Herlant**: The variations of the volume of the nucleus of the egg rendered active by butyric acid.—J. **Effront**: Achrodextrinase. Certain species of *B. mesentericus*, cultivated in a nitrogenous medium, secrete a diastase liquefying starch. The hydrolysis of starch by this ferment was studied in comparative experiments with malt extract, ptyalin, and pancreatic amylase. The behaviour of the mesenteric amylase was distinctive, and the name achrodextrinase is proposed for it. Some practical applications in the textile industry and in the laundry are suggested.—M. **Marage**: Arterial pressure in cases of deafness caused by shell shock. Eighty-two per cent. of the cases examined showed arterial pressure above the normal, and insomnia generally accompanied the hypertension. The pains in the head, usual in these cases, do not appear to be connected with the arterial pressure. The best treatment is d'Arsonvalisation.—M. **Lautier**: The treatment of cases of war-deafness. The Marage method is easy to apply, generally useful, and never harmful. Its general employment in these cases is strongly recommended.—M. **Rappin**: Antituberculous vaccination.

BOOKS RECEIVED.

British Wild Flowers: Their Haunts and Associations. By W. Graveson. Pp. xv+320+plates 1. (London: Headley Bros.) 7*s.* 6*d.* net.

The Tutorial Chemistry. By Prof. G. H. Bailey. Part ii., Metals and Physical Chemistry. Third edition. Pp. viii+460. (London: University Tutorial Press, Ltd.) 4*s.* 6*d.*

Météorologie du Brésil. By C. M. Delgado de Carvalho. Pp. xix+525. (London: John Bale, Ltd.) 25*s.* net.

Chemistry for Beginners. By C. T. Kingzett. Pp. vi+106. (London: Baillière, Tindall, and Cox.) 2*s.* 6*d.* net.

Contributions to Embryology. Vol. iv. Nos. 10, 11, 12, 13. Pp. 106+plates iv. (Washington: Carnegie Institution.)

Carnegie Institution of Washington. Year book, No. 15. Pp. xii+404. (Washington: Carnegie Institution.)

Studies on the Variation, Distribution, and Evolution of the Genus Partula. The Species inhabiting Tahiti. By Prof. H. E. Crampton. Pp. 311+34 plates. (Washington: Carnegie Institution.)

X Rays. By Dr G. W. C. Kaye. Second edition, with illustrations. Pp. xxi+285. (London: Longmans and Co.) 9*s.* net.

Electrical Laboratory Course. By Dr. M. Maclean. Pp. 120. (London: Blackie and Son, Ltd.) 2*s.* net.

A Short System of Qualitative Analysis. By Dr. R. M. Caven. Pp. viii+162. (London: Blackie and Son, Ltd.) 2*s.*

The Chemists' Year Book. Edited by F. W. Atack, assisted by L. Whinyates. 2 vols. Pp. 1030 (London and Manchester: Sherratt and Hughes.)

Studies in Insect Life, and other Essays. By Dr. A. E. Shipley. Pp. ix+338. (London: T. Fisher Unwin, Ltd.) 10*s.* 6*d.* net.

An Introduction to a Biology, and other Papers. By A. D. Darbishire. Pp. xviii+291. (London: Cassell and Co., Ltd.) 7*s.* 6*d.* net.

The Manufacture of Sulphuric Acid and Alkali, with the Collateral Branches. By Prof. G. Lunge. Fourth edition. Supplement to Vol. i., Sulphuric and Nitric Acid. Pp. xii+347. (London: Gurney and Jackson.) 15*s.* net.

Bill's School and Mine: a Collection of Essays on Education. By W. S. Franklin. Second edition. Pp. vii+102. (South Bethlehem, Pa.: Franklin, McNutt, and Charles.) 1 dollar.

Geology: Physical and Historical. By Prof. H. F. Cleland. Pp. 718. (New York: American Book Co.) 3.50 dollars.

DIARY OF SOCIETIES.

THURSDAY, APRIL 12.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Wayleaves: C. Vernier. OPTICAL SOCIETY, at 8.—Light Filters for Eye Protection: L. C. Martin —Accuracy of Observation and Precision in Measurement: Dr. G. A Carse.—Some Methods of Analysing Lens Systems: S. D. Chalmers.—A Simple Proof of the Expression for the Focal Power of a Thick Lens C. Cochrane.

FRIDAY, APRIL 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.

CONTENTS.

Editorial and Publishing Offices:

MACMILLAN AND CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C. 2

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.

Telephone Number: GERRARD 8830.