An interesting related observation was described by A. H. Hughes. He has found that monolayers of the green dye, magnesium naphthalocyanine, were visible, and in conjunction with C. B. Allsopp, he showed that the molecular extinction coefficient in the film is of the same order as that in solution.

The recent work on protein monolayers is of great biological interest. F. A. Askew described the preliminary results obtained by surface pressure measurements on protein films at the liquid-liquid interface between water and bromobenzene. Evidence on two very important issues was brought forward by Prof. E. Gorter. By an ingenious experiment with pepsin and trypsin monolayers, he has shown that when these are spread at an air-water interface, only a negligible amount is lost into the substrate or by denaturation. He also found that myosin prepared below 0° C. does not spread, but can be made to do so by adding trypsin to the substrate. G. Philippi discussed some general theoretical considerations on the homalic state.

One of the most interesting papers read was that by J. H. Schulman on mixed unimolecular films. He described in some detail the phenomenon of 'film penetration'. If a very dilute solution of, for example, a long-chain acid is introduced into the substrate beneath a monolayer of an alcohol, complex formation occurs between the head groups, and the Van der Waals adhesion of the chains leads to formation of a stable mixed film, composed of equal numbers of acid and alcohol molecules whatever the initial proportions. This complex formation is accompanied by a marked increase of surface pressure and a simple proportional change of phase boundary potential. When adsorption on to a protein film occurs without penetration, as in the case of tannic acid or silicic acid, there is no change of surface pressure but only a change of surface potential, although the film has become much more stable and can now resist displacement by fatty acids. The relationship of these phenomena to immunological specificity and to hæmolysis by saponin, fatty acids and complement was discussed.

J. F. Danielli, working with invertebrate ova, discussed the surface conditions of animal cells. O. Gatti described an investigation of the origin of electrical potentials in living tissues. By correlation of the potential difference across frog's skin with its electrical resistance and oxygen uptake, in the presence of various inhibitors, he brought forward strong evidence suggesting that bioelectric potentials have their origin in oriented monolayers and that the effective interfaces are occupied almost entirely by lipins and sterols, proteins being of much less importance.

The meeting was concluded by a beautiful demonstration of intertraction at liquid-liquid interfaces by Sir Almroth Wright.

Ionospheric Studies in India*

By Prof. S. K. Mitra, University of Calcutta

SINCE the middle of the last decade, the study of the conducting upper atmosphere—the ionosphere—has been proceeding vigorously in various parts of the world. The countries where the study originated—England and the United States—are situated at high latitudes, far from the equator. In view of the fact that ionospheric conditions in a subtropical region of low latitude, like that of India, were likely to differ considerably from those in a region of high latitude—particularly with regard to the effect of meteorological disturbances of terrestrial or solar origin, such as thunderstorms, magnetic storms, etc.—the study of the ionosphere was taken up at Calcutta[1] (22° 34′ N., 88° 22′ E.) in 1930 and has been continued uninterruptedly since then. Recently, measurements have been made at Allahabad[2] (25° 26′ N., 81° 50′ E.) and Bangalore[3] (12° 58′ N., 77° 35′ E.) on ionospheric heights—at the former on ionisation density as well—and at Dacca[4] (23° 43′ N., 90° 24′ E.), on fading.

Measurement of the equivalent height of the lower *E* region, by the 'echo' method, carried out systematically at Calcutta according to the programme of the International Polar Year (1932–33), on a wave-length of 75 m. at normal incidence, gave the average value[5] of the height as 90 km. This is lower by about ten per cent than the average value as obtained by the same method in England. Prior to this, measurement carried out with medium wave-length (370·4 m.) for oblique incidence, by the 'angle of incidence' method, had yielded the average value of the *E* layer equivalent height after sunset[1] as 80 km.

The Polar Year height measurements[5], recording the appearance or disappearance of the echoes in different months of the year and at various hours of the day, indicated the nature of the seasonal and diurnal variation of ionisation at such low latitude as that of Calcutta. It was found that at midday in August and September the *E* ionisation density was greater than 2×10^5 equivalent electrons per c.c., that during October–November and April–May it was near this value, and that in the months December to March it was less. Direct measurement of ionisation density by observing the frequency of the wave which just pierces a particular region, after the method developed by Appleton, showed that during the summer solstice (1933) the *E* ionisation density at midday was more than 0·5 million (equivalent electrons) as compared with the corresponding average value in England of 0·18 million. At midnight, the *E* ionisation density was less than 0·2 million for the most part of the year, and the *F* density also less than 0·2 million in April, May and June. The maximum value of the *F* density was found by direct measurement to be more than 1·5 million, which is much greater than the value obtained at higher latitudes.

Records of diurnal variation of *E* ionisation density showed that the nature of the variation on a normal day, that is on a day not disturbed by thunderstorms or other causes, agrees with that

* Substance of a lecture delivered before the Maxwell Society at King's College, London, on January 30.

calculated after Chapman, for the latitude of Calcutta, by assuming that the ionisation is caused by the ultra-violet radiation of the sun. This assumption was justified by results of observations made during the total solar eclipse of August 1933, when the *E* ionisation was found to fall to a minimum value a little after the centre of the eclipse, as predicted by theory[6]. No indication was obtained of the so-called 'corpuscular eclipse' which was due about two hours before the optical eclipse.

The normal variation of ionisation caused by the varying obliquity of the sun's rays was very often disturbed by other causes, the chief among which in Bengal in summer months was thunderstorm. Such storms were of frequent occurrence in the months of April–September and were found to increase abnormally the *E* region ionisation[7]. This confirms the view of C. T. R. Wilson that the electric field of a charged thundercloud is capable of affecting the ionosphere, either directly by discharge or indirectly by shooting up high-speed electrons. It was found in this connexion that, of the abnormal increases of ionisation observed, the daytime increases were related to thunderstorms and the night-time increases to magnetic storms. Observations during the Leonid meteoric shower showed that the meteors by their bombardment could increase considerably the ionisation of the upper atmosphere[8].

Study of the absorption of radio waves during thunderstorm months had shown that the wavelength of the longest wave which could be reflected from the *E* region varied in a regular manner from sunrise to sunset, and did not follow the sudden and erratic outbursts of variation caused by thunderstorms[9]. This showed that during daytime an absorbing region of the ionosphere is formed which is distinct from the usual 'reflecting' region.

In conclusion, stress was laid on the fact that in order to make the ionospheric researches most fruitful, it is essential that there should be close co-operation between workers in different parts of the world. The need of a co-ordinating body in India like the Radio Research Board of England was also emphasised.

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French Statistics*

WE have received a copy of the "Annuaire Statistique" of France for 1934. This large volume contains a wide range of statistics on every branch of French life. The first part gives the annual tables for 1932, 1933 and in some cases 1934, of territory, vital statistics, education, health, production, transport, trade, finance and many other aspects. The second part, conveniently distinguished by a different colour of paper, gives comparative statistics for thirty or forty years and in some tables for more than a century. The last section gives figures of area, population, production, trade, etc., of the chief States of the world for the last fifty years. This section is particularly useful. Another official French publication received is the volume entitled "Statistique de Mouvement de la Population", 12, 1932, "Les causes de décès" which gives for the year under review the causes of death grouped under forty-three headings for every department and large town in France.

Some very interesting statistical information relating to French industry, though unfortunately incomplete, will be found in the Census of Production and Wages taken during 1931. In 1928, France signed an international convention on economic statistics at Geneva whereby the Government undertook to carry out a survey of industrial production as complete as might be possible at least every ten years. To implement this convention, the Government voted a credit of 750,000 francs for the purpose when the general Census was being made in 1931. Previously there had been no regular census of production, though so far back as 1669, Colbert had carried out an industrial survey, and again in 1788, 1812, 1840 and 1860 censuses of industry were undertaken.

The present investigation of 1931 was limited to establishments employing more than ten persons, and only about a quarter of the firms above this size replied to the questionnaires, while in the more important industries such as textiles the proportion was even less. Out of 60,000 questionnaires issued only 25,000 were returned, and after eliminating incomplete returns and those obviously inaccurate, there were left 15,073 returns relating to establishments which between them occupied 159,000 employers and 1,105,000 employees in 1931. Of the employees 772,500 were men, 260,200 women and 72,400 young persons less than 18 years of age.

The summary of the returns shows that in the year previous to the Census, namely, 1930, the 15,000 firms consumed $10\frac{1}{2}$ million tons of coal, $5\frac{3}{4}$ million tons of coke, 426,000 tons of petrol and benzol, 115,000 tons of heavy oil, 690,000 tons of wood fuel and 269,000 tons of lignite. The power utilised, measured in kilowatts, was 690,000 kw. from steam engines, 246,000 kw. from gas engines, 169,000 kw. from water motors and 1,049,000 kw. from electric motors driven by current purchased from outside the works. The total motive force utilised in 1930 was 2,229,000 kw. and the average number of persons employed during that year was 1,189,000. Net production was valued at 27,303 million francs and the wages of the 1,189,344 employees amounted to 12,035 million francs.

In addition to the French statistics, the Census report provides an interesting summary and a valuable comparison of recent censuses of production in Great Britain and the United States. The historical notes on the early French censuses of production are especially useful and interesting.

* Republique Francaise: Présidence du Conseil: Statistique générale de la France. Statistique du mouvement de la population. Nouvelle Série, Tome 12, Année 1932. Partie 2: Les causes de décès. Pp. xlii+287. Annuaire statistique. Vol. 50, 1934. Pp. xl+360+512. Enquètes annexes du recensement de 1931. Enquète industrielle. Pp. 87. (Paris: Imprimerie Nationale, 1935.)