

Executive Committee contains representatives from seven centres in addition to Bangalore. The contributors to the annual summary of Biochemical and Allied Research in India are equally representative.

The necessity, therefore, for a new Society is difficult to understand.

GILBERT J. FOWLER.

Bangalore,
October 8, 1934.

Research Notes.

On the Class-number of the Imaginary Quadratic Field.

RECENTLY Heilbronn (*Quarterly Journal of Mathematics*, 5, 159) has proved an old conjecture of Gauss which remained unproved for more than a century. The knowledge about the class-number and the structure of the class-group of an algebraic field are of great importance in the theory of algebraic numbers. They certainly increase our knowledge of higher arithmetic. Unfortunately we know very little about them. Even in the case of the simplest fields such as the quadratic and cyclotomic fields very little is known. The latter field is important in connection with the great theorem of Fermat. The case of the imaginary quadratic field is very interesting as it is connected with many other branches of mathematical analysis. For instance, the equation of the singular moduli of elliptic functions is of degree equal to the class-number $h(-d)$ of the field $K(-\sqrt{d})$ where the ratio of the periods of the elliptic function belongs to $K(\sqrt{-d})$. The Galois group of the equation is isomorphic with that of the corresponding class-group. Gauss conjectured that $h(-d) \rightarrow \infty$ as $d \rightarrow \infty$. He also proved that the highest power of 2 contained in $h(-d)$ is 2^{t-1} where t is the number of odd prime factors of d . Dirichlet gave a finite expression for the class-number in terms of quadratic residues which he proved by transcendental methods. This is considered by most mathematicians as one of the most beautiful results in mathematics. That was the first time when transcendental methods were employed in the theory of numbers and this has grown to be a separate branch of mathematics since thirty years. There was great development in this branch especially during the past twenty-five years. After fruitless attempts by many scholars, Heilbronn has proved the first conjecture of Gauss by transcendental methods. Now Chowla (*Proc. Indian Acad. Sci.*, 1934, 1) by sharp-

ening his methods slightly, proved that $\frac{h(-d)}{2^{t-1}}$ also tends to ∞ with d which includes another hypothesis of Gauss and Euler. This means that the degree of the equation of singular moduli tends to ∞ with d . Incidentally this also shows those values of d for which the equation is solvable by means of quadratic radicals only are finite in number. It is interesting to find out whether there are only 65 of them as was conjectured by Gauss and Euler. It appears that the upper bound of d obtained by these methods will be far greater than 1848 the highest number that Gauss has given.

K.V.I.

Zur Auflösbarkeit der Gleichung $x^2 - Dy^2 = -1$.

It is known that the diophantine equation $x^2 - Dy^2 = 1$ has an infinite number of solutions for every value of D , but the equation $x^2 - Dy^2 = -1$ does not always possess a solution. A necessary condition for this is that it should be expressible as the sum of two squares but this is by no means sufficient. We have of course the continued fraction condition but this is neither a satisfactory one nor is it simple. The question of its solvability is important in connection with the class number and class field of $K(\sqrt{D})$. Epstein (*Jour. fur. Math.*, 4, 171) treats this problem by very elementary methods and obtains the necessary and sufficient condition to be as follows. There should exist rational integers a, β, γ, δ , such that $D = \beta^2 + \gamma^2$, $K\beta - \gamma\delta = 1$, and $a^2 + \gamma^2$ is a square. Some other allied results are also given in the paper.

K.V.I.

Lineare Räume mit unendlich vielen Koordinaten und Ringe unendlicher Matrizen.

KOTHE and Toeplitz have contributed a very interesting and thoroughly developed paper (*Jour. fur. Math.*, 1934, 4, 171) on linear spaces with an infinite number of

coordinates and rings of infinite matrices in them giving a unified theory of maximal matrix rings in various spaces. The difficulties that arose in the solution of this problem have been conquered by introducing another related space, which is named the dual space and which is formed out of all points. $V = (u_1, u_2, \dots, u_n, \dots)$ for which $\sum u_n x_n$ converges for all points $X = (x_1, x_2, \dots, x_n, \dots)$ of the original space. If the dual of the dual space is identical with the original, then the space is called perfect (Voll Kommen). With these definitions they proved the following theorem; viz., "If the space is perfect then all its linear transformations form a maximal ring." The three spaces for which this theorem was known are easily shown to be perfect by the authors. We have here a separate proof which is very direct and simple.

Next they introduce the idea of convergence and strong convergence without the introduction of a metric as has been done by Hausdorff and Banach. This allows them to introduce homomorphy of two spaces and this has made it possible to consider the problem of obtaining all spaces homomorphic with a given perfect space. It is also shown how the problem of solving an infinite number of equations with an infinity of unknowns can be extended to spaces other than those for which the problem has been solved. The paper is complete in itself and is a very simple and elegant theory of linear transformations in generalised Hilbertian spaces.

K.V.I.

The Magnetic Moment of the Proton.

EVER since Estermann, Frisch and Stern (*Zs. f. Physik*, 1933, 85, 4 and 17) found out that the magnetic moment of the proton was 2.5 nuclear magnetons instead of one nuclear magneton as was assumed before, the accurate determination of the magnetic moment of the proton has become a pressing problem which must be solved before any explanation of nuclear magnetic moments on a quantitative basis is attempted. Now I. I. Rabi, J. M. B. Kellogg and J. R. Zacharias (*Phys. Rev.*, 1934, 46, 157) describe a new method developed by them for determining the protonic magnetic moment. Whereas Stern and his collaborators measured the protonic moment by a direct measurement of the force on a proton, a

correction being made experimentally for the rotational magnetic moment of the molecule, the present authors have used a method involving the interaction between the proton and the valence electron. The experiment consists in deflecting a narrow beam of hydrogen atoms in the normal $^2S_{1/2}$ state by a weak magnetic field of sufficient inhomogeneity. Instead of assuming the two orientations $m_s = +\frac{1}{2}$ and $-\frac{1}{2}$, the atom takes up four positions corresponding to $(m_s, m_i) = (\frac{1}{2}, \frac{1}{2}), (\frac{1}{2}, -\frac{1}{2}), (-\frac{1}{2}, \frac{1}{2})$ and $(-\frac{1}{2}, -\frac{1}{2})$. The component of the magnetic moment of the atom in the direction of the field is respectively $f_1=1, f_2=x/(1+x^2)^{1/2}, f_3=-x/(1+x^2)^{1/2}$ and $f_4=-1$. Here x is given by $x=2\mu_0 H/hc\Delta\nu$ where H is the magnetic field, and $\Delta\nu$ is the hyperfine separation between the levels $F=1$ and $F=0$ in cm^{-1} . Then $\Delta\nu=(32\pi/3hc)\mu_p\mu_o\psi^2(o)$ or putting in numerical values $\mu_p=\Delta\nu/0.0169$. The deflection of a beam is given by

$$S_d = \frac{f_j\mu_o}{4kT} \times \frac{\delta H}{\delta y} (l_1^2 + 2l_1 l_2)$$
 where f_j are the functions mentioned above, l_1 and l_2 are the distances the atom moves in the field and outside the field. The atoms are produced in a long Wood discharge tube. They pass through slits and traverse the inhomogeneous magnetic field due to two wires carrying a current and the deflected beam is detected by means of a plate covered with molybdenum oxide which turns blue where the atomic hydrogen falls on it. The value obtained for the protonic magnetic moment was $3.25 \pm 10\%$ nuclear magnetons. The discrepancy between this and Stern's value $2.5 \pm 10\%$ is rather large, but at present the substantial agreement of the two results is more important than their difference.

The Magnetic Moment of the Deuteron.

THE magnetic moment of the deuteron is a very important quantity since the deuteron is the simplest composite nucleus and a study of its magnetic moment is necessary for an understanding of nuclear structure. Theoretical explanations of nuclear magnetic moments depend upon the assumed value of the magnetic moment of the neutron. There is a conflict of opinion regarding this quantity, Schuler and his collaborators considering it to be -3.5 while Landé and Inglis, and Altschüler and Tamm hold it to be -0.6 . The

magnetic moment of the deuteron must throw some light on that of the neutron since it consists of a neutron and a proton. I. I. Rabi, J. M. B. Kellogg and J. R. Zacharias (*Phys. Rev.*, 1934, **46**, 163) have determined the magnetic moment of the deuteron by the method they have developed for the proton and described in a previous note in this journal. They obtain the value 0.77 ± 0.2 . Since their experimental method does not determine the sign of the magnetic moment the value for the proton may be ± 3.25 ($\pm 10\%$) while that of the deuteron is ± 0.77 (± 0.2). If the magnetic moments of the proton and the neutron are supposed to add together into that of the deuteron, the magnetic moment of the neutron must be about ± 2.5 or ± 4.0 according as the magnetic moments of the proton and neutron are directed opposite to each other or in the same sense.

A New Method for the Determination of Transport Numbers.

THE "Balanced boundary method" developed by Hartley and co-workers (*Trans. Faraday Soc.*, 1934, **30**, 648-662) provides a long-felt want in the moving boundary technique for the determination of transport numbers. Hitherto, one had but to resort to the less accurate Hittorf method for determining the mobilities of the more slowly moving ions. For, one is confronted with a great difficulty in finding a suitable "indicator ion" in such cases. This difficulty is eliminated in the present method by having the slow moving ion in the indicator position and determining its mobility by taking advantage of the Kohlrausch relation:

$$\frac{T_R}{C_R} = \frac{T_X^k}{C_X^k}$$

where T_R and T_X^k are the transference numbers of the leading and the indicator ions at their respective concentrations C_R and C_X^k , the latter referring to the concentration of the indicator ion in the Kohlrausch solution (and not in the initial solution).

Conductimetric analysis *in situ* is shown to be inapplicable for determining the composition of the Kohlrausch solution, owing to the interference by the cyclic electrolysis taking place at the A.C. electrodes. An ingenious device has been adopted for displacing samples of Kohl-

rausch solution into an external conductivity cell, without the interruption of the direct current. A new method of getting at a sharp boundary has also been described.

The method has been tested by measurements with electrolytes whose transference numbers are known and is shown to be capable of a high degree of accuracy.

K.S.G.D.

The Significance of X-Bodies in Virus-Infected Plants.

THE occurrence of cell inclusions in plants caused by viruses or ultramicroscopic organisms, has been recorded in a comparatively few cases, chiefly the mosaics. Apart from their aetiological significance as the prime cause of disease, their utility for diagnostic purposes is quite limited to the few cases known so far. The simple question why these bodies are not to be traced in other cases of virus attacks, has been engaging the attention of several workers. It has been held in some quarters that these are mere artefacts probably brought about through abnormal metabolic products resulting from infection and reacting with the fixatives employed in the cytological technique. Since biochemical changes consequent on virus attack need not be the same in all species of plants examined, this reaction to coagulating agents, apparently identical in the few instances known, may be due to similar changes induced in the different host plants. Whether this is so or not, is a matter for biochemists to investigate. It will, however, readily be seen that these new aggregates or X-bodies result from virus infection and can by no means be construed as the cause of disease. The most recent contribution on this subject is due to Sheffield (*Ann. Appl. Biol.*, 1934, **21**, No. 3). Following his previous announcement on the action of molybdenum on cells, the author chooses two lines of investigation—the first on the action of coagulating agents on the cytoplasm and the formation of bodies in uninfected plants and the second on the possibility of inhibiting the formation of the same through chemicals in virus-infected plants. For want of adequate knowledge on this problem, the author has to adopt miss or hit methods, as the choice of chemicals lies within wide limits. Among those tried many are fixatives used in cytology. The reason for selecting nickel, molybdenum,

etc., are apparently due to the presence of these in such plants. One wonders if these are exclusively present in diseased cells alone. Moreover, the choice of tissues is indeed the prime factor in such studies and offers the greatest difficulty. In spite of this, the attempt made by the author is a valuable one, though cursory. The technique adopted is simple and neat. The intra-cellular changes have been followed closely. Practically everyone of the reagents employed, has been able to induce stimulation of the cytoplasmic stream similar to that which is observed as a result of virus infection. The author has detailed his observations on the action of ammonium molybdate and reproduced in a striking manner, the formation of bodies similar to those observed in aucuba mosaic. It has been argued by the author that this phenomenon is not due to a secondary effect, since analysis of treated plants showed an 'abundance' of molybdenum. It may, however, be suggested, that the application of such heavy chemicals might result in the non-availability of certain essential nutrients, particularly phosphorus in this case. This reaction to such treatments may be intense when the chemical is added to the soil. Several other coagulating reagents were tried and have responded quite similar to the above—thus lactic acid induces the formation of amoeboid bodies—resembling the X-bodies of tobacco mosaic.

The second technique of inhibiting the formation of such bodies in virus-diseased plants or of dispersing the same artificially after their formation, has not yielded any positive result. The subject is one of great interest and it is hoped ere long a further contribution on the same will be made available for the benefit of others engaged in the same field.

V. I.

Synthetic Resin Hyrax.

In a recent note to the *American Mineralogist* (August 1934, 19, No. 8) E. N. Cameron of New York University has discussed the utility of synthetic resin Hyrax as a mounting medium; and it comes as a welcome relief to many petrographers and mineralogists since the use of Hyrax as a medium for mounting minerals has got a decided advantage in certain cases over Canada Balsam. Since Hyrax has a high index of refraction it will be useful

for (i) increasing the relief of minerals which have indices of refraction close to that of Balsam; (ii) decreasing the relief of minerals which have indices of refraction much above that of Balsam; (iii) facilitating the identification of certain minerals. Hence the use of Hyrax as a medium for permanent mounting of grains belonging to mineral assemblages in sedimentary petrography is obvious. The photomicrographs reproduced in the paper further show that intergrowth of minerals can be better studied when mounted in Hyrax.

Periodicity of Earthquakes.

CHARLES DAVISON, the noted seismologist, has contributed a very interesting paper on the diurnal periodicity of Earthquakes in the July-August number of the *Journal of Geology* (42, No. 5). By counting the number of Earthquakes occurring during each hour of the day from the recorded observations from Great Britain, Japan and Italy, he has shown by means of a curve that the maximum falls at midnight and at noon. Considering the causes of earthquakes, he has further suggested that if the earthquakes were mainly due to depression of the crust, the diurnal and annual seismic epochs would occur about midnight and midwinter. If the earthquakes were mainly due to elevation of the crust the epochs would occur about noon and midsummer. Further an important conclusion has been established that the midnight and the winter maxima prevail in regions where the earthquakes are of low intensity, and the noon and summer maxima in regions visited by much destructive shocks.

The Idiochromosomes of an Earwig *Labidura riparia*.

J. J. ASANA and SAJIRO MAKINO (*Jour. of Morph.*, 1934, 56, No. 2, 361-370) describe the behaviour of the chromosomes in the Indian Earwig *Labidura riparia* with special reference to the idiochromosomes. The diploid number is 14—6 pairs of autosomes and XY in the male and 6 pairs of autosomes and XX in the female. The autosomal constitution of this species differs from that of the American forms described by Morgan; the latter has two chromosomes less than the former. The X and Y chromosomes have been traced to a single chromatin nucleolus derived from the nucleolus

of the last spermatogonial division. The chromatin nucleolus retains a clavate form through the early and late periods of growth and this form is retained till the metaphase of the first spermatocyte division is reached. It is suggested that the behaviour of the chromatin nucleolus of *Labidura riparia* resembles that of the chromatin nucleolus of *Oecanthus* described by Makino.

A Cytological Study on the Liver of the Rat with Special Reference to the Intracellular Blood Canaliculi, Inter- and Intra-cellular Bile Canaliculi, Mitochondria and Golgi Apparatus.

EDITH M. JAY (*Jour. of Morph.*, 1934, 56, No. 2, 407-421) makes an interesting con-

tribution to the cytology of the liver and interprets the so-called 'intracellular blood canaliculi' described by Schafer and his pupils as artefacts produced by the differences in the osmotic pressure and the mechanical pressure employed in administering the injection masses. She further demonstrates that a permanent system of intracellular bile canaliculi described by the earlier authors does not exist and that the short knob-like intracellular projections from the intercellular bile canaliculi possibly represent the passage of the secretion into the intracellular canaliculi. Though the presence of glycogen effectively hinders the processes of impregnation, her observations on the Golgi apparatus and mitochondria confirm those of Cramer, Ludford and others.

Irrigation Research in the Punjab.

THE investigations that are being carried out in the Punjab have as their objects the improvement of design of irrigation works, the reduction in the costs of maintenance of channels, the control of the rise in water-table and the prevention of soil deterioration under irrigation. In order to carry out these investigations the following Sections of the Research Institute have been established—Hydraulic Section, Physics Section, Chemical Section, Land Reclamation Section, the Statistical Section and Mathematical Section. A brief account of the work of each of these sections will indicate the lines of work that are being pursued.

1. HYDRAULIC SECTION.

The essential features of a canal headworks in the Punjab are a weir across the river to obtain command of the land and the head regulator of the canal. One or more bays of the weir are provided with under-sluices for purposes of regulation. The weir consists usually of an upstream apron, the crest, the down-stream glacis, and below this the block protection. If the weir fails, the whole of the irrigation in the canal system may fail. It is of the greatest importance, therefore, to design a weir so that it will stand up to the strains imposed upon it. Experience has shown that weirs may fail due to the floor not being heavy enough to withstand the unbalanced head. The pressure under the floor of the weir may be greater than the pressure on the floor. If this is the case and the floor is not strong enough, the floor may be lifted with disastrous consequences. The pressures under the floor as influenced by various forms of design have been studied and, as a complement to this, methods for controlling the flow on the floor have been investigated.

The methods for investigating the flow under a work have already been described.¹ The tanks used in these experiments have been adapted

to study the pressures and it is now possible to place a model of a work in the tank and determine accurately the pressure that will be experienced on any portion of the floor. Fig. 1 is an illustration of a model of Khanki Weir, Bay 4.

In order to examine the condition of flow over the weir a scale model of a section of the weir was constructed in the flume and the effects of the different conditions of flow actually experienced on the work were examined. In order to render a work safe, it is essential that the velocity of flow in contact with the floor should be as low as possible. The methods that have usually been adopted to secure this have had as their basis the destruction of energy. The subject was examined from an entirely new point of view in the Punjab Laboratory. If the high velocity water could be thrown to the surface and a low velocity water be made to travel along the floor, the problem would be solved since a high velocity water at the surface could do no damage. It has been found that by placing arrows a short distance below the crest of the weir and raised control blocks at the end of the floor, the flow along the floor is extremely slow. Determinations of the velocity of flow show that the arrows throw the high velocity water to the surface and the raised blocks check the flow of the bottom water. Under these conditions no standing wave, as usually understood, is formed. Instead a wave which has only a forward motion is produced. In order to distinguish this wave from the standing wave it has been designated "forced jump". Fig. 2 shows the design adopted for the down-stream protection of Khanki Weir.

An examination has now been made of the prototype after the weir, according to the new design, has been in operation for one flood season. It has been found that the form of flow over the weir is identical with that predicted from the model experiments and that the greatest settlement of the loose blocks has been 0.5 foot, while the majority have not settled more than

¹ *Curr. Sci.*, 1934, 2, 367-370.