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Section Meetings

M. W. Keller (Secretary), C. N. Mills (Secretary) & C. H. Wheeler III (Secretary)

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1940 and 1941 income from the Chace Fund for aid in the publication by the American Oriental Society of a volume on Babylonian mathematical tablets by Professor Otto Neugebauer and Doctor A. J. Sachs; (4) to participate formally in symposia Wednesday, December 30, as planned by the Secretaries of Sections A and L, in observance of the 300th anniversary of the death of Galileo and the birth of Newton; (5) to make an appropriation of $400 in 1943 toward the expense of printing and distributing the National Mathematics Magazine for 1942–43, either as a provision in the 1943 budget or from one of the special funds.

On recommendation of the Finance Committee it was voted (1) to continue to employ the Cleveland Trust Company as our financial adviser for 1943; (2) to utilize the appropriation of $200 in the 1942 budget, together with any necessary addition, for the expenses of the regional governors to the 1942 annual meeting, to the extent of one-third of the first-class railroad fare to and from the meeting.

The Board adopted formal resolutions empowering the Cleveland Trust Company to sell certain registered bonds for the sake of a desirable reinvestment and empowering the Cleveland Trust Company to collect interest coupons.

Because of the war conditions it was voted to recall our acceptance of the invitation to meet at Boulder in the summer of 1943, and to express our hope that we may meet there when normal times return.

Miss Marjorie J. Groves was appointed an associate editor for 1942.

W. D. CAIRNS, *Secretary-Treasurer*

NINETEENTH ANNUAL MEETING OF THE INDIANA SECTION

The nineteenth annual meeting of the Indiana Section of the Mathematical Association of America was held Friday and Saturday, April 24 and 25, 1942, at Wabash College, Crawfordsville, Indiana.

Sixty registered at the meetings, including the following thirty-three members of the Association: W. C. Arnold, Emil Artin, W. L. Ayres, Juna L. Beal, L. G. Black, I. W. Burr, G. E. Carscallen, K. W. Crain, W. E. Edington, P. D. Edwards, B. C. Getchell, E. L. Godfrey, G. H. Graves, H. E. H. Greenleaf, C. T. Hazard, Cora B. Hennel, F. H. Hodge, H. K. Hughes, M. W. Keller, W. C. Krathwohl, Cornelius Lanczos, Karl Menger, G. T. Miller, Paul Muehlman, P. M. Pepper, J. C. Polley, C. K. Robbins, L. S. Shively, D. R. Shreve, M. S. Webster, F. J. Weyl, K. P. Williams, H. E. Wolfe.

At the business meeting on Saturday the following officers were elected for next year: Chairman, J. C. Polley, Wabash College; Vice-Chairman, P. M. Pepper, Notre Dame University; Secretary, M. W. Keller, Purdue University. The twentieth annual meeting will be held April 9 and 10, 1943, at Notre Dame University.

At the annual dinner on Friday evening the chairman, Professor P. D. Edwards of Ball State Teachers College, acted as toastmaster and introduced Dr. F. Sparks, President of Wabash College, who welcomed the visitors.

Following the dinner the first session of the Section was held with Professor H. T. Davis of Northwestern University as guest speaker. His subject was "Dinner with Archimedes." Professor Davis invited the audience to have dinner with him at the request of King Ptolemy Philadelphus, the second ruler of Alexandria. The dinner was in honor of Archimedes, a distinguished visitor from Syracuse. At the dinner the audience met the various guests King Ptolemy had invited. The amazingly modern work of the Alexandrian Museum of this golden period was revealed in the conversations between these people, and the court of Ptolemy Philadelphus was shown to equal both in luxury and learning that of any in more modern history.

Saturday morning Professor Davis gave a second lecture. His subject was "A mathematical theory of income and its consequences." He considered the problem of representing mathematically the frequency function which describes the distribution of the national income among income recipients. The distribution is characterized by an abnormally large standard deviation, and by the fact that the modal income is very close to the wolf-point, that is to say, the income of subsistence level. For large incomes the distribution must give asymptotically the Pareto law, which asserts that in normal economies the distribution of income is represented by the formula, $y=ax^{-v}$, where y is the number of people having the income x or greater, and v is approximately 1.5. The function which most satisfactorily describes the distribution is given by

$$\phi(x) = \frac{a}{z^n} \cdot \frac{1}{e^{b/z} - 1}$$

where $z=x-c$, $n-v=2$, c is the wolf point, and $\phi(x)$ is the number of people with incomes between x and $x+dx$.

National industrial production, P, represented by the Douglass-Cobb formula, $P=AL^pC^q$, $p+q=1$, where L measures labor and C measures capital, is found to be a function of the concentration of wealth, represented by the ratio, $p=1/(2v-1)$. The relationship between industrial production and the distribution of income is thus exhibited, and certain consequences derived.

At the two sessions on Saturday the following seven papers were presented:

1. "The work of the Indiana Section" by Professor P. D. Edwards, Ball State Teachers College, retiring chairman of the Indiana Section.

2. "On the curvature of surfaces" by Professor Karl Menger, Notre Dame University.

3. "On the value distribution of meromorphic functions" by Dr. F. J. Weyl, Indiana University.

4. "Results of a diagnostic testing and remedial teaching program" by Dr. D. R. Shreve and Dr. M. W. Keller, Purdue University.

5. "Linear and almost linear sets" by Professor P. M. Pepper, Notre Dame University.

6. "Remarks on a problem of Kakeya" by Dr. J. W. T. Youngs, Purdue University, introduced by Professor Ayres.

7. "On curves in 3-space" by Dr. Peter Scherk, Indiana University, introduced by Professor Williams.

Abstracts of papers follow.

1. Professor Edwards gave a summary of the mathematical work presented at the meetings of the Indiana Section of the Association since its organization in 1924. A statistical summary of papers presented, attendance, etc., was included. The influence of the Indiana Section as an organization was noted and attention was called to needs of the immediate future that must be met by the members.

2. Professor Menger showed how the curvature of a curve C at a point P may be defined by a direct limit process, *viz.*, as the reciprocal of the limit of the radii of circumcircles formed for triples of points of C converging towards P. This definition is exclusively based on the distance between the points of C and, hence, is applicable to any curve contained in a general metric space in the sense of Frechét. In an analogous way, the Gauss curvature of a surface S at a point P may be defined by considering quadruples of points of S converging towards P. However, instead of the circumsphere of a quadruple of points, one has to study the radius of a sphere containing four points whose six distances are respectively equal to those between the points of the quadruple. By a sphere of positive, infinite or negative radius we mean an ordinary sphere in which the distance of two points is the length of the minor arc of the great circle joining the two points, or the euclidean plane, or the hyperbolic plane, respectively.

3. Dr. Weyl's report dealt with R. Nevanlinna's defect relation for meromorphic functions. As the sharpest and most natural generalization of E. Picard's classical theorem that a meromorphic function cannot leave out more than two values, this relation is sufficiently attractive to warrant the search for a proof of greatest possible simplicity. The one presented by Dr. Weyl was based upon ideas of L. V. Ahlfors and might well be considered simple enough to make Nevanlinna's result a possible candidate for inclusion in any graduate course on Complex Variables.

4. Dr. Shreve gave a report on a three-year experiment in the teaching of trigonometry and elementary algebra to freshmen students of engineering in Purdue University. The control group was taught in the usual manner. The experimental group was given seven lessons in review of elementary algebra preceding the study of trigonometry. In teaching the experimental group the concepts and skills to be given particular emphasis were determined from an error analysis of the difficulties which the students in the control group had encountered. He reported that by this procedure it had been possible to reduce the number of failures by more than thirty-five per cent and increase the number

of A's by fifty per cent although the control group was initially slightly superior in ability as measured by preliminary tests.

5. Professor Pepper stated that Menger had shown each semimetric space of five or more points all of whose triples are linear is linear and the existence of four point non-linear sets whose triples are all linear. Professor Pepper made a survey for each k of all $(5+k)$-point semimetric spaces with exactly $k+1$ non-linear triples and showed that each semimetric space of $5+k$ points with at most k non-linear triples is actually linear. He also showed that in any non-linear semimetric space of more than four points at most two points can escape lying in at least one non-linear triple. He gave the following corollary to this: Each non-linear semimetric space which has non-denumerably many points must have non-denumerably many non-linear triples. Congruent imbeddings into function space were given for some of those non-linear spaces which are metric.

6. Dr. Youngs presented an outline of the history of a celebrated problem of Kakeya with a sketch of the elegant solution by Perron.

7. Dr. Scherk showed how some concepts of algebraic geometry can be translated to real non-analytical curves which are assumed to have tangents and osculating planes everywhere. Thus, the local behavior of such a curve can be described by means of a set of three numbers that is the precise generalization of the characteristic (mod 2) of algebraic curves. Since the points of a non-analytic curve are bound together by no tie, one has introduced beside the order, rank, class in the large of such a curve (equal number respectively, of points of the curve in a plane, tangents through a straight line, osculating planes through a point) corresponding local concepts. Assuming reasonable smoothness, he proved that the local order, class, and rank can be expressed through the characteristic in a simple way, and that, especially, the first two are equal. This last result followed at once from the deeper theorem that the first and last of the characteristic numbers are dual to one another, while the second is self-dual.

M. W. KELLER, *Secretary*

THE TWENTY-THIRD ANNUAL MEETING OF THE ILLINOIS SECTION

The twenty-third annual meeting of the Illinois Section of the Mathematical Association of America was held at James Millikin University, Decatur, Illinois, on Friday and Saturday, May 8 and 9, 1942. Professor R. N. Johanson, chairman of the Section, presided at all sessions.

The attendance at the sessions was approximately forty-five, including the following twenty-eight members of the Association: Beulah Armstrong, Edith I. Atkin, S. F. Bibb, O. K. Bower, Laura E. Christman, W. H. Coulter, D. R. Curtiss, J. E. Davis, W. W. Denton, Elinor B. Flagg, A. E. Gault, B. H.

Gere, G. D. Gore, M. R. Hestenes, Mildred Hunt, R. N. Johanson, E. C. Kiefer, J. M. Kinney, W. C. Krathwohl, H. J. Miles, C. N. Mills, G. E. Moore, E. J. Moulton, Margaret Olmsted, F. C. W. Olson, E. W. Ploenges, Ruth B. Rasmusen, E. H. Taylor.

At the annual business meeting the following officers of the Section were elected: Chairman, E. W. Ploenges, James Millikin University; Vice-Chairman, C. N. Mills, Illinois State Normal University; Secretary, E. C. Kiefer, James Millikin University. The members of the Section voted to join with the Indiana and the Michigan Sections in a joint meeting in 1943 to be held at Notre Dame University, the details of this meeting to be announced early next spring. The next regular meeting of the Illinois Section will be held in 1944 at Illinois State Normal University, Normal, Illinois.

The following twelve papers were presented:

1. "Mathematics for the consumer" by Laura E. Christman, Senn High School, Chicago.

2. "The construction and use of a mathematics placement test" by Dr. B. H. Gere, Herzl Junior College, Chicago.

3. "Determinant theory without the use of inversions" by Dr. I. E. Perlin, Illinois Institute of Technology.

4. "Trigonometry for the Navy V-7 program" by Professor G. E. Moore, University of Illinois.

5. "Teaching college geometry from the teacher-training point of view" by Professor C. N. Mills, Illinois State Normal University.

6. "Determinants and Taylor's Theorem" by Dr. Bernard Friedman, Woodrow Wilson Junior College, introduced by the Secretary.

7. "Report of meetings of Board of Governors" by Professor W. C. Krathwohl, Illinois Institute of Technology.

8. "Mathematics and war" by Professor E. J. Moulton, Northwestern University.

9. "A page of vector calculus for sophomores" by Professor G. D. Gore, Central Y.M.C.A. College, Chicago.

10. "Critical points of functions" by Professor M. R. Hestenes, University of Chicago.

11. "Mathematics in the canning industry" by F. C. W. Olson, American Can Company, Maywood, Illinois.

12. "An analogue of Pascal's arithmetical triangle" by Professor S. F. Bibb, Illinois Institute of Technology.

Abstracts of some of the papers follow:

1. High school mathematics may benefit three groups of future citizens: members of professions, members of skilled trades, and consumers. The classical development of high school mathematics aims to help the future member of a profession, essential mathematics and shop mathematics do the same thing for the skilled worker (as far as we can start to grade such needs at this early date) but the consumer is seldom considered in our mathematics program.

Senn High School, Miss Christman stated, is offering a course called "Mathematics for the Consumer" based on the text of the same name by Anna Louise Cowan, published by Stackpole Sons. Decimals and percentage are the mathematical background of the course. Some pupils continue into solid geometry from this course.

2. Dr. Gere outlined a procedure for constructing a placement test. The labor involved in the construction is small but the results are satisfactory for many placement problems. A number of results obtained from the use of a test actually constructed according to this procedure were presented.

4. A three semester hour course designed for men near graduation, with no college mathematics, except perhaps algebra, was described by Professor Moore to show how the University of Illinois meets the needs of the Navy V-7 program. Special emphasis is placed upon computation; half of the course deals with the trigonometry of the earth and the celestrial sphere. With the cooperation of Professor R. H. Baker of the Department of Astronomy students are given lectures, outside class time, on celestial coördinates, time (siderial, solar, mean sun, civil), the sextant and its use, star charts, etc.

5. Professor Mills stated that the golden thread which binds many of the different topics in college geometry is "Harmonic Ratio," saying that by means of analytical relations between the various topics usually considered, the student is given a broader point of view of college geometry and projective geometry. Paper folding exercises and properly designed construction plates afford an interesting approach to the general theorems.

6. Dr. Friedman presented a new method for obtaining old and well-known results. If a determinant is considered as a function of any set of its elements and then Taylor's Theorem is applied to this function, the determinant can be expanded into a sum of terms depending upon the particular elements chosen. In this way, the expansion by minors, the characteristic equation of a determinant, Laplace's expansion, Cauchy's expansion and Cayley's expansion (see Muir and Metzler's Theory of Determinants) can be quickly and conveniently found.

9. Professor Gore adapts to several kinds of motion in the plane the derivative of a vector with respect to a scalar. The object is to give to students of the sophomore levels of calculus, mechanics, and engineering kinematics a common language in which to study motion; and to give them greater facility with such entities as displacement, velocity, and acceleration than has been attained by methods that employ only the usual Cartesian and polar coördinates. The simplification of these subjects, which is achieved by a modicum of vector calculus, seems to warrant the introduction of the concept of the vector derivative at an earlier stage than is now customary in mathematical education.

10. Professor Hestenes considered the historical development of the theory of critical points. He made a survey of various definitions of critical points and their indices, and discussed their relation to restricted maxima and minima, considering these topics from an analytic and a topological point of view. He

pointed out how these results can be extended to obtain similar results in the calculus of variations.

11. Mr. Olson discussed some of the mathematical problems involved in determining the proper processing time and temperature to sterilize canned foods. Bacterial death rates as a function of the temperature are combined with the heating equation to form a criterion of sterility whose solution, although of formidable complexity, has been successfully accomplished by tabulation of auxiliary functions, and more recently by nomograms. Fundamental studies of the properties of the heating equation and its solutions have materially increased the usefulness and scope of mathematics as applied to canning problems.

12. Professor Bibb showed how $y_n=f(x)$, obtained by eliminating the parameter t from the pair of equations $x=t+t^{-1}$, $y_n=t^n+t^{-n}$, $[t\neq 0,\ n=1, 2, 3, \cdots,]$, might be written as $\Sigma_{s=0}^{r}(-1)^s({}_nD_s)x^{n-2s}$, where the ${}_nD_s$ are determinants with elements of the form ${}_nC_p$. He then pointed out the coefficients, ${}_nD_s$, of the polynomials for $n=1, 2, 3, \cdots$, could be arranged as a triangle analogous to that of Pascal.

C. N. MILLS, *Secretary*

THE SPRING MEETING OF THE MARYLAND-DISTRICT OF COLUMBIA-VIRGINIA SECTION

The Spring meeting of the Maryland-District of Columbia-Virginia Section of the Mathematical Association of America was held at Randolph-Macon College at Ashland, Virginia, on Saturday, May 2, 1942, with a morning session, luncheon, and afternoon session. Professor E. J. McShane, chairman of the Section, presided at the sessions.

The attendance was twenty-eight including the following sixteen members of the Association: M. W. Aylor, C. C. Bramble, R. E. Gaines, Isabel Harris, G. A. Hedlund, Evelyn M. Kennedy, A. E. Landry, E. J. McShane, P. W. A. Raine, O. J. Ramler, C. H. Rawlins, Jr., J. N. Rice, R. E. Root, T. McN. Simpson, Jr., C. H. Wheeler III, G. T. Whyburn.

At the invitation of the Section, Dr. G. A. Hedlund of the University of Virginia gave an address on "Symbolic dynamics and topological transformations." A motion was passed expressing the appreciation of the Section to the authorities of Randolph-Macon College for their generous hospitality. The following officers for the ensuing year were elected: Chairman, J. H. Taylor, George Washington University; Secretary, W. K. Morrill, Johns Hopkins University; Members of the Executive Committee, G. A. Hedlund, University of Virginia, O. J. Ramler, Catholic University. The following invitations were accepted for future meetings: Loyola College, Baltimore, Fall meeting, 1942; Johns Hopkins University, Baltimore, Spring meeting, 1943; Trinity College, Washington, Fall meeting, 1943.

After an address of welcome by Dr. J. E. Moreland, President of Randolph-Macon College, the following papers were read:

1. "Quadratic and cubic equations with complex coefficients whose roots have unit modulus" by Professor O. J. Ramler, Catholic University of America.

2. "An application of the calculus of variations to a problem in mechanics" by W. A. Blankinship, University of Virginia, introduced by Professor Whyburn.

3. "Linear velocity fields in a baratropic atmosphere" by Professor R. E. Root, United States Naval Academy.

After these papers there was open discussion on the teaching of college mathematics.

4. "Symbolic dynamics and topological transformations" by Professor G. A. Hedlund, University of Virginia.

Abstracts of the papers follow:

1. Professor Ramler showed that the necessary and sufficient conditions for the roots of the quadratic $z^2+pz+q=0$ to have unit modulus are $p/\bar{p}=q$ and $|p| \leqq z$. When $p/\bar{p}=q$ and $|p|>2$ the roots are inverse points with respect to the unit circle in the Argand diagram. He also showed that the necessary conditions for the roots of the cubic $z^3+pz^2+qz+r=0$ to lie on the unit circle are $|p|=|q|$ and $pq/\bar{p}\bar{q}=r^2$. It was also pointed out that when these conditions are satisfied the roots of the Hessian of the cubic are either on the unit circle or inverse points with respect to it.

2. Mr. Blankinship discussed the problem: "To determine the shape that a rod of uniform cross-section and elasticity will asssume if forced to pass freely through the three points, $(a, 0)$, $(-a, 0)$, and $(0, b)$," He set it up as a Lagrange problem and obtained an explicit solution in terms of elliptic integrals.

3. Dr. Root stated the general equations of motion relative to a system of axes fixed to the moving earth and discussed some of their general implications. Horizontal motion in which the velocity components are linear functions of displacement coordinates were considered in relation to the requirements of the equations of motion.

4. Dr. Hedlund stated that the methods and examples of symbolic dynamics can be applied to the construction of topological transformations on compact metric spaces. He showed that it was relatively simple to obtain an example which displays most of the properties of the geodesic flow on a closed surface of negative curvature in that there exist transitive orbits, the periodic orbits form an everywhere dense set, and there is a continuum of orbits asymptotic to any given orbit. With the aid of known examples of non-periodic recurrent symbolic trajectories, some of the possibilities in the behavior of non-regular minimal sets can be explored.

C. H. WHEELER III, *Secretary*