attention is paid to numerical equalities and inequalities. The work draws its inspiration from Weierstrass, Du Bois-Reymond, and especially from Cauchy. It is distinctly of the modern French School, however, for with the exceptions of Mittag-Leffler. and Lindelöf, who draw from the same source, the names that one meets are Picard, Poincaré, Hadamard, Borel and other less-known French mathematicians.

The chief topics treated are Mittag-Leffler's theorem that a meromorphic function is the sum of an integral (transcendental) function and a series of rational fractions; Weierstrass's theorem that a meromorphic function is the quotient of two integral functions; Hadamard's investigation on Taylor's series with applications to meromorphic functions and to the zeros of integral functions; the generalization of Picard's theorem to the statement that any meromorphic function must take on every value, except possibly two, an infinite number of times; and series of rational fractions, with ordinary and extraordinary distributions of poles, as applied to the study of meromorphic functions. Four notes, two of which Mr. Zoretti contributed, bring the subject so far up to date as to include some memoirs not published when the book went to press.

This little book, like the others, is of great value in putting us abreast of the present state of a particular branch of mathematics. So carefully has the matter been chosen and so clearly has Mr. Zoretti written that only a very limited knowledge of the theory of functions is presupposed. This pedagogical method is peculiarly French. It quickly places the student in absolute command of an advanced field so that he may commence his investigations at once without that vast auxiliary knowledge which some consider necessary. By such a work as these Leçons the whole mathematical world is given the same advantage.

E. B. WILSON.

NOTES.

THE April number (volume 25, number 2) of the *American Journal of Mathematics* contains the following papers: "The double-six configuration connected with the cubic surface, and a related group of Cremona transformations," by EDWARD KAS-

NER ; " Untersuchungen über lineare Differentialgleichungen 4. Ordnung and die zugehörigen Gruppen," by SAUL EPSTEEN ; " The logic of relations, logical substitution groups, and cardinal numbers," by A. N. WHITEHEAD ; " On differential equations belonging to a ternary linearoid group," by F. E. ROSS ; " On a certain group of isomorphisms," by J. W. YOUNG.

THE April number (second series, volume 4, number 3) of the *Annals of Mathematics* contains : " The cardioid and tricuspid : quartics with three cusps," by R. C. ARCHIBALD ; " Note on a partial differential equation of the first order," by E. D. ROE, JR. ; " On a generalization of the set of associated minimum surfaces," by A. S. GALE ; " Twisted quartic curves of the first species and certain covariant quartics," by H. S. WHITE ; " On the characteristics of differential equations, Part I," by E. R. HEDRICK.

AT a meeting held in Boston, April 18, an association of teachers of mathematics in New England was organized for the improvement of methods of mathematical instruction in schools and colleges. Professor T. S. FISKE made an opening address on methods of improving the teaching of mathematics and Mr. W. T. CAMPBELL, of the Boston Latin School, read a paper on " Observational geometry." The following officers were elected : President, Mr. E. H. NICHOLS ; vice-president, Professor W. F. OSGOOD ; secretary and treasurer, Mr. F. P. DODGE, Roxbury Latin School, Boston, Mass. The association has at present about one hundred and sixty members. Copies of the constitution and of the circular letter issued as a call for the recent meeting can be obtained from the secretary.

AT the meeting of the London mathematical society on March 12, the following papers were read : " On the convergence of certain multiple series," by G. H. HARDY ; " On certain sequences for determining the nth root of a rational number," by Mr. S. M. JACOB ; " Note on the approximate calculation of the frequencies of a vibrating circular plate," by Professor H. LAMB ; " On surfaces which have assigned families of curves as their lines of curvature," by Professor A. R. FORSYTH ; " Note on a point in Hilbert's ' Grundlagen der Geometrie,' " by Mr. E. T. DIXON ; " Extension of two theorems on covariants," by Mr. J. H. GRACE ; " Note on double limits and on the inversion of a repeated infinite inte-

gral," by Professor T. J. I'A. BROMWICH ; "On the representation of a group of finite order as an irreducible group of linear substitutions, and the direct establishment of the relations between the group characteristics," by Professor W. BURNSIDE.

THE section of the history of sciences of the international congress of historic sciences, which met in Rome in April, 1903, has decided to form an international commission on the organization of a congress of the history of sciences. The following officers have been chosen : President, J. TANNERY, Paris ; secretaries, P. GIACOT, Turin, and G. LORIA, Genoa. Professor D. E. SMITH has been appointed the American representative. The next meeting of the congress will be held in Berlin, in September, 1906.

THE German association for the promotion of the teaching of mathematics and natural sciences held its twelfth general meeting at Breslau, June 1–5.

THE several American universities below offer during the academic year 1903–1904 advanced courses in mathematics as follows :

UNIVERSITY OF CALIFORNIA.—By Professor I. STRINGHAM : Logic of mathematics, two hours ; Analytic non-euclidean geometry of space, two hours.—By Professor G. C. EDWARDS : Ordinary differential equations, three hours.—By Professor M. W. HASKELL : Theory of functions of a complex variable, three hours.—By Mr. A. W. WHITNEY : Theory of probabilities, two hours.—By Dr. D. N. LEHMER ; Synthetic projective geometry, three hours.—By Dr. E. M. BLAKE : Line geometry, three hours.—By Dr. T. M. PUTNAM : Theory of numbers, three hours ; Mathematical seminar, foundations of dynamics, two hours.

THE UNIVERSITY OF CHICAGO. — The following advanced mathematical courses, four hours weekly, are offered during the four quarters (su, a, w, sp) of the year beginning June 17, 1903 : — By Professor E. H. MOORE : Theory of functions of real variables (su) ; Seminar (a, w, sp).—By Professor O. BOLZA : Theory of equations (a, w) ; Quaternions (sp) ; Elliptic functions, the Weierstrass theory (a) ; Applications of elliptic functions (su) ; Abelian functions (w, sp) ; Invariants (su).—

By Professor H. MASCHKE: Solid analytics (*sp*); Twisted curves and surfaces (*w*, *sp*); Invariants (*w*).—By Professor H. E. SLAUGHT: Advanced integral calculus (*aw*).—By Professor J. W. H. YOUNG: Solid analytics and determinants (*su*); conferences on the pedagogy of mathematics (*su*).—By Professor L. E. DICKSON: Theory of functions of a complex variable (*su*); Theory of functions (*a*, *w*).—By Mr. A. C. LUNN: The differential equations of mathematical physics (*su*, *sp*); Graphic methods in the teaching of elementary mathematics (*su*).—By Dr. S. EPSTEEN: History of elementary mathematics (*su*, 2 hours).—By Professor K. LAVES: Analytic mechanics (*a*, *w*). —By Professor F. R. MOULTON: Introduction to celestial mechanics (*w*, *sp*); Selected chapters of celestial mechanics (*su*).

CORNELL UNIVERSITY.—By Professor L. A. WAIT: Advanced analytic geometry (plane and solid), three hours; Advanced differential calculus, three hours.—By Professor G. W. JONES: Higher algebra and trigonometry, three hours.—By Professor J. McMAHON: Higher plane curves, two hours; Potential function, two hours; Quaternions, two hours; Theoretical mechanics, two hours; Mathematical theory of sound. —By Professor J. H. TANNER: Theory of equations, two hours; Invariants, two hours.—By Dr. J. I. HUTCHINSON: Theory of functions, two hours; Elliptic and abelian functions, two hours; Projective geometry, three hours.—By Dr. V. SNYDER: Advanced integral calculus, two hours; Line geometry, three hours.—By Dr. W. B. FITE: Differential equations, two hours; Theory of groups, three hours.

HARVARD UNIVERSITY. — By Professor J. M. PEIRCE: Quaternions; Theory and application of tetrahedral coördinates; † The algebra of logic; † Finite differences; † The calculus of probabilities; † Linear associative algebra. — By Professors W. E. BYERLY and B. O. PEIRCE: Trigonometric series, spherical harmonics, and the potential function. By Professor W. E. BYERLY: Calculus (second course); Introduction to modern geometry and modern algebra; † Dynamics of a rigid body. — By Professor W. F. OSGOOD: The theory of functions (first course). — By Professor M. BÔCHER: † Infinite series and products; Algebra; † Linear differential equations. — By Dr. C. L. BOUTON: † The theory of numbers; † The elementary theory of differential equations; † Geometric transformations. — By Mr. J. K. WHITTEMORE: Celestial mechanics; † Hydromechanics.

These courses will involve three lectures a week throughout the year, except those preceded by †, which involve about half this number of lectures. Professor Bôcher, Dr. Bouton, and Mr. Whittemore also offer courses in reading and research in Differential equations, Continuous groups, and Differential geometry respectively.

STANFORD UNIVERSITY.—Professor R. E. ALLARDICE : Invariants, two hours, first semester ; Definite integrals, two hours, second semester ; Geometry of three dimensions, two hours ; Theory of functions, three hours.—By Professor R. L. GREEN : Advanced coördinate geometry, two hours ; Theory of equations, three hours.—By Professor L. M. HOSKINS : Theory of attraction and the potential function, two hours.—By Professor G. A. MILLER : Elementary theory of groups, three hours ; Theory of numbers, two hours, second semester ; History of mathematics, two hours, first semester ; Seminar in the theory of groups, two hours.—By Professor H. F. BLICHFELDT : Determinants, two hours, first semester ; Non-euclidean geometry, two hours, second semester ; Differential equations, three hours.

NORTHWESTERN UNIVERSITY :—*First semester.*—By Professor T. F. HOLGATE : Linear systems of conics, two hours.—By Professor H. S. WHITE : Theory of functions, two hours ; Plane cubics and quartics, three hours. *Second semester.*—By Professor T. F. HOLGATE : Theory of numbers, two hours.—By Professor H. S. WHITE : Elliptic functions, three hours ; Projective geometry of surface and twisted curves, two hours.

YALE UNIVERSITY. — By Professor JAMES PIERPONT : Advanced calculus, three hours ; Projective geometry, three hours ; Theory of functions of real variables, three hours. — By Professor P. F. SMITH : Continuous groups, three hours ; Higher analysis for engineers, two hours, first semester. — By Professor H. A. BUMSTEAD : Problems in mathematical physics, two hours. — By Dr. A. S. GALE : Differential equations and function theory, three hours. — By Dr. H. E. HAWKES : Higher algebra, two hours ; Elliptic functions, three hours. — By Dr. W. A. GRANVILLE : Differential geometry, two hours. — By Dr. E. R. HEDRICK : Calculus of variations, three hours. — By Dr. E. B. WILSON : Analytic mechanics, two hours ; Introduction to mathematical physics, two hours ; Non-euclidean geometry, two hours.

THE several foreign universities and technical schools below offer during the present summer semester courses in mathematics as follows:

UNIVERSITY OF BERLIN. — By Professor J. KNOBLAUCH: Analytic geometry, four hours; Theory of partial differential equations, four hours; Theory of ray systems, one hour. — By Professor R. LEHMANN-FILHÉS: Differential equations, four hours; Exercises, one hour. — By Professor H. A. SCHWARZ: Integral calculus, four hours; Exercises; Applications of elliptic functions, two hours; Calculus of variations, four hours; Colloquium; Seminar. — By Professor F. SCHUR: Introduction to the theory of ordinary differential equations, two hours. — By Dr. E. LANDAU: Theory of numbers, four hours; Introduction to the theory of functions, four hours; Theory of Riemann zeta-functions, one hour. — By Professor G. FROBENIUS: Theory of algebraic equations, four hours; Seminar. — By Professor F. H. SCHOTTKY: Theory of abelian functions, four hours; Seminar. — By Professor G. HETTNER: Theory of potential, two hours.

UNIVERSITY OF CZERNOWITZ. — By Professor O. TUMLIRZ: Mathematico-physical seminar, two hours; proseminar, two hours.

UNIVERSITY OF GRAZ. — By Professor J. FRISCHAUF: Differential and integral calculus, and its application to geometry, five hours. — By Professor V. D. R. VON KOLLESBERG: Analytic and projective geometry of the plane, five hours; Mathematical seminar, two hours. — By Dr. J. STREISSLER: Descriptive geometry, three hours.

UNIVERSITY OF INNSBRUCK. — By Professor O. STOLZ: Theory of functions of a complex variable according to Cauchy and Weierstrass, with exercises in the mathematical seminar, three hours; Arithmetic, the theory of real numbers, with exercises in the mathematical seminar, four hours. — By Professor W. WIRTINGER: Higher algebra, three hours; Abelian functions, two hours; Seminar, two hours.— By Professor K. ZINDLER: Plane and solid analytic geometry, two hours; Line geometry, three hours; Seminar, one hour.

UNIVERSITY OF KÖNIGSBERG.—By Professor F. MEYER: Analytic geometry, four hours; Exercises in analytic geometry,

one hour ; Introduction to higher geometry, four hours ; Exercises in higher geometry, one hour.— By Professor A. SCHOEN-FLIES : Theory of differential equations four hours ; Exercises in the mathematical seminar, two hours.— By Professor L. SAALSCHÜTZ : Determinants, two hours; Gaussian and other interesting series, four hours.— By Dr. F. COHN : Applications of the potential theory, three hours.— By Dr. T. VAHLEN : Differential calculus, four hours ; Exercises in differential calculus, one hour.

UNIVERSITY OF MÜNSTER. — By Professor W. KILLING : Differential and integral calculus, I, three hours ; Synthetic geometry, four hours ; Selected topics from elementary mathematics, two hours ; Exercises in the proseminar, two hours ; Exercises in differential and integral calculus, one hour ; Supplement to analytic geometry, one hour.— By Professor R. VON LILIENTHAL : Analytic geometry, I, four hours ; Theory of determinants, with applications, four hours ; Exercises in the mathematical seminar, one hour.— By Dr. M. DEHN : Theory of numbers, four hours ; Higher mathematics for naturalists, three hours ; Exercises in the theory and application of elliptic functions, one hour.— By Dr. J. KARST : Introduction to descriptive geometry.

UNIVERSITY OF PRAG. — By Professor G. PICK : Differential equations, three hours ; Differential and integral calculus, two hours ; Seminar, two hours.—By Professor J. A. GMEINER : Analytic geometry, three hours ; Number congruences, two hours.—By Dr. W. WEISS : Elements of descriptive geometry, two hours.

UNIVERSITY OF VIENNA.—By Professor G. VON ESCHE-RICH : Elements of the differential and integral calculus, five hours ; Exercises, two hours ; Proseminar, one hour ; Seminar, two hours.—By Professor F. MERTENS : Theory of numbers (continuation), five hours ; Exercises in the mathematical seminar, two hour ; in the proseminar, one hour ; Theory of probabilities, three hours ; Mathematical statistics, three hours.— Professor G. KOHN : Synthetic geometry (continuation), four hours, with exercises, one hour ; Theory of invariants, with geometric applications (continuation), two hours.—By Dr. E. BLASCHKE : Introduction to mathematical statistics, II, three hours.—By Dr. DAUBLEBSKY VON STERNECK : Algebra, three

hours.—By Dr. K. CARDA : Selected topics from the theory of contact transformations, two hours.—By Dr. J. PLEMELJ : Theory of potential, with applications (continuation), two hours.

UNIVERSITY OF WÜRZBURG.—By Professor F. PRYM : Integral calculus, six hours ; Exercises on integral calculus, in the proseminar, two hours ; Selected chapters in the theory of functions, in the seminar, two hours. — By Dr. G. ROST : Descriptive geometry, II, four hours ; Analytic and synthetic geometry of conics, four hours ; Application of the infinitesimal analysis to geometry, four hours ; Selected chapters from elementary mathematics in the proseminar, two hours.

UNIVERSITY OF BASEL. — By Professor H. KINKELIN : Algebraic analysis, three hours ; Geometric applications of differential calculus, three hours ; Definite integrals, two hours ; Theory of probabilities, three hours. — By Dr. R. FLATT : Line geometry, two hours.

UNIVERSITY OF BERN. — By Professor J. H. GRAF : Bessel's functions, three hours ; Elliptic functions, three hours ; Function theory, two hours ; Differential equations, two hours ; Differential and integral calculus, two hours ; Mathematics of finance and insurance, two hours ; Seminar, with Professor Huber, two hours ; Seminar (insurance) with Professor Moser, one hour.—By Professor G. SIDLER : On elliptic arcs, whose difference is rectifiable, two hours.—By Professor G. HUBER : Introduction to the theory of algebraic surfaces, two hours.— By Professor E. OTT : Differential calculus, two hours ; Analytic geometry, I, two hours.—By Dr. A. BENTELI : Elements of descriptive geometry, four hours.—By Dr. L. CRELIER : Synthetic geometry of space, two hours.

UNIVERSITY OF GENEVA. — By Professor C. CAILLER : Differential and integral calculus (continuation), three hours : Seminar, two hours. — By Professor H. FEHR : Descriptive and projective geometry, two hours ; Algebra ; General theory of equations, two hours ; Exercises in the calculus (with Professor Cailler), two hours, and in algebra and geometry, two hours. — By Dr. D. MIRIMANOFF : Dirichlet's problem, two hours.

UNIVERSITY OF LAUSANNE. — By Professor H. AMSTEIN: Differential and integral calculus, five hours; Exercises, two hours; Theory of elliptic functions, three hours; Calculus for naturalists, three hours; Selected topics from the integral calculus (definite integrals and series), two hours. — By Professor H. JOLY: Analytic geometry (continuation), two hours; Descriptive geometry (continuation), two hours; Outline of descriptive geometry, four hours; Theory of numbers, two hours.

UNIVERSITY OF ZURICH. — By Professor H. BURKHARDT: Linear differential equations, four hours; Vector analysis, two hours; Seminar, two hours; Mathematical treatment of periodic recurrences in nature, two hours.— By Professor A. WEILER: Analytic geometry, II, two hours; Descriptive geometry, three hours; Mathematical geography, two hours.—Map projections, two hours. — By Dr. F. KRAFT: General theory of assemblages, four hours. — By Dr. E. GUBLER: Theory of numbers, two hours; Political arithmetic, with exercises, two hours.

CARLSRUHE TECHNICAL HIGH SCHOOL. — By Professor R. HAUSSNER: Elementary and analytic geometry of the plane and space, three hours, with exercises, one hour; Synthetic geometry, two hours, with exercises, one hour. — By Professor A. KRAZER: Higher mathematics, I, six hours, with exercises, two hours. — By Professor F. SCHUR: Descriptive geometry, four hours, with exercises, four hours. — By Professor L. WEDEKIND: Higher mathematics, II, two hours. — By Dr. G. HAMEL: Elements of higher mathematics, four hours, with exercises, one hour. — By Dr. W. LUDWIG: Theory of projection, two hours, with exercises, two hours.

MUNICH TECHNICAL HIGH SCHOOL. — By Professor A. VON BRAUNMÜHL: Algebraic analysis, with exercises (continuation); projective geometry synthetically treated, with exercises (continuation); mathematico-historical seminar. — By Professor S. FINSTERWALDER: Higher mathematics, II, with exercises; non-euclidean geometry.— By Professor W. VON DYCK: Partial differential equations of mathematical physics; colloquium, with Professor Finsterwalder. — By Professor L. BURMESTER: Descriptive geometry, with exercises (continuation). — By Professor S. GÜNTHER: Theory of potential with its application to geophysics.

STUTTGART TECHNICAL HIGH SCHOOL. — By Professor W. BRETSCHNEIDER : Elementary mathematics. — By Professor K. MEHMKE : Descriptive geometry; seminar — By Professor K. REUSCHLE : Differential and integral calculus; Plane analytic geometry ; Seminar. — By Dr. E. WÖLFFING : Theory of curves ; Partial differential equations.

THE current numbers of the *Revue générale des sciences*, beginning with volume 14, number 2, contain a very interesting series of articles in which, under the caption " The evolution of mechanics," P. DUHEM discusses the relations of theoretical mechanics to physical theories. The titles of the successive papers will give some idea of the wide field covered : I. Les diverses sortes d'explications mécaniques; II. La mécanique analytique ; III. Les théories mécanique de la chaleur et de l'electricité ; IV. Le retour à l'atomisme et au cartésianisme ; V. Les fondements de la thermodynamique ; VI. La statique générale et la dynamique générale ; VII. Les branches aberrantes de la thermodynamique.

PROFESSOR P. GORDAN, of Erlangen, has been made an honorary member of the University of Juriev (Dorpat). Dr. I. IVANOF and Dr. W. STANIEVICH have been made professors of mathematics at the St. Petersburg Polytechnic School. Dr. L. NATANSON has been promoted to a full professorship of mathematics at the University of Cracow.

PREBENDARY W. A. WHITWORTH, formerly fellow of St. John's College, Cambridge, has been appointed Hulsean lecturer for 1903.

MR. HERBERT KNAPMAN, first Smith's prizeman this year, has been appointed assistant lecturer in mathematics at University College, Reading, England.

MR. W. H. WAGSTAFF delivered the Gresham lectures on geometry this year, April 28–May 1.

PROFESSOR G. DARBOUX has recently been elected member of the bureau of longitudes.

PROFESSOR W. F. OSGOOD, of Harvard University, has been promoted to a full professorship of mathematics.

DR. ARNOLD EMCH, of the University of Colorado, has been promoted to a full professorship of graphics and mathematics.

DR. C. A. NOBLE has been promoted to an assistant professorship of mathematics at the University of California.

AT Lehigh University Professor ALEXANDER MACFARLANE delivered, April 20–30, a course of six lectures on the British mathematicians Kirkman, Babbage, Whewell, Dodgson, Stokes, and Rayleigh.

MR. F. G. WREN has been advanced from an assistant professorship to a professorship of mathematics at Tufts College.

PROFESSOR J. W. MASON, of the College of the City of New York, will retire from service at the end of the present year.

DR. N. M. FERRERS, for a long time one of the editors of the *Quarterly Journal of Mathematics,* died on January 31, 1903.

PROFESSOR JOSIAH WILLARD GIBBS, of Yale University, died at New Haven, April 28, 1903, of heart disease. He was born in New Haven, February 11, 1839, and graduated at Yale in 1858. After receiving the doctor's degree in 1863 from the same institution, he studied in Paris, Berlin, and Heidelberg. In 1871 he was appointed to the professorship of mathematical physics at Yale which he held to the time of his death. Professor Gibbs was a member of the Royal Society of London, of the National Academy of Sciences, and of many other learned bodies. Quite recently he joined the AMERICAN MATHEMATICAL SOCIETY. He was an authority of the first rank in thermodynamics and in the application of vector analysis to physical problems.

NEW PUBLICATIONS.

I. HIGHER MATHEMATICS.

AMODEO (F.). Appunti e riposte. Lettera aperta ad un geometra italiano. Napoli, 1902. 8vo. 10 pp.
——. Dai fratelli di Martino a Vito Caravelli. Napoli, 1902. 8vo. 64 pp.

BIBLIOGRAPHIE der deutschen naturwissenschaftlichen Litteratur. Herausgegeben im Auftrage des Reichsamtes des Innern vom deutschen Bureau der internationalen Bibliographie in Berlin. Vol. 3: 1903–4. Abteilung 1: Mathematik, Mechanik, Physik, Chemie, Astronomie, Meteorologie. No. 1. Jena, Fischer, 1903. 8vo. 48 pp. M. 9.00