

PROCEEDINGS
OF THE
LONDON MATHEMATICAL SOCIETY.

VOL. IX.

FOURTEENTH SESSION, 1877-78.

November 8th, 1877.

ANNUAL GENERAL MEETING, held at 22, Albemarle Street,

Lord RAYLEIGH, F.R.S., President, in the Chair.

The Treasurer (S. Roberts, Esq., M.A.) read his Report, which, on the motion of Dr. Hirst, F.R.S., seconded by Major J. R. Campbell, was accepted. On the motion of Prof. Cayley, F.R.S., Mr. Perigal consented to act as Auditor.

The Secretaries' Report was read and accepted.

From the Report of the Secretaries, it appeared that the number of Members during the past Session was 134, and the number of Foreign Members 7, and that the present number of Life Members is 40.

The Obituary of the Society, during the Session, contained the name of Mr. Olinthus Gregory Downes.

The communications made to the Society during the past Session had been as follows :—

“On the Present State and Prospects of some Branches of Pure Mathematics :” Prof. H. J. S. Smith, F.R.S.

“On Curves having Four-point Contact with a Triply Infinite Pencil of Curves :” Dr. Spottiswoode, F.R.S.

“On some Classes of Multiple Definite Integrals :” Mr. E. B. Elliott, B.A.

“On certain Identical Differential Relations :” Mr. J. W. L. Glaisher, F.R.S.

- "On the Conditions of Perpendicularity in a Parallelepipedal System:" Prof. H. J. S. Smith, F.R.S.
- "On the Condition for the existence of a Surface cutting at Right Angles a given Set of Lines:" Prof. Cayley, F.R.S.
- "The Orthogonal Transformation, and Additions to former Paper on Transformation of Elliptic Functions:" Prof. Clifford, F.R.S.
- "On the Simplest Continuous Manifoldness of Two Dimensions and of Finite Extent:" Mr. Frankland.
- "On the Theory of Electric Images, and its application to the case of Two Charged Spherical Conductors placed opposite one another:" Mr. W. D. Niven, M.A.
- "On Viscous Fluids, and Quaternion Forms of some general Propositions in Fluid Motion:" Mr. J. G. Butcher, B.A.
- "An easy method of finding the Invariant Equation expressing any Poristic Relation between Two Conics:" Prof. Wolstenholme, M.A.
- "Determinant Conditions for Curves or Surfaces, of the same Order, having all their Intersections common:" Mr. J. Hammond, B.A.
- "Numerical Values of the First Twelve Powers of π , of their Reciprocals, and of certain other Related Quantities:" Mr. J. W. L. Glaisher, F.R.S.
- "On some General Classes of Multiple Definite Integrals:" Mr. E. B. Elliott, B.A.
- "On the Partial Differential Equation $S + pP + Qq + Z = 0$:" Prof. H. W. Lloyd Tanner, M.A.
- "On Methods for finding Equations to Axes of a Conic, and the Axes themselves, in Trilinear Coordinates:" Mr. J. J. Walker, M.A.
- "On some Elliptic Function Properties:" Prof. H. J. S. Smith, F.R.S.
- "On the Area of the Quadrangle formed by the Four Points of Intersection of Two Conics:" Mr. C. Leudesdorf, B.A.
- "On a Certain Series:" Mr. J. W. L. Glaisher, F.R.S.
- "On the Equation $\frac{dx}{\sqrt{X}} + \frac{dy}{\sqrt{Y}} = 0$:" Prof. Cayley, F.R.S.
- "Classification of Loci, and a Theorem in Residuation:" Prof. Clifford, F.R.S.
- "On a New View of Pascal's Hexagram:" Mr. T. Cotterill, M.A.
- "On a Class of Integers expressible as the Sum of Two Integral Squares:" Mr. T. Muir, M.A.
- "Some Properties of the Double Theta Functions:" Prof. Cayley, F.R.S.
- "Property of an Envelope;" and "On Hesse's Ternary Operator and Applications:" Mr. J. J. Walker, M.A.

- "On the Circular Relation of Möbius;" and "On the Linear Transformation of the Integral $\int \frac{du}{\sqrt{U}}$:" Prof. Cayley, F.R.S.
- "On some Cases of Parallel Motion:" Mr. H. Hart, M.A.
- "A Method of Solving Partial Differential Equations which have a general First Integral, applied to Equations of the Third Order with Two Independent Variables:" Prof. H. W. Lloyd Tanner.
- "Note on the Correlation of Two Planes:" Dr. Hirst, F.R.S.
- "The Irreducible Case:" Herr Weichold.
- "Generalization of Cases of Five-bar Motion considered at the April Meeting;" "The 'Kinematical Paradox';" and "A Method of Solving by Linkwork $f(x) = 0$, an Algebraical Equation of the n^{th} degree:" Mr. H. Hart.
- "On the Free Motion of a Solid through an Infinite Mass of Perfect Liquid:" Prof. Lamb.
- "On Mean Values:" Prof. M. W. Crofton, F.R.S.
- "On the Canonical Form and Dissection of a Riemann's Surface:" Prof. Clifford, F.R.S.
- "On Eisenstein's Theorem:" Prof. H. J. S. Smith, F.R.S.
- "Proof that every Algebraic Equation has a Root:" Mr. J. C. Malet, M.A.

The following Mathematical Journals had been subscribed for:—

- "Nouvelles Annales de Mathématiques." Paris.
- "Giornale di Matematica." Napoli.
- "Mathematische Annalen." Leipzig.
- "Philosophical Magazine and Journal of Science." London.
- "Quarterly Journal of Mathematics." Cambridge.
- "Messenger of Mathematics." Cambridge.

The following Journals had been presented:—

- "Crelle's Journal." Berlin.
- "Monatsbericht." Berlin.
- "Bulletin de la Société Mathématique de France." Paris.
- "Bulletin des Sciences Mathématiques et Physiques." Paris.
- "Annali di Matematica Pura ed Applicata." Milano.
- "Proceedings of the Royal Society." London.
- "Educational Times." London.
- "Mathematical Reprint from the Educational Times." London.
- "Journal of Education." London.
- "Mémoires de la Société des Sciences physiques et naturelles de Bordeaux." Bordeaux.
- "Jahrbuch über die Fortschritte der Mathematik." Berlin.
- "Proceedings of the Physical Society of London." London.
- "Atti della R. Accademia dei Lincei." Roma.

"Nieuw Archief voor Wiskunde." Amsterdam, 1876.

"Smithsonian Report." Washington, 1876.

"Memorie della R. Accademia di Scieuze, Lettere ed Arti in Modena." Modena.

"Transactions of the Cambridge Philosophical Society." Cambridge.

"Journal of Institute of Actuaries." London.

The following presents had been made to the Society :—

Carte de Visite Likeness from Mr. A. B. Kempe, for the Album.

"Interpolation and Adjustment of Series," by E. L. de Forest. New-haven, 1876.

"Lessons introductory to the Higher Algebra," by G. Salmon, D.D. Third Edition. Dublin, 1876.

"Weitere Untersuchungen über das Ikosaeder, i. ii. iii.," von F. Klein.

"Sur les équations qui se rencontrent dans la Théorie de la Transformation des Fonctions elliptiques," par le Père Joubert, S.J. Paris, 1876.

"Ueber das arithmetisch-geometrische Mittel aus vier Elementen," von C. W. Borchardt.

"Archiv for Mathematik og Naturvidenskab udgivet af Sophus Lie," W. Müller og G. O. Sars. 1876.

"Algemeine Theorie partielle Differential-Gleichungen 1^o," von S. Lie.

"Bidrag til Legemernes Molekylar-Theorie," af C. M. Guldberg.

"Om Attractionen mellem to Cirkel-flader," af O. Pihl.

"Discussion aller Integrations-Methoden der partiellen Differential-Gleichungen 1^o," von S. Lie.

"Sur la résolution des Equations du 2^{me}, 3^{me}, et 4^{me} degré par la fonction $\frac{n}{r}(X)$," par Dr. A. S. Gu'dberg.

(i.) "Zur Theorie des Integralitäts-Faktors." (ii.) "Veralgemeinerung und neue Verwerthung der Jacobischen Multiplier-Theorie," von S. Lie.

"Nautical Almanac" for 1880.

"Haversines, Natural and Logarithmic, used in computing Lunar Distances for the Nautical Almanac," edited by Major-General Han-nyngton. 1876.

"Vorlesungen über Geometrie von A. Clebsch," bearbeitet und herausgegeben von Dr. F. Lindemann. Leipzig, 1876.

"Elementary Treatise on the Differential Calculus," by B. William-son, M.A. 1877.

"Investigation of Corrections to Hansen's Tables of the Moon, with Tables for their Application," by S. Newcomb.

"Report on the Difference of Longitude between Washington and Ogden, Utah," by J. R. Eastman. Washington, 1876.

"Address delivered by J. J. Sylvester, F.R.S., at Johns Hopkins University, on Commemoration Day (Feb. 22, 1877)." Baltimore, 1877.

"Ueber den Verlauf der Abelschen Integrale bei den Curven vierten Grades," von F. Klein.

"Elementary Treatise on the Integral Calculus," by B. Williamson, M.A. 1877.

"La Théorie Hugodécimale, ou la Base scientifique et définitive de l'Arithmologistique universelle," par le Cte. Léopold Hugo. Paris, 1877.

"Theory of Sound," Vol. i., by Lord Rayleigh, F.R.S.

"A Continuation of De Damoiseau's Tables of the Satellites of Jupiter to the year 1900," by D. P. Todd, B.A. Washington, 1876.

"Sull' equazione dell' Icosaedro nella risoluzione delle equazioni del quinto grado," nota del Prof. Klein.

"Astronomical and Meteorological Observations made during the year 1874 at the United States Naval Observatory," by Rear-Admiral C. H. Davis, U.S.N. Washington, 1877.

Catalogue of the Library of the University of London, including the Libraries of George Grote and A. de Morgan. London, 1876.

"Sur le paraboloïde des huit droites," and "Sur les surfaces dont les rayons de courbure principaux sont fonctions l'un de l'autre," par M. A. Mannheim.

"øvelser i Grafisk Statik," af H. G. Zeuthen.

"Résumé du Bulletin de l'Académie Royale Danoise des Sciences et des Lettres pour l'année 1877."

"Lectures on the Elements of Applied Mechanics, comprising—1. Stability of Structures; 2. Strength of Materials," by M. W. Crofton, F.R.S. 1877.

"Ueber correlative oder reciproke Bündel," von Rudolf Sturm.

"Ueber geometrische Erweiterungen des Bezoutschen Fundamentalsatzes," von Dr. H. Schubert, in Hamburg.

"Ueber lineare Differential-Gleichungen," von F. Klein.

"Sur la production du mouvement rectiligne exact, au moyen de tiges articulées," par A. B. Kempe (translated by M. V. Liguine).

"How to Draw a Straight Line," by A. B. Kempe, B.A.

"Sopra i sistemi tripli di superficie isoterme e ortogonali," Memoria di E. Betti.

"Sopra il moto di un sistema di un numero qualunque di punti," E. Betti.

"Boletín de la institucion libre de Enseñanza." Madrid, 1877.

The Meeting then proceeded to the election of the new Council. The Scrutators (Prof. Greenhill and Mr. R. Rawson), having examined

the balloting lists, declared the following gentlemen (nominated by the Council) duly elected :—

President—The Right Hon. Lord Rayleigh, F.R.S. Vice-Presidents—Prof. J. Clerk-Maxwell, F.R.S.; Mr. C. W. Merrifield, F.R.S.; Prof. H. J. S. Smith, F.R.S. Treasurer—Mr. S. Roberts, M.A. Hon. Secretaries—Messrs. Morgan Jenkins, M.A., and R. Tucker, M.A. Other Members—Prof. Cayley, F.R.S.; Mr. T. Cotterill, M.A.; Mr. J. W. L. Glaisher, F.R.S.; Mr. Harry Hart, M.A.; Dr. Henrici, F.R.S.; Dr. Hirst, F.R.S.; Mr. A. B. Kempe, B.A.; Dr. Spottiswoode, F.R.S.; Mr. J. J. Walker, M.A.

Rev. William Ellis, B.A., Caius College, Cambridge, was proposed for election.

The following communications were made to the Society :—

“On the Function $\phi(x) = \frac{ax+b}{cx+d}$,” and “On the Theta Functions :” Prof. Cayley.

“The Calculus of Equivalent Statements :” Hugh McColl, B.A. (communicated by Prof. Crofton, read by Mr. Tucker).

“Progressive Waves :” Lord Rayleigh.

Prof. Clifford communicated notes “On the Triple Generation of Three-bar Curves,” “On the Mass-Centre of an Octahedron,” and “On Vortex Motion.”

The following presents were made to the Society :—

“The Optical Department of the Atmosphere in relation to the Phenomena of Putrefaction and Infection,” by J. Tyndall, F.R.S. (Phil. Trans., Part i. 1876, Vol. 166; read Jan. 13, 1876.)

“On the Atmosphere as a Vehicle of Sound,” by the same. (Read Feb. 12th, 1874.)

“On the Variations of the Daily Mean Horizontal Force of the Earth’s Magnetism produced by the Sun’s Rotation and the Moon’s Synodical and Tropical Revolutions,” by J. A. Broun, F.R.S. (Vol. 166, Part 2; read Jan. 27, 1876.)

“On a Class of Identical Relations in the Theory of Elliptic Functions,” by J. W. L. Glaisher, M.A. (Vol. 165, Part 2; read Jan. 14, 1875.)

“On the Mathematical Theory of Stream-Lines, especially those with four Foci and upwards,” by W. J. M. Rankine, C.E., &c. (Read Feb. 10, 1870); with Supplement.

“Eloge de MM. Alexandre Brongniart et Adolphe Brongniart,” par M. Dumas (Institut de France, Paris, 1877).

“Détermination nouvelle de la Vitesse de la Lumière,” par M. A. Cornu (Journal de l’École Polytechnique, xlv^e cahier); “Sur la détermination de la Vitesse de la Lumière,” par M. A. Cornu (Comptes Rendus, 2 Oct. 1871); “Détermination nouvelle de la Vitesse de la

Lumière" (Comptes Rendus, 10 Fevr. 1873); "Détermination de la Vitesse de la Lumière et de la Parallaxe du Soleil," par M. Cornu (Comptes Rendus, Dec. 14, 1874).

"Détermination, par le principe de Correspondance, de la classe de la développée et de la caustique par réflexion d'une courbe géométrique d'ordre m et de la classe n ," par M. Chasles (Comptes Rendus, t. lxxii. 1871).

"Propriétés des systèmes de coniques, relatives, toutes à certaines séries de normales en rapport avec d'autres lignes ou divers points" (Do. do.)

"Propriétés des systèmes de coniques, dans lesquels se trouvent des conditions de perpendicularité entre diverses séries de droites" (Do. do.)

"Théorèmes divers concernant les systèmes de coniques représentés par deux caractéristiques" (Do. do.)

"Démonstration géométrique d'une proposition due à M. Bertrand," par M. A. Mannheim (Journal de Mathématiques pures et appliquées, 2^e Série, Tome xvii. 1872).

"Sur la surface gauche, lieu des normales principales de deux courbes" (with the last).

"Mémoire sur les pinceaux de droites et les normalies contenant une nouvelle exposition de la théorie de la courbure des surfaces" (same work), par M. A. Mannheim.

"Exposition sommaire d'une théorie géométrique de la courbure des surfaces" (Comptes Rendus, 26 Fev. 1872), par M. Mannheim.

"Recherches géométriques sur le contact du 3^e ordre de deux surfaces" (Do. do., 25 Mars, 1872).

"Démonstration géométrique de quelques théorèmes, au moyen de la considération d'une rotation infiniment petite" (Do. do., 2 Mars, 1874).

"Deux théorèmes nouveaux sur la surface de l'onde" (Do. do., 23 Mars, 1874).

"Construction directe du centre de courbure en un point de la section faite dans une surface par un plan quelconque" (Do. do., 6 Avr. 1874).

"Détermination des relations analytiques qui existent entre les éléments de courbure des deux nappes de la développée d'une surface" (Do. do., 7 Dec. 1874).

"Solutions géométriques de quelques (et de nouveaux) problèmes, relatifs à la théorie des surfaces et qui dépendent des infiniment petits du troisième ordre" (Do. do., 1 Mars, 22 Mars, 1875).

"Sur la résolution des équations les unes par les autres," par M. C. Jordan (Do. do., 13 Mars, 1871).

"Théorèmes sur les groupes primitifs," par M. C. Jordan (Do. do., 26 Juin, 1871).

"Mémoire sur la résolution des équations algébriques les unes par les autres," par M. C. Jordan (extrait du *Journal des Mathématiques pures et appliquées*, 2^e Série, Tome xvi. 1871).

"La Revue Scientifique de la France et de l'étranger revue des cours scientifiques" (2^e Série). No. 10, 2nd Sept. 1871, contains "Rapports des sciences physiques avec les sciences mathématiques—Théorie atomique, Prof. J. Clerk-Maxwell (British Association, Liverpool)," and "La polarisation rotatoire—expériences de Sir Ch. Wheatstone, Mr. Spottiswoode (Royal Institution, Friday Lecture)."

Do. do., No. 47, 24 Mai, 1873, "Histoire des Laboratoires de l'Institut Royale, Mr. Spottiswoode (Royal Institution, Friday Lecture)."

Do. do., No. 20, 2^e Série, 14 Nov. 1874, "Les combinaisons de couleurs produites au moyen de la lumière polarisée, Mr. Spottiswoode (Royal Institution, Friday Lecture)."

(All the above were presented by Dr. Spottiswoode.)

"Annali di Matematica," Serie ii^a, Tomo viii^o, Fasc. 3^o (Ottobre, 1877); Milano.

"Educational Times," Dec. 1877.

"Smithsonian Report," 1876; Washington, 1877.

"Monatsbericht," Aug. 1877; Berlin.

"Nautical Almanac" for 1881, from Lords Commissioners of the Admiralty.

"Elementary Theorems relating to the Geometry of a Space of Three Dimensions, and of Uniform Positive Curvature in the Fourth Dimension," by Simon Newcomb, Washington, U.S. (*Journal für Mathematik*, Band lxxxiii., Heft 4, pp. 293–9): from the Author.

"Quatre modèles représentant des surfaces développables avec des renseignements sur la construction des modèles et sur les singularités qu'ils représentent, par V. Malthe Bruun et C. Croné, avec quelques remarques sur les surfaces développables et sur l'utilité des modèles, par M. le Dr. H. G. Zeuthen," Copenhagen, 1877: from the Authors.

"On Knots," by Prof. Tait (*Trans. R. S. Edin.*, Vol. xxviii., Part i., pp. 145–190, and Plates): from the Author.

"A List of Writings relating to the Method of Least Squares, with Historical and Critical Notes," by Mansfield Merriman, Ph.D. (from the *Transactions of the Connecticut Academy*, Vol. iv., 1877): from the Author.