



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

### **Usage guidelines**

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

### **About Google Book Search**

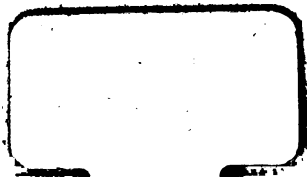
Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

*GENERAL LIBRARY of the  
UNIVERSITY OF MICHIGAN*

PRESENTED BY

*Pres. Angell*

*9-1A-0A*



Mathematics

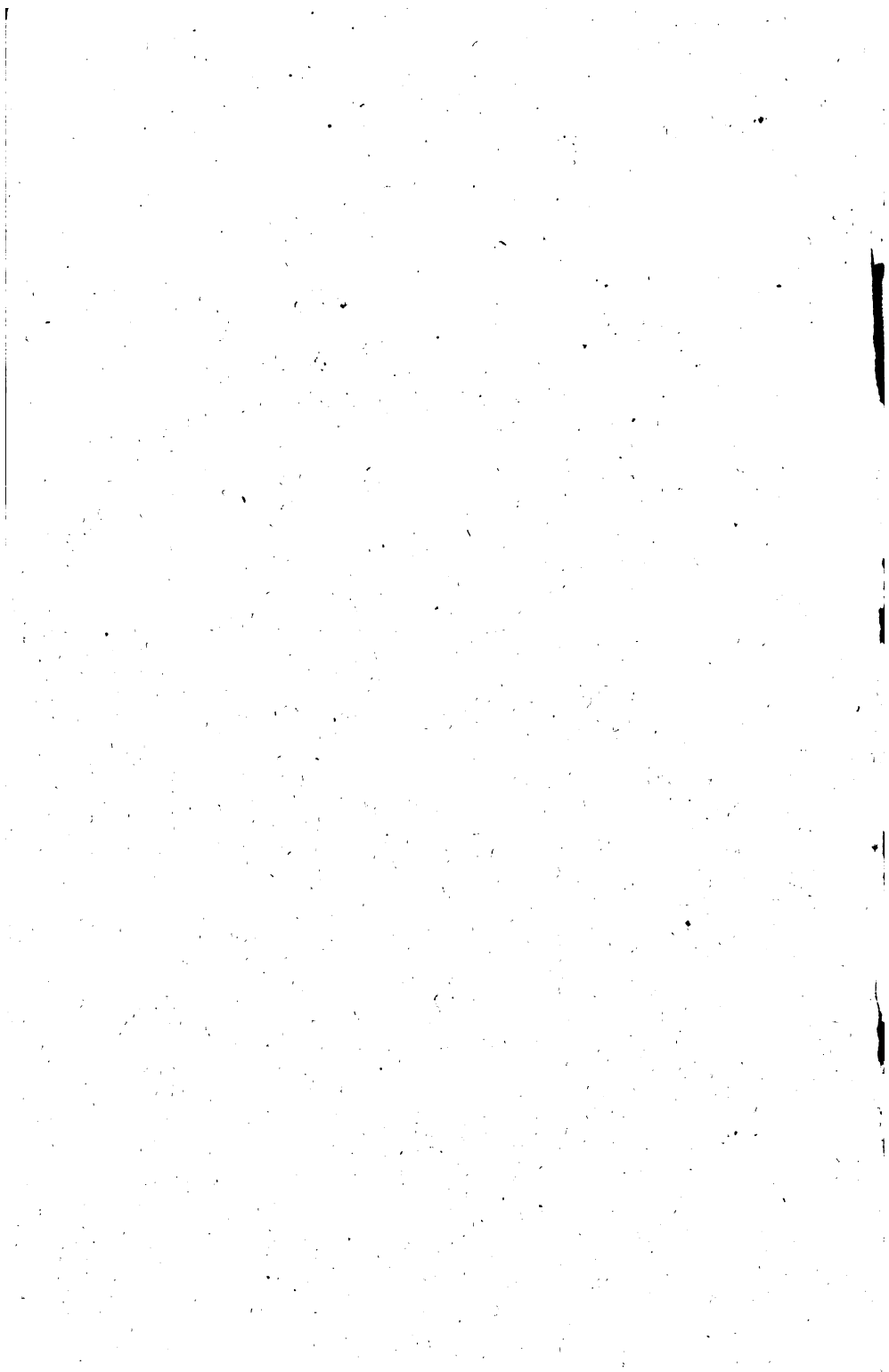
Z

6654

.Q2

M14

HC



From Proc. Camb. Phil. Soc.

1904

INTERNATIONAL ASSOCIATION

FOR

PROMOTING THE STUDY OF QUATERNIONS AND ALLIED  
SYSTEMS OF MATHEMATICS.

---

BIBLIOGRAPHY

OF

QUATERNIONS AND ALLIED SYSTEMS OF  
MATHEMATICS.

BY

ALEXANDER MACFARLANE,

D.Sc., LL.D., F.R.S.E.,

GENERAL SECRETARY OF THE ASSOCIATION.

DUBLIN:

PRINTED AT THE UNIVERSITY PRESS,  
BY PONSONBY AND GIBBS.

1904.



INTERNATIONAL ASSOCIATION  
FOR  
PROMOTING THE STUDY OF QUATERNIONS AND ALLIED  
SYSTEMS OF MATHEMATICS.

---

---

# BIBLIOGRAPHY

OF  
QUATERNIONS AND ALLIED SYSTEMS OF  
MATHEMATICS.

BY  
ALEXANDER MACFARLANE,  
D.Sc., LL.D., F.R.S.E.,  
GENERAL SECRETARY OF THE ASSOCIATION.

DUBLIN:  
PRINTED AT THE UNIVERSITY PRESS,  
BY PONSONBY AND GIBBS.

1904.

*Printed by PONSONBY & GIBBS, Dublin University Press.*

Wol



## PREFACE.

---

THE International Catalogue of Scientific Literature places Quaternions as one division (83), and Ausdehnungslehre and Vector Analysis as another division (84) of Universal Algebra (8). The proximate divisions on either side are General Theory of Complex Numbers (82) and Matrices (85). These are the main and allied branches of Mathematics comprised in this Bibliography. I have also included publications in which vector ideas and methods are applied.

The contributions of each writer are arranged chronologically, the date taken being that of the volume in which the contribution appears. The mark † is printed before the first posthumous publication.

In the use of contractions for the names of serial publications, I have followed the system of the *Jahrbuch über die Fortschritte der Mathematik*; and I have likewise followed it in avoiding the use of Roman numerals. Where the number of the pages of a book is indicated by the sum of two numbers, the former number refers to the preface, and the latter to the text.

The following contractions are used: M.P. for Collected Mathematical Papers; S.P. for Collected Scientific Papers; G.W. for *Gesammelte Werke*; Pr. for *Programmabhandlung*.

© U.S. - 1 - 157  
Entered 11-16-29 F. L. M.

( 4 )

For facilities in the preparation of this Bibliography, I wish to thank the Librarian of the University of Michigan, and, for special assistance, the following members of the Association: Combebiac, Dickstein, van Elfrinkhof, Grassmann, Joly, and Schlegel. Almost every living writer has responded to the request to make the list of his own contributions complete.

ALEXANDER MACFARLANE.

*17th November, 1903*

# BIBLIOGRAPHY

OF

## QUATERNIONS AND ALLIED MATHEMATICS.

---

MAX ABRAHAM.

- 1899 Ueber einige bei Schwingungsproblemen auftretende Differentialgleichungen. *Math. Ann.* **52**, 81-112.  
1901 Geometrische Grundbegriffe. *Encykl. d. math. Wiss.*, **4**, 8-47.

ROBERT EDGAR ALLARDICE.

- 1889 Note on a formula in quaternions. *Edinb. M. S. Proc.*, **7**, 8-12.

MORIZ ALLÉ.

- 1892 Ueber die Ableitung der Gleichungen der drehenden Bewegung eines starren Körpers nach der Grassmann'schen Analyse. *Prag Math. Ges.*, 64-69.

ALEXANDRE ALLÉGRET.

- 1862 *Essai sur le calcul des quaternions de M. W. Hamilton.* Paris: Gauthier-Villars. 7+72. 4°.  
1868 The above reviewed by M. Prouhet. *Nouv. Ann.*, (2), **2**, 333-334.

EDWYN ANTHONY.

- 1881 Notes on quaternions. *Messenger* (2), **10**, 66-72.

JEAN-ROBERT ARGAND.

- 1806 *Essai sur une manière de représenter les quantités imaginaires dans les constructions géométriques.* (Anonymous.) Paris: 78. Small 8°.

- 1814 Essai sur une manière de représenter les quantités imaginaires dans les constructions géométriques. *Ann. de Math. de Gergonne*, 4, 133-147.
- 1815 Réflexions sur la nouvelle théorie des imaginaires, suivies d'une application à la démonstration d'un théorème d'analyse. *Ann. de Math. de Gergonne*, 5, 197-209.
- +1874 Essai sur une manière, etc. 2<sup>o</sup> édition, précédée d'une préface par M. J. Höüel et suivie d'un appendice contenant des extraits des *Annales de Gergonne* relatifs à la question des imaginaires. Paris: Gauthier-Villars. 19+126. 8<sup>o</sup>.
- 1881 *Imaginary Quantities*. The second edition of the above translated into English by A. S. Hardy. New York: Van Nostrand.

BADORFF.

- 1877 Beitrag zur Geometrie des Kreises und der Kugel Pr. Baden.

ALFRED BAKER.

- 1901 The principles at the base of quaternion analysis. *Trans. R. S. C., Section III, (2), 7, 17-20.*

VALENTIN BALBIN.

- 1888 Elementos de calculo de los cuaterniones y sus aplicaciones principales á la geometria al analysis y á la mecanica. Buenos Aires. 19 + 359. 8<sup>o</sup>.

SIR ROBERT STAWELL BALL.

- 1876 The theory of screws: a study in the dynamics of a rigid body. Dublin: Hodges, Foster, & Co. 24 + 194. 8<sup>o</sup>.
- 1898 The discussion on quaternions. *Nature*, 48, 391.
- 1900 A treatise on the theory of screws. Cambridge University Press. 19 + 544. Royal 8<sup>o</sup>.

L. BALLAUFF.

- 1844 Beiträge zur systematischen Darstellung der allgemeinen Arithmetik. *Grunert Arch.*, 5, 259—.
- 1845 Ueber die Potenzen mit imaginären Exponenten. *Grunert Arch.*, 6, 409—

RICHARD BALTZER.

- 1888 Ueber die Einführung der complexen Zahlen. J. für Math., **94**, 87-92.

NAPOLÉON-ERNEST BARIEN.

- 1901 Application de la méthode de Grassmann à une démonstration de deux théorèmes de géométrie différentielle. Nouv. Ann., (4), **1**.

WILLIAM BEEBE.

- 1890 The orbit of Swift's comet 1880 V determined by Gibbs's vector method. By W. Beebe and A. W. Phillips. Astronomical Journal, **9**, 118-117 and 121-124.

R. BEEZ.

- 1875 Ueber conforme Abbildung von Mannigfaltigkeiten höherer Ordnung. Schlömilch Z., **20**, 258-270.  
1896 Zur Theorie der Vektoren und Quaternionen. Schlömilch Z., **41**, 85-87 and 65-84.

GIUSTO BELLAVITIS.

- 1882 Sulla geometria derivata. Ann. Lomb. Veneto, **2**, 250-258.  
1888 Sopra alcune applicazioni di un nuovo metodo di geometria analitica. Poligrafo di Verona, **13**, 58-61.  
1885 Saggio di applicazioni di un nuovo metodo di geometria analitica (Calcolo delle equipollenze). Ann. Lomb. Veneto, **5**, 244-259.  
1886 Teoria delle figure inverse e loro uso nella geometria elementare. Ann. Lomb. Veneto, **6**, 136-141.  
1887-8 Memoria sul metodo delle equipollenze. Ann. Lomb. Veneto, **7**, 248-261 ; **8**, 17-37 and 85-121.  
1848 Soluzioni grafiche di alcuni problemi geometrici del primo e del secondo grado trovato col metodo delle equipollenze. Ven. Ist. Mem., **1**, 225-267.  
1847 Dimostrazione col metodo delle equipollenze di alcuni teoremi in parte considerati dai sig. Bellati e Ridolfi. Ven. Ist. Atti, (1), **6**, 58-59.  
1852 Saggio sull' algebra degli immaginarie. Ven. Ist. Mem., **4**, 248-344.

- 1854 Sposizione del metodo delle equipollenze. Mem. Soc. Ital., 25, 225-309. Published separately at Modena, 1854. Translated by C. A. Laisant, Paris. 1874.
- 1858 Calcolo dei quaternioni di W. R. Hamilton e sua relazione col metodo delle equipollenze. Ven. Ist. Atti, (2), 1, 334-342. Also Mem. Soc. Ital. (1862), 1, 126-186.
1860. Sposizione dei nuovi metodi di geometria analitica. Ven Ist. Mem. 159 pages.
- 1871 Sul calcolo dei quaternioni. Undecima Rivista di Giornali. Ven. Ist. Atti, (2), 204.
- 1873 Sul calcolo dei quaternioni ossia teoria dei rapporti geometrici nello spazio. Duodecima Rivista di Giornali. Ven. Ist. Atti, (2), 69.
- 1873-4 Exposition de la méthode des Équipollences de Giusto Bellavitis: traduction par C. A. Laisant. Nouv. Ann. (2), 12 and 13.
- 1876 Sulle origini del metodo delle equipollenze. Ven. Ist. Mem., 19, 449-491.
- 1878 Sur la thèse de M. Laisant relative au calcul des quaternions. Quattor dicesima Rivista di Giornali. Ven. Ist. Atti: (2), 116.

WOOSTER WOODRUFF BEMAN.

- 1881 A brief account of the essential features of Grassmann's extensive algebra. Translation of Grassmann's "Kurze Uebersicht" in Grunert's Archiv. Analyst, 8, 96-97, and 114-124.
- 1897 A chapter in the history of mathematics. Amer. Assoc. Proc., 46, 33-50.

B. BERLOTY.

- 1886 Théorie des quantités complexes à  $n$  unités principales. Thèse. Paris: Gauthier-Villars. 12 pp. 4°.

V. BJERKNES.

- 1898 Zur Theorie gewisser Vectorgrössen. Christiania. 27 pp. 8°.
- 1900 Vorlesungen über hydrodynamische Fernkräfte. Bd. I. Leipzig.

CARL F. E. BJÖRLING.

- 1876 Ueber eine vollständige geometrische Darstellung einer Gleichung zwischen zwei veränderlichen Grössen. Stockholm Akad. Handl., 13, No. 4.

FRANK HAGAR BIGELOW.

1902. Eclipse meteorology and allied problems. Chap. V., Fundamental physical relations, p. 185-166. Bulletin of the United States Weather Bureau.  
1902 Studies on the statics and kinematics of the atmosphere in the United States. Bulletin of the United States Weather Bureau.

MAXIME BÔCHER.

- 1898 The geometric representation of imaginaries. Annals of Math., 7, 70-72.

OTTO BÖKLEN.

- 1882 Die Rechnung mit Vektoren. Correspondenzbl. f. Gel. u. Realschule.

A. J. BOGUSLAWSKY.

- 1891-2 Algebra of the plane and of space, or calculus of position. (Russian.) Mosk. Math. Samml. 14-16.  
1898 Calculus of position. (Russian.) Charkow Ges., (2), 4, 86-96.

GEORGE BOOLE.

- 1848 Notes on Quaternions. Phil. Mag., (3), 33, 278-280.  
1856 Application of the method of Quaternions to the solution of the partial differential equation  $\nabla^2 u = 0$ . Dublin Proc., 6, 375-385.

A. BREUER.

- 1898 Die Gauss'sche Darstellung complexer Zahlen in geometrischer Beleuchtung. Hoppe Arch., (2), 12, 337-344.

R. BRICARD.

- 1901 Sur la similitude directe dans le plan. Application de la méthode des équipollences. Nouv. Ann., (4), 1, 112-120.

JOHN BRILL.

- 1886 On the application of the theory of complex quantities to plane geometry. *Messenger*, (2), **16**, 8-20.
- 1887 A new method for the graphical representation of complex quantities. *Messenger*, (2), **17**, 80-98.
- 1889 A new geometrical representation of the quaternion analysis. *Cambr. Proc.*, **6**, 156-169.
- 1892 Note on the application of quaternions to the discussion of Laplace's equation. *Cambr. Proc.*, **7**, 120-125 and 151-156.
- 1895 Note on the application of analysis to geometry. *Messenger*, (2), **25**, 49-59.
- 1896 On the generalization of certain properties of the tetrahedron. *Cambr. Proc.*, **9**, 98-108.

ANDRÉ BROCA.

- 1900 Champs de vecteur et champs de force. Action réciproque des masses scalaires et vectorielles. *C.R.* **130**, 109-112.
- 1900 Sur les masses vectorielles de discontinuité. *C. R.* **130**, 817-819.

HENRI BROCARD.

- 1877 Applications mécaniques du calcul des quaternions, par C. A. Laisant. *Compte rendu bibliographique. Nouv. Corresp. Math.* **4**, 115-116.
- 1882 Introduction à la méthode des quaternions, par C. A. Laisant. *Compte rendu bibliographique. Nouv. Ann.*, (8), **1**, 332-335, and *Mathesis*, **2**, 32-34.
- 1887 Théorie et applications des Équipollences, par C. A. Laisant. *Compte rendu bibliographique. Mathesis*, **7**, 184-185.

A. H. BUCHERER.

- 1903 *Elemente der Vectoranalysis*. Leipzig: Teubner, 6 + 91 pp. 8vo.

ARTHUR BUCHHEIM.

- 1888 On the application of quaternions to the theory of the linear complex and the linear congruence. *Messenger*, (2), **12**, 129-130.



- 1888 On the quaternion treatment of the linear complex. Messenger, (2) **13**, 120-124.
- 1884-7 On the theory of screws in elliptic space. Lond. M. S. Proc., **15**, 88-98 ; **16**, 15-27 ; **17**, 240-254 ; **18**, 88-96.
- 1885 On the theory of matrices. Lond. M. S. Proc., **16**, 68-82.
- 1885 A memoir on biquaternions. American J., **7**, 298-326.
- 1886 On Clifford's theory of graphs. Lond. M. S. Proc., **17**, 80-106.

L'ABBÉ BUÉE.

- 1806 Mémoire sur les quantités imaginaires. Lond. Phil. Trans., **96**, 28-88.

WILHELM BUNKHOFFER.

- 1878 Zahlenbüschel, &c. Pr. Bruchsal.
- 1898 Vektorenquadrate im ebenen stetigen Gebilde. Pr.

CESARE BURALI-FORTI.

- 1897 Introduction à la Géométrie différentielle, suivant la méthode de H. Grassmann. Paris : Gauthier-Villars. 11 + 165. 8°.
- 1896-1901 Il metodo del Grassmann nella Geometria proiettiva. Palermo Rend., **10**, 177-195 ; **11**, 64-82 ; **15**, 810-820.
- 1898 Sopra alcune questioni di Geometria differenziale. Palermo Rend., **12**, 111-182.
- 1899 Sur les rotations. Darboux Bull., **34**, 82-92.
- 1900-1 Sur la formule de Taylor pour les formes géométriques. Schlömilch Z., **45**, 52-54.
- 1901-2 Applicazioni del metodo di Grassmann. Le Matematiche, **1**, Nos. 11-12 ; **2**, Nos. 1-2.
- 1902 Sulle radiali. Palermo Rend., **16**, 185-191.
- 1902 Le formule di Frenet per le superfici. Torino Atti., **37**, 233-246.
- 1902 Ingranaggi piani. Torino Atti, **37**, 393-413.
- 1902 Formulaire mathématique, par G. Peano. §§ 91, 92, 98,
- 1903 I vettori nella geometria elementare. Palermo, "Il Pitagora."
- 1904 Lezioni di geometria metrico-proiettiva. Torino : Bocca. 12 + 308 pp.

H. BURHENNE.

- 1858 Zur Theorie der imaginären Grössen. Grunert Arch., **22**, 43.

HEINRICH BURKHARDT,

- 1898 Ueber Functionen von Vectorgrössen, welche selbst wieder Vectorgrössen sind. Gött. Nachr., 155-159. Also Math. Ann., **43**, 197-215.
- 1896 Ueber Vectoranalysis. Deutsche Math. Ver., **5**, 48-52.

LUDWIG BURMESTER.

- 1878-1902. Kinematisch-geometrische Theorie der Bewegung der affinveränderlichen, ähnlich veränderlichen und starren räumlichen oder ebenen Systeme. Schlömilch Z., **23**, 108-181, and **47**, 128-156.
- 1878 Ueber den Beschleunigungszustand ähnlich veränderlicher und starrer ebener Systeme. Civiilingenieur, **24**, 147-172.

WILLIAM BURNSIDE.

- 1894 On the kinematics of non-euclidean space. Lond. M. S. Proc., **26**, 88-56.
- 1899 Octonions: a development of Clifford's biquaternions, by Alex. M'Aulay. Review. Nature, **59**, 411-412.

J. G. BUTCHER.

- 1877 Quaternion forms of some general propositions in fluid motion. Lond. M. S. Proc., **8**, 174-188.

ROBERT CARMICHAEL.

- 1852 Laplace's equation and its analogues. Cambr. and Dublin Math. J., **7**, 126-137.
- 1853 On Laplace's equation and the calculus of quaternions. Dublin Proc., **6**, 216-220.
- 1853 Laplace's equation, its analogues, and the calculus of imaginaries. Phil. Mag., **6**, 273-284.
- 1857 Laplace's equation and the calculus of quaternions. Quart. J., **1**, 227-230.

B. CARRARA.

- 1892 Saggio d'introduzione alla teoria delle quantita complesse geometricamente rappresentate. Cremona: Fezzi.

U. CARSTENS.

- 1900-1 Om multiplication. Nyt. Tidss. for Math., **11A**, 47.

EMMANUEL CARVALLO.

- 1887 Exposition d'une méthode de M. Caspary pour l'étude des courbes gauches. *S. M. F. Bull.*, **15**, 158-166.
- 1890 Formules de quaternions pour la réduction des intégrales multiples les unes dans les autres. *S. M. F. Bull.*, **18**, 80-90.
- 1891 Sur les systèmes linéaires, le calcul des symboles différentiels et leur application à la physique mathématique. *Monatsh. f. Math.*, **2**, 177-216, 225-266, and 311-330.
- 1891 Sur une généralisation du théorème des projections. *Nouv. Ann.*, (3), **10**, 345-347.
- 1891 Théorie des déterminants; multiplication des déterminants. *Nouv. Ann.*, (3), **10**, 219-224 and 341-345.
- 1892 La méthode de Grassmann. *Nouv. Ann.*, (3), **11**, 8-37.
- 1893 Théorèmes de mécanique. *Nouv. Ann.*, (3), **12**, 65-72.
- 1893 Sur les forces centrales. *Nouv. Ann.* (3), **12**, 228-221.
- 1893 Nouveau théorème de mécanique. *Nouv. Ann.*, (3), **12**, 454-456.
- 1894 Sur les surfaces minima. *Darboux Bull.*, (2), **18**, 12-18.
- 1895 Principe d'Huyghens dans les corps isotropes. *C.R.* **120**, 88-91.
- 1896 Généralisation et extension à l'espace du théorème des résidus de Cauchy. *S. M. F. Bull.*, **24**, 180-184.
- 1898 Théorie du mouvement du monocycle et de la bicyclette. *J. de l'Éc. Pol.* (2), 5<sup>o</sup> et 6<sup>o</sup> cahiers.
- 1902 Conférence sur les notions de calcul géométrique utilisées en mécanique et en physique. *Nouv. Ann.* (4), **2**, 433-442.

FERDINAND CASPARY.

- 1882 Ueber die Umformung gewisser Determinanten welche in der Lehre von den Kegelschnitten vorkommen. *Crelle J.*, **92**, 123-144.
- 1883 Ueber einige Determinanten-Identitäten welche in der Lehre von den perspectivischen Dreiecken vorkommen. *Crelle J.*, **95**, 36-43.
- 1884 Ableitung des Weierstrass'schen Fundamentaltheorems für die Sigmafunction mehrerer Argumente aus den Kroneckerschen Relationen für Subdeterminanten symmetrischer Systeme. *Crelle J.*, **96**, 182-184.

- 1887 Ueber die Erzeugung algebraischer Raumcurven durch veränderliche Figuren. *Crelle J.*, **100**, 405-412.
- 1887 Sur les cubiques gauches. *Darboux Bull.* (2), **11**, 222-236.
- 1887 Bemerkung zu den desmischen Tetraedern. *Math. Ann.*, **29**, 581-582.
- 1889 Sur une méthode générale de la géométrie qui forme le lien entre la géométrie synthétique et la géométrie analytique. *Darboux Bull.* (2), **13**, 202-240.
- 1889 Extrait d'une lettre à M. Hermite. *Journ. de Math.* (4), **5**, 73-79.
- 1898 Applications des méthodes de Grassmann ; Centre de gravité d'un quadrilatère et d'un pentagone. *Nouv. Ann.* (3), **17**, 389-411.
- 1899 Applications des méthodes de Grassmann ; vecteurs dans le plan ; définitions, propriétés. *Nouv. Ann.* (3), **18**, 248-278.

AUGUSTIN LOUIS CAUCHY.

- 1847 Exercices d'analyse et de physique mathématique, **4**, p. 84.
- 1849 Sur les quantités géométriques. *C. R.*, **29**, 250-257.
- 1853 Sur les clefs algébriques. *C. R.*, **36**, 70-75, and 129-136.
- 1853 Sur la théorie des moments linéaires et sur les moments linéaires des divers ordres. *C. R.*, **36**, 75-81.
- 1853 Sur les avantages que présente, dans un grand nombre de questions, l'emploi des clefs algébriques. *C. R.*, **36**, 161-169.
- 1853 Mémoire sur les différentielles et les variations employées comme clefs algébriques. *C. R.*, **37**, 38-45, and 57-68.

ARTHUR CAYLEY.

- 1845 On certain results relating to Quaternions. *Phil. Mag.*, **26**, 141-145. *M. P.*, **1**, 123-126.
- 1845 On Jacobi's elliptic functions, in reply to the Rev. B. Bronwin ; and on Quaternions. *Phil. Mag.*, **26**, 208-211. *M. P.*, **1**, 127.
- 1845 On algebraical couples. *Phil. Mag.*, **27**, 38-40. *M. P.*, **1**, 128-131.
- 1847 Note on a system of imaginaries. *Phil. Mag.*, **30**, 257-258. *M. P.*, **1**, 301.

- 1848 On the application of Quaternions to the theory of rotation. Phil. Mag., **33**, 196-200. M. P., **1**, 405-409.
- 1858 A memoir on the theory of matrices. Lond. Phil. Trans., **148**, 17-37. M. P., **2**, 475-496.
- 1859 A sixth memoir on quantities. Lond. Phil. Trans., **149**, 61-90. M. P., **2**, 561-592.
- 1864 On the notion and boundaries of algebra. Quart. J., **6**, 382-384. M. P., **5**, 292-294.
- 1866 A supplementary memoir on the theory of matrices. Lond. Phil. Trans., **156**, 25-35. M. P., **5**, 438-448.
- 1866-9 On the logarithms of imaginary quantities. Lond. M. S. Proc., **2**, 50-54. M. P., **6**, 14-18.
- 1878 On the geometrical representation of imaginary variables by a real correspondence of two planes. Lond. M. S. Proc., **9**, 81-89. M. P., **10**, 316-323.
- 1879 On the correspondence of homographies and rotations. Math. Ann., **15**, 238-240.
- 1881 A geometrical construction relating to imaginary quantities. Messenger, **10**, 1-8. M. P., **11**, 258.
- 1881 On the 8-square imaginaries. American J., **4**, 293-296. M. P., **11**, 363-371.
- 1882 On associative imaginaries. Johns Hopkins Univ. Circ., No. 15, 211-212. M. P., **12**, 105-106.
- 1883 The progress of pure mathematics. President's address at Southport. Brit. Assoc. Rep.
- 1884 On double algebra. Lond. M. S. Proc., **15**, 185-197. M. P. **12**, 60-71.
- 1885 On the quaternion equation  $q Q - Qq' = 0$ . Messenger, **14**, 108-112. M. P., **12**, 300-304.
- 1885 On the matricial equation  $q Q - Qq' = 0$ . Messenger, **14**, 176-178. M. P., **12**, 311-313.
- 1887 On multiple algebra. Quart. J., **22**, 270-303. M. P., **12**, 459-489.
- 1889-98 Collected Mathematical Papers. 13 vols. and index. Cambridge University Press. 4°.
- 1890 Tait's Treatise on Quaternions, 3<sup>o</sup> edition. Chap. IV. Sketch of the analytical theory of quaternions. 146-159.

1895 Coordinates *versus* quaternions. Edinb. Proc., **20**, 271-275.  
M. P., **13**, 541-544.

ERNEST CESÀRO.

1894 I numeri di Grassmann in geometria intrinseca. Rom. Acc.  
L. Rend., (5) **3**, 367-371.

ARNOLD BUFFUM CHACE.

1879 A certain class of cubic surfaces treated by quaternions.  
American J., **2**, 315-323.

CHARLES HIRAM CHAPMAN.

1888 On some applications of the units of an  $n$ -fold space.  
American J., **10**, 225-242.

1891 On the matrix which represents a vector. American J., **13**,  
363-380.

1891-2 Weierstrass and Dedekind on general complex numbers.  
American M. S. Bull., (1), **1**, 150-156.

1892 Application of quaternions to projective geometry. American  
J., **14**, 115-140.

1895 Fundamental theorems in quaternions. Univ. of Oregon  
Bull., **2**, 11-12.

ALEXANDER SMYTH CHRISTIE.

1880 Criticism of de Volson Wood's exposition of quaternions.  
Analyst, **7**, 185-188.

1891 What is a quaternion? Washington Bull., **11**, 579-580.

GEORGE CRYSTAL.

1901 Obituary notice of Professor Tait. Nature, **64**, 305-307.

LAURO CLARIANA Y RICART.

1890 Sobre el espíritu de las matemáticas en los tiempos modernos.  
Barcelona. 8 pp.

1894 Desarrollo de la matemática pura en los tiempos modernos.  
Barcelona. 26 pp.

1903 Conceptos fundamentales de Análisis matemática. Barcelona:  
Juan Gili, 192 pp.

RUDOLF FRIEDRICH ALFRED CLEBSCH.

1872 Zum Gedächtniss an J. Plücker. Gött. Abh., **15**.

## WILLIAM KINGDON CLIFFORD.

- 1873 Preliminary sketch of biquaternions. Lond. M. S. Proc., 4, 381-395. M. P., 181-200.
- 1876 On the classification of geometric algebras. Abstract in Lond. M. S. Proc., 7, 135. M. P., 397-401.
- 1876 On the theory of screws in a space of constant positive curvature. M. P., 402-405.
- 1876 Further note on biquaternions. M. P., 385-395.
- 1876 On the free motion under no forces of a rigid system in an  $n$ -fold homaloid. Lond. M. S. Proc., 7, 67-70. M. P., 286-240.
- 1876 Motion of a solid in elliptic space. M. P., 373-384.
- 1877 Notes of lectures on Quaternions delivered at University College, London: notes by Miss Watson. M. P., 478-515.
- 1878 Applications of Grassmann's extensive algebra. American J., 1, 350-358. M. P., 266-276.
- 1878 Elements of Dynamic: an introduction to the study of motion and rest in solid and fluid bodies. Part I. Kinematic: Books I, II, III. London: Macmillan. 8 + 221. 8°.
- †1882 Mathematical Papers. Edited by Robert Tucker; with an introduction by H. J. S. Smith. London: Macmillan. 70 + 658. 8°.
- †1885 The Common Sense of the Exact Sciences. Edited and completed by Karl Pearson. (The International Scientific Series.) London: Keegan Paul. 13 + 271. 12°.
- †1887 Elements of Dynamic: an introduction to the study of motion and rest in solid and fluid bodies. Part I. Kinematic: Book IV and Appendix. Edited by R. Tucker. 9 + 120. 8°.

## SIR JAMES COCKLE.

- 1848 On certain functions resembling Quaternions, and on a new imaginary in algebra. Phil. Mag., (3), 33, 435-439.
- 1849 On a new imaginary in algebra. Phil. Mag., (3), 34, 37-47.
- 1849 On the symbols of algebra, and on the theory of tessarines. Phil. Mag. (3), 34, 406-410.

- 1849 On systems of algebra involving more than one imaginary, and on equations of the fifth degree. *Phil. Mag.*, (8), **35**, 484-487.
- 1850 On the true amplitude of a tessarine. *Phil. Mag.*, (8), **36**, 290-292.
- 1850 On impossible equations, on impossible quantities, and on tessarines. *Phil. Mag.*, (8), **37**, 281-288.

ARTHUR COHEN.

- 1882 On the differential coefficients and determinants of lines, and their application to analytical mechanics. *Lond. Phil. Trans.*, **182**, 469-510.

JOSEPH V. COLLINS.

- 1899 Note on Grassmann's proof that there can be but two kinds of lineal multiplication of two factors. *American Assoc. Proc.*, **48**, 69-71.
- 1899 A relation between point and vector analysis. *American M. S. Bull.*, (2), **6**, 6-7.
- 1899-1900 An elementary exposition of Grassmann's "Ausdehnungslehre." *American Math. Monthly*, **6**, 198-198, 261-266, and 297-301; **7**, 81-85, 168-166, 181-187, 207-214, and 253-258.
- 1901 Reprint of the above. Springfield, Missouri. 46 pp. 8°.
- 1902 A general notation for vector-analysis. *American M. S. Bull.*, (2), **9**, 74-78.

GASTON COMBEBIAC.

- 1898 Sur l'application du calcul des biquaternions à la géométrie plane. *S. M. F. Bull.*, **26**, 259-263.
- 1899 Calcul des triquaternions. *S. M. F. Bull.*, **27**, 180-194.
- 1902 Calcul des triquaternions (nouvelle analyse géométrique). Thèse. Paris: Gauthier-Villars. 122 pp. 4°.
- 1908 Sur un système numérique complexe représentant le groupe des transformations conformes de l'espace. *S. M. F. Bull.*

CHARLES WORTHINGTON COMSTOCK.

- 1901 The application of quaternions to the analysis of internal stress. Thesis. Denver, Colorado. 84 pp. 8°.



. LOUIS COUTURAT.

1901 La Logique de Leibniz. Appendix V., Sur le calcul géométrique de Grassmann. Paris : Alcan., 14 + 408.

HOMERSHAM COX.

1882 On the application of quaternions and Grassmann's "Ausdehnungslehre" to different kinds of uniform space. Cambr. Trans., 13, 68-148. Cambr. Proc., 4, 194-196.

1888 On systems of circles and bicircular quartics. Quart. J., 19, 74-124.

1891 Application of Grassmann's "Ausdehnungslehre" to properties of circles. Quart. J., 25, 1-71.

LUIGI CREMONA.

1860 Méthode Grassmann et propriété de la cubique gauche. Nouv. Ann., 19, 856-861.

P. CURIE.

1894 Sur la symétrie dans les phénomènes physiques, symétrie d'un champ électrique et d'un champ magnétique. Journ. de Phys., (8), 3, 393—

1900 Procès-verbaux sommaires du Congrès international de physique. Paris : p. 17.

M. F. DANIELS.

1900 Ueber die Derivirte eines Vectors. Schlömilch Z., 45, 203-215.

1901 Sur un système de coordonnées sphériques homogènes. Brux. S. Sc., 25.

1902 Sur le calcul des quaternions. Ens. Math., 3.

1908 Analytische Sphärik in homogenen Coordinaten. Hoppe Arch.

AUGUST JULIEVICH DAVIDOV.

1867 Demonstration élémentaire de la formule

$$e^{mx-1} = \cos mx + \sqrt{-1} \sin mx.$$

S. M. F. Bull., 2, 20-25:

RICHARD DEDEKIND.

1885-7 Theorie der aus  $n$ -Haupteinheiten gebildeten complexen Grössen. Gött. Nachr., 141-159 and 1-7.

1897 Ueber Gruppen, deren sämtliche Theile Normaltheile sind. Math. Ann., 48, 549-561.

ALPHONSE DEMOULIN.

- 1894 Application d'une méthode vectorielle à l'étude de divers systèmes de droites. Bruxelles: Castaigne. Paris: Nony. 6 + 118.

AUGUSTUS DE MORGAN.

- 1842-9 On the foundation of algebra. *Cambr. Trans.*, **7**, 173-188 and 287-300; **8**, 139-142 and 241-254.  
1849 Trigonometry and Double Algebra. London: Taylor & Co. 11 + 167. 8°.

DE CHANCOURTOIS.

- 1869 De l'interprétation des imaginaires en physique mathématique. *C. R.*, **68**, 127-131.

J. G. DARBOUX.

- 1873 Sur une classe remarquable de courbes et de surfaces algébriques et sur la théorie des imaginaires. Paris: Gauthier-Villars. 340 pp.

SAMUEL DICKSTEIN.

- 1875 Beweis eines Satzes aus der Theorie der formalen Operationen. *Grunert Arch.*, **57**, 420-421.  
1875 Theory of the complex numbers and their functions (Polish). In conjunction with K. Hertz. Paris. 60 pp. 4°.  
1879 Hermann Grassmann. Warsaw. 13 pp. 8°.  
1891 Pojęcia i metody matematyki. (Mathematical concepts and methods). Chap. vi. Methods of Grassmann's Ausdehnungslehre, 151-171; Quaternions and vector-analysis, 171-183. Warsaw. 8°.  
1895 Polish translation of Schlegel's "Die Grassmann'sche Ausdehnungslehre."  
1897 Polish translation of Peano's "Saggio di calcolo geometrico." Warsaw. 32 pp. 8°.

GÖRAN DILLNER.

- 1860 Geometrical Calculus (Swedish). Upsala.  
1877 Versuch einer neuen Entwicklung der Hamilton'schen Methode, genannt "Calculus of Quaternions." *Math. Ann.*, **11**, 168-193.

FRIEDRICH DINGELDEY.

- 1885 Ueber die Erzeugung von Curven vierter Ordnung durch Bewegungs-Mechanismen. Diss. Leipzig. 8°.  
1886 Ueber Curven dritter Ordnung mit Doppelpunkt. Math. Ann., 27, 272-276.  
1887 Zur Construction der Hesse'schen Curve der rationalen Curven dritter Ordnung. Math. Ann., 28, 81-83.

ALFRED CARDEW DIXON.

- 1902 On the geometrical interpretation of a quaternion. Quart. J., 33, 271-273.

LUIGI DONATI.

- 1897 Appunti di analisi vettoriale. Bologna. 26 pp. 4°.  
1898 Sulle proprietà caratteristiche dei campi vettoriali. Bologna. 45 pp. 4°.

WILLIAM FISHBURN DONKIN.

- 1850 On the geometrical interpretation of quaternions. Phil. Mag., (3), 36, 489-503.

M. W. DROBISCH.

- 1848 Ueber die geometrische Construction der imaginären Grössen. B. G. Z., Leipzig, Ber. 2, 171-179.

H. DUPORT.

- 1879 Sur une nouvelle représentation des quantités imaginaires. C. R., 88, 1071-1073.  
1880 Sur une mode particulier de représentation des imaginaires. Ann. de l'Ec. Norm., (2), 9, 301-362.

WALTHER DYCK.

- 1882 Gruppentheoretische Studien. Math. Ann., 20, 1-44.

HENRY TURNER EDDY.

- 1902 On the complex product of electromotive force, current, and other vectors. American Assoc. Proc.  
1885 Question 6662. Ed. Times, 43, 186-187.

B. ÉLIE.

- 1892 La fonction vectorielle et ses applications à la physique. Bordeaux Mém., (4), 3, 1-187.

L. VAN ELFRINKHOF.

- 1892 De oplossing van lineaire vector-vergelijkingen in bijzondere gevallen. Nieuw Archief, 19, 132-142.
- 1892 Opmerkingen naar aanleiding der verhandelingen over quaternion-matrices, van den Heer Th. B. van Wettum, in het Nieuw Archief, deel 17 and 18. Nieuw Archief, 19, 143-150.
- 1894 De vergelijking  $V\rho\phi\rho = 0$ . Nieuw Archief, (2), 1, 76-87.
- 1894 Draaiings-matrices en quaternions. Nieuw Archief, (2), 1, 88-100.
- 1897 Eene eigenschap van de orthogonale substitutie van de vierde orde. Trans. Netherland Congress, 237-240.

E. B. ELLIOTT.

- 1887 The quotients of space-directed lines. Washington Bull., 10, 105-107.

FRTZ EMDE.

- 1901 Graphische Zusammensetzung der Felder und der Erregungen. Elektrot. Z., 22, 771.

LEOPOLD VAN EMELLEN.

- 1901 Note sur l'emploi du symbole  $I_3$  dans la recherche des formules trigonométriques. L'Enseignement Math., 3, 210-215.

FRIEDRICH ENGEL.

- 1894 Hermann Grassmann's gesammelte mathematische und physikalische Werke. Herausgegeben von Friedrich Engel. Leipzig: Teubner. 8°.

EDMUND ARTHUR ENGLER.

- 1878 Relations between three intersecting tangents to the parabola. In conjunction with M. L. Holman. American J., 1, 879-888.

GUSTAV VON ESCHERICH.

- 1880 Die Determinanten höheren Ranges und ihre Verwendung zur Bildung von Invarianten. Wien Ber., 83, 1-2.

1882 Die Construction der algebraischen Flächen aus der Anzahl der sie bestimmenden Punkte mittelst reciproker Flächenbündel. Wien. Ber., **85**, 526–533.

1882 Die Construction der algebraischen Curven und Flächen aus der Anzahl sie bestimmender Punkte mittelst reciproker linearer Systemehöherer Stufe. Wien. Ber., **85**, 898–906.

JOSEPH DAVID EVERETT.

1874 On a new method in Statics and Kinematics. Messenger, (2), No. 39. 22 pp.

1875 On a new method in Statics and Kinematics. Part II. Further development of the theory of linear relations between motors. Messenger, (2), No. 45. 11 pp.

1875 On a new method in Statics and Kinematics. Part III. Motor multiplication, or successive motor operations. Messenger, (2), No. 53. 12 pp.

J. EVERARD.

1892 Mémoire sur l'interprétation des symboles dites imaginaires, Paris: Baudry et Cie. 103–118.

FAURE.

1845 Essai sur la théorie et l'interprétation des quantités dites imaginaires. Paris: Bachelier.

ANTONIO FAVARO.

1878 Della vita e degli scritti fisico-matematici di Ermanno Grassmann. Bulletino di bibliografia e di storia delle scienze matematiche e fisiche, **11**, 699–756.

1881 Justus Bellavitis: eine Skizze seines Lebens und wissenschaftlichen Wirkens. Schlömilch Z., **26**, pt. 2, 153–169.

1888 Intorno ad alcune applicazioni del metodo delle equipollenze. Ven. Ist. Atti., **6**.

HENRI FÉRR.

1895 Sur l'emploi de la multiplication extérieure en algèbre. Nouv. Ann., (3), **14**, 74–79.

1899 Application de la méthode vectorielle de Grassmann à la géométrie infinitésimale. Thèse. Paris: Carré et Naud. 96 pp. 8°.

FERRER.

- 1899 Sur un symbole analogue aux déterminants. S. M. F. Bull., 27, 285-288.  
1900 Application du symbole des déterminants positifs. S. M. F. Bull., 28, 128-180.

GALILEO FERRARIS.

- †1897 Teoria geometrica dei campi vettoriali: come introduzione allo studio della elettricità, del magnetismo, &c. Edited by C. Segre. Torino Mem., (2), 47, 259-338.  
†1901 Wissenschaftliche Grundlagen der Elektrotechnik. Deutsch von Leo Finzi. Leipzig: Teubner. 12 + 358. 8°.

HENRY BURCHARD FINE.

- 1886 On the singularities of curves of double curvature. American J., 8, 156-177.  
1886 A theorem respecting the singularities of curves of multiple curvature. American J., 9, 180-184.  
1890 The number-system of algebra; treated theoretically and historically. Boston. 9 + 181.

LEO FINZI.

- 1901 Wissenschaftliche Grundlagen der Elektrotechnik von Galileo Ferraris. Deutsch von Leo Finzi. Leipzig: Teubner. 12 + 358. 8°.

VICTOR FISCHER.

- 1901 Eine Anwendung der Quaternionentheorie auf die thermodynamischen Gleichungen. Crelle J., 124, 98-101.

GEORGE FRANCIS FITZGERALD.

- 1880 On the electromagnetic theory of the reflection and refraction of light. Lond. Phil. Trans., 171, 691-711. S. W., 45-78.  
1882 On electromagnetic effects due to the motion of the earth. Dublin, R. S. Trans., (2), 1. S. W., 111-118.  
1898 Review of Heaviside's "Electrical Papers." Lond.: Electrician, 31, 889-890. S. W., 292-300.

- 1899 On a hydrodynamical hypothesis as to electromagnetic actions. Dublin, R. S. Proc. S. W., 472-477.  
†1902 Scientific Writings: edited by Joseph Larmor. Dublin University Press. 64 + 576.

AUGUST FÖPPL.

- 1894 Einführung in die Maxwell'sche Theorie der Electricität. Mit einem einleitenden Abschnitte über das Rechnen mit Vectorgrößen in der Physik. Leipzig: Teubner. 16 + 418. gr. 8°.  
1897 Die Geometrie der Wilbelfelder. Leipzig: Teubner. 10 + 108. gr. 8°.  
1897-1900 Vorlesungen über technische Mechanik. 4 Bände. Leipzig: Teubner. gr. 8°.  
1902 Lösung des Kreiselpblems mit Hilfe der Vektoren-Rechnung. Schlömilch Z., 48, 272-284.

A. ARZILLA DA FONSECA.

- 1884 Principios elementares do calculo dos quaterniões. Coimbra.  
1885 Applicaçāo dos quaterniões á mecanica. Coimbra.

DAVIET DE FONCENEX.

- 1759 Reflexions sur les quantités imaginaires. Mélanges de Turin, 1, 118-146.

G. FONTENÉ.

- 1898 Un théorème sur des vecteurs relatifs à un tétraèdre. Nouv. Ann., (8), 17, 840, and 19, 379-380.  
1899 Sur des angles résultants. Nouv. Ann., (8), 18, 407-419.  
1899 Sur un système de sept clefs. S. M. F. Bull., 27, 171-180.  
1899 Sur l'enseignement de la théorie des vecteurs. L'Enseignement Math., 1, 50-52.

C. FORMENTI.

- 1888-4 Sui numeri irriducibili coi numeri complessi. Lomb. Ist. Rend., (2), 16, 981-988, and 17, 6-11.

U. FURNARI.

- 1900-1 Elementi di calcolo vettoriale. Periodico di Mat., Suppl., 4, 38-35, 49-58.

ANDREW RUSSELL FORSYTH.

- 1890 Theory of differential equations. Part 1., Chapter v., Grassmann's investigation of Pfaff's problem. Cambridge University Press. 8°.

J. F. FRANÇAIS.

- 1818 Nouveaux principes de géométrie de position, et interprétation géométrique des symboles imaginaires. Gergonne Ann., 4, 61-71.
- 1818 Lettre au Rédacteur : Sur la théorie des quantités imaginaires. Gergonne Ann., 4, 222-235.
- 1814 Lettre au Rédacteur. Gergonne Ann., 4, 364-367.

G. FREGÉ.

- 1873 Ueber eine geometrische Darstellung der imaginären Gebilde in der Ebene. Jena. 8°.

FRITZ.

- 1889 Ueber die erste Grassmann'sche Erzeugungsweise der ebenen Curven dritter Ordnung und deren Analogon im Baum. Pr. Darmstadt.

F. G. FROBENIUS.

- 1878 Ueber lineare Substitutionen und bilineare Formen. Crelle J., 84, 1-68.

ZOEL GARCIA DE GALDEANO.

- 1888 Critica y sintesis del algebra. Toledo. 126 pp. 8°.
- 1892-4 Teoremas problemas y métodos geometricos. El Progreso Matematico.
- 1893 Nota sobre las cantidades imaginarias. M. S. F. Bull., 3, 160-162.
- 1894 El concepto del imaginarismo en la ciencia matematica. Zaragoza. 3 pp. 8°.
- 1896 Las modernas generalizaciones del algebra simbolica y las geometrias no-euclideas. Madrid. 142 pp. 8°.
- 1900 Estudios de Critica y Pedagogia matematicas. Zaragoza. 152 pp. 4°.

CH. GALOPIN-SCHAUB.

- 1896 Premières notions du calcul des quaternions. Paris: Gauthier-Villars. 68 pp. 8°.



M. GARDINER.

- 1869 On the inscription, by a simplification of Sir W. R. Hamilton's process of reduction, of closed  $n$ -gons in any quadric, so that the sides of each shall pass in order through  $n$  given points. Lond. M. S. Proc., 2, 68-66.

CARL FRIEDRICH GAUSS.

- 1881 *Theoria residuorum biquadraticorum*; commentatio secunda. Göttingen gelehrte Anzeigen. G. W., 2, 169-178.  
1882 *Theoria residuorum biquadraticorum*; commentatio secunda. Gött. Abh. 7—. G. W., 2, 95-148.  
† Geometrische Seite der ternären Formen. G. W., 2, 305-310.  
1870 *Gesammelte Werke*. Herausgegeben von der königlichen Gesellschaft der Wissenschaften zu Göttingen. 10 vols. 4°.

ROBERT WILLIAM GENESE.

- 1898 Grassmann's Ausdehnungslehre. Nature, 48, 517.  
1894 Sur l'enseignement des méthodes de Grassmann. Assoc. Franç., 23, 210-216.

E. GENTY.

- 1881 Études sur les courbes gauches unicursales. S. M. F. Bull., 9, 115-162.  
1881 Applications mécaniques du calcul des quaternions. Journ. de Math., (3), 7, 49-70.  
1882 Mémoire de géométrie vectorielle sur les complexes du second ordre qui ont un centre de figure. Journ. de Math., (3), 8, 299-334.  
1898 Solution par la géométrie vectorielle du problème de mathématiques spéciales. Nouv. Ann., (3), 12, 99-106.  
1894 Note sur des couples de surfaces applicables. S. M. F. Bull., 22.  
1881 Études sur les courbes gauches unicursales. S. M. F. Bull., 9, 115-162.

JOSIAH WILLARD GIBBS.

- 1881-4 *Elements of Vector-analysis*; arranged for the use of students in physics. (Not published.) New Haven. 83 pp. 8°.

- 1886 On multiple algebra. Vice-presidential address. American Assoc. Proc., **35**, 87-86.
- 1889 On the determination of elliptic orbits from three complete observations. American National Acad. Memoirs, **4**, 79-104.
- 1891 On the rôle of quaternions in the algebra of vectors. Nature, **43**, 511-518.
- 1891 Quaternions and the Ausdehnungslehre. Nature, **44**, 79-82.
- 1898 Quaternions and vector-analysis. Nature, **47**, 463-465, and **48**, 364-367.
- 1902 Vector-analysis: founded upon the lectures of J. Willard Gibbs, by E. B. Wilson. New York: Scribners. 18 + 486. 8°.

PAUL GLAN.

- 1881-4 Elemente der Quaternionen von W. R. Hamilton. Deutsch von P. Glan. Bd. I., 24 + 746; Bd. II., 78 + 486. Leipzig: Barth. gr. 8°.
- 1895-6 Theoretische Untersuchungen über elastische Körper. Annalen der Physik und Chemie. Neue Folge, **55**, **56**, **57**.

HARVEY GOODWIN.

- 1849 On the pure science of magnitude and direction. Camb. Trans., **8**, 278-286.

W. C. L. GORTON.

- 1888 Line congruences. American J., **10**, 347-367.
- 1891 Rays normal to surfaces. American J., **13**, 173-178.

FRIEDRICH GRAEFE.

- 1882 Einige Sätze über abwickelbare Flächen abgeleitet mit Hilfe der Quaternionen. Grunert Arch., (1), **69**, 1-18.
- 1888 Vorlesungen über die Theorie der Quaternionen mit Anwendung auf die allgemeine Theorie der Flächen und der Linien doppelter Krümmung. Leipzig: Teubner. 164 pp. 8°.
- 1896 Strecken- und Punktrechnung, insbesondere die Rechnung mit parallelen Strecken (Quaternionen Hamiltons und Unverzagts). Grunert Arch., (2), **15**, 94-116.

## HERMANN GRASSMANN.

- 1842-3 Theorie der Centralen. Crelle J., **24**, 262-282 and 372-380; **25**, 57-73.
- 1844 Die lineale Ausdehnungslehre: ein neuer Zweig der Mathematik, dargestellt und durch Anwendungen auf die übrigen Zweige der Mathematik, wie auch auf die Statik, Mechanik, die Lehre von Magnetismus und der Krystallonomie erläutert. Leipzig: Wigand. 2nd edition in 1878. G. W., **1**, Theil 1, 1-320.
- 1845 Ueber die Wissenschaft der extensiven Grösse oder die Ausdehnungslehre. Grunert Arch., **6**, 337-350.
- 1845 Neue Theorie der Electrodynamik. Pogg. Ann., **64**, 1-17. G. W., **2**, Theil 2, 147-160.
- 1846 Grundzüge zu einer rein geometrischen Theorie der Curven, mit Anwendung einer rein geometrischen Analyse. Crelle J., **31**, 111-132.
- 1847 Geometrische Analyse, geknüpft an die von Leibniz erfundene geometrische Charakteristik. Gekrönte Preisschrift. Mit einer erläuternden Abhandlung von A. F. Möbius. Leipzig: Wiedmann. G. W., **1**, Theil 1, 321-399.
- 1848 Ueber die Erzeugung der Curven dritter Ordnung durch gerade Linien, und über geometrische Definitionen dieser Curven. Crelle J., **36**, 177-182.
- 1852 Der allgemeine Satz über die Erzeugung aller algebraischen Curven durch Bewegung gerader Linien. Crelle J., **42**, 187-192.
- 1852 Die höhere Projectivität und Perspectivität in der Ebene; dargestellt durch geometrische Analyse. Crelle J., **42**, 193-203.
- 1852 Die höhere Projectivität in der Ebene, dargestellt durch Functionsverknüpfungen. Crelle J., **42**, 204-212.
- 1852 Erzeugung der Curven vierter Ordnung durch Bewegung gerader Linien. Crelle J., **44**, 1-25.
- 1853 Zur Theorie der Farbenmischung. Pogg. Ann. **89**, 69-84. G. W., **2**, Theil 2, 161-173.
- 1854 On the theory of compound colours. Phil. Mag., **7**, 254-264.

- 1854 Extrait d'un Mémoire. Réclamation de priorité au sujet d'articles de M. Cauchy sur les clefs algébriques, et de M. B. de Saint-Venant sur l'interprétation des clefs algébriques et des déterminants. C. R., 38, 748-744.
- 1855 Allgemeiner Satz über die lineale Erzeugung aller algebraischen Oberflächen. Crelle J., 49, 1-9.
- 1855 Grundsätze der stereometrischen Multiplication. Crelle J., 49, 10-20.
- 1855 Ueber die verschiedenen Arten der linealen Erzeugung algebraischer Oberflächen. Crelle J., 49, 21-86.
- 1855 Die stereometrische Gleichung zweiten Grades, und die dadurch dargestellten Oberflächen. Crelle J., 49, 87-46.
- 1855 Die stereometrischen Gleichungen dritten Grades, und die dadurch erzeugten Oberflächen. Crelle J., 49, 47-65.
- 1855 Sur les différens genres de multiplication. Crelle J., 49, 128-141.
- 1856 Die lineale Erzeugung von Curven dritter Ordnung. Crelle J., 52, 254-275.
- 1862 Die Ausdehnungslehre; vollständig und in strenger Form bearbeitet. Berlin: Enslin. G. W., 1, Theil 2. 512 pp.
- 1867 Grundriss der Mechanik; für den Unterricht in Prima. Pr.: Stettin. G. W., 2, Theil 2, 8-45.
- 1869 Bildung rationaler Dreiecke. Angenäherte Construction von  $\pi$ . Grunert Arch., 49, 1-8.
- 1869 Lösung der Gleichung  $x^3 + y^3 + z^3 + w^3 = 0$  in ganzen Zahlen. Grunert Arch., 49, 49-50.
- 1870 Elementare Auflösung der allgemeinen Gleichung vierten Grades. Grunert Arch., 51, 98-96.
- 1872 Zur Theorie der Curven dritter Ordnung. Gött. Nachr., 505-509.
- 1872 Ueber zusammengehörige Pole und ihre Darstellung durch Producte. Gött. Nachr., 567-576.
- 1874 Die neuere Algebra und die Ausdehnungslehre. Math. Ann. 7, 538-548.
- 1877 Zur Electrodynamik. Crelle J., 83, 57-64. G. W., 2, Theil 2, 208-212.

- 1877 Die Mechanik nach den Principien der Ausdehnungslehre. *Math. Ann.*, **12**, 222–240. *G. W.*, **2**, Theil 2, 46–72.
- 1877 Der Ort der Hamilton'schen Quaternionen in der Ausdehnungslehre. *Math. Ann.*, **12**, 375–386.
- 1877 Bemerkungen zur Theorie der Farbenempfindungen. Anhang zu W. Preyer's Elementen der reinen Empfindungslehre. Jena: Dufft. 85–93. *G. W.*, **2**, Theil 2, 213–221.
- 1877 Ueber die physikalische Natur der Sprachlaute. *Wiedemann's Ann.*, **1**, 606–629. *G. W.*, **2**, Theil 2, 222–240.
- †1878 Verwendung der Ausdehnungslehre für die allgemeine Theorie der Polaren und den Zusammenhang algebraischer Gebilde. *Crelle J.*, **84**, 273–283.
- †1878 Die Ausdehnungslehre von 1844. Second edition, with preface and three appendices: 1° Ueber das Verhältniss der nichteuklidischen Geometrie zur Ausdehnungslehre. 273–275. 2° Ueber das eingewandte Product. 275–277. 3° Uebersicht über das Wesen der Ausdehnungslehre (aus Grunert Arch.). 277–293. Leipzig: Wigand. 84 + 801. 8°.
- 1880 Hermann Grassmann: sein Leben und seine mathematisch-physikalischen Arbeiten. R. Sturm, E. Schröder und L. Sohncke. *Math. Ann.*, **14**, 1–45.
- 1878 Hermann Grassmann: ein Nekrolog. F. Junghaus. *Schlömilch Z.*, **23**, pt. 2, 69–75.
- 1894—Gesammelte mathematische und physikalische Werke. Herausgegeben von Friedrich Engel. 1° Band, 1° Theil: unter der Mitwirkung von Eduard Study. Die Ausdehnungslehre von 1844, pp. 1–320; Geometrische Analyse, pp. 321–425. 2° Theil: in Gemeinschaft mit Hermann Grassmann dem Jüngeren. Die Ausdehnungslehre von 1862. 2° Band, 2° Theil: herausgegeben von Jacob Lüroth and Friedrich Engel. Die Abhandlungen zur Mechanik und zur mathematischen Physik. Leipzig: Teubner. 8°.

HERMANN GRASSMANN, JR.

- 1886-98 Anwendung der Ausdehnungslehre auf die allgemeine Theorie der Raumkurven und krummen Flächen. Erster Teil: Raumkurven, 1-25. Zweiter Teil: Krumme Flächen, 26-58. Dritter Teil: Krumme Flächen, 59-92. Halle a. S.: Waisenhaus. 4°.
- 1894-8 Punktrechnung und projektive Geometrie. Erster Teil: Punktrechnung, 1-28. Zweiter Teil: Grundlagen der projektiven Geometrie, 29-58. Dritter Teil: Die linearen Verwandtschaften in der Ebene, 59-120. Halle a. S.: Waisenhaus. 4°.
- 1896 Die Ausdehnungslehre von 1862. Herausgegeben von Friedrich Engel in Gemeinschaft mit Hermann Grassmann, jr. G. W., 1° Band, 2° Theil. Leipzig: Teubner. 8 + 506 pp. 8°.
- 1899 Schraubenrechnung und Nullsystem. Halle a. S.: Waisenhaus. 20 pp. 4°.

ROBERT GRASSMANN.

- 1891 Formelbuch der Ausdehnungslehre. Stettin. 14 pp.
- 1891 Die Ausdehnungslehre oder die Wissenschaft von den extensiven Grössen in strenger Formelentwicklung. Stettin. 7 + 270 pp. 8°.

CHARLES GRAVES (Bishop of Limerick).

- 1847 On algebraic triplets. Dublin Proc., 3, 51-54, 57-64, 80-84, 105-108.
- 1849 On a system of triple algebra and its application to the geometry of three dimensions. Phil. Mag., 34, 119-126.
- 1850 A general theorem in the calculus of quaternions. Dublin Proc., 4, 347-348.
- 1853 On a formula containing a symbol which denotes rotation through a given angle and round a given axis by means of rectangular coordinates and differential coefficients. Dublin Proc., 5, 140-141.
- 1853 On the properties of the functions of two variables employed in the interpretation of triplets. Dublin Proc., 5, 423-429.

1855 On the solution of the equation of Laplace's functions.  
Dublin Proc., 6, 162-171, 186-194, 221-228.

1856 Development of a function of a quaternion. Dublin Proc.  
6, 885-887.

JOHN THOMAS GRAVES.

1829 An attempt to rectify the inaccuracy of some logarithmic  
formulæ. Lond. Phil. Trans., 171-186.

1884 On the theory of exponential functions. Brit. Assoc. Rep.,  
523-581.

1847 On a theorem respecting products of sums of eight squares.  
Dublin Proc., 3, 527-580.

ROBERT PERCEVAL GRAVES.

1882-9 Life of Sir William Rowan Hamilton ; including selections  
from his poems, correspondence, and miscellaneous writ-  
ings. Dublin : University Press. 3 volumes. 8°.

DUNCAN FARQUHARSON GREGORY.

1888 On the real nature of symbolical algebra. Edinb. Trans., 14,  
208-216. C. P., 1-18.

1889 On the existence of branches of curves in several planes.  
Cambr. Math. J., 1, 259-266. C. P., 189-149.

1841 On a difficulty in the theory of algebra. Cambr. Math. J.,  
3, 158-159. C. P., 235-242.

†1865 Mathematical Writings : edited by William Walton. Cam-  
bridge. 24 + 267 pp. 8°.

F. H. GRIESSEMANN.

1900-1 Elementar-Nachweis des Satzes von Frobenius über die  
Ausnahmestellung der Quaternionen unter dem komplexen  
Zahlsystem von mehr als 2 Einheiten. Monatsh. f. Math.,  
11, 182.

P. TH. GRINWIS.

1890 De oplossing van quaternion-vergelijkingen. Diss. Utrecht :  
van Boekhoven. 75 pp. 8°.

R. F. GWYTHER.

1882 Notes on some Quaternion transformations. Manchester  
Mem. (8), 7, 174-177.

JOHN GEORGE HAGEN.

1894 Synopsis der höheren Mathematik. 2° Band: Geometrie der algebraischen Gebilde. 5° Abschnitt: Die Ausdehnungslehre. Berlin: Dames. 4 + 416 pp. 4°.

KUJURO HAKII.

1898 Lectures on Quaternions. Part I. Introductory. In conjunction with S. Kimura. (Japanese.) Tokio. 12 + 117.

SIR WILLIAM ROWAN HAMILTON.

1834 On conjugate functions, or algebraic couples, as tending to illustrate generally the doctrine of imaginary quantities, and as confirming the results of Mr. (J. T.) Graves respecting the existence of two independent integers in the complete expression of an imaginary logarithm. Brit. Assoc. Rep., 519-523.

1837 Theory of conjugate functions, or algebraic couples, with a preliminary and elementary essay on Algebra as the Science of Pure Time. Dublin Trans., 17, 293-422.

1843 On a new species of imaginary quantities connected with a theory of Quaternions. 13th Nov., 1843. Dublin Proc., 2, 424-434.

1844 Additional researches in the theory of Quaternions. Dublin Proc., 3, 1-16.

1845 Theorem derived from Quaternions. Dublin Proc., 3, 109.

1846 On the expression and proof of Pascal's theorem by means of quaternions, and on some other connected subjects. Dublin Proc., 3, 273-292.

1844-50 On Quaternions. Phil. Mag., 25, 10-13, 241-246, 489-495; 26, 220-224; 29, 26-31, 113-122, 326-328; 30, 458-461; 31, 214-219, 278-293, 511-519; 32, 367-374; 33, 58-60; 34, 294-297, 340-343, 425-439; 35, 133-137, 200-204; 36, 305-306. Earlier articles translated in Nouv. Ann., 12, 275-283 (1853).

1844-5 On Quaternions. Brit. Assoc. Rep., p. 2 and p. 3 respectively.

1846-9 On symbolical geometry. Cambr. and Dublin Math. J., 1, 45-57, 137-154, 256-263; 2, 47-52, 180-183, 204-209; 3, 68-84, 220-225; 4, 84-89, 105-118.



- 1847 On two theorems of central forces. *Dublin Proc.*, **3**, 808-809.
- 1847 A new mode of geometrically conceiving and of expressing in symbolical language the Newtonian law of attraction. *Dublin Proc.* **3**, 844-858.
- 1847 On a theorem of hodographic isochronism. *Dublin Proc.*, **3**, 417.
- 1847 A theorem of anhodographic isochronism. *Dublin Proc.*, **3**, 465-466.
- 1847 On the application of the calculus of Quaternions to the theory of the moon. *Dublin Proc.*, **3**, 507-521.
- 1847 Illustration from geometry of the theory of algebraic Quaternions. *Dublin Proc.*, **3**, App., 81-86.
- 1847 On the application of the method of Quaternions to some dynamical questions. *Dublin Proc.*, **3**, App. 86-50.
- 1847 Additional applications of the theory of algebraic Quaternions, *Dublin Proc.*, **3**, App., 51-60.
- 1847 On an isoperimetrical problem treated by the calculus of Quaternions. *Brit. Assoc. Rep.*, 2° part, p. 4.
- 1847 On some applications of the calculus of Quaternions to the theory of the Moon. *Brit. Assoc. Rep.*, 2° part, p. 4.
- 1848 Researches respecting Quaternions. First series. *Dublin Trans.*, **21**, 199-296.
- 1849 Exercises in Quaternions. *Cambr. and Dublin Math. J.*, **4**, 161-168.
- 1849 On some new applications of Quaternions to Geometry. *Brit. Assoc. Rep.*, 2° part, p. 1.
- 1850 On additional applications of Quaternions to surfaces of the second order. *Dublin Proc.*, **4**, 14-19.
- 1850 Application of Quaternions to the rotation of a solid body. *Dublin Proc.*, **4**, 98-56.
- 1850 Application of Quaternions to the determination of the distances of any recently discovered comet or planet from the Earth. *Dublin Proc.*, **4**, 75.
- 1850 On the double mode of generation of an ellipsoid. *Dublin Proc.*, **4**, 178.
- 1850 Additional theorems respecting certain reciprocal surfaces. *Dublin Proc.*, **4**, 192-198.

- 1850 On Quaternions applied to problems respecting the construction of a circle touching three given circles on a sphere, and of a sphere touching four given spheres. *Dublin Proc.*, **4**, 255.
- 1850 On theorems relating to surfaces, obtained by the method of Quaternions. *Dublin Proc.*, **4**, 306-308.
- 1850 On the equation of the ellipsoid. *Dublin Proc.*, **4**, 324-325.
- 1850 On the inscription of certain gauche polygons in surfaces of the second degree. *Dublin Proc.*, **4**, 325-326.
- 1850 On the construction of the ellipsoid by two sliding spheres. *Dublin Proc.*, **4**, 341-342.
- 1850 On a theorem respecting ellipsoids, obtained by the method of Quaternions. *Dublin Proc.*, **4**, 349-350.
- 1850 On some results obtained by the Quaternion analysis respecting the inscription of gauche polygons in surfaces of the second order. *Dublin Proc.*, **4**, 380-387.
- 1850 Inscription of gauche polygons in central surfaces of the second order. *Dublin Proc.*, **4**, 541-557.
- 1850 On polygons inscribed on a surface of the second order. *Brit. Assoc. Rep.*, 2<sup>o</sup> part, p. 2.
- 1852-3 On continued fractions in Quaternions. *Phil. Mag.*, **3**, 371-373; **4**, 303; **5**, 117-118, 236-238, 321-326.
- 1852 On Biquaternions. *Brit. Assoc. Rep.*, 2<sup>o</sup> part, p. 2.
- 1853 On a proof from Quaternions of the celebrated theorem of Joachimsthal. *Dublin Proc.*, **5**, 71.
- 1853 A generalization of Pascal's theorem. *Dublin Proc.*, **5**, 100-101.
- 1853 On the nature and properties of the aconic function of six vectors. *Dublin Proc.*, **5**, 177-186.
- 1853 On the connexion of Quaternions with continued fractions and quadratic equations. *Dublin Proc.*, **5**, 219-221, 299-301.
- 1853 On the geometrical interpretation of some results obtained by calculation with biquaternions. *Dublin Proc.*, **5**, 388-390.
- 1853 On the geometrical demonstration of some theorems obtained by means of the Quaternion analysis. *Dublin Proc.*, **5**, 407-415.

- 1858 Theorem concerning polygonic 'syngraphy.' Dublin Proc., 5, 474-475.
- 1858 Lectures on Quaternions. Dublin: Hodges and Smith. 64 + 72 + 786. 8°.
- 1854 On an extension of Quaternions. Brit. Assoc. Rep., 2° part, p. 1.
- 1854-5 On some extensions of Quaternions. Phil. Mag., 7, 492-499; 8, 125-137, 261-269; 9, 46-51, 280-290.
- 1855 On the conception of the anharmonic quaternion, and on its application to the theory of involution in space. Brit. Assoc. Rep., 2° part, p. 7.
- 1856 Memorandum respecting a new system of roots of unity. [The Icosian Calculus.] Phil. Mag., 12, 446.
- 1857 On some applications of Quaternions to cones of the third degree. Brit. Assoc. Rep., 2° part, p. 3.
- 1857 On the Icosian Calculus. Brit. Assoc. Rep., 2° part, p. 3.
- 1857 Nichol's Cyclopaedia of the Physical Sciences: Letters on Quaternions. Second edition in 1860. London and Glasgow: Griffin.
- 1858 On the integrations of certain equations. Dublin Proc., 6, 62-68.
- 1858 On the celebrated theorem of Dupin. Dublin Proc., 6, 86-88.
- 1858 On some extensions of Quaternions. Dublin Proc., 6, 114-115.
- 1858 On the solution of the equation of Laplace's functions. Dublin Proc., 6, 181-185.
- 1858 Symbolical extensions of Quaternions; and geometrical applications of Quaternions. Dublin Proc., 6, 250, 260, 311.
- 1858 Account of the Icosian Calculus. Dublin Proc., 6, 415-416.
- 1858 On a general expression by Quaternions for cones of the third order. Dublin Proc., 6, 506 and 512.
- 1858 On a certain harmonic property of the envelope of the chord connecting two corresponding points of the Hessian of a cubic curve. Dublin Proc., 6, 524.
- 1859 On some Quaternion equations connected with Fresnel's wave-surface for bi-axal crystals. Brit. Assoc. Rep., 2° part, p. 248.

- 1859 The same. *Natural History Review*. *Quart. J.*, **6**, 240-242, 365.
- 1859 The same. *Dublin Proc.*, **7**, 122-124, 163.
- 1860 On anharmonic co-ordinates. *Natural History Review*, **7**, 242-246, 325-327, 506-509.
- 1862 The same. *Dublin Proc.*, **7**, 286-289, 329, 350-354.
- 1862 On geometrical nets in space. *Dublin Proc.*, **7**, 532-532.
- 1862 Quaternion proof of a theorem of reciprocity of curves in space. *Brit. Assoc. Rep.*, 2<sup>o</sup> part, p. 4.
- 1862 On the existence of a symbolic and biquadratic equation which is satisfied by the symbol of linear or distributive operation on a Quaternion. *Phil. Mag.*, **24**, 127-128.
- 1864 On a new and general method of inverting a linear and quaternion function of a Quaternion. *Dublin Proc.*, **8**, 182-183.
- 1864 On the existence of a symbolic and biquadratic equation, which is satisfied by the symbol of linear operation in Quaternions. *Dublin Proc.*, **8**, 190-191.
- 1864 On gauche curves of the third degree. *Dublin Proc.*, **8**, 331-334.
- 1864 On a general centre of applied forces. *Dublin Proc.*, **8**, 394.
- 1864 On the locus of the osculating circle to a curve in space. *Dublin Proc.*, **8**, 394.
- 1864 On the eight imaginary umbilicar generatrices of a central surface of the second order. *Dublin Proc.*, **8**, 471.
- †1866 *Elements of Quaternions*. Preface by William Edwin Hamilton. London: Longmans & Co. 59 + 762 pp. 8°. German translation by P. Glau, in two volumes, 1831-4.
- 1866 *Life of Sir William Rowan Hamilton*: by P. G. Tait. *North British Review*, **45**, 57—.
- 1899-1901 *Elements of Quaternions*. Second edition; edited by Charles Jasper Joly. Vol. i., with preface by the editor. 80 + 533 pp. Vol. ii., with 13 appendices by the editor. 54 + 502 pp. London: Longmans. 4°.

WILLIAM EDWIN HAMILTON.

- 1866 Editor's preface to the first edition of the "Elements of Quaternions."

HERMANN HANKEL.

- 1867 Vorlesungen über die complexen Zahlen. I., Theorie der complexen Zahlensysteme; insbesondere der gemeinen imaginären Zahlen und der Hamilton'schen Quaternionen. Leipzig: Voss. 12 + 196 pp. 8°.
- 1869 Die Entwicklung der Mathematik in den letzten Jahrhunderten. Tübingen. 8°.

ARTHUR SHEBBURNE HARDY.

- 1887 Elements of Quaternions. Boston: Ginn & Co. 8 + 284 pp. 8°.
- 1881 Imaginary Quantities: a translation of Argand's Essai. New York: Van Nostrand.

HARRY HART.

- 1883 Quaternion proof of the triple generation of the three-bar motion.
- 1888 On the linear vectorial equation of the central pedal of a conic. *Messenger*, (2), 12, 32.

ARTHUR STAFFORD HATHAWAY.

- 1891 On some theorems of integration in Quaternions. *Indiana Proc.*, 1, 63-64.
- 1892 Analytical and Quaternion treatments of the Problem of Sun and Planet. *Indiana Proc.*, 2, 20-24.
- 1892 Lineo-linear vector functions. (Abstract.) *American Assoc. Proc.*, 41, 59-62.
- 1894 Review of M'Aulay's *Utility of Quaternions in Physics*. *American M. S. Bull.*, (1), 3, 179-185.
- 1895 Elementary proof of the quaternion associative principle. *American M. S. Bull.*, (2), 2, 48-45.
- 1896 Orthogonal surfaces. (Quaternion development.) *Indiana Proc.*, 6, 85-86.
- 1896 A primer of Quaternions. New York: Macmillan. 7 + 118 pp. 8°.
- 1897 Quaternions as numbers of four-dimensional space. *American M. S. Bull.*, (2), 4, 54-57.
- 1897 Alternate processes. *Indiana Proc.*, 7, 117-127.
- 1898 Linear transformations in four dimensions. *American M. S. Bull.*, (2), 5, 99-94.

- 1899 Review of M'Aulay's *Octonions*. American M. S. Bull., (2),  
6, 74-77.  
1901 Quaternions and fourfold space. American M. S. Bull., (2),  
7, 245-248.  
1902 Quaternion space. American M. S. Trans., 3, 46-59.

ROBERT BALDWIN HAYWARD.

- 1886 The correlation of the different branches of elementary  
mathematics. A. I. G. T. Report for 1886. 81-52.  
1892 The algebra of coplanar vectors and trigonometry. London :  
Macmillan. 29 + 343. Small 8°.

OLIVER HEAVISIDE.

- 1882-3 The relations between magnetic force and electric current.  
The London Electrician. E. P. (Electrical Papers), 1,  
195-281.  
1888 The energy of the electric current. Electrician. E. P.,  
1, 281-255.  
1888 Some electrostatic and magnetic relations. Electrician,  
April 14, p. 510; April 28, p. 558; May 5, p. 582; June 2,  
p. 54. E. P., 1, 255-272.  
1885-7 Electromagnetic induction and its propagation. The Elec-  
trician, 1885-6-7. E. P., 1, 429-560.  
1885 On the electromagnetic wave-surface. Phil. Mag., (5), 19,  
397-419. E. P., 2, 1-23.  
1889 The general solution of Maxwell's electromagnetic equations,  
etc. Phil. Mag., (5), 27, 29-50. E. P., 2, 468-485.  
1892 On the forces, stresses, and fluxes of energy in the electro-  
magnetic field. Lond. Phil. Trans., 83, 427-433. E. P.,  
2, 521-574.  
1891-2 The elements of vectorial algebra and analysis. Electrician,  
Nov. 13, 1891, to Dec. 9, 1892. Electromagnetic Theory,  
1, 132-305.  
1892 Electrical Papers. 1° vol., 20 + 560. 2° vol., 16 + 587.  
London : Macmillan. 8°.  
1898 Vectors *versus* Quaternions. Nature, 47, 533-534.  
1894 Quaternionic innovations. Nature, 49, 246.  
1893-9 Electromagnetic Theory. 1° vol., 12 + 466. 2° vol.,  
16 + 542. London : The Electrician Publishing Co. 8°.

OLAUS HENRICI.

- 1890 The theory of screws. *Nature*, **42**, 127-182.  
1897 On a notation in vector-analysis. *Brit. Assoc. Rep.*, 560, 561.  
1908 Vectors and Rotors : with applications. By O. Henrici and  
G. C. Turner. London : Arnold. 16 + 204 pp. 8°

A. S. HERSCHEL.

- 1862 Sir W. R. Hamilton's Icosian game. *Quart. J.*, **5**, 305.

K. HERTZ.

- 1875 Theory of the complex numbers and their functions. In  
conjunction with S. Dickstein. (Polish.) Paris, 60 pp. 4°.  
1887 Die Elemente der Hamilton'schen Quaternionen. (Polish.)  
Warsaw. 142 pp. 8°.

K. HEUN.

- 1902 Formeln und Lehrsätze der allgemeinen Mechanik. Leipzig.  
112 pp. 8°.

WILLIAM MITCHINSON HICKS.

- 1876 Quaternion investigation of strains and fluid motion. *Quart. J.*,  
**14**, 271-292.

H. W. L. HIME.

- 1894 Outlines of Quaternions. London : Longmans. 15 + 190. 8°.  
1898 Question 11770. *Ed. Times*, **59**, 76.  
1894 Question 10171. *Ed. Times*, **60**, 92.

FRANK LAUREN HITCHCOCK.

- 1902-3 On vector differentials. (Quaternion method.) *Phil. Mag.*,  
(6), **3**, 576-586, and **4**, 187-197.

O. HÖLDER.

- 1886 Bemerkung zu der Mittheilung des Herrn Weierstrass : Zur  
Theorie der aus  $n$  Haupteinheiten gebildeten complexen  
Grösse. *Gött. Nachr.*, 241-244.  
1889 Bemerkung zur Quaternionentheorie. *Gött. Nachr.*, 34-38.

M. L. HOLMAN.

- 1878 Relations between three intersecting tangents to the parabola.  
In conjunction with E. A. Engler. *American J.*, **1**, 379-  
383.

J. HOÜEL.

- 1869 Sur le calcul des equipollences, méthode d'analyse géométrique de M. Bellavitis. *Nouv. Ann.*, (2), 6, 289-312, 387-357. Also Gauthier-Villars, 46 pp. 8°.
- 1874 Essai sur une manière de représenter les quantités imaginaires dans les constructions géométriques; par R. Argand. 2° édition, précédée d'une préface par M. J. Hoüel. 12 pp.
- 1874 Théorie élémentaire des quantités complexes. 4 parties. Paris: Gauthier-Villars. 8°.
- 1874 Éléments de la théorie des quaternions (4° partie de Théorie élémentaire des quantités complexes). Paris: Gauthier-Villars. 7 + 298. 8°.
- 1883 Considérations élémentaires sur les généralisations successives de l'idée de quantité de l'analyse mathématique. Paris. 8°.

EDWARD V. HUNTINGTON.

- 1901 Ueber die Grund-Operationen an absoluten und complexen Grössen in geometrischer Behandlung. Braunschweig: Vieweg.

HUSSEIN TEVFIK PACHA.

- 1892 Linear Algebra: 2° édition. Constantinople: Boyajian, royal 8°.

EDWARD WILLYS HYDE.

- 1880 Mechanics by Quaternions. *Analyst*, 7, 137-144, 177-184; 8, 17-24, 49-55.
- 1884 Calculus of direction and position. *American J.*, 6, 1-18.
- 1888 Geometric division of non-congruent quantities. *Annals of Math.*, 4, 9-18.
- 1888 The directional theory of screws. *Annals of Math.*, 4, 137-155.
- 1890 The directional calculus, based upon the methods of Hermann Grassmann. Boston: Ginn & Co. 12 + 187.
- 1892 Macfarlane's Algebra of Physics. *Annals of Math.*, 7, 79-88.
- 1894 The screw as a unit in a Grassmannian system of the sixth order. *Annals of Math.*, 8, 38-44.
- 1896 Higher Mathematics: edited by Merriman and Woodward. Chap. viii., Grassmann's space-analysis. New York: Wiley. 11 + 576 pp. 8°.



- 1897 Loci of the equations  $p = \phi^*e$  and  $p = \phi^*\psi^*e$ . Schlömilch Z., **42**, 122-182.
- 1897 An analogue to De Moivre's theorem in a plane-point system. Annals of Math., **11**, 129-186.
- 1900 On a surface of the sixth order which is touched by the axes of all screws reciprocal to three given screws. Annals of Math., (2), **2**, 179-188.
- 1902 Wilson's Gibbs' Vector analysis. Terrestrial Magnetism and Atmospheric Electricity, **7**, 115-124.

WILLIAM WOOLSEY JOHNSON.

- 1875 Note on a spherical proposition. (Associative principle in Quaternions.) Messenger, (2), **4**, 14.
- 1880 Origin of the name "Quaternions." Analyst, **7**, 52.

W. J. JOHNSTON.

- 1890 Question 10462. Ed. Times, **53**, 121.

CHARLES JASPER JOLY.

- 1894 The theory of linear vector functions. Dublin Trans., **30**, 597-647.
- 1895 Scalar invariants of two linear vector functions. Dublin Trans., **30**, 709-728.
- 1896 Quaternion invariants of linear vector functions and Quaternion determinants. Dublin Proc., **4**, 1-16.
- 1897 Vector expressions for curves. Part I. Unicursal curves. Dublin Proc., (3), **4**, 874-899.
- 1897 On the homographic division of planes, spheres, and space; and on the systems of lines joining corresponding points. Dublin Proc., (3), **4**, 515-525.
- 1897 The associative algebra applicable to hyperspace. Dublin Proc., (3), **5**, 73-123.
- 1899 Astatics and Quaternion functions. (Abstract.) Dublin Proc., (3), **5**, 866-869.
- 1899 Some properties of the general congruency of curves. (Abstract.) Dublin Proc., (3), **5**, 663-665.
- 1899 Some applications of Hamilton's operator  $\nabla$  in the calculus of variations. Dublin Proc., (3), **5**, 666.

- 1899-1901 Elements of Quaternions, by Sir W. R. Hamilton.  
2° edition. Edited by Charles Jasper Joly. 1° vol.  
With preface by the editor. 80 + 588. 2° vol. With  
18 appendices by the editor. 54 + 508. London :  
Longmans. 4°.
- 1900 Properties of the general congruency of curves. Dublin  
Trans., **31**, 868-892.
- 1900 On the place of the Ausdehnungslehre in the general associa-  
tive algebra of the Quaternion type. Dublin Proc., (8), **6**,  
18-18.
- 1901 The interpretation of a Quaternion as a point symbol. Dublin  
Trans., **32**, 1-16.
- 1901 Quaternion arrays. Dublin Trans., **32**, 17-30.
- 1901 Representation of screws by weighted points. Dublin Trans.,  
**32**, 61-92.
- 1902 Review of Calcul des Triquaternions, par M. Combebiac.  
Math. Gazette, **2**, 202-204.
- 1902 Integrals depending on a single Quaternion variable. Dublin  
Proc., **24** A, 6-20.
- 1902 The multi-linear Quaternion function. Dublin Proc., **24** A,  
47-52.
- 1902 Quaternions and projective geometry. (Abstract.) London  
Proc., **71**, 177-178.
- 1908 Quaternions and projective geometry. London Phil. Trans.,  
**201** A, 228-327.

V. A. JULIUS.

- 1878 De leer der Quaternions in hare toepassing op de leer van den  
circulaireren hodograaf. Utrecht. 8°. 8 + 127 pp.

F. JUNGHANS.

- 1878 Hermann Grassmann. Ein Nekrolog. Schlömilch Z., **23**, 69-75.

PHILIP KELLAND.

- 1878 Introduction to Quaternions : with numerous examples. In  
conjunction with P. G. Tait. London : Macmillan. 8°.
- †1882 Introduction to Quaternions. 2° edition. London :  
Macmillan. 18 + 282 pp. 8°. 3° edition, edited by  
C. G. Knott, in 1904. 17 + 208 pp. 8°.

ALFRED BRAY KEMPE.

- 1886 On the theory of mathematical form. Lond. Phil. Trans.,  
177, 1-70.  
1886 On an extension of ordinary algebra. Messenger, (2), 15,  
188-190.

A. E. KENNELLY.

- 1895 Resonance in alternating current lines. In conjunction with  
E. J. Houston. Trans. Amer. Inst. Electrical Engineers,  
12, 188-157.

SHUNKICHI KIMURA.

- 1895 Note on Quaternions. Nature, 52, 866.  
1895 Letter to the Editor: To friends and fellow-workers in  
Quaternions. In conjunction with P. Molenbroek.  
Nature, 52, 545-546.  
1895 Letter to the Editor: To those interested in Quaternions  
and allied systems of mathematics. Science, (2), 2., 524-  
525.  
1895 Geometrical nature of the surface of shells. (Japanese.) Tokio.  
168 pp.  
1896 On the nabla of Quaternions. Annals of Math., 10, 127-155.  
1898 Past and present of Quaternions. (Japanese.) Sendai. 28 pp.  
1898 Lectures on Quaternions. Part 1., Introductory. (Japanese.)  
In conjunction with Kujuro Hakii. Tokio. 12 + 117.  
1900 Application of Quaternions to Dynamics. Tokio. 100 pp.

KINDEL.

- 1887 Eine reciproke Zuordnung der räumlichen Elemente. Pr.  
Berlin: Kölln. G. 4°.

KIRCHNER.

- 1887 Ein Beitrag zur Bewegung unveränderlicher ebener Systeme.  
Pr.: Meiningen.

THOMAS PENYNGTON KIRKMAN.

- 1848 On Pluquaternions and homoid products of sums of  $n$  squares.  
Phil. Mag., 33, 447-459, and 494-509.

FELIX KLEIN.

- 1897 Ueber die Theorie des Kreisels. Heft I. : Die kinematischen und kinetischen Grundlagen der Theorie. Von F. Klein und A. Sommerfeld. Leipzig : Teubner, 4 + 196. gr. 8°.
- 1899 Ueber den Stand der Herausgabe von Gauss' Werken. Math. Ann., 51, 128-133. Also Gött. Nachr., 1898, p. 8.

A. KNESEK.

- 1901 Neue Begründung der Proportions- und Aehnlichkeitslehre, unabhängig vom Archimedischen Axiom und dem Begriff des Incommensurabeln. Berl. M. G. Ber. 4.

CARGILL GILSTON KNOTT.

- 1891 Article on Quaternions in Chambers' Encyclopedia.
- 1892 Recent innovations in vector theory. Edinb. Proc., 19, 212-237. Also Nature, 47, 590-593.
- 1893 Vectors and Quaternions. Nature, 48, 148-149, and 516-517.
- 1893 The Quaternion and its depreciators. Edinb. M. S. Proc., 11, 62-80.
- 1900 Professor Klein's view of Quaternions : a criticism. Edinb. Proc., 23, 24-34.
- 1901 Review of the second edition of Hamilton's "Elements of Quaternions." Phil. Mag., (6), 2, 418-420.
- 1902 Review of "Vector-analysis" by Gibbs and Wilson. Phil. Mag. (6), 4, 614-622.
- 1904 Kelland and Tait's Introduction to Quaternions. 3° edition, revised and edited by C. G. Knott. 17 + 208 pp. 8°.

FRITZ KÖLMEL.

- 1886 Die Grassmann'sche Erzeugungsweise von ebenen Curven dritter Ordnung. Diss. Tübingen.

GABRIEL KOENIGS.

- 1897 Leçons de Cinématique : Cinématique théorique. Note X. Sur la composition des rotations et sur les quaternions. Paris : Hermann. grand 8°.

A. P. KOTELNIKOF.

- 1895 Screw-calculus and some of its applications to geometry and mechanics. (Russian.) Kasan. 215 pp. 8°.

- 1896 Screws and complex numbers. (Russian.) Kasan Ges.  
1898 Projective theory of vectors. (Russian.) Kasan Ges., (2), 3,  
No. 29, App., 1-112.  
1899 Theory of vectors. Kasan.

FERDINAND KRAFT.

- 1898 Abriss des geometrischen Kalküls, nach Grassmann's Werken  
bearbeitet. Leipzig: Teubner. 12 + 255 pp. 8°.  
1894 Aequivalenz der Linientheilsysteme, dargestellt mittelst des  
geometrischen Kalküls. Schlömilch Z., 39, 87-115,  
129-161.  
1902 Équivalence des rotations autour d'axes parallèles et des  
translations d'une système invariable. L'Enseignement  
mathématique, 3, 175-200.  
1902 Équivalence du mouvement d'une ligne droite invariable  $\sigma$  au  
déplacement d'une position donnée  $\sigma_1$  à une autre position  
donnée  $\sigma_2$ . Ens. Math., 4.  
1908 Équivalence du mouvement d'une plan invariable  $\Sigma$  d'une  
position donnée  $\Sigma_1$  à une autre position donnée  $\Sigma_2$ . Ens.  
Math., 5.  
1908 Équivalence du mouvement d'un système invariable à trois  
dimensions  $\Sigma$  qui passe d'une manière quelconque d'une  
position donnée  $\Sigma_1$  à une autre position donnée  $\Sigma_2$ . Ens.  
Math., 5.

HEINRICH KÜHN.

- 1758 Meditationes de quantitibus imaginariis construendis et  
radicibus imaginariis exhibendis. Peterb. Trans.

C. KÜPPER.

- 1890 Die Schraubenbewegung, das Nullsystem und der lineare  
Complex. Monatsh. f. Math., 95-104.

KYSÄUS.

- 1850 Bedeutung und Anwendung der Zahlen in der Geometrie.  
Pr.: Siegen.

CHRISTINE LADD.

- 1880 On De Morgan's extension of the algebraic processes.  
American J., 3, 210-225.

EDM. LAGUERRE.

- 1867 Sur le calcul des systèmes linéaires. J. de l'Ec. Pol., **25**, 215-.
- 1885 Recherches sur la géométrie de direction. Méthodes de transformation. Anticaustiques. Paris : Gauthier-Villars.

CHARLES ANGE LAISANT.

- 1878-4 Exposition de la méthode des Equipollences, par G. Bellavitis. Traduction française. Nouv. Ann., (2), **12** and **13**.
- 1874 The same. Paris : Gauthier-Villars. 24 + 188 pp. 8°.
- 1875 Mémoire sur les puissances des points; étude de Géométrie plane. Assoc. Franç., 189-158.
- 1877 Applications mécaniques du calcul des quaternions. Thèse. Paris : Gauthier-Villars. 77 pp. 4°. Also Journ. de Math., **3**, 325-400.
- 1877 Sur le centre de gravité d'un polygone. Nouv. Ann., (2), **16**, 407.
- 1877 Sur quelques propriétés des polygones. Assoc. Franç., **142**—
- 1877 Centre de gravité d'un arc de cercle. Nouv. Corresp. Math., p. 347.
- 1878 Note sur un théorème sur les mouvements relatifs. C. R., **87**, 294-206.
- 1878 Réflexions sur la cinématique du plan. Nouv. Ann., (2), **17**, 481-507.
- 1878 Sur la cinématique du plan. Assoc. Franç., 81-86.
- 1878 Sur une généralisation de la division harmonique. Assoc. Franç., p. 185.
- 1878 Note touchant deux théorèmes de Lagrange sur le centre de gravité. S. M. F. Bull., **6**, 193-194.
- 1879 Sur la transformation exponentielle. Assoc. Franç., 206-211.
- 1879 Théorème sur le mouvement du centre de gravité d'un système de points mobiles. Soc. Philom. Bull., p. 82.
- 1880 Giusto Bellavitis. Darboux Bull. (2), **4**, 343-348.
- 1880 Extrait d'une lettre " Sur les quantités négatives et imaginaires." Nouv. Corr. Math., p. 119.
- 1881 Introduction à la méthode des quaternions. Paris : Gauthier-Villars. 22 + 242 pp. 8°.

- 1881 Sur les développements de certains produits algébriques. Assoc. Franç., 84-108.
- 1882 Simple remarque sur les podaires. Assoc. Franç., 104-106.
- 1882 Propriétés du mouvement d'une figure plane qui reste semblable à elle-même. Assoc. Franç., 106-108.
- 1882 Sur certaines propriétés des centres de gravité. S. M. F. Bull., 10, 40-44.
- 1883 Sur un système de figures semblables dans un même plan. Assoc. Franç. 178-180.
- 1887 Des rayons de courbure dans les transformations isogonales. S. M. F. Bull., 15, 39-41.
- 1887 Démonstration nouvelle du théorème fondamental de la théorie des équations. S. M. F. Bull., 15, 42-44.
- 1887 Sur l'inversion d'un système de  $n$  points ; construction de deux points remarquables du plan du triangle. Assoc. Franç., 4 pages.
- 1887 Théorie et applications des équipollences. Paris: Gauthier-Villars. 16 + 299 pp. 8°.
- 1888 Solution des questions, 237 et 238. Journ. de Math. Spec., (8), 2, 23-24 and 66-68.
- 1889 Note sur les variations du rapport anharmonique de quatre points dont trois sont fixes. S. M. F. Bull., 17, 169-171.
- 1889 Sur le théorème de d'Alembert. J. de Math. spec. (8), 3, 77-88.
- 1890 Propriétés du triangle ; orientation moyenne ; points equisegmentaires. Assoc. Franç., 7 pages.
- 1890 Interpolation cinématique. Assoc. Franç., 5 pages.
- 1890 Sur deux genres remarquables de courbes planes. Assoc. Franç., 6 pages.
- 1890 Sur la représentation analytique des figures planes et leur segmentation. S. M. F. Bull., 18, 123-131.
- 1890 Quelques propriétés focales des coniques. Soc. Philom. Bull. (8), 2, 182-191.
- 1891 Sur l'extension de la géométrie cartésienne aux figures imaginaires. S. M. F. Bull., 19, 29-30.
- 1892 Quelques propriétés cinématiques d'un système de deux mouvements simultanés. Teixeira, J., 97-102.

- 1892 Note relative au symbole  $i'$  et en général à l'opération,  $p^e$ .  
S. M. F. Bull., **20**, 12-15.
- 1892 Constructions et formules relatives au triangle. Nouv. Ann.,  
(8), **11**, 209-212.
- 1892 Solution de la composition de mathématiques. Nouv. Ann.,  
(8), **11**, 262-265.
- 1892 Quelques remarques sur les courbes unicursales. Assoc. Franç.,  
25-26.
- 1898 Communication d'une lettre d'Abel Transon datée 29. Juin  
1868. S. M. F. Bull., **20**, 104-106.
- 1898 Centres de gravité de certain systèmes de poids. Soc.  
Philom. Bull.
- 1894 Quelques propriétés du mouvement d'une figure plane. Soc.  
Philom. Bull.
- 1895 Note sur le principe des signes appliqués aux aires. Revue de  
Math. Spec., **5**, 65-66.
- 1896 Sur la courbure des courbes planes. Kasan Ges. (2), **6**,  
4 pages.
1899. Aire d'une courbe gauche fermée. Assoc. Franç., 135-140.
1901. Transformations des coordonnées barycentriques. Ens.  
Math. **3**.

EMANUEL LASKER.

- 1896-7 An essay on the Geometrical Calculus. Lond. M. S. Proc.,  
**28**, 217-260, 500-581.

ENRICO LEGNAZZI.

- 1881 Commemorazione di Giusto Bellavitis c. cenni sulle sue opere.  
Padova, 8°.

A. LIBICKY.

- 1896 Grundlagen der Grassmann'schen geometrischen Rechnungs-  
weise. (Bohemian.) Casopis, **25**, 187-198, 265-284, 321-  
341.

SOPHUS LIE.

- 1869 Ueber eine Darstellung der Imaginären in der Geometrie.  
Crelle J., **70**, 346-358.
- 1869 Repräsentation der Imaginären der Plangeometrie. A. S. C.,  
16-88, 107-146.



- 1898 Vorlesungen über continuierliche Gruppen. Bearbeitet und herausgegeben von G. Scheffers. Leipzig. 12 + 810. Especially Kapitel 21, pp. 610-664.

FERDINAND LIPPICH.

- 1864 Ueber die Fresnel'sche Interpretation der imaginären Grössen. Gött. Nachr., 78-80.  
1870 Die Ebene und Gerade als Elemente eines dem barycentrischen analogen Calculs. Mittheilungen d. naturw. Vereins f. Steiermark, 2, 1-46.

RUDOLF LIPSCHITZ.

- 1880 Principes d'un calcul algébrique qui contient comme espèces particulières le calcul des quantités imaginaires. C. R., 91, 619-621, 660-664.  
1886 Untersuchungen über die Summen von Quadraten. Bonn: Cohen. 8°.

ALFRED LODGE.

- 1892 Vector algebra. Nature, 47, 3-5.  
1893 Vectors and Quaternions. Nature, 48, 198-199.

FRANK H. LOUD.

- 1893 A construction for the imaginary points and branches of plane curves. Annals of Math., 8, 29-37.  
1893 The circular locus geometrically constructed to show imaginary values of the variables. Colorado College Studies, 4, 5-30.

ABBOTT LAURENCE LOWELL.

- 1878 Surfaces of the second order as treated by Quaternions. American Acad. Proc., 5 (new series), 222-251.

F. LUCAS.

- 1872 Nouvelle méthode d'Analyse fondée sur l'emploi des coordonnées imaginaires. C. R., 75, 1250-1253.

JAKOB LÜROTH.

- 1881 Grundriss der Mechanik. München: Ackermann, 6 + 80 pp.

ALEXANDER M' AULAY.

- 1884 Some general theorems in Quaternion integration. *Messenger*, **15**, 26-37.
- 1889 Establishment of the fundamental properties of Quaternions. *Messenger*, **18**, 181-186.
- 1889 The transformation of multiple surface integrals into multiple line integrals. *Messenger*, **18**, 189-145.
- 1889 Differentiation of any (scalar) power of a Quaternion. *Edinb. Proc.*, **17**, 201-206.
- 1890 Proposed extension of the powers of Quaternion differentiation. *Edinb. Proc.*, **18**, 98-123.
- 1892 Quaternions as a practical instrument of physical research. *Phil. Mag.*, (5), **33**, 477-495.
- 1892 On the mathematical theory of electromagnetism. *Lond. Phil. Trans.*, **183**, 685-779.
- 1898 Utility of Quaternions in Physics. London: Macmillan. 11 + 107 pp. 8°.
- 1898 Quaternions. *Nature*, **47**, 151.
- 1898 Notes on a modification of Maxwell's electrical theory. *Phil. Mag.* (5), **36**, 175-186.
- 1896 On the wave-surface and rotation of polarization plane in an anisotropic medium. *Phil. Mag.* (5), **42**, 224-231.
- 1896 Octonions. (Abstract.) *Lond. R. S. Proc.*, **59**, 169-181.
- 1898 Octonions: a development of Clifford's Biquaternions. Cambridge: University Press. 14 + 253 pp. 8°.
- 1900 Notes on the electromagnetic theory of light. *Phil. Mag.* (5), **49**, 228-242.

ALEXANDER MACFARLANE.

- 1888 Note on plane algebra. *Edinb. Proc.*, **12**, 184-186.
- 1891 Principles of the algebra of physics. *American Assoc. Proc.*, **40**, 65-117.
- 1892 The imaginary of algebra. *American Assoc. Proc.*, **41**, 38-55.
- 1898 Vectors *versus* Quaternions. *Nature*, **48**, 75-76 and 540-541.
- 1898 The fundamental theorems of analysis generalized for space. Printed by the author. 81 pp. 8°.

- 1894 On the definitions of the trigonometric functions. Printed by the author. 41 pp. 8°.
- 1894 The principles of elliptic and hyperbolic analysis. Printed by the author. 47 pp. 8°.
- 1894 Collected papers on space-analysis. (The preceding five papers.) New York: Lemcke and Buechner.
- 1898 The analytical treatment of alternating currents. Chicago Electrical Congress Proc., 24-32.
- 1898 M'Aulay's "Utility of Quaternions in physics." Physical Review, 1, 887-890.
- 1898 Heaviside's "Electromagnetic Theory: vol. 1." Physical Review, 2, 152-154.
- 1896 Letter on the proposed Quaternion Association. Science, (2), 3, 99-100.
- 1896 Higher Mathematics: edited by Mansfield Merriman and R. S. Woodward. Chap. ix., Vector-analysis and Quaternions. New York: Wiley.
- 1897 Whitehead's "Treatise on universal algebra." Science (2), 9, 324-328.
- 1897 Hathaway's "Primer of Quaternions." Physical Review, 4, 421-423.
- 1897 Recent books on Quaternions. Science, (2), 3, 699-701.
- 1897 Application of hyperbolic analysis to the discharge of a condenser. Trans. American Inst. Electrical Engineers, 14, 163-184.
- 1897 Sur la résolution de l'équation du troisième degré. Assoc Franç.
- 1899 The fundamental principles of algebra: vice-presidential address. American Assoc. Proc., 43, 21-51, and Science, (2), 10, 345-364.
- 1900 Brief of twelve lectures on space-analysis, delivered at the University of Pennsylvania. Bulletin of the Univ. of Penna., April, 1900.
- 1900 Vector differentiation. Washington Bull., 14, 73-92.
- 1900 Théorie de l'équation quadratique. L'Enseignement Math., 2, 383-369.
- 1900 Differentiation in the Quaternion analysis. Dublin Proc., (3), 6, 199-215.

- 1900 Hyperbolic Quaternions. *Edinb. Proc.*, **23**, 169–180.
- 1900 Les idées et principes du calcul géométrique. Bibliothèque de Congrès international de philosophie. Paris: Armand Colin, **3**, 405–423.
- 1900 Application of space-analysis to curvilinear coordinates. *Compte rendu du 2<sup>m</sup>e Congrès international des mathématiciens*, 805–811.
- 1902 Report on recent progress in the Quaternion analysis. *American Assoc. Proc.*, **51**, 305–326.
- 1903 Peter Guthrie Tait, his life and works. *Bibl. Math.*, (8), **4**, 185–200.

P. A. MACMAHON.

- 1903 The application of quaternions to the algebra of invariants. *Lond. M. S. Proc.*

MAHLER.

- 1884 Einleitung in die Grassmann'sche Ausdehnungslehre. Pr.: Ulm.

E. G. MALCOLM.

- 1886 Le calcul géométrique. 2<sup>e</sup> partie. 52 pp. 8°.

MAXIMILIEN MARIE.

- 1890–1 Réalisation et usage des formes imaginaires en Géométrie. *Nouv. Ann.*, (8), **9** and **10**. Also Gauthier-Villars, 179 pp. 8°.

J. MASSAU.

- 1893 Cours de mécanique. Paris: Gauthier-Villars.

GEORGE BALLARD MATHEWS.

- 1885 Solution of question 7922, proposed by Sylvester. *Ed. Times*, **43**, 105.
- 1885 Solution of question 8576, proposed by J. J. Walker. *Ed. Times*, **46**, 32.

WILHELM MATZKA.

- 1851 Versuch einer richtigen Lehre von der Realität der vorgeblich imaginären Grössen der Algebra oder einer Grundlehre von der Ablenkung algebraischer Grössenbeziehungen, *Prag Ber.*, (5), **6**, 181–360.

JAMES CLERK MAXWELL.

- 1870 Address to the mathematical and physical section of the British Association. Report, **40**, S. P., **2**, 215-229.
- 1871 Remarks on the mathematical classification of physical quantities. Lond. M. S. Proc., **3**, 224-232. Also Scientific Papers, **2**, 257-266.
- 1873 Review of Kelland and Tait's "Introduction to Quaternions." Nature, **9**, 137-138.
- 1873 Treatise on Electricity and Magnetism. 1° vol., Introduction.
- 1876 Matter and Motion. London: Society for Promoting Christian Knowledge. 8 + 128.
- †1890 Scientific Papers; edited by W. D. Niven. 2 vols. Cambridge Univ. Press.

RUDOLF MEHMKE.

- 1880 Anwendung der Grassmann'schen Ausdehnungslehre auf die Geometrie der Kreise in der Ebene. Inaugural Dissertation. Stuttgart. 78 pp. 8°.
- 1888 Ueber die Geschwindigkeiten beliebiger Ordnung eines in seiner Ebene bewegten ähnlich-veränderlichen ebenen Systems. Civilingenieur, (2), **29**, 11 pp.
- 1884 Ausdehnung einiger elementar-geometrischen Sätze auf Räume von beliebig vielen Dimensionen. Grunert Arch., **70**, 210-218.
- 1884 Ueber die Bestimmung von Trägheits-Momenten mit Hilfe Grassmann'scher Methoden. Math. Ann., **23**, 148-151.
- 1886 Bemerkung über die Subdeterminanten symmetrischer Systeme. Math. Ann., **26**, 209-210.
- 1886 Eine kinematische Aufgabe. Festschrift, Darmstadt. 8 pp.
- 1890 Ueber die Bewegung eines starren ebenen Systems in seiner Ebene. Schlämilch Z., **35**, 1-24.
- 1891 Ueber zwei charakteristische Eigenschaften der linearen Punkttransformation. Schlämilch Z., **36**, 206-218.
- 1892 Ueber eine allgemeine Construction der Krümmungsmittelpunkte ebener Curven und eine neue Begründung der Fundamentalsätze der Flächentheorie. Rivista di Mat., **2**, 65-71.

- 1892 Kleine Beiträge zu den Anwendungen der Methoden von Grassmann. I., Ueber die Projection einer Raumkurve von einem ihrer Punkte aus. II. Verallgemeinerung: Transformation einer durch einen "Fundamentalpunkt" gehenden Curve. Schlömilch Z., **37**, 805-810.
- 1892 Ueber die Aenderung der Hauptkrümmungen einer Fläche bei einer beliebigen Berührungstransformation. Rivista di Mat., **2**, 159-161.
- 1893 Untersuchungen über die auf die Krümmung von Curven und Flächen bezüglichen Eigenschaften der Berührungstransformation. Schlömilch Z., **38**, 7-26.
- 1895 Metrische Eigenschaften der cubischen Raumcurven. Schlömilch Z., **40**, 211-241.

H. C. R. MÉRAY.

- 1879 Essai sur le calcul des quantités associées en systèmes et sur son application à la théorie des equations simultanées. Ann. de l'Ec. Norm., (2), **8**.

MANSFIELD MERRIMAN.

- 1896 Higher Mathematics. Edited by M. Merriman and R. S. Woodward. Chaps. VIII. and IX. New York: Wiley. 11 + 576 pp.

JOSEF MERTEN.

- 1882 Einige Anwendungen der Hamilton'schen Quaternionen. Pr. Saaz. Böhmen. 8°.
- 1888 Anwendung der Hamilton'schen Quaternionen auf die Statik. I. Theil. Theorie der Kräftepaare und der Momente. II. Theil. Theorie der Momente. Saaz, Böhmen. 20 pp.

W. H. METZLER.

- 1893 Matrices which represent vectors. Boston Technology Quarterly, **6**, 348-351.
- 1894 Homogeneous strains. Annals of Math., **8**, 148-156.

M. MEYER.

- 1889 Einführung in die Quaternionenrechnung. Chemnitz. 4°.

GEORGE ABRAM MILLER.

- 1898 On the Quaternion group. American Philos. Soc. Proc., **37**, 812-819.

GEORGE M. MINOHIN.

- 1886 A treatise on statics. Chap. XIV. Astatic equilibrium,  
Third edition : Oxford.

AUGUST FERDINAND MÖBIUS.

- 1827 Der barycentrische Calcul : ein neues Hilfsmittel zur analytischen Behandlung der Geometrie. Leipzig : Barth. 8°. G. W., 1, 1-388.
- 1837 Lehrbuch der Statik ; 2 Theile. Leipzig : Göschen. G. W., 3, 1-497.
- 1838 Ueber die Zusammensetzung unendlich kleiner Drehungen. Crelle J., 18, 189-212 ; G. W., 1, 545-570.
- 1848 Die Elemente der Mechanik des Himmels. Leipzig : Weidmann. G. W., 4, 1-318.
- 1844 Ueber die Zusammensetzung gerade Linien und eine daraus entspringende neue Begründungsweise des barycentrischen Calculs. Crelle J., 28, 1-9. G. W., 1, 601-612.
- 1847 Die Grassmann'sche Lehre von Punktgrössen und den davon abhängigen Grössenformen. Preface to Grassmann's Preisschrift. G. W., 1, 613-633.
- 1856 Ueber eine Methode, um von Relationen, welche der Longimetrie angehören, zu entsprechenden Sätzen der Planimetrie, zu gelangen. Crelle J., 52, 229-242.
- 1857 Ueber imaginäre Kreise. G. W., 2, 315-328.
- 1858 Ueber conjugirte Kreise. G. W., 2, 329-348.
- 1859 Neuer Beweis des in Hamilton's "Lectures on Quaternions" aufgestellten associativen Principis bei der Zusammensetzung von Bogen grösster Kreise auf der Kugelfläche. Leipz. Ber., 11, 138-149. G. W., 2, 55-70.
- † Ueber geometrische Addition und Multiplication. G. W., 4, 658-697.
- †1835-7 Gesammelte Werke Herausgegeben von Richard Baltzer, Felix Klein, und Wilhelm Scheibner. Leipzig : Hirzel 8°.

PIETER MOLENBROEK.

- 1891 Ueber die geometrische Darstellbarkeit imaginärer Punkte im Raume. Hoppe Arch., (2), 10, 261-282.
- 1891 Theorie der Quaternionen. Leiden : Brill. 12 + 284 pp. 8°.

- 1892 Sur une représentation géométrique des points imaginaires dans l'espace. *Nouv. Ann.*, **19**, 118-182.
- 1893 Anwendung der Quaternionen auf die Geometrie. Leiden : Brill. 9 + 257 pp. 8°.
- 1898 Over de toepassing der quaternionen op de mechanica en de natuurkunde. *Amst. Akad. Verh.*, **2**, 1-38.
- 1895 To friends and fellow-workers in Quaternions. In conjunction with S. Kimura. *Nature*, **52**, 545-546.
- 1895 To those interested in Quaternions and allied systems of Mathematics. In conjunction with S. Kimura. *Science*, (2), 524-525.

GEORGE GAVIN MORRICE.

- 1887 Note on the multiplication of nonions. *Messenger*, (2), **17**, 104-105.
- 1890 Note on a quaternary group of 51840 linear substitutions. *Lond. M. S. Proc.*, **21**, 58-62.
- 1892 Second note on a quaternary group of 51840 linear substitutions. *Lond. M. S. Proc.*, **23**, 218-217.

FRANZ MOTH.

- 1848 Ueber die Anwendbarkeit der imaginären Zahlformen in der Geometrie. *Münch. Abh.*, **3**, 87-150.

TSUTO MOTODA.

- 1890 Quaternion proofs of theorems relating to asymptotic lines. *Messenger*, **19**, 188.

A. MOUCHOT.

- 1865 Nouvelle interprétation géométrique des valeurs imaginaires d'une variable. *C. R.*, **61**, 118-115.

G. J. MOUNIER.

- 1882 Eene byzondere eigenschap der quaternionen. *Nieuw Archief*, **8**, 81-88.

C. V. MOUREY.

- 1828 La vraie théorie des quantités negatives, et des quantités prétendues imaginaires. 2° edition 1861. Paris: Gauthier-Villars. 12 + 144 pp. 12°.



EMIL MÜLLER.

- 1891 Die Liniengeometrie nach den Principien der Grassmann'schen Ausdehnungslehre. *Monatsh. f. Math.*, **2**, 267–290.
- 1892–3 Die Kugelgeometrie nach den Principien der Grassmann'schen Ausdehnungslehre. *Monatsh. f. Math.*, **3**, 365–402; **4**, 1–52.
- 1893 Neue Methode zur Ableitung der statischen Gesetze. Mittheilungen d. k. k. technol. Gewerbe-Museums in Wien. N. F., **3**, 18–72.
- 1895 Anwendung der Grassmann'schen Methoden auf die Theorie der Curven und Flächen zweiten Grades. *Crelle J.*, **115**, 234–253.
- 1896 Die Geometrie der Punktepaare und Kreise im Raume nach Grassmann'schen Principien. *Monatsh. f. Math.*, **7**, 77–89.
- 1897 Ueber das gemischte Product. *Math. Ann.*, **48**, 589–594.
- 1898 Die Geometrie orientierter Kugeln nach Grassmann'schen Methoden. *Monatsh. f. Math.*, **9**, 269–315.
- 1899 Beweis einiger Determinantensätze mittels der Grassmann'schen Ausdehnungslehre. *Schlömilch Z.*, **44**, 28–40.
- 1903 Die einem Steiner'schen Satze entsprechende algebraische Identität. *Monatsh. f. Math.*, **14**, 182–186.

G. W. MÜLLER.

- 1841 Anwendung der Lehre vom Zuge auf die Nachweisung der geometrischen Bedeutung der Form  $a + b\sqrt{-1}$  *Grunert Arch.*, **1**, 397–400.

E. NETSCH.

- 1901 Ueber ein in der Vectoranalysis auftretendes System partieller Differentialgleichungen 1<sup>o</sup> Ordnung. *Dresden Ber.*, **10**.

G. NÉDÉLEC.

- 1897 Le calcul vectoriel et ses applications en géométrie et en mécanique. Paris: Gauthier-Villars. 246 pp. 8°.

JOSEPH NEUBERG.

- 1884 Sur les tétraèdres de Möbius. *Liège Mem.*, (2), 11.

F. NIEMÖLLER.

1891 Anwendungen der linealen Ausdehnungslehre an die Theorie der Determinanten. Pr.: Osnabrück. 4°.

B. NIEWEGLÓWSKI.

1901 Sur la théorie des moments. (Polish.) Wiad. mat., Warsaw, 5, 141–149.

HERMANN NOTH.

1874–9 Die vier Species in den Elementen der Geometrie. Pr.: Freiberg i. S.

1882 Die Arithmetik der Lage. Leipzig: Barth. 8°.

MATTHEW O'BRIEN.

1847 Contributions towards a system of symbolical geometry and mechanics (Abstract). Phil. Mag. (2), 31, 189–148.

1849 On a new notation for expressing various conditions and equations in Geometry, Mechanics, and Astronomy. Cambr. Trans., 8, 415–428.

1849 Contributions towards a system of symbolical geometry and mechanics. Cambr. Trans., 8, 497–507.

1849 On the symbolical equation of vibratory motion of an elastic medium, whether crystallised or uncrystallised. Cambr. Trans., 8, 508–528.

1851 On the interpretation of the product of a line and a force. Phil. Mag. (4), 1, 394–397.

1851 On symbolical statics. Phil. Mag. (4), 1, 491–495.

1851 On symbolical mechanics. Phil. Mag. (4), 2, 121–125.

1852 On symbolic forms derived from the conception of the translation of directed magnitude. Lond. Phil. Trans., 142, 161–206.

J. ODSTRČIL.

1879 Kurze Anleitung zum Rechnen mit den Quaternionen. Halle a. S.: Nebert. 8 + 78 pp. 8°.

MARTIN OHM.

1829 Versuch eines vollkommen consequenten Systems der Mathematik. 2nd edition. 1852. Berlin. 8°

1842 Der Geist der math. Analysis. Berlin. 2° edition, Erlangen.

1843 *The spirit of mathematical analysis*. Translation by Alexander John Ellis. London. 12°.

DINO PADELETTI.

1882 *Principii della teoria dei quaternioni elementarmente esposti*. Batt. G., 20, 1-48.

1882 *Su un calcolo nella teoria delle dinami analogo a quello dei quaternioni*. Napoli Rend., 21, 111-119.

1882 *Osservazioni sulla teoria delle dinami*. Napoli Rend.

1883 *Sulla più semplice forma dell' equazioni di equilibrio di un sistema rigido vincolato*. Napoli Rend.

PAUL PAINLEVÉ.

1888 *Sur la représentation conforme des polygones*. C.R., 106, 478-476.

GEORGES PAPELIER.

1888 *Solution des questions 287 et 288 ; par Laisant et Papelier*. Journ. de Math. spéc., (3), 2, 28-24, 66-68.

1889 *Application du calcul des quaternions à l' étude des surfaces du second ordre*. S. M. F. Bulletin, 17, 182-204.

GEORGE PEACOCK.

1880 *A treatise on algebra*. Cambridge. 88 + 685 pp. 8°.

1883 *Report on the recent progress and present state of certain branches of analysis*. Brit. Assoc. Rep., 185-352.

1842-5 *A treatise on algebra*. 1° vol., *Arithmetical Algebra*. 16 + 399. 2° vol., *Symbolical Algebra and its application to the geometry of position*. 10 + 455. Cambridge: Deighton.

GIUSEPPE PEANO.

1888 *Calcolo geometrico secondo l' Ausdehnungslehre di H. Grassmann*. Torino: Bocca. 10 + 170 pp.

1888 *Teoremi su massimi e minimi geometrici*. Palermo Rend., 2, 189-192.

1890 *Sulla definizione dell' area d'una superficie* Lincei Rend., 54-57.

1891 *Gli elementi di calcolo geometrico*. Torino: Candeletti, 42 pp. 8°.

- 1891 Die Grundzüge des geometrischen Calcüls : Uebersetzung von Schepp. Leipzig : Teubner.
- 1895 Sistemi lineari di vettori nel piano. Torino Atti.
- 1895 Elenco bibliografico sull' " Ausdehnungslehre " di H. Grassmann. Rivista di Mat.
- 1895 Quaternion Society. Rivista di Mat., 5, 169.
- 1896 Trasformazioni lineari dei vettori di un piano. Torino Atti, 31, 157-166.
- 1896 Saggio di calcolo geometrico. Torino Atti, 31, 952-975.
- 1897-8 Entwicklung der Grundbegriffe des geometrischen Calcüls. Uebersetzung von Lanner. Pr. Salzburg.
- 1898 Analisi della teoria dei vettori. Torino Atti, 33, 518-534.
- 1901 Formulaire de Mathématiques, 3. Cinquième partie — Vecteurs. Torino : Bocca. 8 + 281 pp. 12°.
- 1902 La geometria basata sulle idee di punto e distanza. Torino Atti.
- 1903 Formulaire Mathématique, 4. Torino : Bocca. 16+408 pp. 12°.

KARL PEARSON.

- 1885 The Common Sense of the Exact Sciences. By W. K. Clifford. Edited and completed by Karl Pearson. (International Scientific Series.) London : Kegan Paul. 13 + 271 pp. 12°.

WILLIAM PEDDIE.

- 1898 On the fundamental principles of Quaternions and other vector-analyses. Edinb. M. S. Proc., 11, 85-92.
- 1898 The elements of Quaternions (Abstract). Edinb. M. S. Proc., 11, 180-186.
- 1902 Quaternion binaries : an extension of quaternions to give an eight-element system applicable to ordinary space. Edinb. Proc., 24, 70.
- 1902 On the use of Quaternions in the theory of screws. Edinb. Proc., 24, 314-320.

BENJAMIN PEIRCE.

- 1870 Linear Associative Algebra. Read before the National Academy of Sciences at Washington, and published in thograph.

- 1875 On the uses and transformations of linear algebra. American Acad. Proc. (2), 2, 395-400.
- †1881 Linear Associative Algebra. With notes and addenda by C. S. Peirce. American J., 4, 97-192.

CHARLES SANDERS PEIRCE.

- 1875 On the application of logical analysis to multiple algebra. American Acad. Proc. (2), 2, 392-394.
- 1878 Note on Grassmann's calculus of extension. American Acad. Proc. (2), 5, 115-116.
- 1881 Notes and addenda to "Linear Associative Algebra," by Benjamin Peirce. American J., 4, 97-192.
- 1882 On the relative forms of Quaternions. Johns Hopkins Univ. Circ., 179.

JAMES MILLS PEIRCE.

- 1899 Determinants of Quaternions. American M. S. Bull., (2) 5, 335-337.

JOHN PERRY.

- 1899 Practical Mathematics. Summary of six lectures delivered to workmen. Sixth chapter on vectors. London: Eyre & Spottiswoode.

JULIUS PETERSEN.

- 1887 Ueber  $n$  dimensionale complexe Zahlen. Gött. Nachr.

ANDREW WHEELER PHILLIPS.

- 1890 The orbit of Swift's comet, 1880 V, determined by Gibbs's vector method. By W. Beebe and A. W. Phillips. Astronomical Journal, 9, 118-117 and 121-124.

LUDWIG PILGRIM.

- 1879 Ueber die Anzahl der Theile, in welche ein Gebiet  $k^{\text{ter}}$  Stufe durch  $n$  Gebiete  $(k-1)^{\text{ter}}$  Stufe getheilt werden kann. Schlömilch Z., 24, 188-192.

GUSTAVE PLARR.

- 1857 De quelques transformations, &c. Brit. Assoc. Rep., pt. I., 101-104.

- 1876-9 On the establishment of the elementary principles of Quaternions on an analytical basis. *Edinb. Trans.*, **27**, 175-202, **28**, 87-41.
- 1876 On the elimination of  $\alpha\beta\gamma$  from the conditions of integrability of  $Su\alpha\rho$ ,  $Su\beta\rho$ ,  $Su\gamma\rho$ . *Edinb. Trans.*, **27**, 251-278.
- 1877 On the roots of the equation  $V\rho\phi\rho = 0$ . *Edinb. Proc.*, **9**, 287.
- 1877 Addition to the paper "On the establishment of the elementary principles of Quaternions." *Edinb. Proc.*, **9**, 402.
- 1878 Note relative aux §§ 439, 440 du "Traité élémentaire des Quaternions" de M. Tait. *C. R.*, **86**, 1454-1456.
- 1879 On the solutions of the equation  $V\rho\phi\rho = 0$ ,  $\phi\rho$  representing a linear vector function generally not self-conjugate. *Edinb. Trans.*, **28**, 45-91.
- 1882 On the establishment of the elementary principles of Quaternions on an analytical basis. *Brit. Assoc. Rep.*, part II., 451-452.
- 1882 On a particular case of the symbolic cubic. *Edinb. Proc.*, **11**, 842-854.
- 1882 On Minding's theorem. *Edinb. Proc.*, **11**, 528-548.
- 1882-4 *Traité élémentaire des Quaternions*, par P. G. Tait. Traduit sur la 2<sup>o</sup> édition anglaise, avec additions de l'auteur, et notes du traducteur, par G. Plarr. Deux Volumes. 1<sup>o</sup> Partie. *Theorie, Applications géométriques*. 2<sup>o</sup> Partie. *Géométrie des courbes et des surfaces. Cinématique. Applications à la Physique*. Paris: Gauthier-Villars. 8°.
- 1884 On the quaternion expression for the finite displacements of a system of points of which the mutual distances remain invariable. *Edinb. Proc.*, **12**, 151-171.
- 1888 On the roots of  $\epsilon^2 = -1$ . *Edinb. Proc.*, **15**, 98-96.
- 1888-90 On the determination of the curve, on one of the coordinate planes, which forms the outer limit of the positions of the point of contact of an ellipsoid which always touches the three planes of reference. *Edinb. Trans.*, **33**, 465-499, and **35**, 471-487.
- 1888 Review of Balbin's "Quaternions." *Nature*, **37**, 145-147.

J. PLAŠIL.

- 1877-8 Une remarque physique sur les quantités imaginaires.  
(Bohemian.) Casopis, 7, 178-175.

JOHN PLAYFAIR.

- 1778 On the arithmetic of impossible quantities. Lond. Philos.  
Trans., 14, 856-867.  
1808 Review of Buée's "Mémoire sur les quantités imaginaires."  
Edinburgh Review, 12, 806-818.

HENRI POINCARÉ.

- 1884 Sur les nombres complexes. C. R., 99, 740-742.  
1900 Sur les groupes continus. Cambr. Trans., Stokes' Jubilee  
vol., 220-255.  
1901 Quelques remarques sur les groupes continus. Palermo  
Rend., 18, 821-868.

L. PRANDTL.

- 1908 Grundsätze für eine einheitliche Schreibung der Vektoren-  
rechnung im technischen Unterricht. Deutsche Math.  
Ver. 12, 444-445.

W. PREYER.

- 1877 Elemente der reinen Empfindungslehre. Jena: Dufft.

EUGENE PROUHET.

- 1868 Review of Allegret's "Essai sur la théorie des quaternions."  
Nouv. Ann., (2), 2, 333-334.

PUNGA.

- 1901 Vectoranalysis. Zeitschrift für Electrotechnik. Oct. 20 and 27.

W. H. L. JANSSEN VAN RAAJ.

- 1898 Sur les quantités imaginaires en algèbre. Archives Teyler,  
(2), 4, 58-118.

R. RAIMONDI.

- 1887 Sull' equazione vettoriale della circonferenza. Batt. G., 25,  
219-222.

HENRI RÉSAL.

- 1862 Traité de cinématique pure. 64 pp.

J. M. REY Y HEREDIA.

1865 Teoria transcendental de las cantidades imaginarias. Madrid.  
848 pp.

FRIEDRICH BIECKE.

1856 Die Rechnung mit Richtungszahlen, oder die geometrische  
Behandlung imaginärer Grössen. Stuttgart: Metzler.  
4 + 170 pp. 8°.

VIRGINIO RETALI.

1888 Ricerche sopra l'immaginario in geometria. Bologna: Gam-  
berini.

BERNARD RIEMANN.

1851 Grundlagen für eine allgemeine Theorie der Functionen einer  
veränderlichen complexen Grösse. Inaugural disserta-  
tion; Göttingen. 2° edition, 1867.

†1876 Gesammelte mathematische Werke und wissenschaftlicher  
Nachlass. Herausgegeben von H. Weber. Leipzig:  
Teubner. 8 + 526. 8°.

OLINDE RODRIGUES.

1840 Des lois géométriques qui régissent les déplacements d'un  
système solide dans l'espace, et de la variation des co-  
ordonnées provenant de ces déplacements considérées in-  
dépendamment des causes qui peuvent les produire. Journ.  
de Math., 5, 380-440.

P. ROMER.

1868 Principes fondamentaux de la méthode des quaternions.  
(Russian.) Kief: Typographie universitaire. 219 pp.

RONALD ROSS.

1901 The algebra of space; being a brief description of a system  
of geometrical algebra placed on an arithmetical basis.  
London: George Philip and Son. 32 pp.

ERNST RUDERT.

1900 Ueber kleine Kugelkreise. Diss. 37 pp. 4°. Leipzig:  
Teubner.



ROBERT RUSSELL.

1893 The geometry of the cubic. Dublin Proc., (3), 2, 170-175.

BARRÉ DE SAINT-VENANT.

1845 Mémoire sur les sommes et les différences géométriques et sur leur usage pour simplifier la Mécanique. C. R., 21, 620-625.

1858 De l'interprétation (géométrique) des clefs algébriques et des déterminants. C. R., 36, 582-585.

GEORGE SALMON.

1862 Geometry of three dimensions. Appendix on Quaternions in first and second editions.

1852 A treatise on the higher plane curves. 1° edition. Note on imaginary points and curves. 801-806.

EMILE SARRAU.

1885-9 Traité de l'Electricité et du Magnétisme, par James Clerk Maxwell. Suivi d'un Appendice sur la théorie des quaternions, par E. Sarrau. Paris: Gauthier-Villars.

1889 Notions sur la théorie des quaternions. Paris: Gauthier-Villars. 8°.

RENÉ DE SAUSSURE.

1896 Sur une géométrie de l'espace réglée. C. R., 123, 784-787.

1896 Étude de géométrie cinématique réglée. American J., 18, 304-346.

1897 Calcul géométrique réglé. American J., 19, 329-370.

1897 Principles of a new line-geometry. Cathol. Univ. of America Bull., 3, 81-86.

GEORG WILHELM SCHEFFERS.

1889 Zur Theorie der aus  $n$  Haupteinheiten gebildeten complexen Grössen. Leipz. Ber. 290-307.

1889 Ueber die Berechnung von Zahlensystemen. Leipz. Ber. 400-457.

1891 Zurückführung complexer Zahlensysteme auf typische Formen. Math. Ann., 39, 298-390.

- 1898 Ueber die Reducibilität complexer Zahlensysteme. *Math. Ann.*, **41**, 601–604.
- 1898 Sur la généralisation des fonctions analytiques. *C.R.* **116**, 1114–1116.
- 1898 Théorèmes relatifs aux fonctions analytiques à  $n$  dimensions. *C. R.*, **116**. 1242–1244.
- 1898 Sophus Lie, Vorlesungen über kontinuierliche Gruppen. Bearbeitet und herausgegeben von G. Scheffers. Leipzig. 12 + 810. Kapitel 21, p. 610–664.
- 1898–4 Verallgemeinerung der Grundlagen der gewöhnlich complexen Grössen. *Leipz. Ber.* 828–848 and 120–134.

HERMANN SCHEFFLER.

- 1846 Ueber das Verhältniss der Arithmetik zur Geometrie, insbesondere über die geometrische Bedeutung der imaginären Zahlen. Braunschweig. 8 + 428.
- 1851 Der Situationskalkül. Versuch einer arithmetischen Darstellung der niederen und höheren Geometrie auf Grund einer abstracten Auffassung der räumlichen Grössen, Formen und Bewegungen. Braunschweig. 14 + 404.
- 1880 Die polydimensionalen Grössen und die vollkommenen Primzahlen. Braunschweig: Vieweg. 201 pp. 8°.

LEOPOLD SCHEDEL.

- 1876 Die Bernoullischen Functionen und das Taylor'sche Theorem, etc. Jena.
- 1885 Grundzüge der Algebra nach Grassmann'schen Principien. Halle a. S.: Schmidt.

ADOLF SCHEPP.

- 1891 Die Grundzüge des geometrischen Calculs, von G. Peano. Autorisirte deutsche Ausgabe. Leipzig: Teubner. 4 + 98 pp. gr. 8°.

G. v. SCHERFF.

- 1880 Elementares Handbuch der Quaternionen, von P. G. Tait. Uebersetzung, von Dr. G. v. Scherff. Leipzig: Teubner. 16 + 392 pp. 8°.

## VICTOR SCHLEGEL.

- 1871 Untersuchungen über eine Fläche dritter Ordnung mittelst der Grassmann'schen Ausdehnungstheorie. Pr. Waren. Berlin: Calvary. 42 pp. 4°.
- 1871 Proben aus einer neuen, auf der Grassmann'schen Ausdehnungslehre fussenden, Bearbeitung der Elementar-Mathematik. Hoffmann Z., 2, 308–312.
- 1872–5 System der Raumlehre; nach den Prinzipien der Grassmann'schen Ausdehnungslehre. Erster Theil: Geometrie. 16 + 156. Zweiter Theil: Die Elemente der modernen Geometrie und Algebra. 9 + 257. Leipzig: Teubner. 8°.
- 1873 Ueber die mechanische Erzeugung von Curven. Math. Ann., 6, 321–329.
- 1876 Zwei Sätze vom Schwerpunkte. Schlömilch Z., 21, 450–451.
- 1878 Hermann Grassmann: sein Leben und seine Werke. Leipzig: Brockhaus. 82 pp.
- 1878 Ueber die geometrische Darstellung des Imaginären vom Standpunkte der Ausdehnungslehre. Schlömilch Z., 23, 141–157.
- 1878 Ueber die Verallgemeinerung einer Erzeugungsart der Curven zweiten Grades. Schlömilch Z., 23, 402–407.
- 1879 Ueber neuere geometrische Methoden, und ihre Verwandtschaft mit der Grassmann'schen Ausdehnungslehre. Schlömilch Z., 24, 83–95.
- 1882 Einige geometrische Anwendungen der Grassmann'schen Ausdehnungslehre. Pr. Waren. 81 pp.
- 1882 Quelques théorèmes de géométrie à  $n$  dimensions. S. M. F. Bull., 10, 172–207.
- 1883 Sur le théorème de M. Laisant, relatif aux centres de gravité. S. M. F. Bull., 10, 220–222.
- 1883 Die Ausdehnungslehre als Mittel zur Analysis elementargeometrischer Aufgaben. Hoffmann Z., 14, 81–86.
- 1883 Lösung von drei Aufgaben. Hoffmann Z., 14, 517, 518, 520.
- 1886 Ueber Entwicklung und Stand der  $n$ -dimensionalen Geometrie, mit besonderer Berücksichtigung der vier-dimensionalen. Leopoldina, 15 pp. 4°. Separatausgabe. Leipzig: Engelmann.

- 1887 Zum Gauss'schen Fundamentalsatz der Axonometrie. Hoffmann Z., **18**, 109-110.
- 1888 Sur les distances moyennes entre un point et des variétés de points, discrètes ou continues. Assoc. Franç., 266-281.
- 1891 Ueber die verschiedenen Formen von Gruppen, etc. Hoppe Arch., (2), **10**, 288-299.
- 1892-3 Introduction aux méthodes géométriques de H. Grassmann. El Progreso Matematico, **2**, 281-288, 332-336 ; **3**, 48-57.
- 1893 Sur le théorème de M. Haton de la Goupillière relatif au centre des moyennes distances. S. M. F. Bull., **21**, 49-51.
- 1894 Die Hauptmethoden der Grassmann'schen Ausdehnungslehre in ihrer Anwendung auf die Mechanik dargestellt. Der Civilingenieur, **40**, 1-34.
- 1894 Petites observations mathématiques. El Progreso Matematico, **4**, 169-177 and 219-222.
- 1894 On the problem of the minimum sum of the distances of a point from given points. American M. S. Bull., (2), **1**, 33-52.
- 1894 Solucion de la cuestion, 249. El Progreso Matematico, **5**, 178-180.
- 1895 Sur un système de coordonnées tétraédriques. S. M. F. Bull., **23**, 216-219. Abstract in Nouv. Ann., **11**, 70-74.
- 1895 Die Grassmann'sche Ausdehnungslehre. Ein Beitrag zur Geschichte der Mathematik in den letzten fünfzig Jahren. Schlömilch Z., **41**, 1-21 and 41-59. Separatausgabe. Leipzig: Teubner. 44 pp. 8°. Polish translation by S. Dickstein: Warsaw.
- 1896 Einige Sätze vom Schwerpunkt. Proc. Chicago Math. Congress. New York: Macmillan. 331-336.
- 1896 Der pythagoräische Lehrsatz in mehr dimensional en Räumen. Proc. Chicago Math. Congress, 337-340.
- 1900 Sur le développement et l'état actuel de la géométrie à  $n$  dimensions. L'Enseignement Math., **2**, 77-114.
- ERNST SCHROEDER.
- 1878 Lehrbuch der Arithmetik und Algebra. Leipzig: Teubner. 10 + 360 pp.

- 1880 Hermann Grassmann: sein Leben und seine mathematisch-physikalischen Arbeiten. In conjunction with R. Sturm and L. Sohncke. *Math. Ann.*, **14**, 1-45

FRIEDRICH SCHUR.

- 1888 Zur Theorie der aus  $n$  Haupteinheiten gebildeten complexen Zahlen. *Math. Ann.*, **33**, 49-60.  
1898 Lehrbuch der analytischen Geometrie, pp. 149-154. Leipzig: Veit.  
1908 Ueber Zusammensetzung von Vektoren. *Z. für Math.*

ROBERT FORSYTH SCOTT.

- 1880 A treatise on the theory of determinants. Cambridge.  
1880 On cubic determinants and other determinants of higher class, and on determinants of alternate numbers. *Lond. M. S. Proc.* **11**, 17-29.  
1882. On some forms of cubic determinants. *Lond. M. S. Proc.*, **13**, 33-42.

CORRADO SEGRE.

- 1885 Sur une expression nouvelle du moment mutuel de deux complexes linéaires. *J. für Math.* **99**, 169-172.  
1892 Le rappresentazioni reali delle forme complesse e gli enti iperalgebrici. *Math. Ann.*, **40**, 413-468.  
1897 Teoria geometrica dei campi vettoriali; par Galileo Ferraris. Edited by C. Segre. *Torino Mem.*, (2), **47**, 259-338.

SERVOIS.

- 1813 Sur la théorie des quantités imaginaires. Lettre au Redacteur. *Gergonne Ann.*, **4**.

A. SEYDLER.

- 1881 Zur Theorie der complanaren Biquaternionen oder der doppelt complexen Grössen. *Prag Ber.*, 80-104.

W. J. C. SHARP.

- 1885 On the application of Joachimstahl's method of studying surfaces, and of an extension of it to surfaces defined by Quaternion equations, including the solution of question 7821. *Ed. Times*, **43**, 47-49.  
1886 Question 7174. *Ed. Times*, **44**, 119-120.

JAMES BYRNIE SHAW.

- 1895 The linear vector operator of Quaternions. *American J.*, **19**, 267-282. Abstract in *American M. S. Bull.*, (2), **2**, 2-3.
- 1895 A new application of Quaternions to Geometry. Abstract in *American M. S. Bull.* (2), **2**, 8.
- 1895 Development of some useful Quaternion expressions with applications to geometry of three and four dimensions. (Abstract.) *American Assoc. Proc.*, **44**, 21.
- 1896 Sedenions (title). *American Assoc. Proc.*, **45**, 26.
- 1897 Quaternion invariantive operators. (Abstract.) *American M. S., Bull.*, (2), **4**, 6.
- 1897 Development of the A-process in Quaternions, with a geometrical application. *American J.*, **19**, 198-216.
- 1898 Dual algebras. *American M. S. Bull.*, (2), **4**, 363.
- 1899 Some quaternion integrals and their related classes of functions. *American M. S. Bull.*, (2), **5**, 228.
- 1899 Some generalizations in multiple algebra and matrices. *American M. S. Bull.*, (2), **5**, 380-381.
- 1900 Multiple algebra. *American M. S. Bull.*, (2), **6**, 378-379.
- 1902 Commutativity of matrices and application to the theory of linear associative algebra. *American M. S. Bull.*, (2), **8**, 204.
- 1902 Theory of linear associative algebra. *American M. S. Bull.*, (2), **9**, 74. *American M. S. Trans.*, **4**, 251-287.
- 1908 On nilpotent algebras. *American M. S. Bull.*, (2), **9**, 388. *American M. S. Trans.*, **4**, 405-422.

SIEBECK.

- 1858 Ueber die graphische Darstellung imaginärer Functionen. *Crelle J.*, **55**, 221-253.

O. SIMONY.

- 1885 Ueber zwei universelle Verallgemeinerungen der algebraischen Grundoperationen. *Wien Ber.*, **91**.

SEBASTIAN SIRCOM.

- 1888 Solution of a question proposed by Sylvester. No. 7,740. *Ed. Times*, **48**, 23-24.

F. SLATE.

1901 The use of axis-vectors. *Nature*, **64**, p. 54.

H. J. S. SMITH.

1882 Introduction to the "Mathematical Papers of W. K. Clifford."  
pp. lxii-lxx.

PERCEY F. SMITH.

1908 Josiah Willard Gibbs: A short sketch and appreciation of his  
work in pure mathematics. *American M. S. Bull.*, (2),  
**10**, 84-89.

ARNOLD SOMMERFELD.

1897 Ueber die Theorie des Kreisels. Heft I. Exkurs über die  
Quaternionentheorie, pp. 55-68. Von F. Klein und A.  
Sommerfeld. Leipzig: Teubner.

J. SOMOFF.

1878 Sur les vitesses virtuelles d'une figure invariable assujetties à  
des équations de conditions quelconques de forme linéaire.  
*Petersb. Bull.*, **18**, 162-184.

1878-9 Theoretische Mechanik. Zwei Bände. Uebersetzt von A.  
Ziwet. Leipzig. 8°.

WILLIAM SPOTTISWOODE.

1850 On the geometrical interpretation of Quaternions. *Phil. Mag.*  
(8), **37**, 108-118.

1850 On the equation  $Q = q(w, x, y, z) = w + ix + jy + kz$ . *Phil.*  
*Mag.*, (8), **36**, 185-187.

1850 On the Quaternion expressions of coplanarity and homo-  
conicisim. *Phil. Mag.*, (8), **36**, 879-881.

1872 On some recent generalizations of algebra. Presidential  
address. *Lond. M. S. Proc.*, **4**, 147-164.

1878 Presidential address before the British Association. Report,  
17-20.

G. P. STARKWEATHER.

1899 Non-quaternion number-systems containing no skew units.  
*American J.*, **21**, 369-386.

1901 A class of number-systems in six units. *American J.*, **23**,  
378-402.

CHARLES PROTEUS STEINMETZ.

- 1893 Complex quantities and their use in electrical engineering. Proc. of the Chicago International Electrical Congress, 38-75.
- 1897 Theory and calculation of alternating current phenomena. With the assistance of Ernst J. Berg. New York: Johnston Company. 17 + 431. 2° edition in 1898; 3° edition in 1900; German translation in 1899.
- 1901 Theoretical elements of electrical engineering. New York, 8 + 330. 2° edition in 1902.

KYPARISSOS STEPHANOS.

- 1888 Sur une représentation des homographies binaires par des points de l'espace, avec application à l'étude des rotations sphériques. Math. Ann., 22, 299-367.
- 1888 Sur la théorie des quaternions. Extrait d'une lettre adressée à M. Felix Klein. Math. Ann., 22, 589-592.
- 1888 Sur les nombres complexes composés avec plusieurs unités symboliques. Volume commémoratif du 50<sup>m</sup>e anniversaire de la fondation de l'Université d'Athènes. (Greek.) Athens. 11 pp.
- 1898 Sur les systèmes associatifs de nombres symboliques. Verh. d. intern. Math. Congr., I., 141-142.
- 1899 Sur une extension du calcul des substitutions linéaires. C. R., 128, 593-596.
- 1900 Sur une extension du calcul des substitutions linéaires. Journ. de Math., (5), 6, 73-128.

G. J. STOKES.

- 1900 Logical theory of the imaginary. Mind. 9.

OTTO STOLZ.

- 1885-6 Vorlesungen über allgemeine Arithmetik. Leipzig: Teubner. 8°.

WASHINGTON IRVING STRINGHAM.

- 1878 Investigations in Quaternions. American Acad. Proc., 13, 310-341.



- 1879 The Quaternion formulæ for quantification of curves, surfaces and solids, and for barycentres. *American J.*, **2**, 205-211.
- 1882 Determination of the finite Quaternion groups. *American J.*, **4**, 345-358.
- 1884 On a geometrical interpretation of the linear bilateral quaternion equation. *American Assoc. Proc.*, **33**, 54-55.
- 1884 On the rotation of a rigid system in space of four dimensions. *American Assoc. Proc.*, **33**, 55-56.
- 1893 Uniplanar algebra: being part I. of a propædæutic to the higher mathematical analysis. San Francisco: Berkeley Press. 13 + 141 pp. 12°.

WENDELL M. STRONG.

- 1901 Note on non-quaternion number-systems. *American M. S. Trans.*, **2**, 43-48.

FRANZ JOSEF STUDNICKA.

- 1875 Ueber die reducirte Form der Quaternionen. *Prag Ber.*, 183-186.
- 1876 Ueber die Quaternionentheorie. (Bohemian.) *Casopis*, **5**.
- 1888 Neuer Beweis des Satzes, dass das Product der Summe von acht Quadratzahlen mit der Summe von acht Quadratzahlen sich als Summe von acht Quadratzahlen darstellen lass. *Prag Ber.*, 475-481.
- 1893 Beitrag zur Quaternionenlehre. *Prag Ber.*, 10 pp.
- 1894 Ueber Quaternionen. (Bohemian.) *Casopis*, **23**, 145-.
- 1891 Neuer Beitrag zur Quaternionenlehre. *Prag Ber.*, 18 pp.
- 1894 Neue Lehrsätze, Summen von Quadratzahlen betreffend. *Prag Ber.*
- 1894 Ueber Funktionen einer quaternionalen Variablen. *Prag Ber.*

EDUARD STUDY.

- 1885 Ueber die Geometrie der Kegelschnitte. *Habilitations-Schrift*. Leipzig.
- 1885 Ueber die Maassbestimmung extensiver Grössen. *Diss.* München.

- 1889 *Complexe Zahlen und Transformationsgruppen.* Leipz. Ber., **41**, 177- , 218- .
- 1889 *Ueber Systeme von complexen Zahlen.* Gött. Nachr.
- 1889 *Methoden zur Theorie der ternären Formen.* Leipzig: Teubner. 12 + 210.
- 1891 *Von den Bewegungen und Umlegungen.* Math. Ann., **39**, 441-564.
- 1894 *Hermann Grassmann's "Gesammelte mathematische und physikalische Werke."* I. Band, I. Theil. Unter der Mitwirkung von Eduard Study. Herausgegeben von Friedrich Engel. Leipzig: Teubner. 12 + 486 pp. 8°.
- 1896 *Betrachtungen über Doppelverhältnisse.* Leipz. Ber., **48**, 199-220.
- 1899 *Neue Darstellung der Kräfte durch geometrische Figuren.* Leipz. Ber.
- 1899 *Theorie der gemeinen und höheren complexen Grössen.* Encykl. d. Math. Wiss., **1**, 147-184.
- 1900 *Die Geometrie der Dynamen.* Deutsche Math. Ver., **8A**, 204.
- 1900-1 *Die Hauptsätze der Quaternionentheorie.* Mittheilungen des Naturwiss. Vereins von Neuvorpommern und Rügen. Greifswald.
- 1901 *Geometrie der Dynamen. Die Zusammensetzung von Kräften und verwandte Gegenstände der Geometrie.* Leipzig: Teubner. 240 pp.

RUDOLF STURM.

- 1876 *Sulle forze in equilibrio.* Annali di Mat., (2), **7**, 217-246.
- 1880 *Hermann Grassmann: sein Leben und seine mathematisch-physikalischen Arbeiten.* In conjunction with E. Schröder and L. Sohncke. Math. Ann., **14**, 1-45.
- 1888 *Ueber Collineation und Correlation.* Math. Ann., **22**, 569-588.

JAMES JOSEPH SYLVESTER.

- 1888-4 *Sur les quantités formant un groupe de nonions.* C. R., **97**, 1886-1840, **98**, 273-276, 471-475.
- 1888-4 *On quaternions, nonions, sedenions, etc.* Johns Hopkins Univ. Circ., **3**. Nos. 7 and 9. **4**, No. 28.

- 1884 Sur la résolution générale de l'équation en matrices. C. R.,  
99, 409-412, 432-436.
- 1884 Lectures on the principles of universal algebra. American  
J., 6, 270-286.
- 1884 The genesis of an idea, or story of a discovery relating to  
equations in multiple quantity. Nature, 31, 85-86.
- 1884 On the three laws of motion in the world of universal algebra.  
Johns Hopkins Univ. Circ., No. 83.
- 1884 Sur les équations monothétiques. C. R., 99, 13-15.
- 1884 Sur la solution du cas le plus général des équations linéaires  
en quantités binaires, c'est-à-dire, en quaternions ou en  
matrices du second ordre. C.R., 99, 117-118.
- 1884 Sur les deux méthodes, celle de Hamilton et celle de l'auteur,  
pour résoudre l'équation linéaire en quaternions. C. R.,  
99, 473-476.
- 1884 Sur l'achèvement de la nouvelle méthode pour résoudre  
l'équation linéaire la plus générale en quaternions. C. R.,  
99, 502-505.
- 1884 Sur la solution explicite de l'équation quadratique de  
Hamilton en quaternions ou en matrices du second ordre.  
C.R., 99, 555-558.
- 1867 Thoughts on inverse orthogonal matrices, etc. Phil. Mag.  
(4), 34, 461-475.
- 1888 On the involution and evolution of quaternions. Phil. Mag.  
(5), 16, 894-896.
- 1884 On the solution of a class of equations in quaternions. Phil.  
Mag. (5), 17, 892-897.
- 1885 Question 7922. Prove that the equation in quaternions  
 $x^2 - px = 0$  has four roots, and that these roots, if regarded  
as belonging to the square of the equation, obey Harriot's  
law. Ed. Times, 43, 105-107.
- HENRY TABER.
- 1890 On the theory of matrices. American J., 12, 337-396.
- 1891 On certain identities in the theory of matrices. American J.,  
13, 159-172.
- 1891 On the application to matrices of any order of the Quaternion  
symbols S and V. Lond. M. S. Proc., 22, 67-79.

## PETER GUTHRIE TAIT.

- 1859 Quaternion investigations connected with Fresnel's wave surface. *Quart. J.*, **3**, 190-210. *S. P.* **1**, 1-19.
- 1859 Note on the Cartesian equation of the wave-surface. *Quart. J.*, **3**, 269-270. *S. P.* **1**, 20-21.
- 1860 Quaternion investigations connected with electrodynamics and magnetism. *Quart. J.*, **3**, 331-342. *S. P.*, **1**, 22-32.
- 1860 Quaternion investigation of the potential of a closed circuit. *Quart. J.*, **4**, 143-144. *S. P.*, **1**, 33-34.
- 1862 Formulæ connected with small continuous displacements of the particles of a medium. *Edinb. Proc.*, **4**, 617-623. *S. P.*, **1**, 37-42.
- 1862 Quaternions. *Messenger*, **1**, 78-91, 140-156, 203-220.
- 1863 Note on a quaternion transformation. *Edinb. Proc.*, **5**, 115-119, *S. P.*, **1**, 43-61.
- 1864 Elementary physical applications of quaternions. *Quart. J.*, **6**, 279-301.
- 1866 Sir William Rowan Hamilton. *North British Review*, **45**, 57.
- 1867 An elementary treatise on Quaternions, Oxford: Clarendon Press, 18 + 320. 2<sup>o</sup> edition in 1873, Cambridge: University Press, 20 + 296. 3<sup>o</sup> edition in 1890, Cambridge: University Press. 27 + 422 pp. 8<sup>o</sup> German translation by von Scherff in 1880. French translation by Plarr in 1882-4.
- 1867 Note on the reality of the roots of the symbolical cubic which expresses the properties of a self-conjugate linear and vector function. *Edinb. Proc.*, **6**, 92-93. *S. P.*, **1**, 74-75.
- 1867 Note on a celebrated geometrical problem. *Edinb. Proc.* *S. P.*, **1**, 76-77.
- 1868 On the rotation of a rigid body about a fixed point. *Edinb. Trans.*, **25**, 261-304. *S. P.*, **1**, 86-127.
- 1870 On the most general motion of an incompressible fluid. *Edinb. Proc.*, **7**, 143-144. *S. P.*, **1**, 134-135.
- 1870 On Green's and other allied theorems. *Edinb. Trans.*, **26**, 69-84. *S. P.*, **1**, 136-150.
- 1870 Note on linear partial differential equations. *Edinb. Proc.* **7**, 190-192. *S. P.*, **1**, 151-152.

- 1870 Note on linear differential equations in quaternions. Edinb. Proc., 7, 811-818. S. P., 1, 158-158.
- 1870-2 On some quaternion integrals. Edinb. Proc., 7, 818-820, 784-788. S. P., 1, 159-160, 161-163.
- 1871 Address to Section A of the British Association. Brit. Assoc. Rep., pt. 2, 1-8. French translation; Mondes, (2), 28, 445-457.
- 1871 Mathematical notes. Edinb. Proc., 7, 494-498, and 498-506.
- 1871 On the operation  $\phi$  ( $\nabla$ ). Edinb. Proc., 7, 607-608.
- 1872 On orthogonal isothermal surfaces. Edinb. Trans. 27, 105-128. S. P., 1, 176-193.
- 1872 Note on the strain function. Edinb. Proc., 7, 667-668. S. P., 1, 194-198.
- 1878 Note on the transformation of double and triple integrals. Edinb. Proc. S. P., 1, 284-286.
- 1878 Note on the various possible expressions for the force exerted by an element of one linear conductor on an element of another. Edinb. Proc. S. P., 1, 287-244.
- 1878 Introduction to Quaternions, with numerous examples. By P. Kelland and P. G. Tait. Chap. x. Vector equations of the first degree, due to Tait alone. London: Macmillan. 2<sup>o</sup> edition in 1882. 18 + 232 pp. 8<sup>o</sup>. 8<sup>o</sup> edition edited by C. G. Knott in 1904.
- 1877 Note on vector conditions of integrability. Edinb. Proc., 9, 527-538. S. P., 1, 352-356.
- 1878 Review of Clifford's "Dynamic." Nature, 18, 89-91.
- 1878 Note on the surface of a body in terms of a volume integral. Edinb. Proc., 9, 541-542. S. P., 1, 360.
- 1879 Quaternion investigations connected with Minding's theorem. Edinb. Proc., 10, 200.
- 1879 Quaternion proof of Minding's theorem. Lond. M. S. Proc., 10, 101-103.
- 1880 Hamilton, Ency. Brit., 9th edition. S. P., 2, 440-444.
- 1880 On a graphical solution of the equation  $V\rho\phi\rho = 0$ . Edinb. Proc., 10, 402-404. S. P., 1, 404-405.
- 1880 On Minding's theorem. Edinb. Trans., 29, 675-685. S. P., 1, 412-422.

- 1881 On some space-loci. *Edinb. Proc.*, **11**, 197-198.
- 1884 On an equation in quaternion differences. *Edinb. Proc.*,  
561-562. *S.P.*, **2**, 101-102.
- 1884 Note on reference frames. *Edinb. Proc. S.P.*, **2**, 104-106.
- 1886 Quaternions. *Ency. Brit.*, 9th edition. *S. P.*, **2**, 445-456.
- 1888 Quaternion notes. *Edinb. Proc.*, **15**, 879-880. *S.P.*, **2**,  
280-281.
- 1889 Note on Mr. M'Aulay's paper on differentiation of any power  
of a Quaternion. *Edinb. Proc.*, **16**, 205-206.
- 1889 The relation among four vectors. *Edinb. Proc.*, **16**, 88-90.  
*S.P.*, **2**, 285-287.
- 1889 On the relation among the line, surface, and volume integrals.  
*Edinb. Proc.*, **16**, 257. *S.P.*, **2**, 288.
- 1889 Quaternion note on a geometrical problem. *Edinb. Proc.*,  
**16**, 315-319. *S.P.*, **2**, 289-291.
- 1890 On the importance of Quaternions in Physics. *Phil. Mag.*,  
(5), **29**, 84-97. *S.P.*, **2**, 297-308.
- 1890 Note on a curious operational theorem. *Edinb. M.S. Proc.*,  
**8**, 21-22. *S.P.*, **2**, 312.
- 1891 Quaternions and the Ausdehnungslehre. *Nature*, **44**, 105-106.
- 1892 Note on the division of space into infinitesimal cubes. *Edinb. Proc.*, **19**, 193-197. *S.P.*, **2**, 329-332.
- 1893 Vector analysis. *Nature*, **47**, 225-226.
- 1893 Quaternions as an instrument in physical research. (Review  
of M'Aulay's "Utility of Quaternions in Physics.")  
*Nature*, **49**, 193-194.
- 1894 Note on the antecedents of Clerk-Maxwell's electrodynamical  
wave equations. *Edinb. Proc.*, **20**, 213-214. *S.P.*, **2**,  
388-389.
- 1894 On the electromagnetic wave surface. *Edinb. Proc.*, **21**,  
165-166. *S.P.*, **2**, 390-391.
- 1894 On the intrinsic nature of the quaternion method. *Edinb. Proc.*, **20**, 276-284. *S.P.*, **2**, 392-398.
- 1896 On the linear and vector function. *Edinb. Proc.*, **21**, 160-164. *S.P.*, **2**, 406-409.

- 1897 On the linear and vector function. Edinb. Proc., 21, 310-312. S.P., 2, 410-412.
- 1897 Note on the solution of equations in linear and vector functions. Edinb. Proc., 21, 497-505. S.P., 2, 418-420.
- 1897 On the directions which are most altered by homogeneous strain. Edinb. Proc., 22, 162-164. S.P., 2, 421-423.
- 1898 Scientific Papers. Vol. I., 14 + 498. Vol. II., 14 + 500 in 1900. Cambridge: University Press. 4°.
- 1899 On the linear and vector function. Edinb. Proc., 22, 547-549. S.P., 2, 424-426.
- 1899 On the claim recently made for Gauss to the invention (not the discovery) of quaternions. Edinb. Proc. 23, 17-23.
- 1901 On the linear and vector function. Edinb. Proc., 547.
- † 1902 Quaternion notes. Communicated by C. G. Knott. Edinb. Proc., 24, 344.

GASTON TARRY.

- 1886 Représentation géométrique des coniques et quadriques imaginaires. Paris: Gauthier-Villars.
- 1888 Nouvel essai sur la géométrie imaginaire. Assoc. franç.
- 1889 Géométrie générale. Assoc. franç.

F. GOMES TEIXEIRA.

- 1883 Sur la théorie des imaginaires. Brux. S. sc. 417-427.

T. N. THIELE.

- 1897 Essai sur la représentation analytique de la direction, par Caspar Wessel. Seconde preface, xi-xiv.

ORESTE TOGNOLI.

- 1898 Gli elementi complessi nella geometria analitica. Batt. G., 31, 137-150.

ABEL TRANSON.

- 1867 Le principe et la règle des signes. Nouv. Ann., (2), 6, 289-298.
- 1868 Communication d'une lettre d'Abel Transon datée 29 Juin 1868, par M. Laisant. S. M. F. Bull., 20, 104-106.
- 1868 Démonstration de deux théorèmes d'algèbre. Nouv. Ann. (2) 7, 97-110.
- 1868 Application de l'algèbre directive à la géométrie. Nouv. Ann. (2), 7, 145-157, 198-208, 241-264.

G. C. TURNER.

1908 Vectors and Rotors. In conjunction with O. Henrici.  
London: Arnold, 16 + 204 pp. 8°.

G. TZITZEICA.

1900-1 Asupra vectorilor. Gaceta Matematica; Bukarest, 6, 58.

K. W. UNVERZAGT.

1876 Theorie der goniometrischen und der longimetrischen Quaternionen; zugleich als Einführung in die Rechnung mit Punkten und Vektoren. Wiesbaden: Kreidel. 2 + 812 pp. 8°.

1878 Der Winkel als Grundlage mathematischer Untersuchungen. Jahresbericht der höheren Bürgerschule zu Wiesbaden.

1881 Ueber die Grundlagen der Rechnung mit Quaternionen. Jahresbericht der städtischen Realschule zu Wiesbaden.

K. TH. VAHLEN.

1902 Ueber Bewegungen und complexe Zahlen. Math. Ann., 58, 585-598.

HERMANN VALENTINER.

1897 Essai sur la représentation analytique de la direction, par Caspar Wessel. Première preface, iii-x.

F. VALLÉS.

1841 Études philosophiques sur la science du calcul. Paris: Gauthier-Villars. 8°.

1869-72 Des formes imaginaires en algèbre. Paris: Gauthier-Villars. 3 parts.

JAN VERSLUYS.

1872 Démonstration nouvelle de la propriété associative de la multiplication des Quaterniones. Arch. Néerl., 7.

1875-6 Theorie der Quaternionen. Nieuw Archief, 1, 41-58, 97-124; 2, 185-150.

FEDERICO VILLAREAL.

1901 Calculo geometrico. Lima: Mesinas. 40 pp. 8°.



WOLDEMAR VOIGT.

- 1898 Die fundamentalen physikalischen Eigenschaften der Krystalle. Leipzig.  
1900 Ueber die Parameter der Krystallphysik und über gerichtete Grössen höherer Ordnung. Gött. Nachr., 355-379.  
1901 The above more extended. Ann. der Physik., (4), 5, 241-275.

EMIL WAELSOH.

- 1889 Zur Invariantentheorie der Liniengeometrie. Wien Ber., 98.

JOHN JAMES WALKER.

- 1879 Quaternion proof of Minding's theorem. Lond. M. S. Proc., 10, 100-101.  
1881 Quaternion proof of Mr. Samuel Roberts's theorem of four co-intersecting spheres. Lond. M. S. Proc., 12, 147-148.  
1882 Solutions of questions 5,803 and 6,674. Ed. Times, 37, 46-47 and 57.

JOHN WALLIS.

- 1685 De Algebra tractatus. London. Folio.  
1693 Wallis' Works. The second volume contains De Algebra tractatus. Chapters 66-69 treat of imaginaries. London. Folio.

WILLIAM WALTON.

- 1840 On the general interpretation of equations between two variables in analytical geometry. Cambr. Math. J., 2, 109-118.  
1840 On the general theory of multiple points. Cambr. Math. J., 2, 155-167.

JOHN WARREN.

- 1828 A treatise on the geometrical representation of the square roots of negative quantities. Cambr. 154 pp. 8°.  
1829 Consideration of the objections raised against the geometrical representation of the square roots of negative quantities. Lond. Phil. Trans., 119, 241-254.  
1829 On the geometrical representation of the powers of quantities whose indices involve the square roots of negative quantities. Lond. Phil. Trans., 119, 339-359.

J. H. MACLAGAN WEDDERBURN.

- 1903 On the general scalar function of a vector. *Edinb. Proc.*, **24**, 409–412.  
1903 On the applications of Quaternions in the theory of differential equations. *Edinb. Proc.*, **24**, and *Edinb. Trans.*, **40**, 709–721.

E. WEICHEERT.

- 1896 Ueber die Grundlagen der Electrodynamik. *Wiedemann Ann.*, **59**, 288–323.  
1899 Grundlagen der Electrodynamik. *Festschrift*.

CASPAR WESSEL.

- 1799 Om Directionens analytiske Betyning. *Memoirs Roy. Soc. of Denmark*.  
†1896 The same. Reprinted in *Arch. for Math. ok Nat.*, **18**.  
1897 Essai sur la représentation analytique de la direction. Translation of the above, with prefaces, by H. Valentiner and T. N. Thiele. Copenhagen: Höst. 14 + 60 pp. 4°.

TH. B. VAN WETTUM.

- 1884 Over de complexe getallen en verhouding van richting. *Diss. Deventer*.  
1890 De quaternion van Hamilton als matrix van Cayley. *Nieuw Archief*, **17**, 206–216.  
1891 Over den Quaternion-matrix. *Nieuw Archief*, **18**, 168–186.  
1893 Over het quotient van twee ruimte-vectoren, en over een quaternion. *Nieuw Archief*, **2**, 68–76.  
1894 Researches on matrices and quaternions. 1°. The matrix of the second order. 2°. Some properties of versor-arcs. 3°. The matrix as a unit-quotient of vectors. 4°. On the solution of a linear vector equation. Leyden: Brill. 26 pp. 4°.

EDOUARD WEYR.

- 1884 Sur la théorie des quaternions. *C. R.*, **98**, 906–907, 1920–1923.  
1887 Ueber binäre Matrizen. *Prag Ber.*, **25**, 358—.  
1889 Zur Theorie der bilinearen Formen. *Monatsh. f. Math.*, **1**.

ALFRED NORTH WHITEHEAD.

- 1898 A Treatise on Universal Algebra. Vol. i. 11 + 586 pp.  
Cambridge: Univ. Press. Grand 8°.

M. M. U. WILKINSON.

- 1889 On the scalar relations connecting six vectors. Edinb. Proc.,  
16, 178-186.  
1890 Some multinomial theorems in Quaternions. Edinb. Proc.,  
17, 149-157.

EDWIN BIDWELL WILSON.

- 1901 Vector analysis: a text-book for the use of students of mathe-  
matics and physics; founded upon the lectures of J.  
Willard Gibbs. New York: Scribners. 18 + 486 pp. 8°.

DE VOLSON WOOD.

- 1879 Elements of coordinate geometry. 1° part: Cartesian  
geometry. 2° part: Quaternions. 3° part: Modern  
geometry and an appendix. New York: Wiley. 8°.  
1880 Quaternions. Analyst, 7, 11-13, 88-88, 65-71, 121-128.  
1881 Reply to criticisms on his exposition of Quaternions by A. S.  
Christie. Analyst, 8, 10-16.

ROBERT WOODHOUSE.

- 1801 On the necessary truth of certain conclusions obtained by  
means of imaginary quantities. Lond. Phil. Trans., 20,  
89-119.  
1803 The principles of analytical calculation. Cambridge. 4°.

ROBERT SIMPSON WOODWARD.

- 1896 Higher Mathematics. Edited by M. Merriman and R. S.  
Woodward. Chaps. viii. and ix. New York: Wiley.  
11 + 576 pp.

WILLEM ABRAHAM WYTHOFF.

- 1898 De Biquaternion als Bewerking in de Ruimte van vier  
Afmetingen. (Thesis.) Amsterdam: Ipenbuur & van  
Seldam. 152 pp. 8°.

1898 Een stelsel bewerkingen in de ruimte van vier afmetingen  
analoog met Hamilton's quaternion. Amst. Versl., 6,  
520-530.

WILLIAM HENRY YOUNG.

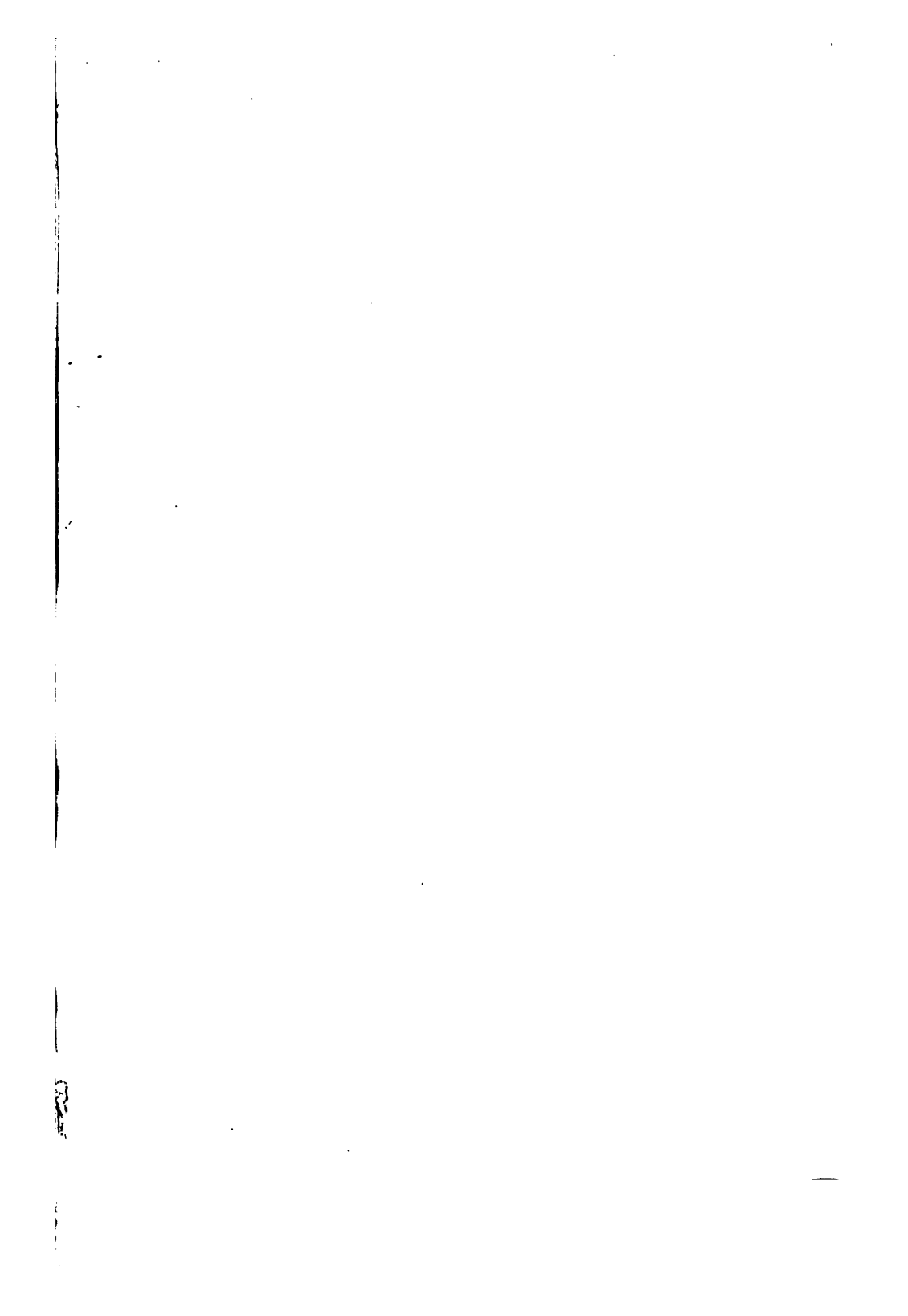
1898 On systems of one-vectors in space of  $n$  dimensions. Lond.,  
M. S. Proc., 29, 478-487.

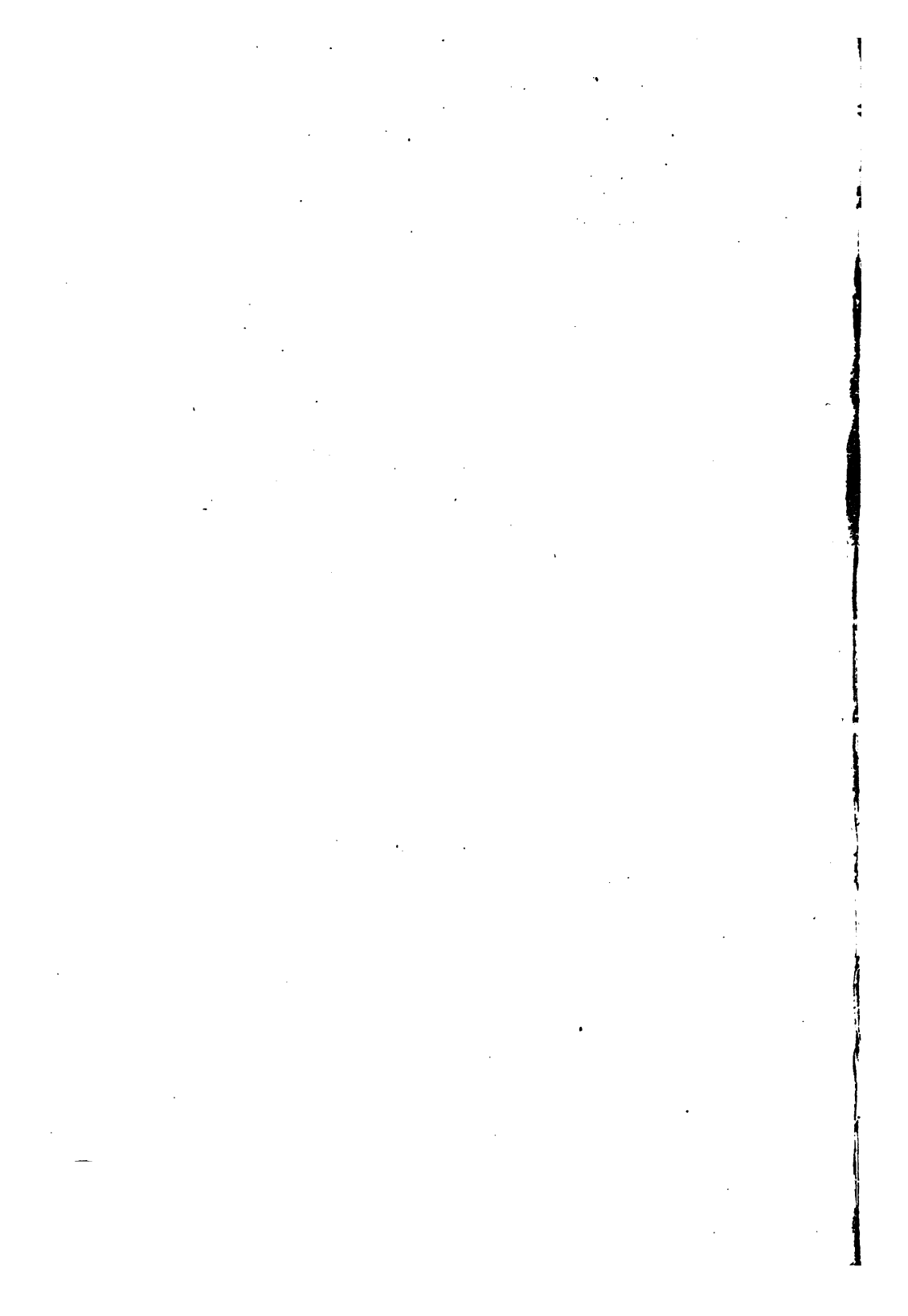
J. ZANCHEVSKY.

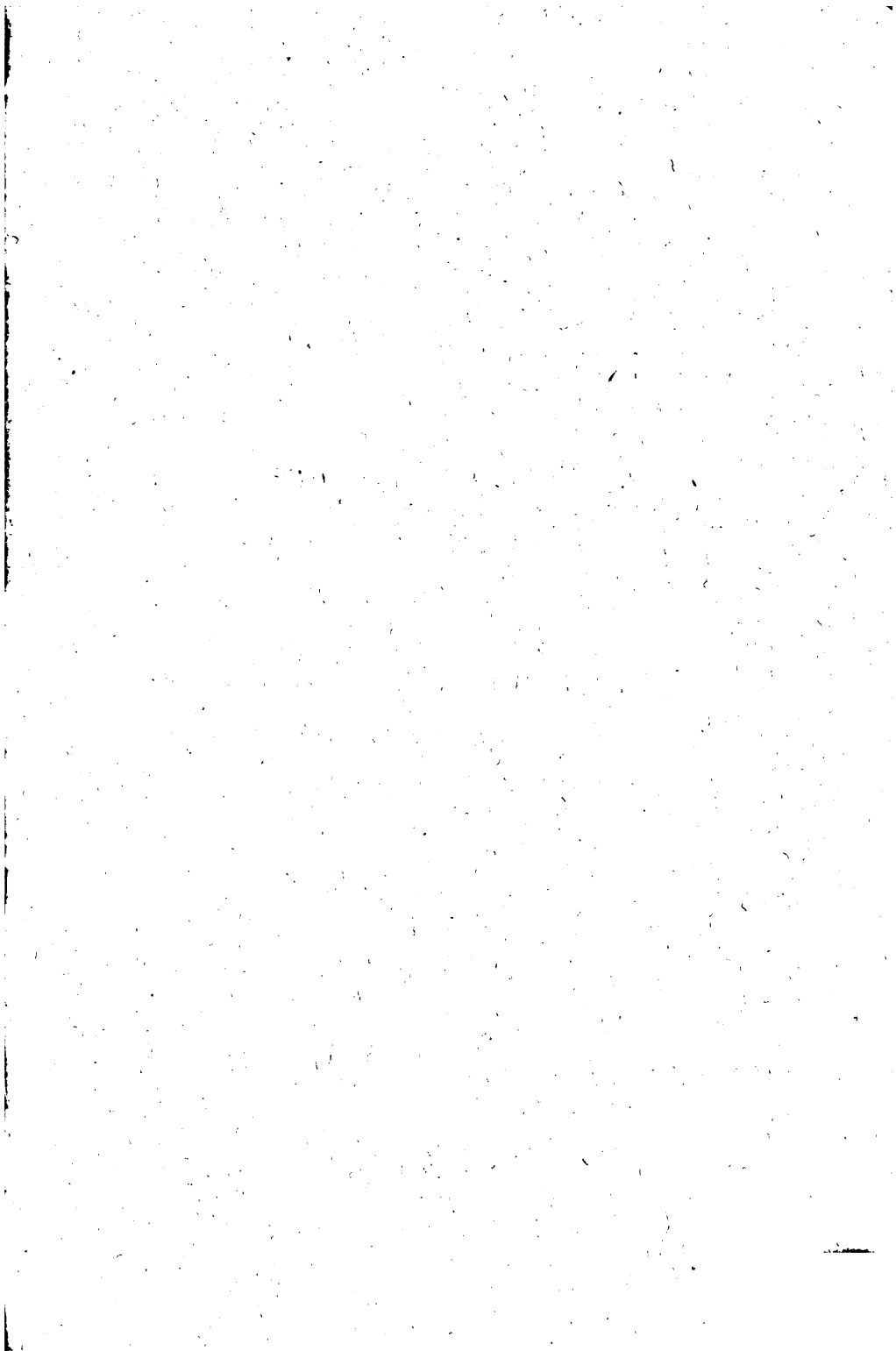
1889 Theory of Screws and its application to Mechanics. (Russian.)  
Odessa. 20 + 181.

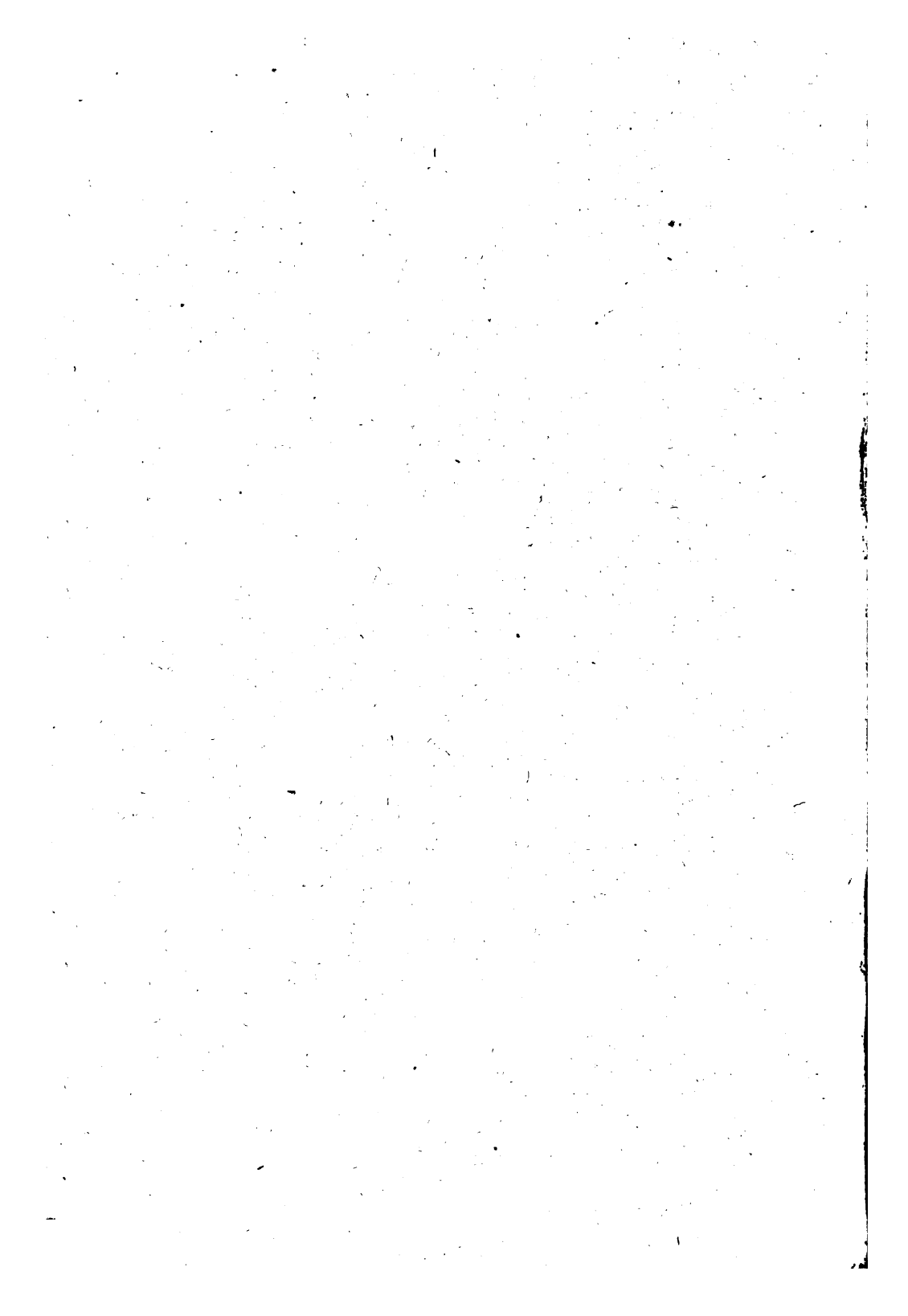
ALEXANDER ZIWET.

1878 Theoretische Mechanik, von J. Somoff. Zwei Bände, übersetzt  
von A. Ziwet. Leipzig. 8°.











BOOKS LIBRARY  
MAR 18 1905

UNIVERSITY OF MICHIGAN



3 9015 06570 0497

