

Coda: Legendre's Choice of *Symmetry*—What's in a Word?

The problem Legendre addressed was clearly mathematical, more specifically, geometrical: how should the mutual relations of convex solids whose faces are congruent, respectively, be characterized? He was concerned with mathematical-geometrical objects, not with material-physical objects, and his point of departure was Euclid's problematic definitions of the mutual relations of solid bodies which are equal and similar. He excluded applying the term, *symmetry*, to plane figures because the issue for him had to do with superposability of solids and in the plane this had already been adequately treated in Euclid's *Elements*. Legendre's concept of symmetry, which resolved this problem, was both unprecedented and consistent with the Euclidean tradition and, with this innovation, symmetry became for the first time a powerful concept in a scientific domain.

Legendre made a discovery: a convex polyhedron has a counterpart with congruent faces that is equal to it in volume and yet the two bodies cannot be superposed. He called this mutual relation of such two polyhedra *symmetrical*, but he does not share with the reader his reasons for choosing the term, *symmetry*, as the name for this relation. Although we can suggest reasons, we are unlikely to find any that would inspire complete confidence. It seems that Legendre had three possible kinds of precedents for the usage of this word: the Encyclopaedists' concept of respective symmetry, Euclid's usage of *symmetry* for commensurability, and the association of symmetry with regularity in 18th century scientific texts.

The architectural usage of *respective symmetry* in the 18th century had been extended to naval architecture in the design of shipbuilding (see §§ 4.2.3, 4.2.4, and 9.2), while the Euclidean usage of *symmetry* in mathematics was no longer current in the 17th century (see Ch. 2). It stands to reason that Legendre knew about all of these meanings, given their usages in the French language and in the literature on engineering, respectively.¹

¹ Monge's textbook of 1788 on statics had been well received and widely used (a second edition had already appeared before Legendre's textbook on geometry was published), and it is likely that Legendre was aware of the work by this leading fellow mathematician. Note also that Didot, Legendre's publisher, was a printer and bookseller *pour les Mathématiques, la Marine, l'Architecture etc.* It can, therefore, safely be assumed that Legendre knew of the aesthetic definitions of symmetry which appeared in the *Encyclopédie* and treatises on architecture as well as

Thus, one reasonable conjecture is that Legendre's choice was related to *respective symmetry* which he may have understood as a purely mathematical abstraction without any aesthetic considerations (as is the case with the Euclidean usage of *symmetry* for commensurability that had no aesthetic component). In his explanatory note for illustrating the mutual relation of equality by symmetry, Legendre introduces a mirror as a "central feature", thus rendering the symmetry truly bilateral (which, as we explained in Ch. 4, was not the case for respective symmetry). The notion that elements organized in a certain order that repeats itself in reverse comes to fruition in Legendre's conception of mutually symmetrical polyhedra. Legendre searched for a distinctive term which would capture the mutual relation of the inverse ordering of the faces of a polyhedron when they are equal and similar to those of a given polyhedron, and decided to give a new meaning to a word that previously had an entirely different connotation. That is, he may have decided to take a term from the domain of architecture and apply it to a scientific problem. In any event, this had been already the case with the application of *symmetry* in naval architecture.

A second possible source of influence on Legendre is the terminology of Euclid's *Elements*. Legendre sought a term for a mutual relation. There are not so many mathematical terms in Euclid for mutual (or, reciprocal) relations: e.g., equality, similarity, congruence, parallel, and commensurable. But only symmetrical was not in current mathematical usage at the time of Legendre. For example, "parallel" has retained its meaning in current usage. *Summetria* in Euclid's *Elements*, Book X, referred to a mutual relation of two quantities of the same kind (irrespective of their spatial arrangement) which have a common measure. It was subsequently replaced by the term, *commensurability*. Hence, *symmetry* was available for use in a different way.

In his *Éléments de géométrie*, Legendre does not include any discussion of the Euclidean sense of symmetry, that is, commensurability; thus, he was free to assign a new meaning to this term. In a lengthy explanatory note in Book III: *Les proportions des figures*, Legendre says:

N. B. For the intelligibility of this book and those that follow, it is necessary to have at hand the theory of proportions for which we refer [the reader] to standard treatises on arithmetic and algebra . . . If A, B, C, D are lines, . . . then [if we] let each represent a number of units (whole or fractional, commensurable or incommensurable [*commensurable ou incommensurable*]), the proportion between lines A, B, C, D becomes a proportion of numbers.²

the application of the concept in the design of ships. And, of course, Legendre was familiar with Euclid's *Elements*.

² Legendre [1794] 1817, 61: "*N. B.* Pour l'intelligence de ce livre et des suivants, il faut avoir présente la théorie des proportions, pour laquelle nous renvoyons aux traités ordinaires d'arithmétique et d'algebre. . . Si A, B, C, D sont des lignes, . . . alors A, B, C, D représentent chacune un certain nombre d'unités, entier ou rompu, commensurable ou incommensurable, et la proportion entre les lignes A, B, C, D, devient une proportion de nombres." It is noteworthy that the German translation retains the original French *commensurable* and *incommensurable*: see Crelle (tr.) 1822, 76.

Note that here Legendre does not invoke the term, *symmetry*, which classically stood for commensurability (see Ch. 2). Legendre considers the theory of proportion too elementary for extended discussion, despite Book V of Euclid's *Elements* on the theory of proportion which underlies definitions 1 and 2 of commensurability and incommensurability (i.e., in the Greek original *summetria* and *asummetria*) in Book X of Euclid's *Elements*. Indeed, Legendre omitted the contents of these books from his *Éléments*,³ for he did not take the theory of proportions to be a serious part of geometry. Instead, he suggests consulting (elementary) textbooks on arithmetic and algebra for more details. In any event, *symmetrical* was available as a term to be given a new definition.

The association between regularity and symmetry offers a third possible source for Legendre's choice. The two terms were often used together in the 18th and early 19th centuries, but regularity was not available to Legendre because "regular polygon" and "regular body" had been fixed expressions in geometry since the 16th century.⁴ Symmetry is weaker than regularity.⁵ In mutually symmetrical bodies, some things are the same but others are different; in Legendre's symmetrical polyhedra some things are the same (faces and solid angles), but the order is different. In any event, since "regular" was not used for a reciprocal relation, Legendre was unlikely to apply it to his discovery; yet he might have found its association with "symmetrical" suggestive.⁶

In the rare instances of scientific usages of *symmetry* in the 18th century preceding Legendre's work on geometry the term was undefined: see Linnaeus (botany, 1738), Adanson (botany, 1763), Laplace (probability, 1776), Romé de l'Isle (crystallography, 1783), Monge (statics, 1788), and Haüy (crystallography, 1791). Linnaeus and Laplace are in fact special cases: the former extends a meaning found in Vitruvius but says nothing to explain it; the latter has a definition but it is idiosyncratic (see §§ 6.1.1, and 9.3.1). There are then a few precedents for Legendre's choice of the term in near contemporary scientific usages (although not recorded in any dictionary at the time).

³ Heath ([1926] 1956, 2: 117, 121, 126, 137) mentions that Barrow and Simson comment on Euclid's Book V. On the views of Weierstrass and Dedekind, see Heath [1926] 1956, 2: 124. As far as we can tell, Heath does not note the absence of these topics in Legendre's *Éléments*.

⁴ Piero della Francesca (d. 1492) was probably responsible for coining the expression, "regular body", but the relevant text was not published during the Renaissance. For a facsimile of the manuscript of his *Libellus de quinque corporibus regularibus*, see Piero della Francesca 1995. Luca Pacioli used this expression for the first time in print without giving his source (though his Italian text follows the Latin of Piero della Francesca very closely): see Pacioli 1509, Part 3: "Libellus in tres partiales tractatus divisus quinque corporum regularium et dependentium active perscrutationis." See also Field 1997.

⁵ Martin (see Ch. 9, nn. 43 and 44, above) is a good example of this claim: regular polygons satisfy more conditions than symmetrical polygons, e.g., a square is regular and symmetrical whereas a rectangle is irregular and symmetrical.

⁶ Regularity and symmetry were still associated after 1800, see Ch. 6, n. 33, and § 6.2.

In contrast to the paucity of scientific usages of *symmetry* prior to the beginning of the French Revolution in 1789, by the end of the Revolutionary and Napoleonic period in 1815 the term, *symmetry*, was well established in a great variety of scientific contexts.⁷ The “birth pangs” were over: see Haüy (crystallography, 1793), Legendre (geometry, 1794), Sullivan (crystallography, 1794), Lacroix (algebraic functions, 1797), Haüy (crystallography, 1797), Bichat (zoology, 1798), Tedenat (algebraic functions, 1801), Garnier (algebraic functions, 1801), Haüy (crystallography, 1801), Francoeur (mechanics, 1801), Martin (geometry, 1802), Biot (analytic geometry, 1802), Poinsot (statics, 1803), Biot (astronomy, 1805), Correia da Serra (botany, 1805), Biot (optics, 1806), Hirsch (geometry, 1807), Lamarck (zoology, 1809), Hirsch (algebraic functions, 1809), Garnier (geometry, 1810), Poisson (mechanics, 1811), Poisson (electricity, 1812), Candolle (botany, 1813), Cauchy (geometry, 1813), Laplace (probability, 1814), Haüy (crystallography, 1815), and Cauchy (algebraic functions, 1815).

In spite of the fact that the application of the concept of symmetry in science was novel, very few of the practitioners thought it necessary to put forward a definition of the concept of symmetry; among the exceptions are Francoeur and Poisson both of whom applied the concept in connection with the issue of center of gravity. Contrast this absence of definitions with previous usages in scientific contexts: Rheticus (astronomy, 1540), Copernicus (astronomy, 1543),⁸ Maurolico (geometry, 1543) and Galileo (astronomy, 1611, 1612, 1623, and 1632; optics, 1613; statics, 1638). In these instances, scholars had no need to provide definitions since they were appealing to common usage (see §§ 2.7.1, 5.2, and 5.3). In the 16th and 17th centuries meanings of the concept included well proportioned, proportional, and moderate.

Legendre does not appeal to this set of meanings; rather, he offers a formal definition for his new concept, clothed in a classical term. This does not mean that Legendre was unaware of the common usage that had developed in the 18th century; indeed, the meaning of correspondence may have influenced his choice of the term, *symmetry*, for the new relation in solid geometry that he discovered and articulated.

We stress the fact that Legendre's choice was a contingent event that had far reaching consequences, surely unforeseen when the choice was made. In a certain sense, Legendre's choice of the term, *symmetry*, was arbitrary: if he had decided to use a different word, we—moderns—might have used it. For example, he could have invented a new expression, something like Kant's *incongruent counterparts*; after all, this expression suits Legendre's discovery very well. Evidently, Legendre preferred to stay within the framework of Euclidean terminology. As it happened, Legendre, in a moment of inspiration, chose *symmetry*.

⁷ The story of scientific developments in France at this time goes well beyond the scope of this monograph. See, e.g., Gillispie 2004, 2: “The paucity of French talent expressing itself in the humanities in our period [1789 to 1815] is to be contrasted to the galaxy of leading scientific lights . . . a larger scientific population [in France] than in the rest of Europe put together.”

⁸ Despite the usages by Copernicus and Rheticus, there is no association of harmony with symmetry in the period from 1735 to 1815 in scientific contexts.

What role did Legendre play in the proliferation of the application of *symmetry* between 1794 and 1815 which we have reported? Burckhardt, for example, suggested that, for his definition of symmetry, Häüy may have depended on Legendre. Burckhardt had in mind Häüy's usage of 1815, that is, the law of symmetry (see Ch. 6, n. 68, above). This conjecture, however, was based on a very limited survey of sources and we think a direct linkage unlikely. Indeed, we note that the two usages are very different. As we have shown, the meaning of Häüy's concept of symmetry changed throughout the years, culminating in the "law of symmetry" which expresses a rotational property of a single crystal, not a relation of two distinct entities (see § 6.2).

We have been puzzled that in the early 19th century the term, *symmetry*, conveyed a variety of meanings; yet, to the best of our knowledge, no attempt was made to articulate a common theme underlying them. Our conjecture is that Legendre's usage may have made it easier for others to invoke symmetry in scientific contexts. Certainly, it is a historical fact that there are many more scientific usages in the 20 years after 1794 than in the previous 20 years. And we recall that several authors (e.g., Lacroix, Garnier, and Cauchy) were aware of Legendre's usage a few years after the first edition of Legendre's textbook had been published.

Legendre's concept of symmetry expresses a relation of distinct bodies. It stands in contrast to symmetry as a property of a single entity. From the definition of Perreault through the Encyclopaedists' definition of respective symmetry, expressed so clearly by Montesquieu in his metaphor of the balance, as well as its extension to naval architecture and its applications in natural history, all the meanings had to do with the overall understanding of some relation applied to a single entity. Indeed, the appeal to a property of a single entity fits the early history of symmetry, beginning with Vitruvius. Legendre, however, gave a new sense to the concept that departs from the tradition in many ways.

Our story now comes to an end. We have sought to chart the trajectories of usages of *symmetry* from antiquity to the early years of the 19th century and to mark critical junctures with "mileposts". We designed this historical study to contribute to the philosophical issue: how are scientific concepts made, and how are they introduced into scientific domains? Among the building blocks for constructing scientific theories are scientific concepts: to be "productive", to have tangible consequences, concepts have to be put into words. A scientific concept without a name—a word—is just a phantom; it cannot serve as a solid foundation for scientific development. While symmetry may belong to a deep stratum of the human psyche, turning it into a scientific concept and articulating it was a major step in the advance of modern science. And the key move, revolutionary in its implications, was made by Legendre in 1794.

Postscript

Since completing our text, we found that in 1814—20 years after the publication of Legendre's *Éléments de géométrie*—André-Marie Ampère (1775–1836), the celebrated French physicist and mathematician, introduced into chemistry Legendre's purely geometrical concept of symmetry (including a reference to the relevant treatise). Ampère sought to explain chemical phenomena by means of the spatial arrangement of atoms and molecules (which he called *molécules* and *particules*, respectively),¹ and he cited Legendre's concept of symmetry as a relation of two polyhedra in a physical (or chemical), rather than a mathematical, context. In the examples we discussed in works on physics prior to 1815 (Ch. 9), the sense of the concept of symmetry as the relation of two geometrical solids was not applied to material bodies. Indeed, Ampère's appeal to symmetry is the earliest usage of Legendre's concept in physics (or chemistry), as far as we can determine. The context of Ampère's discussion and his interest in the center of gravity of material objects make it clear that symmetry is a physical concept here:

... the extremities of these two new lines will be the four summits of a tetrahedron symmetrical [*symétrique*] (1) to the first, which will have its center of gravity at the same point, and the eight summits of those two tetrahedra joined in this manner will be those of a parallelepiped. It is thus that the parallelepiped form results from the union of the two tetrahedra.

(1) See the definition of symmetrical polyhedra in the Geometry of Mr. Legendre [(1) *Voyez dans la Géométrie de M. Legendre, la définition des polyèdres symétriques*].²

Once again we see the impact of Legendre's revolutionary concept of symmetry, this time in a domain other than mathematics.

¹ See Seymour H. Mauskopf. 1969. "The Atomic Structural Theories of Ampère and Gaudin: Molecular Speculation and Avogadro's Hypothesis." *Isis* 60: 61–74, esp. p. 63.

² André-Marie Ampère. 1814. "Lettre de M. Ampère à M. le comte Berthollet, sur la détermination des proportions dans lesquelles les corps se combinent d'après le nombre et la disposition respective des molécules dont leurs particules intégrantes sont composées." *Annales de Chimie* 90: 43–86, on p. 52. Cf. an anonymous translation: André-Marie Ampère. 1815. "Letter from M. Ampere to Count Berthollet, on the Determination of the Proportions in which Bodies are combined, according to the respective Nature and Arrangement of the Molecules of which their integrant Molecules are composed." *Philosophical Magazine and Journal* 45: 41–43, 109–116, 188–193, and 344–349. The English translation (p. 110) does not include Ampère's explicit reference to Legendre. Although Ampère (1814, 55) cites Haüy and certainly depends on some of his ideas, there is no trace of Ampère's usage of symmetry in Haüy's paper of 1815 on "the law of symmetry." See also § 6.1.2, nn. 68–77, above.

References

- Académie Française. 1694. *Dictionnaire de l'Académie Française*. 1st edn. Paris: Coignard.
- Accademia della Crusca. [1612] 1623. *Vocabulario degli Accademici della Crusca*. 2nd edn. Venice: Sarzina.
- Adanson, Michel. 1763. *Familles des plantes*. 2 vols. Paris: Vincent.
- Aelst, Pierre van. (tr.) 1545. *Serlio: Reigles generales de l'Architecture, sur les cinq manieres d'edifices. . . avec les exemples d'antiquitez, selon la doctrine de Vitruue*. Antwerp: Aelst.
- Agrippa of Nettesheim, Heinrich C. [1533] 1967. *De occulta philosophia*. Facsimile reprint, Edited by Karl A. Nowotny. Graz: Akademische Druck u. Verlagsanstalt. See French (tr.) 1651.
- Aiton, Eric J. 1973. "Infinitesimals and the Area Law." In Krafft et al. (eds.) 1973, pp. 285–305.
- Aiton, Eric J., Alistair M. Duncan, and Judith V. Field. (trs.) 1997. *Kepler: The Harmony of the World*. Memoirs of the American Philosophical Society, 209. Philadelphia: American Philosophical Society.
- Alberti, Leone Battista. 1485. *De re aedificatoria*. Florence: Laurentius. See Leoni (tr.) [1726] 1955; Lücke 1975–1979; Rykwert, Leach, and Tavernor (trs.) 1988.
- Alberti, Leone Battista. *De pictura*. See Grayson (ed. and tr.) 1972.
- Allard, André. 1996. "The influence of Arabic mathematics in the medieval West." In Rashed (ed.) 1996, 2: 539–580.
- Allen, Grant. 1879. "The Origin of the Sense of Symmetry." *Mind* 4: 301–316.
- Andersen, Hanne, Peter Barker, and Xiang Chen. 2006. *The Cognitive Structure of Scientific Revolutions*. Cambridge: Cambridge University Press.
- André, Yves Marie. 1741. *Essai sur le beau, ou l'on examine en quoi consiste précisément le Beau dans le Physique, dans le Moral, dans les Ouvrages d'Esprit, & dans la Musique*. Paris: H. L. & J. Guerin. See Cousin (ed.) [1843] 1969.
- Anon. (tr.) 1692. *An Abridgment of the Architecture of Vitruvius, containing a system of the whole works of that authors*. First done in French by Mons[ieur] Perrault. London: A. Sirall and T. Child.
- Anon. 1750. "II. Zugabe zum Januarius: Nürnberg." *Göttingische Zeitungen von gelehrten Sachen auf das Jahr MDCCL*, 75–78.
- Apollonius of Perga. *Treatise on Conic Sections*. See Heath (tr.) [1896] 1961.
- Arabatzis, Theodore, and Vasso Kindi. 2008. "The Problem of Conceptual Change in the Philosophy and History of Science." In Stella Vosniadou. (ed.) 2008. *International Handbook of Research on Conceptual Change*. London: Routledge.
- Arago, François J. D. 1820. "Expériences relatives à l'aimantation du fer et de l'acier par l'action du courant voltaïque." *Annales de chimie et de physique* 15: 93–102.
- Arago, François J. D. 1854. "Aimantation d'une aiguille au moyen du passage du courant électrique en hélice." *Oeuvres de François Arago*. Paris: Gide et Baudry; Leipzig: Weigel, 4: 413–416.
- Archimedes. *De planorum aequilibriis*. See Mugler (ed. and tr.) 1971.
- Ariew, Roger. (ed. and tr.) 2000. *G. W. Leibniz and Samuel Clarke: Correspondence*. Indianapolis: Hackett.

- Ariew, Roger, and Daniel Garber. (eds. and trs.) 1989. *G. W. Leibniz: Philosophical Essays*. Indianapolis and Cambridge: Hackett.
- Aristotle. *De caelo*. See Stocks (tr.) [1984] 1995; Guthrie (ed. and tr.) [1939] 1960.
- Aristotle. *Nicomachean ethics*. See Rackham (tr.) [1926/1934] 1968.
- Aristotle. *Metaphysica*. See William Ross (ed. and tr.) [1908/1928] 1966.
- Aristotle. *On the Parts of Animals*. See Lennox (tr.) 2001; Louis (ed. and tr.) 1956.
- Aristotle, Pseudo-. *De mundo*. See Forster (tr.) [1914/1931] 1968.
- Augustine, Bishop of Hippo. *De natura boni*. See Roland-Gosselin (ed. and tr.) 1949.
- Augustine, Bishop of Hippo. *De musica*. See Jacobsson (ed. and tr.) 2002.
- Augustine, Bishop of Hippo. *De vera religione*. See Daur (ed.) 1962; Burleigh (tr.) 1953.
- Aujac, Germaine. (ed. and tr.) 1975. *Géminos: Introduction aux phénomènes*. Paris: Les Belles Lettres.
- Baker, Woods. (tr.) 1851. *Monge: An Elementary Treatise on Statics*. Philadelphia: E. C. & J. Biddle.
- Barker, Peter, and Bernard R. Goldstein. 2001. "Theological Foundations of Kepler's Astronomy." *Osiris* 16: 88–113.
- Barker, Peter, and Bernard R. Goldstein. 2003. "Patronage and the Production of *De Revolutionibus*." *Journal for the History of Astronomy* 34: 345–368.
- Barnes, Jonathan. (ed.) [1984] 1995. *The Complete Works of Aristotle*. 2 vols. Princeton: Princeton University Press.
- Barrow, Isaac. 1684. *Lectiones habitæ in scholis publicis Academiae Cantabrigiensis An. dom. MDCLXV*. London: Playford pro Georgio Wells.
- Barrow, Isaac. (tr.) [1655] 1659. *Euclidis Elementorum*. London: R. Daniel.
- Barrow, Isaac. (tr.) 1660. *Euclide's Elements*. London: R. Daniel.
- Beck, Lewis W. (tr.) 1950. *Kant: Prolegomena*. Based on the Carus translation. Indianapolis: Bobbs-Merrill.
- Belhoste, Bruno. 1991. *Augustin-Louis Cauchy: A Biography*. Translated by Frank Ragland. New York and Berlin: Springer.
- Belot, Gordon. 2005. "Dust, time and symmetry." *British Journal for Philosophy of Science* 56: 255–291.
- Benjamin, Francis S., Jr., and Gerald J. Toomer. 1971. *Campanus of Novara and Medieval Planetary Theory*. Madison, Milwaukee, and London: University of Wisconsin Press.
- Berger, Robert W. 1970. "Charles Le Brun and the Louvre Colonnade." *The Art Bulletin* 52: 394–403.
- Berggren, J. Lennart, and Alexander Jones. (trs.) 2000. *Ptolemy's Geography*. Princeton: Princeton University Press.
- Bichat, Xavier. 1798. "Mémoire sur les rapports qui existent entre les organes à forme symétrique, et ceux à forme irrégulière." *Mémoires de la Société Médicale d'Émulation . . . pour l'an V^e de la République (1797 v. st.)*, pp. 477–487.
- Biot, Jean-Baptiste. 1802. *Traité analytique des courbes et des surfaces du second degré*. Paris: Duprat.
- Biot, Jean-Baptiste. 1805a. *Essai de géométrie analytique, appliqué aux courbes et aux surfaces du second ordre*. 2nd edn. Paris: Bernard.
- Biot, Jean-Baptiste. 1805b. *Traité élémentaire d'astronomie physique*. Premier et second livres. Paris: Bernard.
- Biot, Jean-Baptiste. (tr.) 1806. *Physique mécanique*, par E. G. Fischer. Paris: Bernard. See Fischer 1805.
- Blomfield, Reginald. [1911–1921] 1973. *A History of French Architecture*. Vols. 1 and 2: *From the reign of Charles VIII till the death of Mazarin, 1494–1661*; vols. 3 and 4: *From the death of Mazarin till the death of Louis XV, 1661–1774*. New York: Hacker Art Books.
- Blunt, Anthony. [1953] 1986. *Art and Architecture in France 1500–1700*. Harmondsworth, Middlesex: Penguin.
- Boas, George. 1973. "Microcosm and macrocosm." In Wiener (ed.) 1973, 3: 126–131.
- Boethius. *De institutione arithmetica*. See Guillaumin (ed. and tr.) 1995.

- Bouguer, Pierre. 1746. *Traité du navire, de sa construction, et de ses mouvemens*. Paris: Jombert.
- Bowen, Alan C., and Bernard R. Goldstein. 1996. "Geminus and the concept of Mean Motion in Greco-Latin Astronomy." *Archive for History of Exact Sciences* 50: 157–185.
- Boyer, Carl B. [1956] 1988. *History of Analytic Geometry*. Princeton Junction: Scholar's Bookshelf.
- Boyer, Carl B., and Uta C. Merzbach. 1989. *A History of Mathematics*, 2nd edn. New York: Wiley.
- Brading, Katherine, and Elena Castellani. (eds.) 2003. *Symmetries in Physics: Philosophical Reflections*. Cambridge: Cambridge University Press.
- Brading, Katherine, and Elena Castellani. 2003a. "Introduction." In Brading and Castellani (eds.) 2003, pp. 1–18.
- Brading, Katherine, and Elena Castellani. 2007. "Symmetries and invariances in classical physics." In Butterfield and Earman (eds.) 2007, pp. 1331–1367.
- Bradley, James. 1727–1728. "A letter from the Reverend Mr. James Bradley Savilian Professor of Astronomy at Oxford, and F.R.S. to Dr. Edmond Halley Astronom. Reg. &c. giving an Account of a new discovered Motion of the Fix'd Stars." *Philosophical Transactions* 35: 637–661.
- Bragard, Roger. (ed.) 1963. *Jacobi Leodiensis Speculum musicae: Liber tertius*. Corpus Scriptorum de Musica, 3. Rome: American Institute of Musicology.
- Brentjes, Sonja. 2001. "Observations on Hermann of Carinthia's Version of the *Elements* and Relation to the Arabic Transmission." *Science in Context* 14: 39–84.
- Bretschneider, Karl G., and Heinrich E. Bindsell, (eds.) 1834–1860. *Philippi Melanthonis opera quae supersunt omnia*. In *Corpus Reformatorum*. 28 vols. Halle: Apud C. A. Schwetschke et filium.
- Brown, Gregory. 1988. "Leibniz's Theodicy and the Confluence of Worldly Goods." *Journal of the History of Philosophy* 26: 571–591.
- Brunschvicg, Léon. (ed.) [1904] 1965. *Pensées de Blaise Pascal*, nouvelle édition collationnée sur le manuscrit autographe. 3 vols. Paris: Hachette. Reprinted, Vaduz: Kraus.
- Brunschvicg, Léon. [1905] 1986. *Original des Pensées de Pascal: fac-simile du manuscrit 9202 (fonds français) de la Bibliothèque nationale*. Kyoto: Rinsen.
- Buchenau, Artur. (ed.) 1912. *Kant: Vorkritische Schriften*. 2 vols. Berlin: Bruno Cassirer.
- Burckhardt, Jacob. [1925] 1958. *The Civilization of the Renaissance in Italy*. Translated from the German by S. G. C. Middlemore, with an introduction by Benjamin Nelson and Charles Trinkaus. New York: Harper & Row.
- Burckhardt, Johann J. 1988. *Die Symmetrie der Kristalle: von René-Just Haüy zur kristallographischen Schule in Zürich*, mit einem Beitrag von Erhard Scholz. Basel, Boston, and Berlin: Birkhäuser.
- Burke, Edmund. [1757/1759] 1998. *A Philosophical Enquiry into the Sublime and Beautiful and other Pre-Revolutionary Writings*. Edited by David Womersley. London: Penguin.
- Burke, John G. 1966. *Origins of the science of crystals*. Berkeley and Los Angeles: University of California Press.
- Burleigh, John H. (tr.) 1953. *Augustine: Earlier Writings*. The Library of Christian Classics, vol. VI. Philadelphia: Westminster Press.
- Burnett, Charles. 2001. "The Coherence of the Arabic-Latin Translation Program in Toledo in the Twelfth Century." *Science in Context* 14: 249–288.
- Buroker, Jill V. 1981. *Space and Incongruence: The Origin of Kant's Idealism*. Dordrecht: Reidel.
- Bury, Robert G. (ed. and tr.) [1926] 1984. *Plato: Laws*. In *Plato in twelve volumes*. Vols. 10–11. Cambridge, MA, and London: Harvard University Press.
- Busard, Hubertus L. L. 1977. *The translation of the Elements of Euclid from the Arabic into Latin by Hermann of Carinthia (?) Books VII–XII*. Amsterdam: Mathematisch Centrum.
- Busard, Hubertus L. L. 1983. *The First Latin Translation of Euclid's Elements Commonly Ascribed to Adelard of Bath*. Toronto: Pontifical Institute of Mediaeval Studies.
- Busard, Hubertus L. L. 1984. *The Latin translation of the Arabic version of Euclid's Elements commonly ascribed to Gerard of Cremona*. Introduction, edition and critical apparatus. Leiden: Brill.

- Busard, Hubertus L. L. 1987. *The Mediaeval Latin Translation of Euclid's Elements Made Directly from the Greek*. Stuttgart: Steiner.
- Busard, Hubertus L. L. (ed.) 1991. *Jordanus de Nemore, De elementis arithmetice artis: A medieval treatise on number theory*. 2 vols. Stuttgart: Steiner.
- Busard, Hubertus L. L. 1997. "A Latin Translation of an Arabic Commentary on Book X of Euclid's *Elements*." *Mediaeval Studies* 59: 19–110.
- Busard, Hubertus L. L. 1998. "Über den lateinischen Euklid im Mittelalter." *Arabic Sciences and Philosophy* 8: 97–129.
- Busard, Hubertus L. L. 2005. *Campanus of Novara and Euclid's Elements*. 2 vols. Wiesbaden: Steiner.
- Busard, Hubertus L. L., and Menso Folkerts. 1992. *Robert of Chester's (?) Redaction of Euclid's Elements, the so-called Adelard II Version*. 2 vols. Basel, Boston, and Berlin: Birkhäuser.
- Butterfield, Jeremy, and John Earman. (eds.) 2007. *Philosophy of Physics*. Amsterdam and Boston: Elsevier North-Holland.
- Camerarius, Joachim. (tr.) 1532. See Dürer 1532.
- Campa-Molina, Jorge et al. 2006. "Nano and micro reoriented domains and their relation with the crystal structure in the new ferroelectric boracite $Zn_3B_7O_{13}Br$." *Journal of Physics: Condensed Matter* 18: 4827–4837.
- Candolle, Augustin-Pyramus de. 1813. *Théorie élémentaire de la botanique*. Paris: Déterville.
- Castellani, Elena. 2003. "Symmetry and Equivalence." In Brading and Castellani (eds.) 2003, pp. 425–436.
- Cauchy, Augustin. [1813a] 1905. "Recherches sur les polyèdres: premier mémoire." *Journal de l'École Polytechnique* 9: 68 ff. Reprinted in Cauchy 1905, Series 2, 1: 7–25.
- Cauchy, Augustin. [1813b] 1905. "Sur les polygones et les polyèdres: second mémoire." *Journal de l'École Polytechnique* 9: 87 ff. Reprinted in Cauchy 1905, Series 2, 1: 26–38.
- Cauchy, Augustin. [1815a] 1905. "Mémoire sur le nombre des valeurs qu'une fonction peut acquérir, lorsqu'on y permute de toutes les manières possibles les quantités qu'elle renferme." *Journal de l'École Polytechnique* 10: 1 ff. Reprinted in Cauchy 1905, Series 2, 1: 64–90.
- Cauchy, Augustin. [1815b] 1905. "Mémoire sur les fonctions qui ne peuvent obtenir que deux valeurs égales et de signes contraires par suite des transpositions opérées entre les variables qu'elles renferment." *Journal de l'École Polytechnique* 10: 29 ff. Reprinted in Cauchy 1905, Series 2, 1: 91–169.
- Cauchy, Augustin. 1905. *Oeuvres complètes*. Paris: Gauthier-Villars.
- Cayré, Fulbert, and Georges Folliet. (eds.) 1949. *Œuvres de Saint Augustin*. Vol. 1: La morale chrétienne. 2nd edn. Paris: Desclée de Brouwer.
- Cesariano, Cesare. (tr.) [1521] 1968. *Vitruvius: De architectura libri dece traducti de latino in vulgare, affigurati*. [A translation into Italian, with commentary, of *De architectura*.] Como: G. da Ponte. Facsimile reprint, Bronx, NY: B. Blom.
- Chalmers, Alan F. 1970. "Curie's Principle." *The British Journal for the Philosophy of Science* 21: 133–148.
- Chester, Marvin. 2002. "Is symmetry identity?" *International Studies in the Philosophy of Science* 16: 111–124.
- Cicero. *De natura deorum*. See Rackham (ed. and tr.) [1933] 1961.
- Clagett, Marshall. 1976. *Archimedes in the Middle Ages*. Vol. 2: The translations from the Greek by William of Moerbeke. *Memoirs of the American Philosophical Society*, 117A. Philadelphia: American Philosophical Society.
- Clagett, Marshall. 1978. *Archimedes in the Middle Ages*. Vol. 3: The fate of the medieval Archimedes: 1300 to 1565. *Memoirs of the American Philosophical Society*, 125C. Philadelphia: American Philosophical Society.
- Clairaut, Alexis Claude. 1801. *Éléments d'algebre*. Avec des Notes et des Additions très-étendues, par le citoyen Garnier; Précédés d'un traité d'Arithmétique par Théveneau; avec une Instruction sur les nouveaux poids et Mesures. 6th edition, volume 2. Paris: Courcier.

- Clarke, Samuel. 1717. *A collection of papers, which passed between the late Learned Mr. Leibnitz, and Dr. Clarke, in the years 1715 and 1716. Relating to the principles of Natural Philosophy and Religion*. London: J. Knapton.
- Clavelin, Maurice. [1968] 1974. *The Natural Philosophy of Galileo*. Translation by Arnold J. Pomerans. Cambridge, MA, and London: MIT Press.
- Collingwood, Robin G. [1939] 1978. *An Autobiography*. Oxford: Oxford University Press.
- Commandino, Federico. 1572. *Euclidis Elementorum libri XV*. Pesaro: Camillo Francischini.
- Cooper, John M. (ed.) 1997. *Plato: Complete Works*. Assistant editor Douglas S. Hutchinson. Indianapolis and Cambridge: Hackett.
- Cooper, Thompson. 1898. "Sullivan, Sir Richard Joseph". In *Dictionary of National Biography*. Edited by Sidney Lee. New York: Macmillan, and London: Smith, Elder & Co., 55: 163.
- Copernicus, Nicolas. 1543. *De revolutionibus orbium coelestium*. Nuremberg: Petreius. See Edward Rosen (tr.) 1992; Wallis (tr.) [1939] 1952.
- Cornford, Francis M. [1914] 1934. *The origin of Attic comedy*. Cambridge: Cambridge University Press.
- Cornford, Francis M. (tr.) 1957. *Plato's Theory of Knowledge*. New York: Liberal Arts Press.
- Cornford, Francis M. (tr.) [1959] 1987. *Plato: Timaeus*. New York: Macmillan.
- Correia da Serra, José. 1805. "Observations sur la famille des orangers et sur les limites qui la circonscrivent." *Annales du Muséum d'Histoire Naturelle* 6: 376–387.
- Courvoisier, Leo. (ed.) 1964. *Euler: Commentationes astronomicae, ad praecessionem et nutationem pertinentes*. In *Leonhardi Euleri Opera omnia*, Ser. 2, 30. Zurich: Füssli.
- Cousin, Victor. (ed.) [1843] 1969. *André: Essai sur le beau*. In *Oeuvres philosophique du Père André*. Paris: Delahays, pp. 1–190. Reprinted, Geneva: Slatkine Reprints.
- Couturat, Louis. (ed.) [1903] 1966. *Opuscules et fragments inédits de Leibniz*. Hildesheim: Olms.
- Crelle, August L. (tr.) 1822. *Die Elemente der Geometrie, und der ebenen und sphärischen Trigonometrie*, von A. M. Legendre; aus dem Französischen nach der 11. Auflage übersetzt und mit einigen Anmerkungen begleitet von August L. Crelle. [Translated from the 11th edn. of Legendre's *Éléments de géométrie* by August L. Crelle, with some additional notes.] Berlin: Maurer.
- Crew, Henry, and Alfonso de Salvio. (trs.) [1914] 1954. *Dialogues Concerning Two New Sciences*. New York: Dover.
- Curie, Pierre. [1894/1908] 1984. "Sur la symétrie dans les phénomènes physiques, symétrie d'un champ électrique et d'un champ magnétique." *Journal de Physique* 3: 393ff. Reprinted, with new pagination, in *Oeuvres de Pierre Curie*, publiées par les soins de la Société française de physique. Paris: Gauthier-Villars, 1908, pp. 118–141 which, in turn, was reprinted, Paris and Montreux: Editions des Archives Contemporaines, 1984. See Rosen and Copié (trs.) 1982.
- Czartoryski, Paweł. 1978. "The Library of Copernicus." *Studia Copernicana* 16: 355–396.
- Dahan, Amy. 1980. "Les Travaux de Cauchy sur les Substitutions. Étude de son approche du concept de groupe." *Archive for History of Exact Sciences* 23: 279–319.
- D'Alembert, Jean Le Rond. 1767. *Mélanges de littérature, d'histoire, et de philosophie*. 5 vols. Amsterdam: Z. Chatelain.
- Darwin, Charles. [1859] 1861. *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life*. 3rd edn. London: John Murray.
- Daston, Lorraine. 1988. *Classical Probability in the Enlightenment*. Princeton: Princeton University Press.
- Daur, Klaus-D. (ed.) 1962. *Augustine: De vera religione*. In *Aurelii Augustini Opera* IV, 1. Corpus Christianorum, Series Latina 32. Turnhout: Brepols.
- Davies, Charles. (tr.) 1862. *Elements of geometry and trigonometry, from the works of A. M. Legendre*, adapted to the course of mathematical instruction in the United States. New York: Barnes & Burr.
- Daviler, Augustin-Charles. 1691. *Cours d'architecture qui comprend les ordres de Vignole*. Vol. 3: *Explication des termes d'Architecture*. Paris: N. Langlois.

- Davis, Richard Beale. 1955. "The Abbé Correa in America, 1822–1820: The Contributions of the Diplomat and Natural Philosopher to the Foundations of Our National Life. Correspondence with Jefferson and Other Members of the American Philosophical Society and with other Prominent Americans." *Transactions of the American Philosophical Society* NS 45: 87–197.
- Delorme, Philibert. 1567. *Le premier tome de l'architecture*. Paris: Morel.
- De Morgan, Augustus. [1837] 1849. "Theory of Probabilities." In *Encyclopaedia Metropolitana*. Edited by Edward Smedley, Hugh J. Rose, and Henry J. Rose. London: J. J. Griffin, and Glasgow: R. Griffin, 2: 393–490.
- Deparcieux, Antoine. 1741. *Nouveaux traités de trigonométrie rectiligne et spherique démontrés par une méthode nouvelle . . . accompagnés de tables . . . avec un traité de gnomonique*. Paris: H.-L. Guerin and J. Guerin.
- Descartes, René. 1637. *Les Météores*. In *Discours de la méthode pour bien conduire sa raison, & chercher la verité dans les sciences. Plus la dioptrique, les meteores, et la geometrie, qui sont des essais de cete methode*. Leiden: I. Maire. See Olscamp (tr.) 1965.
- Desmond, Karen. 2000. "New light on Jacobus, Author of *Speculum musicae*." *Plainsong and Medieval Music* 9: 19–40.
- Dhombres, Jean et al. (eds.) 1992. *L'école normale de l'an III: Leçons de mathématiques*. An annotated edition, with introductions and appendices, of the courses given by Pierre Simon de Laplace, Joseph Louis Lagrange, and Gaspard Monge in Year 3 [= 1795]. Paris: Dunod.
- Diderot, Denis. [1749/1951] 1963. *Lettre sur les aveugles*. Edited by Robert Nicklaus. 2nd edn. Geneva: Droz.
- Diderot, Denis. 1751. Entry *Beau*, in Diderot et al. 1751–1765, 2: 169–181. See also Naigeon (ed.) Year 8 [= 1799–1800], 2: 375–438.
- Diderot, Denis. "Le Salon 1765." See Naigeon (ed.) Year 8 [= 1799–1800], 13: 1–336; Goodman (ed. and tr.) 1995.
- Diderot, Denis et al. 1751–1765. *Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers*. 17 vols. Paris: Briasson. Vol. 1 (1751), entries *Asymétrie*, *Axe*; vol. 2 (1751), entry *Beau*; vol. 3 (1753), entries *Commensurable*, *Congruence*; vol. 4 (1754), entry *Coquilles de terre*; vol. 7 (1757), entries *Géométrie*, *Goût*; vol. 8 (1765) entry *Incommensurable*; vol. 11 (1765), entry *Nombre*; vol. 13 (1765), entry *Proportion*; vol. 15 (1765), entries *Solide*, *Sphérique (Géométrie & Astronomie)*, *Spirale*, *Symétrie*; vol. 17 (1765), entry *Vis*.
- Dijksterhuis, Eduard J. [1956] 1987. *Archimedes*. Translated by Cary Dikshoorn. Princeton: Princeton University Press.
- Diogo, Maria Paula, Ana Carneiro, and Ana Simões. 2001. "The Portuguese naturalist Correia da Serra (1751–1823) and his impact on early nineteenth-century botany." *Journal of the History of Biology* 34: 353–393.
- D'Ooge, Martin L. (tr.) 1926. *Nicomachus of Gerasa: Introduction to Arithmetic*. With studies in Greek arithmetic by Frank E. Robbins and Louis C. Karpinski. New York: Macmillan.
- Drake, Stillman. (tr.) [1953] 1974. *Galileo: Dialogue Concerning the Two Chief World Systems—Ptolemaic & Copernican*. 2nd edn. Berkeley, Los Angeles and London: University of California Press.
- Drake, Stillman. (tr.) 1957. *Galileo: Letters on Sunspots*. In Drake (tr.) 1957, pp. 87–144.
- Drake, Stillman. (tr.) 1957. *Discoveries and Opinion of Galileo*. New York: Doubleday.
- Drake, Stillman. (tr.) 1960. *Galileo Galilei: The Assayer*. Translated from the Italian. In Drake and O'Malley 1960, pp. 151–336.
- Drake, Stillman, and Charles D. O'Malley. (trs.) 1960. *The Controversy on the Comets of 1618*. Philadelphia: University of Pennsylvania Press.
- Duhamel du Monceau, Henri Louis. [1752] 1758. *Éléments de l'architecture navale, ou Traité pratique de la construction des vaisseaux*. 2nd edn., revised and augmented. Paris: Jombert.
- Duncan, Alistair M. 1976. *Copernicus: On the revolutions of the heavenly spheres*. Newton Abbot and London: David and Charles.
- Duncan, Alistair M. (ed. and tr.) 1981. *Johannes Kepler: Mysterium Cosmographicum (The Secret of the Universe)*. New York: Abaris.

- Dürer, Albrecht. [1528] 1969. *Vier Bücher von menschlicher Proportion*. Nuremberg: Hieronymus Formschneyder. Reprinted, Dietikon-Zürich: Verlag Bibliophile Drucke von Josef Stocker.
- Dürer, Albrecht. 1532. *De symmetria partium in rectis formis humanorum corporum*. A translation of Dürer 1528, books I and II, by Joachim Camerarius. Nuremberg: Hieronymus Formschneyder. See Levy (tr.) [1532] 2003.
- Earman, John. 1991. "On the other hand. . . ." In Van Cleve and Frederick (eds.) 1991, pp. 235–255.
- Earman, John, and John D. Norton. (eds.) 1997. *The Cosmos of Science: Essays of Exploration*. Pittsburgh: University of Pittsburgh Press.
- Edwards, Harold M. (tr.) 1984. "Galois: 'Memoir on the Conditions for Solvability of Equations by Radicals'." In *Idem*. 1984. *Galois Theory*. New York and Berlin: Springer. pp. 101–113 (Appendix 1).
- Endress, Peter, K. 1999. "Symmetry in flowers: diversity and evolution." *International Journal of Plant Sciences* 160 [Supplement: Development, Function, and Evolution of Symmetry in Plants]: S3–S23.
- Euclid. *Elements*. See Busard 1977, 1983, 1984, 2005; Commandino 1572; and Heath (tr.) [1926] 1956.
- Euclid. 1482. *Elementa*. Venice: Ratdolt.
- Euler, Leonhard. [1749] 1967. *Scientia navalis, pars prima*. St. Petersburg: Academy of Sciences. Reprinted in Truesdell (ed.) 1967.
- Euler, Leonhard. [1750] 1964. "Auszug eines Briefes von Hrn. Euler über die Vorstellung der Sternbilder auf der Himmelskugel." In *Göttingische Zeitungen von gelehrten Sachen auf das Jahr MDCCL*. Göttingen: Universitäts-Buchhandlung, pp. 475–477. Reprinted in Courvoisier (ed.) 1964, pp. 101–102.
- Euler, Leonhard. 1755. "Principes de la trigonométrie sphérique." *Histoire de l'académie royale des sciences et des belles-lettres de Berlin, année 1753*. Berlin: Ambroise Haude, pp. 223–257.
- Euler, Leonhard. [1758] 1953. "Elementa doctrinae solidorum demonstratio nonnullarum insignium proprietatum, quibus solida hedris planis inclusa sunt praedita." *Novi Commentarii Academiae Scientiarum Imperialis Petropolitanae* 4: 109–140. Reprinted in Speiser (ed.) 1953, pp. 71–93.
- Euler, Leonhard. 1773. *Théorie complete de la construction et de la manoeuvre des vaisseaux: mise à la portée des ceux, qui s'appliquent à la navigation*. St. Petersburg: Académie Impériale des Sciences. See Watson (tr.) 1776.
- Evans, James, and J. Lennart Berggren. 2006. *Geminus's Introduction to the Phenomena: A translation and study of a Hellenistic survey of astronomy*. Princeton and Oxford: Princeton University Press.
- Falkenburg, Brigitte. 2001. "Incongruent Counterparts: Kant's 1768 Argument Against Relationism." In Gerhardt, Horstmann, and Schumacher (eds.) 2001, 2: 13–18.
- Federico, Pasquale J. 1982. *Descartes on Polyhedra: A Study of the De solidorum elementis*. New York and Berlin: Springer.
- Feingold, Mordechai. (ed.) 1990. *Before Newton: The Life and Times of Isaac Barrow*. Cambridge: Cambridge University Press.
- Féraud, Jean-François. 1787–1788. *Dictionnaire critique de la langue française*. 3 vols. Marseilles: Mossy. Available online at: <http://humanities.uchicago.edu/orgs/ARTFL/>
- Ferreiro, Larrie D. 2007. *Ships and Science: The Birth of Naval Architecture in the Scientific Revolution, 1600–1800*. Cambridge, MA: MIT Press.
- Field, Judith V. 1997. "Rediscovering the Archimedean polyhedra: Piero della Francesca, Luca Pacioli, Leonardo da Vinci, Albrecht Dürer, Daniele Barbaro, and Johannes Kepler." *Archive for History of Exact Science* 50: 241–289.
- Fischer, Ernst Gottfried. 1805. *Lehrbuch der mechanischen Naturlehre*. Berlin: G. C. Nauck's Buchhandlung. See Biot (tr.) 1806.
- Flamsteed, John. 1725. *Historiae coelestis britannicae*. 3 vols. London: H. Meere.
- Flamsteed, John. 1729. *Atlas Coelestis*. Edited by Margaret Flamsteed and James Hodgson. London: n. p.

- Forster, Edward S. (tr.) [1914/1931] 1968. [*Pseudo-*]Aristotle: *De mundo*. In William Ross (ed.) 1908–1952, vol. 3.
- Fowler, Harold N. (ed. and tr.) [1914] 1971. *Plato's Euthyphro, Apology, Critic, Phaedo, Phaedrus*. In *Plato in twelve volumes*. Vol. 1. London: W. Heinemann; and Cambridge, MA: Harvard University Press.
- Francoeur, Louis B. Year 9 [= 1800–1801]. *Traité de mécanique élémentaire*. Paris: Perronneau.
- Francoeur, Louis B. [Year 9 (= 1800–1801)] 1804. *Traité élémentaire de mécanique*. 3rd edn., considerably augmented. Paris: Courcier.
- Frank, F. Charles. 1974. “Descartes’ Observations on the Amsterdam Snowfalls of 4, 5, 6 and 9 February 1634.” *Journal of Glaciology* 13: 535–539.
- Fréart de Chambray, Roland. (tr.) 1650. *Les quatre livres de l'architecture d'André Palladio: mis en français*. Paris: Edme Martin.
- Frede, Dorothea. (tr.) 1997. *Plato: Philebus*. In John Cooper (ed.) 1997, pp. 398–456.
- Freer, Stephen. (tr.) 2003. *Linnaeus' Philosophia Botanica*. Oxford: Oxford University Press.
- French, John. (tr.) 1651. *Three books of occult philosophy written by Henry Cornelius Agrippa of Nettesheim . . . ; translated out of the Latin into the English tongue by J. F.* London: Printed by R. W. for Gregory Moule.
- Fritz, Hans-Joachim. 1995. *Vitruv: Architekturtheorie und Machtpolitik in römische Antike*. Münster: Lit.
- Funkhouser, H. Gray. 1930. “A Short Account of the History of Symmetric Functions of Roots of Equations.” *American Mathematical Monthly* 37: 357–365.
- Galen. *De temperamentis libri III*. See Kühn (ed.) 1821–1833, 1: 509–694.
- Galilei, Galileo. [1890–1909] 1968. *Le Opere di Galileo Galilei*. Edited by A. Favaro. 20 vols. Florence: Barbera.
- Galois, Évariste. [1831/1846] 1989. “Mémoire: Sur les conditions de résolubilité des équations par radicaux.” In Liouville, Joseph, and Auguste Chevalier. (eds.) [1846] 1989. *Galois: Oeuvres mathématiques*. Sceaux: Éditions Jacques Gabay, pp. 417–433. See Edwards (tr.) 1984, 101–113 (Appendix 1).
- García Doncel, Manuel et al. (eds.). 1987. *Symmetries in physics (1600–1980)*. 1st International Meeting on the History of Scientific Ideas, Sant Feliu de Guíxols, Catalonia, Spain, September 20–26, 1983. Barcelona: Universitat Autònoma de Barcelona.
- Garnier, Jean-Guillaume. 1801. “Notes et Additions”. In Clairaut 1801, 221–448.
- Garnier, Jean-Guillaume. [1807] 1810. *Réciproques de la géométrie, suivies d'un recueil de théorèmes et de problèmes*. 2nd edition. Paris: Courcier.
- Geminus. *Introduction to the phenomena*. See Evans and Berggren (trs.) 2006, and Aujac (ed. and tr.) 1975.
- Gerard, Alexander. (tr.) 1759. “An essay on taste by De Montesquieu.” In *An Essay on Taste, with three dissertations on the same subject by Mr. De Voltaire, Mr. D'Alembert, and Mr. De Montesquieu*. London: A. Millar, pp. 257–314.
- Gerhardt, Volker, Rolf-Peter Horstmann, and Ralph Schumacher. (eds.) 2001. *Kant und die Berliner Aufklärung: Akten des IX. Internationalen Kant-Kongresses*. 2 vols. Berlin and New York: Walter de Gruyter.
- Gillispie, Charles C. (ed.) 1970–1990. *Dictionary of Scientific Biography*. 18 vols. New York: Scribner.
- Gillispie, Charles C. 2004. *Science and Polity in France: The Revolutionary and Napoleonic Years*. Princeton and Oxford: Princeton University Press.
- Glare, Peter G. W. (ed.) [1982] 1985. *Oxford Latin Dictionary*. Oxford: Clarendon Press.
- Goldstein, Bernard R. 1997. “What’s New in Kepler’s New Astronomy?” In Earman and Norton (eds.) 1997, pp. 3–23.
- Goldstein, Bernard R. 2002. “Copernicus and the Origin of his Heliocentric System.” *Journal for the History of Astronomy* 33: 219–235.
- Goldstein, Bernard R., and Giora Hon. 2005. “Kepler’s move from *orbs* to *orbits*: documenting a revolutionary scientific concept.” *Perspectives on Science* 13: 74–111.

- Goldstein, Bernard R., and Giora Hon. 2007. "Celestial Charts and Spherical Triangles: The Unifying Power of *Symmetry*." *Journal for the History of Astronomy* 38: 1–14.
- Goodman, John. (ed. and tr.) 1995. *Diderot: On Art*. Edited and translated by John Goodman, with an introduction by Thomas Crow. 2 vols. Vol. 1: *The Salon of 1765* and *Notes on Painting*. New Haven and London: Yale University Press.
- Granger, Frank. (ed. and tr.) [1931] 1962. *Vitruvius: On Architecture*. 2 vols. Cambridge, MA: Harvard University Press.
- Grant, Edward. (ed. and tr.) 1971. *Nicole Oresme and the Kinematics of Circular Motion: Tractatus de commensurabilitate vel incommensurabilitate motuum celi*. Edited with an Introduction, English translation, and Commentary. Madison: University of Wisconsin Press.
- Gratacap, Louis Pope. 1918. "Haüy's *Traité de Minéralogie*." *American Mineralogist* 3: 110–125. http://www.minsocam.org/MSA/collectors_corner/arc/hauyv.htm
- Grayson, Cecil. (ed. and tr.) 1972. *Leon Battista Alberti: On Painting and On Sculpture*. London: Phaidon.
- Gross, David J. 1996. "The role of symmetry in fundamental physics." *Proceedings of the National Academy of Sciences* 93: 14256–14259.
- Grube, George M. A. and C. David C. Reeve (trs.) 1997. *Plato: Republic*. See John Cooper (ed.) 1997, pp. 971–1223.
- Guillaumin, Jean-Yves. (ed. and tr.) 1995. *Boèce: Institution arithmétique*. Paris: Les Belles Lettres.
- Guthrie, William K. C. (ed. and tr.) [1939] 1960. *Aristotle: On the heavens*. Cambridge, MA: Harvard University Press.
- Hacking, Ian. 1971. "Equipossibility Theories of Probability." *The British Journal for the Philosophy of Science* 22: 339–355.
- Hacking, Ian. [1975] 2006. *The Emergence of Probability: A Philosophical Study of Early Ideas about Probability, Induction, and Statistical Inference*. 2nd edn. Cambridge: Cambridge University Press.
- Hacking, Ian. [1990] 2004. *The Taming of Chance*. Cambridge: Cambridge University Press.
- Hardie, Colin. (ed. and tr.) 1966. *The Six-Cornered Snowflake*. Latin text edited and translated by Colin Hardie, with essays by Lancelot L. Whyte and Basil John Mason. Oxford: Clarendon Press.
- Hart, Vaughan, and Peter Hicks. (trs.) 1996–2001. *Sebastiano Serlio: On Architecture; a translation of Tutte l'opere d'architettura et prospetiva*. With commentary; vol. 1: Books I–V; vol. 2: Books VI–VII. New Haven and London: Yale University Press.
- Haskell, Mellen W. (tr.) 1892–1893. "Klein: 'A comparative review of recent researches in geometry'." English translation of Klein 1872. *Bulletin of the New York Mathematical Society* 2: 215–249.
- Hasnawi, Ahmad, Abdelali Elamrani-Jamal, and Maroun Aouad. 1997. *Perspectives arabes et médiévales sur la tradition scientifique et philosophique grecque*. Leuven–Paris: Peeters.
- Hatfield, Gary. (ed. and tr.) [1997] 2004. *Kant: Prolegomena to any future metaphysics that will be able to come forward as science*. New York, Cambridge: Cambridge University Press.
- Haüy, René-Just. 1791. "Observations sur les propriétés électriques du Borate magnésio-calcaire." *Annales de chimie* 9: 59–63.
- Haüy, René-Just. 1793. "Mémoire sur les méthodes minerologiques." *Annales de chimie* 18: 225–240.
- Haüy, René-Just. 1797. "Mémoire sur les Crystaux appelés communément pierres de croix." *Mémoires de l'Académie des Sciences, année 1790, tirés des registres de cette Académie*, pp. 27–44.
- Haüy, René-Just. 1800. "Physique". *Séances des Écoles Normales*. 3: 310–331.
- Haüy, René-Just. 1801. *Traité de minéralogie*. 5 vols. Paris: Delance.
- Haüy, René-Just. 1815. "Mémoire sur une loi de cristallisation, appelée loi de symétrie." *Mémoire du Muséum d'Histoire Naturelle* 1: 81–101, 206–225, 273–298, 341–352.

- Heath, Thomas L. (tr.) [1896] 1961. *Apollonius of Perga: Treatise on Conic Sections*, edited in modern notation. Cambridge: Heffer.
- Heath, Thomas L. (tr.) [1897] 1950. *The Works of Archimedes*. New York.
- Heath, Thomas L. (tr.) [1926] 1956. *The Thirteen Books of Euclid's Elements*. 3 vols. New York: Dover.
- Heiberg, Johan L. (ed.) 1899–1903. *Ptolemaeus: Syntaxis mathematica*. 2 vols. Leipzig: Teubner.
- Heller, Siegfried. 1964. “Über Euklids Definitionen ähnlicher und kongruenter Polyeder.” *Janus* 51: 277–290.
- Herrmann, Wolfgang. 1973. *The Theory of Claude Perrault*. London: Zwemmer.
- Hipler, Franz. 1870–1874. “Analecta Warmiensia: Studien zur Geschichte der ermländischen Archive und Bibliotheken.” *Zeitschrift für die Geschichte und Altertumskunde Ermlands* 5: 316–488.
- Hirsch, Meier. 1807. *Sammlung geometrischer Aufgaben*. Part 2. Berlin: Frölich.
- Hirsch, Meier. 1809. *Fortsetzung der Sammlung von Beispieln, Formeln und Aufgaben aus der Buchstabenrechnung und Algebra*. Part 1. Berlin: Duncker und Humblot. See John Ross (tr.) 1827.
- Hogarth, William. [1753] 1997. *The Analysis of Beauty*. Edited with an introduction and notes by Ronald Paulson. New Haven: Yale University Press.
- Hon, Giora. 1993. “Review of: Klaus Mainzer 1988, and Bas C. van Fraassen 1989.” *Philosophia* 22: 445–452.
- Hon, Giora. 2004. “Putting Error to (Historical) Work: Error as a Tell-tale in the Studies of Kepler and Galileo.” *Centaurus* 46: 58–81.
- Hon, Giora, and Bernard R. Goldstein. 2004. “Symmetry in Copernicus and Galileo.” *Journal for the History of Astronomy* 35: 273–292.
- Hon, Giora, and Bernard R. Goldstein. 2005. “How Einstein Made Asymmetry Disappear: Symmetry and Relativity in 1905.” *Archive for History of Exact Sciences* 59: 437–544.
- Hon, Giora, and Bernard R. Goldstein. 2006a. “Symmetry and Asymmetry in Electrodynamics from Rowland to Einstein.” *Studies in History and Philosophy of Modern Physics* 37: 635–660.
- Hon, Giora, and Bernard R. Goldstein. 2006b. “Unpacking ‘For reasons of symmetry’: Two Categories of Symmetry Arguments.” *Philosophy of Science* 73: 419–439.
- Hooykaas, Reijer. 1975. “Romé de l’Isle.” In Gillispie (ed.) 1970–1990, 11: 520–524.
- Huggard, E. M. (tr.) [1951/1985] 1990. *G. W. Leibniz: Theodicy. Essays on the goodness of God, the freedom of man, and the origin of evil*. Edited with an introd. by Austin Farrer. Chicago and La Salle, IL: Open Court.
- Hugonnard-Roche, Henri et al. (eds. and trs.) 1982. *Georgii Joachimi Rhetici Narratio Prima*. Wrocław and Warsaw: Ossolineum.
- Hutchins, Robert M. (ed.) 1952. *Great Books of the Western World*. Vol. 16: *Ptolemy, Copernicus, Kepler*. Chicago: Encyclopaedia Britannica.
- Hutton, Charles. 1795. *A mathematical and philosophical dictionary: containing an explanation of the terms, and an account of the several subjects, comprized under the heads mathematics, astronomy, and philosophy both natural and experimental*. London: J. Johnson, and G. G. and J. Robinson.
- Itard, Jean. 1973. “Legendre, Adrien-Marie.” In Gillespie (ed.) 1970–1990, 8: 135–143.
- Jacobsson, Martin. (ed. and tr.) 2002. *Aurelius Augustinus: De musica liber VI*. Studia Latina Stockholmiensia, 147. Stockholm: Almqvist & Wiksell.
- Jacobus Leodiensis. *Speculum musicae*. See Bragard (ed.) 1963.
- Jaucourt, Louis de. 1765. Entry *Proportions*, in Diderot et al. 1765, 13: 468ff.
- Jaeger, Francis M. [1917] 1920. *Lectures on the Principle of Symmetry and its Applications in All Natural Sciences*. Second improved and augmented edition. Amsterdam: Elsevier; Cambridge: Cambridge University Press.
- James, John. (tr.) 1708. *A Treatise of the Five Orders of Columns of Architecture*. Written in French by Claude Perrault, made English by John James of Greenwich. London: Motte.

- Jones, Alexander. 1999. "Geminus and the Isia." *Harvard Studies in Classical Philology* 99: 255–267.
- Jordanus de Nemore. *De elementis arithmetice artis*. See Busard (ed.) 1991.
- Jussieu, Antoine Laurent de. 1777. "Examen de la famille des renoncules." *Histoire de l'Académie Royale des Sciences. Année 1773. Avec les Mémoires de Mathématique & de Physique, pour la même Année*, 214–240. See Stevens 1994, 274–295.
- Jussieu, Antoine Laurent de. 1778. "Exposition d'un nouvel ordre de plantes adopté dans les démonstrations du Jardin Royal." *Histoire de l'Académie Royale des Sciences. Année 1774. Avec les Mémoires de Mathématique & de Physique, pour la même Année*, 175–197. See Stevens 1994, 295–312.
- Kambartel, Walter. 1972. *Symmetrie und Schönheit; über mögliche Voraussetzungen des neueren Kunstbegriffs in der Architekturtheorie Claude Perraults*. München: W. Fink.
- Kant, Immanuel. [1768] 1912. "Von dem ersten Grunde des Unterschiedes der Gegenden im Raume." In Buchenau (ed.) 1912, 2: 393–400. See Walford and Meerbote (eds. and trs.) 1992, "Kant: 'Concerning the ultimate ground of the differentiation of directions in space'." pp. 363–372.
- Kant, Immanuel. [1783] 1920. *Prolegomena zu einer jeden künftigen Metaphysik, die als Wissenschaft auftreten können*. Edited by Karl Vorländer, 6th edn. Leipzig: Felix Meiner. See Beck (tr.) 1950; Hatfield (ed. and tr.) [1997] 2004.
- Katzir, Shaul. 2004. "The emergence of the principle of symmetry in physics." *Historical Studies in the Physical and Biological Sciences* 35: 35–65.
- Keill, John. 1718. *Introductio ad veram astronomiam, seu, Lectiones astronomicae: habitae in schola astronomica Academiae Oxoniensis*. Oxford: Clements.
- Keill, John. 1721. *An introduction to the true astronomy, or, Astronomical lectures read in the astronomical school of the University of Oxford*. London: Lintot.
- Kepler, Johannes. [1596] 1621. *Mysterium Cosmographicum*. Frankfurt: E. Kempfer. Reprinted in Duncan (ed. and tr.) 1981.
- Kepler, Johannes. 1611. *Strena Seu De Nive Sexangula*. Frankfurt am Main: Tampach. See also *KGW*, 4: 261–280, and Hardie (ed. and tr.) 1966.
- Kepler, Johannes. 1618–1621. *Epitome Astronomiae Copernicanae [Epitome of Copernican Astronomy]*. Linz: Tampachius. Reprinted in *KGW*, vol. 7. See Wallis (tr.) [1939] 1952.
- Kepler, Johannes. [1619] 1990. *Harmonice mundi*. Reprinted in *KGW*, vol. 6. See Aiton et al. (trs.) 1997.
- Kepler, Johannes. 1937–. *Johannes Keplers gesammelte Werke*. Edited by M. Caspar et al. München: C. H. Beck.
KGW. See Kepler 1937–.
- Kirby, John. (tr.) 1734. *Isaac Barrow: The Usefulness of Mathematical Learning explained and demonstrated: Being Mathematical Lectures read in the Publick Schools at the University of Cambridge*. London: Stephen Austen. See Barrow 1684.
- Klein, Felix. 1872. *Vergleichende Betrachtungen über neuere geometrische Forschungen*. Erlangen: A. Deichert. See Haskell 1892–1893.
- Klein, Felix. 1926. *Vorlesungen über die Entwicklung der Mathematik im 19. Jahrhundert*. Part 1. Berlin: Springer.
- Klein, Felix. [1926] 1979. *Development of Mathematics in the 19th Century*. Translated by Michael Ackerman. Brookline, MA: Math Sci Press.
- Koertge, Noretta. 1977. "Galileo and the Problem of Accidents." *Journal of the History of Ideas* 38: 389–408.
- Koetsier, Teun. 1991. *Lakatos' Philosophy of Mathematics: A Historical Approach*. Amsterdam: North-Holland.
- Krafft, Fritz, Karl Meyer, and Bernhard Sticker. (eds.) 1973. *Internationales Kepler-Symposium, Weil der Stadt 1971*. Hildesheim: Gerstenberg.
- Kühn, Karl Gottlob. (ed.) 1821–1833. *Claudii Galeni Opera omnia*. 20 vols. Leipzig: Knobloch.
- Lacroix, Sylvestre F. 1797. *Traité du calcul différentiel et du calcul intégral*, vol. 1. Paris: Duprat.

- Lacroix, Sylvestre F. Year 7 [= 1798–1799]. *Éléments de géométrie, précédés de réflexions sur l'ordre à suivre dans ces Éléments, sur la manière de les écrire, et sur la méthode en mathématiques*. Paris: Chez Duprat, de l'imprimerie de Crapelet.
- Lagrange, Joseph Louis. [1770–1771] 1869. "Réflexions sur la résolution algébrique des équations." *Nouveaux Mémoires de l'Académie royale des Sciences et Belles-Lettres de Berlin*, 1770 and 1771. Reprinted in Lagrange 1867–1892, vol. 3 (1869), 205–421.
- Lagrange, Joseph Louis. 1867–1892. *Oeuvres de Lagrange*. 14 vols. Paris: Gauthier-Villars.
- Lakatos, Imre. 1976. *Proofs and Refutations*. Cambridge: Cambridge University Press.
- Lamarck, Jean-Baptiste. 1801. *Système des Animaux sans vertèbres*, . . . Paris: Déterville.
- Lamarck, Jean-Baptiste. 1809. *Philosophie zoologique, ou Exposition des considérations relatives à l'histoire naturelle des animaux*. . . 2 vols. Paris: Dentu.
- Laplace, Pierre-Simon. 1776. "Recherches sur l'intégration des équations différentielles aux différences finies et sur leur usage dans la théorie des hasards." *Mémoires de mathématique et de physique, Présentés à l'Académie Royale des Sciences, par divers Savans, & lus dans ses Assemblées, année 1773*. 7: 37–163. Reprinted in Laplace 1878–1912, vol. 8 (1891), 69–197. See Pulskamp (tr.) 2007.
- Laplace, Pierre-Simon. 1796. *Exposition du Système du Monde*. 2 vols. Paris: Cercle-Social.
- Laplace, Pierre-Simon. 1800. "Mathématiques." *Séances des Écoles Normales* 6: 32–73. Reprinted in Laplace 1878–1912, vol. 14 (1912), 146–177. See also Dhombres et al. (eds.) 1992, 48–167.
- Laplace, Pierre-Simon. 1812. *Théorie analytique des probabilités*. Paris: Courcier.
- Laplace, Pierre-Simon. 1814. *Essai philosophique sur les probabilités*. Paris: Courcier. See Truscott and Emory (trs.) [1902] 1951.
- Laplace, Pierre-Simon. 1878–1912. *Oeuvres complètes de Laplace*. 14 vols. Paris: Gauthiers-Villars.
- Larson, James L. 1967. "Linnaeus and the Natural Method." *Isis* 58: 304–320.
- Lebesgue, Henri. 1924. "Remarques sur les deux premières démonstrations du théorème d'Euler relatif aux polyèdres." *Bulletin de la Société Mathématique de France* 52: 315–336.
- Le Bonniec, Henri. (ed. and tr.) 1953. *Pline L'Ancien: Histoire naturelle, Livre XXXIV*. With a commentary by Hubert Gallet de Santerre and Henri Le Bonniec. Paris: Les Belles Lettres.
- Legendre, Adrien-Marie. 1794. *Éléments de géométrie, avec des notes*. Paris: Didot. See Legendre [1794] 1813; Legendre [1794] 1817; Crelle (tr.) 1822; and Davies (tr.) 1862.
- Legendre, Adrien-Marie. [1794] 1813. *Éléments de géométrie, avec des notes*. 10th edn. Paris: Didot.
- Legendre, Adrien-Marie. [1794] 1817. *Éléments de géométrie, avec des notes*. 11th edn. Paris: Didot.
- Leibniz, Gottfried W. [1677] 1999. "Elementa verae pietatis, sive de amore dei super omnia." In *Sämtliche Schriften und Briefe*. Series 6 (Philosophische Schriften), vol. 4 (1677–June 1690), Part B. Berlin: Akademie Verlag, pp. 1357–1366.
- Leibniz, Gottfried W. [1686/1903] 1966. "Primæ veritates." In Couturat (ed.) [1903] 1966, 518–523; Ariew and Garber (eds. and trs.) 1989, 30–34.
- Leibniz, Gottfried W. [1710] 1720. *Essais de Theodicée sur la bonté de Dieu, la liberté de l'homme et l'origine du mal*. Amsterdam: Mortier. See Huggard (tr.) [1951/1985] 1990.
- Leibniz, Gottfried W. [1714/1840] 1954. *G. W. Leibniz: Principes de la nature et de la grâce fondés en raison et principes de la philosophie ou monadologie*. Edited by André Robinet. Paris: Presses Universitaires de France. See Rescher (tr.) 1991.
- Le Muet, Pierre. 1623. *Manière de bastir pour toutes sortes de personnes*. Paris: Tauernier.
- Le Muet, Pierre. (tr.) 1645. *Traicté Des cinq Ordres d'Architecture, tradvrit dv Palladio Par le Sr. Le Mvet*. Paris: F. Langlois [Partial translation of Palladio 1570, Book I, into French.].
- Lennox, James G. (tr.) 2001. *Aristotle: On the Parts of Animals*. Oxford: Clarendon Press.
- Leoni, James. (tr.) [1726] 1955. *Ten Books on Architecture by Leone Battista Alberti*. See Rykwert (ed.) 1955.
- Le Tourneur, St. 1978. "Francoeur, Louis-Bejamin." *Dictionnaire de Biographie Française* 14: 1002–1003.

- Le Tourneur, St. 1980. "Garnier, Jean-Guillaume." *Dictionnaire de Biographie Française* 16: 502–503.
- Levy, Silvio. (tr.) [1532] 2003. *Albrecht Dürer: De symmetria partium in rectis formis humanorum corporum*. Digitized facsimile, with an English translation. Oakland, CA: Octavo [electronic edition].
- Lévy, Tony. 1997. "Les *Éléments* d'Euclide en hébreu (XIII^e–XIV^e siècles)." In Hasnawi, Elamrani-Jamal, and Aouad 1997, pp. 79–94.
- Lewis, Charlton T., and Charles Short. [1879] 1951. *A Latin Dictionary*. Oxford: Clarendon Press.
- L'Huillier, Ghislaine. (ed.) 1990. *Le Quadrupartitum numerorum de Jean de Murs: introduction et édition critique*. Geneva: Droz.
- Liddell, Henry G., Robert Scott, and Henry S. Jones. [1940] 1996. *A Greek-English Lexicon*. With the assistance of Roderick McKenzie. Oxford: Clarendon Press.
- Lie, Sophus. [1895] 1989. "Influence de Galois sur le développement des mathématiques." In *Le centenaire de l'École Normale 1795–1895*. Paris: Hachette. Reprinted in *Évariste Galois: Oeuvres mathématiques*. Sceaux: Jacques Gabay.
- Linnaeus, Carl. 1738. *Caroli Linnaei . . . Classes plantarum: seu systemata plantarum omnia a fructificatione desumta, quorum XVI universalis & XIII partialia, compendiose proposita secundum classes, ordines et nomina generica cum clave cujusvis methodi et synonymis genericis. Fundamentorum botanicorum pars II*. Leiden: Conrad Wishoff.
- Linnaeus, Carl. 1751. *Philosophia botanica*. Stockholm: Kiesewetter. Reprinted 1966. Codicote, Herts., and New York: Wheldon & Wesley. See Freer (tr.) 2003.
- Lorch, Richard. 2001. "Greek–Arabic–Latin: The Transmission of Mathematical Texts in the Middle Ages." *Science in Context* 14: 313–331.
- Louis, Pierre. (ed. and tr.) 1956. *Aristote: Les parties des animaux*. Paris: Les Belles Lettres.
- Lücke, Hans-Karl. 1975–1979. *Alberti index: Leon Battista Alberti, De re aedificatoria, Florenz 1485: Index verborum*. 4 vols. Munich: Prestel.
- Mach, Ernst. [1872] 1910. "Die Symmetrie." In Ernst Mach 1910. *Populär-Wissenschaftliche Vorlesungen*. 4th edn. Leipzig: Barth, pp. 110–116. See McCormack (tr.) [1894] 1986.
- Mach, Ernst. [1883/1912] 1988. *Die Mechanik in ihrer Entwicklung historisch-kritisch dargestellt*. Edited by Renate Wahsner and Horst-Heino von Borzeszkowski. 7th edn. Berlin: Akademie-Verlag. See McCormack (tr.) [1893/1960] 1974.
- Mach, Ernst. [1886] 1922. *Die Analyse der Empfindungen und das Verhältnis des Physischen zum Psychischen*. 9th edn. Jena: Fischer. See Cora M. Williams (tr.) [1897/1914] 1959.
- Mach, Ernst. [1905/1926] 2002. *Erkenntnis und Irrtum: Skizzen zur Psychologie der Forschung*. Reprint of the 5th edn., edited by Martin Eberhardt. Berlin: Parerga. See McCormack and Foulkes (trs.) 1976.
- Mahoney, Michael S. 1990. "Barrow's Mathematics: Between Ancients and Moderns." In Feingold (ed.) 1990, pp. 179–249.
- Maimonides. *The Guide of the Perplexed*. See Pines (tr.) [1963] 1969.
- Mainzer, Klaus. [1988] 1996. *Symmetries of Nature: A Handbook for Philosophy of Nature and Science*. Berlin and New York: Walter de Gruyter.
- Maitland, Francis. (tr.) [1914] 1996. *Poincaré: Science and Method*. Bristol: Thoemmes Press.
- Mallgrave, Harry Francis. [2005] 2007. *Modern Architectural Theory: A Historical Survey, 1673–1968*. Cambridge and New York: Cambridge University Press.
- Margolis, Eric, and Stephen Laurence. 2006. "Concepts." In *The Stanford Encyclopedia of Philosophy*. Edited by Edward N. Zalta. <<http://plato.stanford.edu/archives/spr2006/entries/concepts/>>.
- Martin, Roger. Year 10 [= 1801–1802]. *Éléments de mathématiques a l'usage des écoles nationales*. Paris: Didot.
- Martindale, Mark Q., and Jonathan Q. Henry. 1998. "The Development of Radial and Biradial symmetry: The Evolution of Bilaterality." *American Zoologist* 38: 672–684.
- Mason, Basil John. 1966. "On the Shapes of Snow Crystals: a commentary on Kepler's essay 'On the Six-Cornered Snowflake'." In Hardie (ed. and tr.) 1966, 47–56.

- Maurice, Jean-Frédéric-Théodore. 1833. "Mémoire sur les travaux et écrits de M. Legendre." *Bibliothèque universelle des sciences, belles-lettres et arts* 52: 45–78.
- Maurolico, Francesco. 1543. *Cosmographia Francisci Maurolyci*. Venice: L. A. Giunta.
- Mauskopf, Seymour H. 1976. *Crystals and compounds: Molecular structure and composition in 19th-century French science*. Transactions of the American Philosophical Society, NS 66.
- McCormack, Thomas J. (tr.) [1893/1960] 1974. *Mach: The Science of Mechanics, A Critical & Historical Account of Its Development*. 6th edn. La Salle, IL: Open Court.
- McCormack, Thomas J. (tr.) [1894] 1986. Mach: "On symmetry." In Ernst Mach 1986. *Popular Scientific Lectures*. Introduction by Jeremy Bernstein. La Salle, IL: Open Court, pp. 89–106.
- McCormack, Thomas J., and Paul Foulkes. (trs.) 1976. *Knowledge and Error: Sketches on the Psychology of Enquiry*. Translated from the German with an introduction by Erwin N. Hiebert. Dordrecht: Reidel.
- Mehra, Jagdsish, and Arthur S. Wightman. (eds.) [1995] 1997. *Eugene Paul Wigner: Philosophical Reflections and Synthesis*. Annotated by Gerard G. Emch. New York and Berlin: Springer.
- Mendels, Judy. 1980. "Review of: Frank Baron, (ed.) 1978. *Joachim Camerarius (1500–1574)*. Munich: Fink Verlag." *German Studies Review* 3: 133–134.
- Menut, Albert D., and Alexander J. Denomy. (ed. and tr.) 1968. *Nicole Oresme: Le Livre du ciel et du monde*. Edited by Albert D. Menut and Alexander J. Denomy. Translated with an introduction by Albert D. Menut. Madison, Milwaukee, and London: University of Wisconsin Press.
- Melanchthon, Philipp. *Philippi Melanthonis opera quae supersunt omnia*. See Bretschneider and Bindsell (eds.) 1834–1860.
- Mercer, Christia. 2001. *Leibniz's Metaphysics: Its Origins and Development*. Cambridge: Cambridge University Press.
- Michaud, Louis Gabriel. 1854–1865. "Tedenat, Pierre". In *Biographie universelle ancienne et moderne* 41: 109. [The article is signed M–dj, expanded in the list of contributors as "Michaud junior". We assume this means Louis Gabriel Michaud (1773–1858), the younger brother of Joseph Fr. Michaud (1767–1839); the two brothers were the co-founders of this biographical series.]
- Mill, John Stuart. [1843] 1941. *A System of Logic: Ratiocinative and Inductive, being a connected view of the principles of evidence and the methods of scientific investigation*. New impression. London and New York: Longmans, Green & Co.
- Miller, Naomi. 1970. "Review of: Henry Wotton [1624] 1970." *The Journal of the Society of Architectural Historians* 29: 64–67.
- Mirbel, Charles-François Brisseau de. 1810. "Considérations sur la manière d'étudier l'Histoire naturelle des Végétaux. . . ." *Annales du Muséum d'histoire naturelle* 15: 110–141.
- Molière, Jean-Baptiste. 1671. *Le bourgeois gentilhomme: comédie-ballet*. Paris: P. Le Monnier.
- Monge, Gaspard. 1788. *Traité élémentaire de statique, à l'usage des colleges de la marine*. Paris: J. B. G. Musier. See Baker (tr.) 1851.
- Monge, Gaspard, and Jean Nicolas P. Hachette. 1802. "Application d'algèbre a la géométrie." *Journal de l'École Polytechnique* 4: 143–172.
- Montesquieu, Charles de Secondat. 1757. Entry *Goût*, in Diderot et al. 1757, 7: 761–767. See Gerard (tr.) 1759.
- Morgan, Michael J. 1977. *Molyneux's Question: Vision, Touch and the Philosophy of Perception*. Cambridge and New York: Cambridge University Press.
- Mugler, Charles. (ed. and tr.) 1970. *Archimède: De la sphère et du cylindre, La mesure du cercle, et Sur les conoïdes et les spheroids*. Paris: Les Belles Lettres.
- Mugler, Charles. (ed. and tr.) 1971. *Archimède: Des spirales, De l'équilibre des figures planes, L'arénaire, et La quadrature de la parabole*. Paris: Les Belles Lettres.
- Müller-Wille, Staffan. 1995. "Linnaeus' concept of a 'symmetry of all parts'." *Jahrbuch für Geschichte und Theorie der Biologie* 2: 41–47.
- Naigeon, Jacques-André. (ed.) Year 8 [= 1799–1800]. *Oeuvres de Denis Diderot publiées sur les manuscrits de l'Auteur*. 15 vols. Paris: Deterville.

- Neugebauer, Otto. 1968. "On the Planetary Theory of Copernicus." *Vistas in Astronomy* 10: 89–103.
- Newton, Isaac. [1707] 1752. *Arithmetica universalis Isaaci Newtoni, sive de compositione et resolutione arithmetica*. Edited by Antonio Lecchi, S. J. Milan: Apud Joseph Marellum.
- Newton, Isaac. [1720] 1728. *Universal Arithmetick: or a Treatise of Arithmetical Composition and Resolution*. London: J. Senex et al. Reprinted in Whiteside 1967, vol. 2.
- Newton, Isaac. [1730] 1952. *Opticks*. 4th edn. London: William Innys. Reprinted, New York: Dover.
- Nicomachus. *Introduction to arithmetic*. See D'Ooge (tr.) 1926.
- Nobelstiftelsen. 1972. *Nobel Lectures including Presentation Speeches and Laureates' Biographies: Physics, 1963–1970*. Amsterdam, London, and New York: Elsevier.
- North, John. 1995. *Astronomy and Cosmology*. New York and London: Norton.
- Nowacki, Horst. 2006. "Developments in Fluid Mechanics Theory and Ship Design before Trafalgar." Berlin: Max Planck Institute for the History of Science. Preprint 308.
- Nowacki, Horst. 2007. "Leonhard Euler and the Theory of Ships." Berlin: Max Planck Institute for the History of Science. Preprint 326.
- Olskamp, Paul J. (tr.) 1965. *Descartes: Discourse on Method, Optics, Geometry, and Meteorology*. The Library of Liberal Arts. Indianapolis: Bobs-Merrill.
- Oresme, Nicole. *Le livre du ciel et du monde*. See Menut and Denomy (ed. and tr.) 1968.
- Oresme, Nicole. *Tractatus de commensurabilitate vel incommensurabilitate motuum celi*. See Grant (ed. and tr.) 1971.
- Oxford English Dictionary*. 2006. The online edition. <http://www.oed.com/>
- Pacioli, Luca. 1509. *De divina proportione*. Venice: Paganus.
- Palladio, Andrea. 1570. *I quattro libri dell'architettura*. Venice: D. de' Franceschi. See Le Muet (tr.) 1645; Fréart de Chambray (tr.) 1650; Tavernor and Schofield (tr.) 1997.
- Park, David. 1968. "Resource Letter SP-1 on Symmetry in Physics." *Journal of Physics* 36: 577–584.
- Pascal, Blaise. [1670] 1688. *Pensées de M. Pascal sur la religion et sur quelques autres sujets, qui ont été trouvées après sa mort parmi ses papiers*, édition nouvelle. Amsterdam: Abraham Wolfgang. See Brunschvicg (ed.) [1904] 1965; Brunschvicg (ed.) [1905] 1986; Trotter (tr.) 1904; and Walker (tr.) 1688.
- Pasteur, Louis. [1848] 1922. "Recherches sur les relations qui peuvent exister entre la forme cristalline, la composition chimique et le sens de la polarisation rotatoire." *Annales de chimie et de physique* 3rd Ser. 24: 442–459. Reprinted in *Oeuvres de Pasteur*, P. Vallery-Radot (ed.), 1: 65–80. Paris: Masson and Cie.
- Pérez-Gómez, Alberto, and Indra K. McEwen. (trs.) 1993. *Ordonnance for the five kinds of columns after the method of the ancients by Claude Perrault*. Introduction by Alberto Pérez-Gómez and translation by Indra Kagis McEwen. Santa Monica: Getty Center for the History of Art and the Humanities.
- Perrault, Claude. 1673. *Les dix livres d'Architecture de Vitruve corrigez et traduits nouvellement en françois, avec des notes & des figures*. Paris: Coignard.
- Perrault, Claude. 1674. *Abregé des dix livres d'architecture de Vitruve*. Paris: Coignard. See Anon. (tr.) 1692.
- Perrault, Claude. 1683. *Ordonnance des cinq especes de colonnes selon la methode des anciens*. Paris: Coignard. See James (tr.) 1708; and Pérez-Gómez and McEwen (trs.) 1993.
- Piero della Francesca. 1995. Facsimile of Vatican, MS Urb. lat. 632: *Libellus de quinque corporibus regularibus*. In Edizione nazionale degli scritti di Piero della Francesca. Vol. 3. Florence: Giunti.
- Pines, Shlomo. (tr.) [1963] 1969. *Moses Maimonides: The Guide of the Perplexed*. Translated with an Introduction and Notes. With an Introductory Essay by Leo Strauss. Chicago and London: University of Chicago Press.
- Plato. *Laws*. See Bury (ed. and tr.) [1926] 1984.
- Plato. *Theaetetus*. See Cornford (tr.) 1957.

- Plato. *Timaeus*. See Cornford (tr.) [1959] 1987.
- Plato. *Phaedo*. See Fowler (ed. and tr.) [1914] 1971.
- Plato. *Philebus*. See Frede (tr.) 1997.
- Plato. *Republic*. See Grube and Reeve (trs.) 1997.
- Playfair, John. 1795. *Elements of Geometry*. Edinburgh: Bell & Bradfute; and London: G. G. & J. Robinson.
- Pliny. *Historia naturalis*. See Rackham (ed. and tr.) [1938/1944] 1949; 1952. See also Le Bonniec (ed. and tr.) 1953.
- Poincaré, Henri. [1908] 1920. *Science et méthode*. Paris: Flammarion. See Maitland (tr.) [1914] 1996.
- Poinsot, Louis. 1803. *Éléments de statique*. Paris: Calixte-Volland.
- Poisson, Siméon Denis. 1811. *Traité de mécanique*. 2 vols. Paris: Courcier.
- Poisson, Siméon Denis. 1812. "Mémoire sur la distribution de l'électricité à la surface des corps conducteurs." *Mémoires de la Classe des Sciences Mathématiques et Physiques de l'Institut Impérial de France, Année 1811*. Première Partie. Pages 1–92.
- Pollitt, Jerome J. 1965. *The Art of Greece 1400–31 BC: Sources and Documents*. Englewood Cliffs, NJ: Prentice-Hall.
- Post, Heinz R. 1971. "Correspondence, Invariance and Heuristics." *Studies in History and Philosophy of Science* 2: 213–255.
- Pouille, Emmanuel. 1973. "John of Murs." In Gillispie (ed.) 1970–1990, 7: 128–133.
- Pritchard, James. 1987. "From Shipwright to Naval Constructor: The Professionalization of 18th-century French Naval Shipbuilders." *Technology and Culture* 28: 1–25.
- Pseudo-Aristotle. *De mundo*. See Forster (tr.) [1914/1931] 1968.
- Ptolemy. *Almagest*. See Toomer (tr.) 1984.
- Ptolemy. *Optics*. See Smith (tr.) 1996.
- Ptolemy. Geography. See Berggren and Jones (trs.) 2000.
- Pulschke, Richard J. (tr.) 2007. "Laplace's 'Recherches sur l'intégration des équations différentielles aux différences finies et sur leur usage dans la théorie des hasards'." pp. 1–135. Linked to <http://cerebro.xu.edu/math/Sources/Laplace/index.html>
- Rackham, Harris. (tr.) [1926/1934] 1968. *Aristotle: The Nicomachean ethics*. London and Cambridge, MA: Harvard University Press.
- Rackham, Harris. (ed. and tr.) [1933] 1961. *Cicero: De natura deorum*. Cambridge, MA, and London: Harvard University Press.
- Rackham, Harris. (ed. and tr.) [1938/1944] 1949. *Pliny: Natural History*. Vol. 1. Cambridge, MA: Harvard University Press.
- Rackham, Harris. (ed. and tr.) 1952. *Pliny: Natural History*. Vol. 9. Cambridge, MA: Harvard University Press.
- Rashed, Roshdi. (ed.) 1996. *Encyclopedia of the History of Arabic Science*. 3 vols. London and New York: Routledge.
- Raven, John E. 1951. "Polyclitus and Pythagoreanism." *The Classical Quarterly* 1: 147–152.
- Recorde, Robert. 1557. *The whetstone of witte*. London: Kyngstone.
- Redhead, Michael L. G. 1975. "Symmetry in intertheory relations." *Synthese* 32: 77–112.
- Regiomontanus, Johannes. 1496. *Epitoma in Almagestum Ptolemei*. Edited by Giovanni Abiosi. Venice: Johannes Hamman. Reprinted in Schmeidler (ed.) 1972.
- Rescher, Nicholas. (tr.) 1991. *G. W. Leibniz's Monadology: An Edition for Students* [with commentary]. London: Routledge.
- Richter, Jean Paul. (ed.) [1883] 1970. *The Notebooks of Leonardo da Vinci*. Vol. 1. New York: Dover.
- Roche, John J. 1981. "The Radius Astronomicus in England." *Annals of Science* 38: 1–32.
- Roche, John J. 1987. "A Critical Study of Symmetry in Physics from Galileo to Newton." In García Doncel et al. 1987, pp. 1–28.
- Roland-Gosselin, Bernard. (ed. and tr.) 1949. *Augustine: De natura boni*. In Cayré and Folliet (eds.) 1949, 1: 437–509.

- Romé de l'Isle, Jean-Baptiste Louis de. [1772] 1783. *Cristallographie, ou description des formes propres a tous les corps du regne minéral, dans l'état de combinaison saline, pierreuse ou métallique*. 2nd edn. 4 vols. Paris: Imprimerie de Monsieur.
- Rommeaux, Sabine, Ahmed Djebbar, and Bernard Vitrac. 2001. "Remarques sur l'Histoire du Texte des *Éléments* d'Euclide." *Archive for History of Exact Science* 55: 221–295.
- Rose, Paul Lawrence. 1975. *The Italian Renaissance of Mathematics*. Geneva: Droz.
- Rosen, Edward. (tr.) [1939] 1959. *Three Copernican Treatises*. New York: Dover.
- Rosen, Edward. (tr.) 1992. *Nicholas Copernicus: On the Revolutions*. Baltimore and London: The Johns Hopkins University Press.
- Rosen, Joe. (ed.) 1982. *Symmetry in Physics: Selected Reprints*. Stony Brook, NY: American Association of Physics Teachers.
- Rosen, Joe, and P. Copié. (trs.) 1982. Curie: "On symmetry in physical phenomena, symmetry of an electric field and of a magnetic field." In Joe Rosen (ed.) 1982, pp. 17–25.
- Ross, John A. (tr.) 1827. *Hirsch's Collection of Examples, Formulae, & Calculations, on the Literal Calculus and Algebra*. London: Black, Young, and Young.
- Ross, William D. (ed. and tr.) [1908/1928] 1966. *Aristotle: Metaphysica*. Oxford: Clarendon Press.
- Ross, William D. (ed.) 1908–1952. *The Works of Aristotle*. 12 vols. Oxford: Clarendon Press.
- Rowland, Ingrid D. 2001. "Review of: Frédérique Lemerle (ed.) 2000. *Les Annotations de Guillaume Philandrier sur le De Architectura de Vitruve, Livres I à IV*. Paris: Picard." *Journal of the Society of Architectural Historians* 60: 235–236.
- Rowland, Ingrid D., Thomas N. Howe, and Michael J. Dewar. (trs.) 1999. *Vitruvius's Ten Books on Architecture*. Cambridge: Cambridge University Press.
- Ruffini, Paolo. 1799. *Teoria generale delle equazioni, in cui si dimostra impossibile la soluzione algebrica della equazioni generali di grado superiore al quatro*. 2 vols. Bologna: S. Tommaso d'Aquino.
- Rupprich, Hans. (ed.) 1956. *Dürer: schriftlicher Nachlass*. Vol. 1. Berlin: Deutscher Verein für Kunstwissenschaft.
- Ruskin, John. 1858. *The elements of drawing; in three letters to beginners*. New York: Wiley & Halsted.
- Ruskin, John. [1880] 1989. *The Seven Lamps of Architecture*. Second edition. New York: Dover.
- Rusnock, Paul, and Rolf George. 1995. "A Last Shot at Kant and Incongruent Counterparts." *Kant-Studien* 86: 257–277.
- Rykwert, Joseph. (ed.) 1955. *Ten Books on Architecture by Leone Battista Alberti*. Translated into English by James Leoni [in 1726, from the Italian translation by Cosimo Bartoli, published in Florence in 1550]. London: Alec Tiranti.
- Rykwert, Joseph, Neil Leach, and Robert Tavernor. (trs.) 1988. *Leon Battista Alberti: On the Art of Building in Ten Books*. Cambridge, MA, and London: MIT Press.
- Sacrobosco. *Tractatus de Sphaera*. See Thorndike (ed. and tr.) 1949.
- Sambursky, Samuel. 1962. *The Physical World of Late Antiquity*. London: Routledge & Kegan Paul.
- Sarton, George. 1921. "Review of: Jaeger [1917] 1920. 'The Principle of Symmetry and Its Applications to Science and to Art'." *Isis* 4: 32–38.
- Savage-Smith, Emilie. 1985. *Islamicate celestial globes: their history, construction, and use*. Washington, DC: Smithsonian.
- Savot, Louis. 1624. *L'Architectvre françoise des bastimens particuliers*. Paris: Cramoisy.
- Savot, Louis. [1624] 1673. *L'Architectvre françoise des bastimens particuliers*. Avec des Figures et des Notes de M. Blondel. Paris: François Clouzier l'ainné.
- Scamozzi, Vincenzo. 1615. *L'idea dell'architettura universale*. Vol. 1. Venice: Presso Lautore.
- Schmeidler, Felix. (ed.) 1972. *Regiomontanus: Opera collectanea*. Osnabrück: Zeller.
- Schneer, Cecil J. 1960. "Kepler's New Year's Gift of a Snowflake." *Isis* 51: 531–545.
- Schneer, Cecil J. 1967. "Review of: Hardie (ed. and tr.) 1966." *Isis* 58: 134–136.
- Scholz, Erhard. 1989a. "The Rise of Symmetry Concepts in the Atomistic and Dynamistic Schools of Crystallography, 1815–1830." *Révue d'Histoire des Sciences* 42: 109–122.
- Scholz, Erhard. 1989b. *Symmetrie Gruppe Dualität*. Basel, Boston, Berlin: Birkhäuser.

- Sedley, David. 1989. "Teleology and Myth in the *Phaedo*." *Proceedings of the Boston Area Colloquium in Ancient Philosophy* 5: 359–383.
- Serlio, Sebastiano. 1537. *Regole generali di architettura sopra le cinque maniere de gli edifici cioe, thoscano, dorico, ionico, corinthio, et composito; con gli essempli dell'antiquita, che per la maggior parte concordano con la dottrina di Vitruvio*. Venice: Marcolini da Forli.
- Serlio, Sebastiano. [1584/1619] 1964. *Tutte l'opere d'architettura, et prospettiva di Sebastiano Serlio, . . .* diviso in sette libri. Edited by Giovanni Domenico Scamozzi. Venice: G. de' Franceschi. Repr. Ridgewood, NJ: Gregg Press. See Hart and Hicks (trs.) 1996–2001.
- Sezgin, Fuat. (ed.) 1986. "Abd al-Rahmān al-Sūfī: *The book of constellations (Kitāb ṣuwar al-kawākib)*. Reproduced from Oxford, Bodleian Library, MS Marsh 144 (copied in 1009–10 A.D.). Frankfurt/M.: Institut für Geschichte der Arabisch-Islamischen Wissenschaften an der Johann Wolfgang Goethe Universität.
- Simson, Robert. 1756a. *The Elements of Euclid*, viz. The first six books, together with the Eleventh and Twelfth. In this Edition, the Errors, by which Theon, or others, have long ago Vitiated these Books, are Corrected, And some of Euclid's Demonstrations are Restored. Glasgow: Foulis.
- Simson, Robert. 1756b. *Euclidis Elementorum*, libri priores sex, item undecimus et duodecimus, ex versione latina Federici Commandini: . . . Glasgow: Foulis.
- Smith, A. Mark. (tr.) 1996. *Ptolemy's Theory of Visual Perception: An English Translation of the Optics With Introduction and Commentary*. Transactions of the American Philosophical Society, 86.2. Philadelphia: American Philosophical Society.
- Speiser, Andreas. (ed.) 1953. *Commentationes Geomericæ*. In *Leonhardi Euleri Opera Omnia*, Series 1, 26. Lausanne and Zurich: Füssli.
- Stevens, Peter F. 1984. "Hüüy and A.-P. Candolle: Crystallography, Botanical Systematics, and Comparative Morphology, 1780–1840." *Journal of the History of Biology* 17: 49–82.
- Stevens, Peter F. 1994. *The Development of Biological Systematics: Antoine-Laurent de Jussieu, Nature, and the Natural System*. New York: Columbia University Press.
- Stevin, Simon. 1634. "L'art pondénaire, ou la statique." In *Les œuvres mathématiques de Simon Stevin*. Edited by Albert Girard. 6 vols. Leiden: Bonaventure & A. Elsevier.
- Stocks, John L. (tr.) [1984] 1995. *Aristotle: On the Heavens*. See Barnes (ed.) [1984] 1995, 1: 447–511.
- Strauss, Walter L. (ed. and tr.) 1972. *Albrecht Dürer: The Human Figure; The Complete "Dresden Sketchbook"*. New York: Dover.
- Sullivan, Richard J. 1794. *A View of Nature, in Letters to a Traveller among the Alps, with Reflections on Atheistical Philosophy, now Exemplified in France*. Vol. 1. London: T. Becket.
- Tadgell, Christopher. 1980. "Claude Perrault, François Le Vau and the Louvre Colonnade." *The Burlington Magazine* 122: 326–337.
- Tavernor, Robert, and Richard Schofield. (tr.) 1997. *Andrea Palladio: The Four Books on Architecture*. Cambridge, MA, and London: MIT Press.
- Tedenat, Pierre. 1801. *Leçons élémentaires de mathématiques*. Part 2, vol. 1. Paris: Duprat.
- Thomas, Thomas. 1587. *Dictionarium linguae latinae et anglicanae*. Cambridge: T. Thomas; and London: R. Boyle.
- Thomson, David. 1984. *Renaissance Paris: Architecture and Growth, 1475–1600*. Berkeley and Los Angeles: University of California Press.
- Thomson, William, and Gustav Junge. 1930. *The Commentary of Pappus on Book X of Euclid's Elements: Arabic text and translation*. Cambridge, MA: Harvard University Press.
- Thordike, Lynn. (ed. and tr.) 1949. *The Sphere of Sacrobosco and its commentators*. Chicago: University of Chicago Press.
- Todhunter, Isaac. 1865. *A History of the Mathematical Theory of Probability from the Time of Pascal to that of Laplace*. Cambridge, London: Macmillan.
- Toomer, Gerald J. (tr.) 1984. *Ptolemy's Almagest*. New York and Berlin: Springer.
- Touret, Jacques L. R., and Robert P. W. Visser. (eds.) 2004. *Dutch pioneers of the earth sciences*. Amsterdam: Koninklijke Nederlandse Akademie van Wetenschappen.
- Touret, Lydie. 2004. "Crystals models: milestone in the birth of crystallography and mineralogy as sciences." In Jacques Touret and Visser (eds.) 2004, pp. 43–58.

- Trotter, William F. (tr.) 1904. *The Thoughts of Blaise Pascal*. London: Dent. The translator's name is given on p. 372, not on the title page. Reprinted several times as Pascal's *Pensées* (often without the name of the translator), e.g., Pascal's *Pensées*. Introduction by T. S. Eliot. New York: Dutton, 1958.
- Truesdell, Clifford A. (ed.) 1967. *Euler: Scientia navalis, pars prima*. In *Leonhardi Euleri Opera omnia*, Ser. 2, 18. Zurich: Füssli.
- Truscott, Frederick W., and Frederick Lincoln Emory. (trs.) [1902] 1951. *A philosophical essay on probabilities*. Translated from the 6th French edition of 1840. New York: Dover.
- Van Cleve, James, and Robert E. Frederick. (eds.) 1991. *The Philosophy of Right and Left*. Dordrecht, Boston, and London: Kluwer.
- Vandermonde, Alexandre Théophile. 1774. "Mémoire sur la résolution des équations". *Histoire de l'Académie Royale des Sciences, Année M. DCCLXXI [1771]*, 365–416.
- Van Fraassen, Bas C. 1989. *Laws and Symmetry*. Oxford: Clarendon Press.
- Van Helden, Albert. 1985. *Measuring the Universe: Cosmic Dimensions from Aristarchus to Halley*. Chicago and London: University of Chicago Press.
- Vinci, Leonardo da. *The Notebooks*. See Richter (ed.) [1883] 1970.
- Vitruvius. *De architectura*. See Granger (ed. and tr.) [1931] 1962; Rowland et al. (trs.) 1999.
- Vogel, Kurt. 1971. "Hirsch, Meier." *Neue Deutsche Biographie* 9: 217.
- Walford, David. 2001. "Towards an Interpretation of Kant's 1768 *Gegenden im Raume* Essay." *Kant-Studien* 92: 407–439.
- Walford, David, and Ralf Meerbote. (eds. and trs.) 1992. *Immanuel Kant: Theoretical philosophy 1755–1770*. New York: Cambridge University Press.
- Wallis, Charles G. (tr.) [1939] 1952. *Nicolaus Copernicus: On the Revolutions of the Heavenly Spheres*. In Hutchins (ed.) 1952, 16: 497–838.
- Wallis, Charles G. (tr.) [1939] 1952. *Johannes Kepler: Epitome of Copernican Astronomy, Books IV and V*. In Hutchins (ed.) 1952, 16: 839–1004.
- Walker, Joseph. (tr.) 1688. *Monsieur Pascall's thoughts, meditations, and prayers, touching matters moral and divine, as they were found in his papers after his death*. London: Jacob Tonson.
- Ward, William H. [1926] 1976. *The Architecture of the Renaissance in France*. 2nd revised edn. New York: Hacker Art Books.
- Watson, Henry. (tr.) 1776. *Euler: A Compleat Theory of the Construction and Properties of Vessels with Practical Conclusions for the Management of Ships made easy to Navigators*. London: Emsley.
- Wehr, Hans. 1971. *A Dictionary of Modern Written Arabic*. Edited by J. Milton Cowan. 3rd revised edn. Ithaca: Spoken Language Services.
- Weyl, Hermann. 1928. *Gruppentheorie und Quantenmechanik*. Leipzig: S. Hirzel.
- Weyl, Hermann. [1939] 1966. *The Classical Groups, their Invariants and Representations*. Princeton: Princeton University Press.
- Weyl, Hermann. 1952. *Symmetry*. Princeton: Princeton University Press.
- Weyl, Hermann, and Olaf Helmer. [1927] 1949. *Philosophy of Mathematics and Natural Science*, revised and augmented English edition [by the author], based on a translation by Olaf Helmer, Princeton: Princeton University Press.
- Whiteside, Derek T. 1967. *The Mathematical Works of Isaac Newton*. 2 vols. New York and London: Johnson Reprint Corporation.
- Whyte, Lancelot L. 1966. "Kepler's unsolved problem and the *facultas formatrix*." In Hardie (ed. and tr.) 1966, 57–63.
- Wigner, Eugene P. [1959] 1979. "The unreasonable effectiveness of mathematics in the natural sciences." The Richard Courant Lecture delivered at New York University in 1959. Reprinted in Wigner 1979, pp. 222–237.
- Wigner, Eugene P. [1964a] 1997a. "The role of invariance principles in natural philosophy." In *Proceedings of the International School of Physics "Enrico Fermi"* 29 (1964). Reprinted in Mehra and Wightman (eds.) [1995] 1997, pp. 311–320.

- Wigner, Eugene P. [1964b] 1997b. "Symmetry and conservation laws." In *Proceedings of the National Academy of Sciences* 51 (1964). Reprinted in Mehra and Wightman (eds.) [1995] 1997, pp. 297–310.
- Wigner, Eugene P. 1979. *Symmetries and Reflections*. Woodbridge, CT: Ox Bow Press.
- Wiener, Philip P. (ed.) 1973. *The dictionary of the history of ideas*. 4 vols. New York: Scribner's.
- Williams, Cora May. (tr.) [1897/1914] 1959. *Mach: The analysis of sensations, and the relation of the physical to the psychical*. Translated from the 1st German edn.; revised and supplemented from the 5th German edn. by Sydney Waterlow; with a new introd. by Thomas S. Szasz. New York: Dover.
- Williams, Roger L. 2001. *Botanophilia in Eighteenth-Century France: The Spirit of the Enlightenment*. Dordrecht, Boston, and London: Kluwer.
- Wolff, Christian. [1713–1715] 1742. *Compendium Elementorum matheseos Universae*. 2 vols. Lausanne and Geneva: M.-M. Bousquet.
- Wolff, Christian. [1716] 1978. *Mathematisches Lexicon, Darinnen die in allen Theilen der Mathematick üblichen Kunst-Wörter erkläret, und zur Historie der Mathematischen Wissenschaften dienliche Nachrichten ertheilet. ...* Leipzig: J. F. Gleditschen. Reprinted in: *Christian Wolff: Gesammelte Werke*. Series 1, vol. 11. Edited by Joseph E. Hoffmann. Hildesheim and New York: Olms.
- Wotton, Henry. [1624] 1970. *The Elements of Architecture*. New York and Amsterdam: Da Capo Press & Theatrum Orbis Terrarum.
- Zedler, Johann Heinrich. [1744] 1997. "Symmetrie." In *Grosses vollständiges Universal-Lexicon*. Leipzig und Halle: Verlegts Zedler. Facsimile reprint, Graz: Akademische Druck u. Verlagsanstalt, 41: 715–716.
- Zinner, Ernst. [1968] 1990. *Regiomontanus: His Life and Work*. Translated by Ezra Brown. Amsterdam, New York, and Oxford: North Holland.

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