Mercator, Nicolaus (Kauffman, Niklaus) | Encyclopedia.com

(*b*. Eutin [?], Schleswig-Holstein, Denmark [now Germany], *ca*. 1619; *d*. Paris, France, 14 January [?] 1687)

mathematics, astronomy.

His father was probably the Martin Kauffman who taught school at Oldenburg in Holstein from 1623 and died there in 1638. Doubtless educated in boyhood at his father's school, Nicolaus graduated from the University of Rostock and was appointed to the Faculty of Philosophy in 1642. At Copenhagen University in 1648 he superintended a "Disputatio physica de spiritibus et innato calido" and over the next five years produced several short textbooks on elementary astronomy and spherical trigonometry; one of his title pages at this time describes him as "mathematician and writer on travels to the Indies."

His tract on calendar improvement (1653) caught Cromwell's eye in England and, whether invited or not, he subsequently left Denmark for London. There he resided for almost thirty years and came universally to be known by his latinized name, an "anglization" which he himself soon adopted. Unable to find a position in a university, Mercator earned a living as a mathematical tutor, but soon he made the acquaintance of Oughtred, Pell, Collins, and other practitioners. In November 1666, on the strength of his newly invented marine chronometer, he was elected a fellow of the Royal Society; earlier, in Oldenburg's *Philosophical Transactions of the Royal Society*, he had wagered the profits (seemingly nonexistent) from his invention against anyone who could match his expertise in the theory of Gerard Mercator's map. Through his Latin version (1669) of Kinckhuysen's Dutch *Algebra*, commissioned by Collins at Seth Ward's suggestion, he came into contact with Newton, and the two men later exchanged letters on lunar theory. Aubrey portrays Mercator at this time as "of little stature, perfect; black haire, … darke eie, but of great vivacity of spirit … of a soft temper (*amat Venerem aliquantum*): of a prodigious invention, and will be acquainted (familiarly) with nobody." In September 1676 Hooke unsuccessfully proposed Mercator as Mathematical Master at Christ's Hospital. In 1683 he accepted Colbert's commission to plan the waterworks at Versailles, but died soon afterward, having fallen out with his patron.

Mercator's early scientific work is known only through the university textbooks which he wrote in the early 1650&s; if not markedly original, they show his firm grasp of essentials. His *Trigonometria sphaericoram logarithmica* (1651) gives neat logarithmic solutions of the standard cases of right and oblique triangles and tabulates the logarithms of sine, cosine, tangent, and cotangent functions (his "Logarithmus," "Antilogarithmus," "Hapsologarithmus," and "Anthapsologarithmus") at l' intervals. His *Cosmographia* (1651) and *Astronomia* (1651) deal respectively with the physical geography of the earth and the elements of spherical astronomy. In his *Rationes mathematicae* (1653) he insists on drawing a basic distinction between rational and irrational numbers: the difference in music is that between harmony and dissonance; in astronomy that between a Keplerian "harmonice mundi" and the observable solar, lunar, and planetary motions. In the tract De *emendatione annua* (1653[?]) he urges the reform of the 365–day year into months of (in sequence) 29, 29, 30, 30, 31, 31, 32, 31, 31, 31, 30, and 30 days.

Mercator's first published book in England, *Hypothesis astronomica nova* (1664), in effect combines Kepler's hypothesis (that planets travel in elliptical orbits round the sun, with the sun at one focus) with his vicarious hypothesis (in which the equant circle is centered in the line of apsides at a distance from the sun roughly 5/8 times the doubled eccentricity): Mercator sets this ratio exactly equal to the "divine section" , with an error even in the case of Mars of less than 2'. (Here a mystical streak in his personality gleams through, for he compares his hypothesis to a knock-kneed man standing with arms outstretched, a "living image of Eternity and the Trinity." He later expounded similar insights in an unpublished manuscript on *Astrologia rationalis*.) Subsequently, in 1670, he showed his skill in theoretical astronomy by demolishing G. D. Cassini's 1669 method for determining the lines of apsides of a planetary orbit, given three solar sightings. He showed that it reduced to the Boulliau-Ward hypothesis of mean motion round an upper-focus equant and pointed out its observational inaccuracy. (His enunciation of the "true" Keplerian hypothesis, that time in orbit is proportional to the focal sector swept out by the planet's radius vector, may well have been the source of Newton's knowledge of this basic law.) The two books of his *Institutiones astronomicae* (1676) offered the student an excellent grounding in contemporary theory, and Newton used them to fill gaps in his rather shaky knowledge of planetary and lunar theory. Some slight hint of the practical scientist is afforded by the barometric measurements made during the previous half year, which Mercator registered at the Royal Society in July 1667. No working drawings are extant of the Huygenian pendulum watch—which he designed in 1666—or of its marine mounting (by gimbal suspension), but an example "of a foote diameter" was made.

Mercator is remembered above all as a mathematician. In 1666 he claimed to be able to prove the identity of “the logarithmical Tangent-line beginning at 45 deg.” with the “true Meridian-line of the Sea-Charte” (Mercator map). This declaration is not authenticated but not necessarily empty. It is difficult to determine how far his researches into finite differences—which were restricted to the advancing-differences formula—were independent of Harriot’s unpublished manuscripts on the topic, to which Mercator perhaps had access. In his best-known work, *logarithmotechnia* (1668), he constructed logarithms from first principles (if $a^b = c$, then $b = tog_a c$), making ingenious use of the inequality

p = 1/2, 1/3, …,

while in supplement (a late addition to the manuscript submitted in 1667) he used the St. Vincent-Sarasa hyperbola-area model to establish, independently of Hudde and Newton, the series expansion

The circulation by Collins of the “De analysi,” composed hurriedly by Newton as a riposte, seems to have effectively blocked Mercator’s plans to publish a complementary *Cyclomathia* with allied expansions (on Newtonian lines) of circle integrals. The “Introductio brevis” which he added in 1678 to Martyn’s second edition of the anonymous *Euclidis elementa geometrica* commendably sought to simplify the Euclidean definitions for the beginner by introducing motion proofs: a circle is generated as the ripple on the surface of a stagnant pool when a stone is dropped at its center, a line as the instantaneous meet of two such congruent wave fronts. His *Hypothesis astronomica nova* contains the first publication of the polar equation of an ellipse referred to a focus.

BIBLIOGRAPHY

I. Original Works. The trio of textbooks put out by Mercator at Danzig in 1651 appeared under the titles *Cosmographia, sive descriptio coeli et terrae in circulos …*, *Trigonometria sphaericorum logarithmica*, *… cum canone triangulorum emendatissimo…*; and *Astronomia sphaerica decem problematis omnis ex fundamento tradita*. They were reissued shortly afterward at Leipzig … *Conformatae ad exactissimas docendi leges pro tironibus*, *… privatis hactenus experimentis comprobatae*. At Copenhagen Mercator published in 1653 his study on mathematical rationality, *Rationes mathematicae subductae*, and also his propagandist tract on calendar improvement, *De emendatione annua diatribae duae…*.

During the next ten years he apparently wrote nothing for the press, but at length produced his *Hypothesis astronomica nova, et consensus ejus cum observationibus* (London, 1664). His wager regarding the logarithmic nature of the Mercator map was announced in “Certain Problems Touching Some Points of Navigation,” in *Philosophical Transactions of the Royal Society*, **1** no. 13 (4 June 1666), 215–218, In 1668 appeared his major work, *Logarithmotechnia: sive methodus construendi logarithmos nova, accurata, & facilis; scripto antehàc communicata, anno sc. 1667 nonis Augusti: cui nunc accedit vera quadratura hyperbolae, & inventio summae logarithmorum* (London, 1668), later reprinted in F. Maseres, *Scriptores logarithmici*, I (London, 1791), 169–196; to Wallis’ “account of it in *Philosophical Transactions of the Royal Society*, **3** (17 Aug. 1668), 753–759, Mercator added “Some further Illustration,” *ibid*., 759–764. For a page-by-page analysis of the bk. see J. E. Hofmann, “Nicolaus Mercators *Logarithmotechnia* (1668),” in *Deutsche Mathematik*, **3** (1938), 446–466. His “Some Considerations … Concerning the Geometrick and direct Method of Signior Cassini for finding the Apogees, Excentricities and Anomalies of the Planets; as that was printed in the *Journal des sçavans of Septemb*. 2. 1669” appeared in *Philosophical Transactions of the Royal Society*, **5** , no. 57 (25 Mar. 1670), 1168–1175.

His astronomical compendium, *Institutionum astronomicarum libri duo, de motu astrorum communi & proprio, secundum hypotheses veterum & recentiorum praecipuas* … came out at London in 1676 (reissued Padua, 1685): Newton’s lightly annotated copy is now at Trinity College, Cambridge, NQ.10.152. In an app. to the compendium Mercator reprinted his earlier *Hypothesis nova* (the preface excluded). His “Introductio brevis, qua magnitudinum ortus ex genuinis principiis, & ortarum affectiones ex ipsa genesi derivantur” was adjoined in 1678 to John Martyn’s repr. of the “Jesuit’s Euclid,” in *Euclidis elementa geometrica, novo ordine ac methodo fere, demonstrata* (London, 1666).

None of Mercator’s correspondence with his contemporaries seems to have survived, although that with Newton (1675–1676) on lunar vibration is digested in the *Institutiones astronomicae*, 286–287; compare the remark added by Newton to the third bk. of the third ed. of his *Principia*, Propositio XVII (London, 1726), 412. The MS (Bodleian, Oxford, Savile G.20) of Mercator’s Latin rendering of Kinckhuysen’s *Algebra ofte Stelkonst* (Haarlem, 1661) is reproduced in *The Mathematical Papers of Isaac Newton*, II (Cambridge, 1968), 295–364, followed by Newton’s “Observations” upon it, *ibid*., 364–446.

Thomas Birch in his biography in *A General Dictionary Historical and Critical*, VII (London, 1738), 537 539 [= J. G. de Chaufepié, *Nouvean Dictionaire historique et critique*, III (Amsterdam, 1753), 79], records the existence in Shirburn Castle of “a manuscript containing Theorems relating to the Resolution of Equations, the Method of Differences, and the Construction of Tables; and another, intitled, *Problema arithmeticum ad doctrinam de differentialium progressionibus pertinens*”; these are now in private possession. Birch also lists (*ibid*., 539) the section titles of Mercator’s unpublished “Astrologia rationalis, argumentis solidis explorata” (now Shirburn 180.F.34). Details of his chronometer are given by Birch in his *History of the Royal Society*, II (London, 1756), 110–114, 187, and in Oldenburg’s letter to Leibniz of 18 December 1670 (C. I. Gerhardt, *Die Briefwechsel von G. W. Leibniz*, I [Berlin, 1899], 48). References to the lost treatise on circle quadrature, *Cyclomathia* occur in John Collins’ contemporary correspondence with James Gregon (see the *Gregory Memorial Volume* [London, 1939], 56, 60, 153).

II. Secondary Literature. J. E Hofmann's *Nicolaus Mercator (Kauffman), sein Leben und Wirken, vorzugsweise als Mathematiker* (in *Akademie der Wissenschaften und der Literatur in Maintz [Abh. der Math.-Nat. Kl.]*, no. 3 [1950]) is the best recent survey of Mercator's life and mathematical achievement. On his personality and habits see John Aubrey, *Letters … and Lives of Eminent Men*, II (London, 1813), 450– 451, 473, or *Brief Lives* (London, 1949), 135, 142, 153–154. J.-B. Delambre gives a partially erroneous estimate of Mercator's equant hypothesis of planetary motion in his *Histoire de l'astronomie moderne*, II (Paris, 1821), 539–546; sec also Curtis Wilson, "Kepiefs Derivation or the Elliptical Path," in *Isis* **59** (1968), 5–25,esp. 23.

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