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(*b*. Alcácer do Sol, Portugal, 1502; *d*, Coimbra,Portugal, 11 August 1578)

*mathematics, cosmography*.

Nuñez's parents are believed to have been Jewish, since he was registered as a "new Christian." He was married at Salamanca in 1523 to Giomar de Arias, daughter of a Spanish Christian, Pedro Fernandez de Arias; they had six children. The earliest information on his education places him as an independent student at the University of Salamanca in 1521 and 1522. He moved to Lisbon in 1524 or 1525, at which time he received a bachelor's degree in medicine while simultaneously extending his knowledge of mathematics and studying astrology. This excellent preparation served as a basis for his appointment as royal cosmographer on 16 November 1529. In recognition of his abilities as a practical researcher, he was named on 4 December 1529 to the professorship of moral philosophy at the University of Lisbon, then to the chair of logic (15 January 1530); during 1531 and 1532 he also held the chair of metaphysics. At the same time Nuñez was pursuing his own studies, and on 16 February 1532 he graduated as licentiate in medicine from the University of Lisbon.

The professorship of mathematics at Lisbon was moved to Coimbra in 1537; and on 16 October 1544 Nuñez was named to the post, which he occupied until his retirement on 4 February 1562. On 22 December 1547 he was named chief royal cosmographer and fulfilled the duties of the office until his death.

Nuñez was called to court on 11 September 1572 by his former student Sebastian, grandson of John III. He remained in Lisbon for two years as adviser for the projected reform of weights and measures, which was promulgated in 1575. He was also appointed professor of mathematics for the instruction of pilots, navigators, and cartographers. After the reform of weights and measures he returned to Coimbra, where he remained until his death.

Considered the greatest of Portuguese mathematicians, Nuñez reveals in his discoveries, theories, and publications that he was a first-rate geographer, physicist, cosmologist, geometer, and algebraist. In addition to works in Portuguese (*Tratado da sphera*), he wrote and published several works in Latin so that his discoveries might be utilized by educated people of other nations. His writings are rigorously scientific and usually contain a profusion of drawings and figures so that they may be understood more easily.

Among Nuñez's students in Lisbon were the brothers of John **III** , Louis and Henry, the latter the future king and cardinal. While at Coimbra he taught Clavius, known as the sixteenth-century Euclid. Also among his outstanding students were Nicolas Coelho de Amaral, who succeeded Nuñez in his professorship; Manuel de Figueredo, who became chief royal cosmographer; and João de Castro, viceroy of India, and one of the greatest Portuguese navigators.

Nuñez made important contributions in the design of instruments. In astronomical observations the impossibility of precisely measuring small portions of an arc was an impediment, and to overcome this difficulty he conceived the idea of the nonius. In its original form this instrument, consisting of forty-four concentric auxiliary circles, was attached to an astrolabe for measuring fractions of a degree. Upon each circle and upon their quadrants were equal divisions, ranging from eighty-nine on the circle of greatest diameter to forty-six on the circle of least diameter. Each circle had one division less than the one outside it and one division more than the one inside, making it possible to take a reading from the circle that gave the most accurate approximation.

This instrument has not been modified during the four centuries since it was devised, but it has been refined. In 1593 Clavius reduced the auxiliary circles to one divided into sixty-one parts and divided the limb of the astrolabe into sixty; and in 1631 Pierre Vernier let the auxiliary arc move freely by attaching it to the alidade of the astrolabe. (The latter variationis called a vernier in some countries.) With the nonius exceedingly small measures may be read on any scale or system of division, either circular or rectilinear.

As a navigator Nuñez made a significant discovery based on observations reported to him in 1533 by Admiral Martim Afonso de Sousa. They relate to rhumb line sailing and to great circle sailing. The former is the course of the ship while sailing on a single bearing (always oblique to the meridian in the direction of one and the same point of the compass), subsequently (1624) called "loxodrome" by Willebrord Snell. The latter, which is the shortest distance between any two terrestrial points, has been called "orthodrome"; in it the bearing varies. Until that time pilots had considered them equivalent; but Nuñez demonstrated their dissimilarity, an important discovery that exerted great influence on the making of charts for navigation. For this purpose

he conceived and drew curved rhumb lines (1534–1537), several years before Mercator made a loxodromic terrestrial globe with rhumb lines for eight sea routes in each quadrant, drawn from various points in different latitudes (1541).

Another of Nuñez's contributions to navigation was his technique for determining latitude by means of two readings of the sun's altitude and the azimuth, with solutions that were quite interesting and ingenious but of little practical use on shipboard; they relate more to the concerns of a scientist in the observatory than to the needs of a practical navigator and therefore have fallen into disuse.

In physics and seamanship Nuñez wrote a commentary on Aristotle's mechanical problem of propulsion by oars. It is a contribution to the geometry of motion—an attempt to determine, at each moment and in every circumstance, the deviation of the boat in relation to the oars.

Nuñez's cosmological theories relating to solar and lunar motions are important, as are his inquiries into the duration of day and night, the transformation of astronomical coordinates, and other problems concerning the motions of celestial bodies. He commented on the planetary theories of Georg Peurbach; worked on the problem of determining the duration of twilight; and solved the problem of afterglow or second twilight.

Nuñez also exhibited mathematical ability in geometry with his original solutions to the problems of spherical triangles. He demonstrated the errors made by Oronce Fine, professor at the Collège de France, in his attempt to solve three problems by means of ruler and compass: trisecting an angle, doubling a cube, and squaring a circle.

Finally, Nuñez was a poet; his highly regarded sonnets were collected and published by Joaquin Ignacio de Fraitas (Coimbra, 1826).

# BIBLIOGRAPHY

**I.** Original Works. *Tratado da sphera* (Lisbon, 1537) consists of three parts : (1) annotated translations by Nuñez from Sacrobosco's *Tractatus de sphaera*, writingson the theory of the sun and moon by Georg Peurbach, and the first book of Ptolemy's *Geography*; (2) two writings by Nuñez, a treatise on certain difficulties in navigation and a treatise in defense of his navigation chart and tables of the movements of the sun and its declination; (3) an epigram in Latin written to Nuñez by Jorge Coelho. The first part of this work was reprinted at Lisbon in 1911 and 1912, the second part in 1913, and a facs. ed. was published at Munich in 1915. There is aned. of a French trans. prior to 1562, published in France. The Latin version, Opera quae complectuntur, prinnnn :duos libros … , was published at Basel in 1566 and in subsequent, much improved, eds. in 1573 and 1592. It is in this work that the theory of loxodromic curves is first set forth.

Other works are *De crepuseulis fiber unus* (Lisbon, 1542; 2nd ed., Coimbra, 1571), which treats the afterglow and the nonius; *Astronotmici introductorii De Sphaera epitome* (n.p., n.d. [1543 ?]), with 12 folios thought to be an introduction to *Tratado da sphera; De erratis Promtii Orontii Finaei, regii mathematicarum Lutetice professoris* (Coimbra, 1546; 2nd ed. 1571); and *Libro de álgebra en arithmética y geometría* (Antwerp, 1567).

In *De crepusculis,* Nuñez mentions MS treatises, now believed lost, on the geometry of spherical triangles, on the astrolabe, on the geometrical representation of the sphere on a plane surface, on proportions in measurement, and on the method of delineating a globe for the use of navigators. Another MS mentioned is a work on the sea routes to Brazil. In catalog no. 508, item no. 15, of Maggs Bros. bookstore in London, there is a reference to "Codice de circa 1560 de Nunes (Pedro) y Vaz Fraguoso (Pedro)," containing the elements of navigation and routes to the East, which is believed to have been compiled by Vaz Fraguoso.

**II.** Secondary Literature. See the following, listed chronologically: Diccionario enciclopédico hispano-americano, XIII (Barcelona, 1813), 1190–1198; Rodolfo Guimaräes, Sur la vie et / 'oeuvre de Pedro Nanes (Coimbra, 1915); Luciano Pereira da Silva, *As obras de Pedro Nunes, sua cronologia bibliográfica* (Coimbra, 1925); and A. Fontoura da Costa, *Pedro Nunes* (1502–1578) (Lisbon, 1938); and Quarto centendrio da publicacao de Tratado de sphera de Pedro Hares (Lisbon, 1938).

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