PEDRO NUNES (1502 – August 11, 1578)

by HEINZ KLAUS STRICK, Germany

The Portuguese postage stamps pictured here, issued in 2002, show a portrait of PEDRO NUNES, Portugal's most renowned mathematician and cosmographer. They illustrate some of the topics that NUNES worked on throughout his life.

Little is known about his origins. He came from a family that had been Jewish but had converted to Christianity. He was born in the southern Portuguese town of Alcácer do Sal, for which reason his name often included the epithet *Salaciense*. He began his studies in Spain, in Salamanca, and then transferred to Lisbon. In 1525, he completed his formal education with a degree in medicine, which at the time included studies in astrology (and therefore also astronomy and mathematics). He eventually obtained a teaching position at the University of Lisbon, where he taught such subjects as morals, philosophy, logic, and metaphysics.

In 1537, the university was relocated to Coimbra, in northern Portugal (the University of Coimbra, founded in 1290, is one of the oldest universities in Europe). There, PEDRO NUNES was appointed professor of mathematics. In addition to his responsibilities in mathematics, he was also charged with finding ways to improve the techniques of navigation, which was a matter of the greatest importance, since success would ensure that Portugal could maintain its strong position as a maritime power.

In 1531, the Portuguese king, JOHANN III, asked NUNES to take over the scientific education of his younger brothers, and later as well that of his grandson, the future KING SEBASTIAN, as “court tutor.” In 1547, the king appointed NUNES to the position of supreme royal cosmographer for life (cosmography is the science of describing the earth and the cosmos).

PEDRO NUNES is considered one of the greatest mathematicians of his time. His most famous pupil was the Jesuit CHRISTOPHER CLAVIUS (1538-1612) of Bamberg, who later became the head of the commission for creating the *Gregorian calendar* (1582). He was also the “inventor” of the decimal point (separating the integral part of a number from the base-ten fractional part).

NUNES was perhaps the last significant scientist to have made significant improvements in the geocentric solar system of PTOLEMY. NUNES took no position for or against the heliocentric system of NICOLAUS COPERNICUS (1473-1543), though he pointed out in one of his articles that there existed calculational errors in COPERNICUS’s magnum opus, *De Revolutionibus Orbium* (On the Revolutions of the Celestial Spheres).

PEDRO NUNES solved the mathematical-astronomical problem of how to calculate the duration of twilight for an arbitrary location on Earth and day of the year (*De crepusculis*, 1542), a question taken up a century later by JOHANN BERNOULLI (1667-1748) and his brother JACOB (1655-1705) using the newly developed differential calculus, although with less success.

In 1532, NUNES wrote his *Libro de Algebra en Arithmetica y Geometria*, in Portuguese. This work deals with, among other subjects, the solution of quadratic and cubic equations, describing the state of knowledge on that subject at the time.

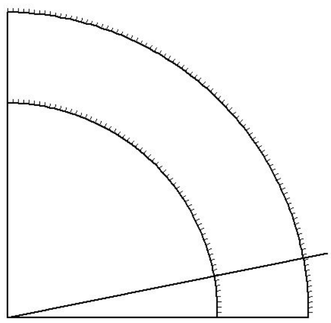
In that work, he made systematic use of the notation contained in Luca Pacioli's *Summa de arithmetica, geometria, proportioni et proportionalita* of 1494 (this was the first comprehensive book on mathematics written in Italian), and he further abbreviated that work's notation.

For example, he abbreviated *cosa* to *co* (eventually, the mathematical notation would become even briefer: *x*), *cu* for *cubo* (x^3). The book was never printed, because Nunes was expecting to achieve larger sales through a Spanish translation. When such a translation finally appeared, in 1567, in Antwerp (then part of the Spanish Netherlands), its content had been to some degree made obsolete, for in the meantime, Girolamo Cardano (1501-1576) had succeeded in giving general formulas for the solution of cubic equations (*Ars magna*, 1545).

Like all scientists of his time, Pedro Nunes published primarily in Latin. His Latinized name, Petrus Nonius Salaciensis, lives on in the term "nonius," the word – in use even to this day – for, according to the Oxford English Dictionary, "a device consisting of a series of concentric arcs engraved on a quadrant, used for the accurate measurement of angles, altitudes, and heights."

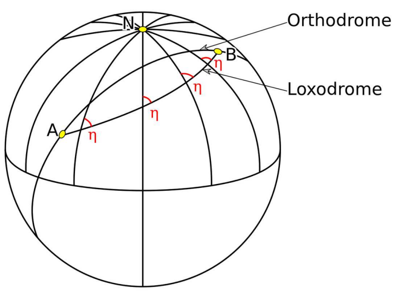
While Nunes was not the inventor of the *nonius*, one can find in a 1546 work of his on the theory of navigation, *Navigandi Libri Duo*, an idea that was developed further by Christopher Clavius and others, which then led finally, in 1631, to the invention, by the Frenchman Pierre Vernier, of the *nonius* as it is known today.

Nunes made the following suggestion: Suppose one were to draw 45 concentric quarter-circles within a quadrant. One could then divide the first of these into 90 equal sections of arc. Then, one could divide the second quarter-circle into 89 such sections, the third into 88, and so on, the last being divided into 46 equal segments. If one were unable to read off an angle on the first scale because demarcation of the angle occurs between two division points on the one-degree scale, then one should locate one of the inner quarter-circles on which the demarcation lands most closely on one of the division points and then convert the appropriate fraction.



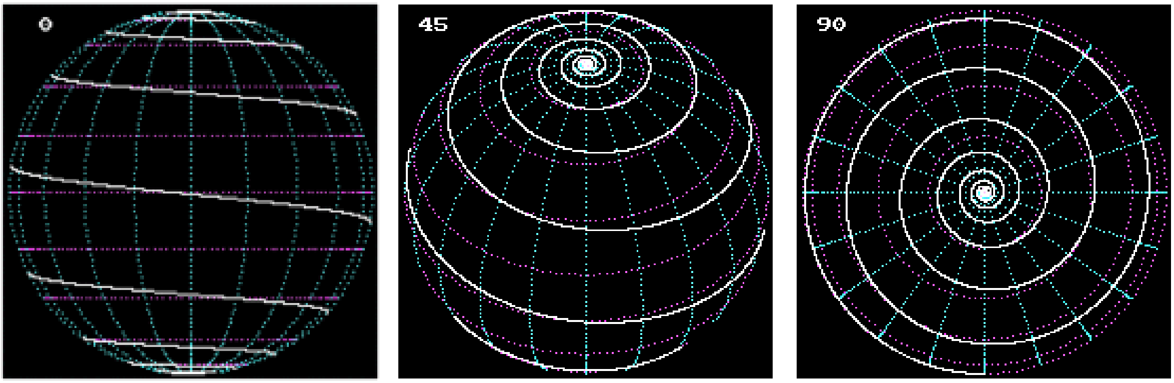
Such a system is pictured on the left-hand side of the Portuguese postage stamp from 1978, labelled "O NONIO." The diagram above serves as an illustration of the method of measurement: The marker passes quite precisely through the eighth demarcation point of the quarter-circle with 63 equal segments. Therefore, the included angle is equal to $8/63 \cdot 90°$ ($\approx 11.43°$).

Nunes was the first to recognize that it would be an advantage in maritime navigation if a ship could be steered *along a fixed route*. These lines, which are pictured in the right half of the postage stamp, are called *loxodromes* (from the Greek *loxos* = oblique, *dromos* = course) or *rhumb lines*. The Portuguese term is *curvas dos rumos* (from the Latin *rhombus*, from Greek *rhombos* = *rhombus*, spinning top; akin to Greek *rhembein*, to whirl).



To be sure, such a route would *not necessarily* be the shortest course between the origin and destination points – such a shortest route would go along a *great circle*, also called *orthodrome* (see graphics to the left, Wikipedia CC BY-SA 2.5).

If one is navigating along a great circle, one must pay constant attention to the direction of travel, since the angles to the circles of longitude are constantly changing.



Rhumb line (Image source: Wikipedia, CC BY-SA 3.0)

A rhumb line goes around the globe helically and is directed asymptotically toward the North or South Pole.

In 1537, NUNES emphasized in one of his works the advantage of having nautical charts on which the circles of latitude and longitude could be displayed as a rectangular coordinate system, because that would make the loxodromes appear as straight lines.

The first to realize NUNES's proposal was GERARDUS MERCATOR (1512-1594), who solved the required mathematical problem associated with the proposed representation by his discovery of a projection of the sphere onto a circumscribed cylinder (known as the *MERCATOR projection*).

First published 2008 by Spektrum der Wissenschaft Verlagsgesellschaft Heidelberg

www.spektrum.de/wissen/pedro-nunes-1502-1578/965117

Translated by David Kramer

English version first published by the *European Mathematical Society* 2014