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(*b*. Leiden, Netherlands, 1580; *d*. Leiden, 30 October 1626), *mathematics, optics, astronomy*.

Snel was the son of Rudolph Snellius, or Snel van Royen, professor of mathematics at the new University of Leiden, and of Machteld Cornelisdochter. He studied law at the university but became interested in mathematics at an early age. Through the influence of Van Ceulen, Stevin, and his father, he received permission in 1600 to teach mathematics at the university. Soon afterward he left for Würzburg, where he met Van Roomen. He then went to Prague to conduct observations under Tycho. He also met Kepler, and traveled to Altdorf and Tübingen, where he saw Mästlin, Kepler's teacher. In 1602 Snel studied law in Paris. He returned home in 1604, after having traveled to Switzerland with his father, who was then in Kassel at the court of the learned Prince Maurice of Hesse.

At Leiden, Snel prepared a Latin translation of Stevin's *Wisconstighe Ghedachtenissen*, which was then being published; Snel's translation appeared as *Hypomnemata mathematica* (1608). He also busied himself with the restoration of the two books of Apollonius on plane loci, preserved only in abstract by Pappus. Related tasks on other books of Apollonius also occupied Viète (*Apollonius gallus* [1600]) and Ghetaldi (*Apollonius redivivus* [1607–1613]). Snel's work was in three parts; the first remained in manuscript and is preserved at the library of the University of Leiden; the second appeared under the title *resuscita geometria* (1607); and the third was published as *Apollonius batavus* (1608).

In 1608 Snel received the M.A. and married Maria De Lange, daughter of a burgomaster of Schoonhoven; only three of their eighteen children survived. After his father's death in March 1613, Snel succeeded him at the university, and two years later he became professor. He taught mathematics, astronomy, and optics, using some instruments in his instruction.

Sharing the admiration of his father and of Maurice of Hesse for Ramus, Snel published Ramus' *Arithmetica*, with commentary, in 1613. He later published *P. Rami Meetkonst* (1622), an annotated Dutch translation by Dirck Houtman of Ramus' *Geometria*. It was the only one of Snel's works to be published in Amsterdam; all the others appeared at Leiden. Snel's *De re numeraria* (dedicated to Grotius), a short work on money in Israel, Greece, and Rome, also dates from 1613.

During this period Snel prepared the Latin translation of two books by Van Ceulen, probably at the request of his widow, Adriana Symons. His rather careless translation of *Van den Circkel* includes some notes by Snel, among them the expression √(s-a) (s-b)(s-c) (s-d) for the area of a cyclic quadrilateral. Although this expression had already appeared in the work of Brahmagupta, it seems to be the first time that it was used in Europe.

Snel's lack of attention to this translation may have been due to preoccupation with geodetic work. In 1615 he became deeply involved in the determination of the length of the meridian, selecting for this work the method of triangulation, first proposed by Gemma Frisius in 1533 and also used by Tycho. Snel developed it to such an extent that he may rightfully be called the father of triangulation. Starting with his house (marked by a memorial plaque in 1960), he used the spires of town churches as points of reference. Thus, through net of triangles, he computed the distance from Alkmaar to Bergen-op-Zoom (around 130 kilometers). The two towns lie on approximately the same meridian. Snel used the distance from Leiden to Zoeterwoude (about 5 kilometers) as a baseline. His instruments were made by Blaeu; and the huge, 210-centimeter quadrant used for his triangulations is suspended in the hall of the Leiden astronomical observatory. The unit of measure was the Rhineland rod (1 rod = 3.767 meters), recommened by Stevin to the States General in 1604 (Stevin, *Principal Works*, **IV** [1964], 24); and, following Stevin, the rod was divided into tenths and hundredths. The results were presented In *Eratosthenes batavus* (1617).

In order to locate his house with respect to three towers in Leiden, Snel solved the so-called recession problem for three points. The problem is often named after Snel, as well as after L. Pothenot (1692); and claims have been made for Ptolemy.

Dissatisfied with his geodetic work. Snel began to correct it, aided by his pupils, and extended his measurements to include the distance from Bergen-op-Zoom to Mechelen. Unaided by logarithms, he continued this work throughout his life. His early death in 1626 prevented him from publishing his computations, which are preserved his own copy of *Eratosthenes batavus* at the Royal Library in Brussels. They were recently checked by N. D. Haasbroek and were found to be conscientious and remarkably accurate. Haasbroek could not say as much for the way in which Musschenbroek handled these notes in his “De magnitudine terrae,” in *Physicae experimentales* ... (1729).

Snel published some observations by Biürgi and Tycho in 1618, and his descriptions of the comets of 1585 and 1618, published in 1619, show Sbel to be a follower of the Ptolemaic system. Although he demonstrated from the parallax that the comet was beyond the moon and therefore could not consist of terrestrial vapors, he still believed in the character of comets as omina.

In the *Cyclometricus* (1621) π was found, by Van Ceulen's methods, to thirty-four decimals; and the thirty-fifth decimal, found in Van Ceulen's papers, was added. Snel also explained his own shorter method, following and improving on Van Lansberge's *Cyclometria nova* (1616), establishing the inequality

of which the inequality to the left agrees with Cusa's result in *Perfectio mathematica* (1458).

In 1624 Snel published his lessons on navigation in *Tiphys batavus* (Tiphys was the pilot of the *Argo*). The work is mainly a study and tabulation of Pedro Nuñez' so-called rhumb lines (1537), which Snel named "loxodromes." His consideration of a small spherical triangle bounded by a loxodrome, a parallel, and a meridian circle as a plane right triangle foreshadows the differential triangle of Pascal and later mathematicians.

The last works published by Snel himself were *Canon triangulorum* (1626) and *Doctrina triangulorum* (1627), the latter completed by his pupil Hortensius. The *Doctrina*, which comprise a plane and spherical trigonometry, includes the recession problem for two points, often named after P. A. Hansen (1841). It uses the polar triangle for the computation of the sides of a spherical triangle.

Snel's best-known discovery, the law of refraction of light rays, which was named after him, was formulated probably in or after 1621, and was the result of many years of experimentation and of the study of such books as Kepler's *Ad Vitellionem paralipomena* (1604) and Risner's *Optica* (1606), both of which quote Ibn al-Haytham and Witelo. Snel's manuscript, which contained his results, has disappeared, but it was examined by Issac Vossius (1662) and by Huygens, who commented on it in his *Dioptrica* (1703, 1728). Snel's wording of his law has been preserved in what C. De Waard considered to be an index of the manuscript preserved in Amsterdam, and it checks with the account of Snel's law given by Vossius: If the eye O (in the air) receives a light ray coming from a point R in a medium (for example, water) and refracted at S on the surface A of the medium, then O observes the point R as if it were at L on the line $RM \perp$ surface A. Then $SL{:}SR$ is constant for all rays. This agrees with the present formulation of the law, which states that sin r: sin i is constant, where i and r are the angles that OS and SR make with the normal to A at S.

The priority of the publication of the law remains with Descartes in his *Dioptrique* (1637), stated without experimental verification. Descartes has been accused of plagiarism (for example, by Huygens), a fact made plausible by his visits to Leiden during and after Snel's days, but there seems to be no evidence for it.

Snel was buried in the Pieterskerk in Leiden. The monument erected to him and his wife, who died in 1627, is still there.

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