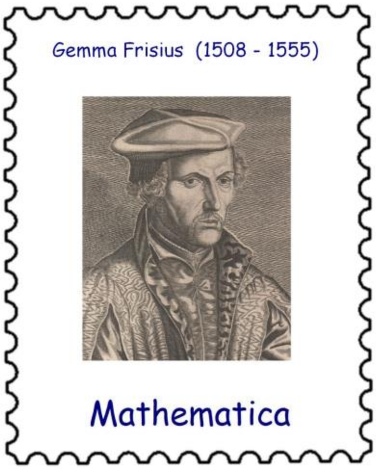
GEMMA FRISIUS (December 8, 1508 – May 25, 1555)

by HEINZ KLAUS STRICK, Germany



GEMMA FRISIUS was born as REGNIER (REINER) GEMMA in Dokkum in the Dutch province of Friesland. The place is still known today as a place of pilgrimage – in memory of BONIFATIUS, Bishop of Mayence (Mainz) and papal legate for Germania, who was murdered there in 754 by Frisian missionary opponents.

REGNIER's parents died when the boy was still a small child, and so he came into the care of relatives in Groningen. Because of a deformity of the feet, he was dependent on crutches – until he was six years old, when his stepmother took him on a pilgrimage to Dokkum. It is said that from that day on he was able to walk independently. Even though he no longer had to use his crutches, he remained a frail person throughout his life.

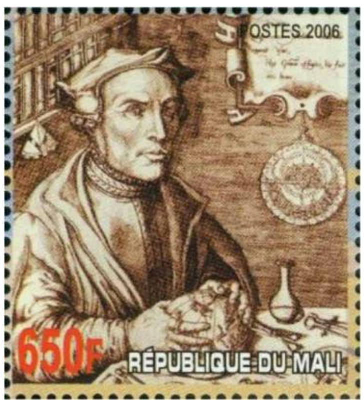
After attending school in Groningen, REGNIER GEMMA transferred to the University of Leuven (Louvain) in 1525 to study medicine. During the preceding introductory semester he also attended lectures in mathematics and astronomy.

Because of his health problems (and presumably mainly because of the activities described in more detail below) he took a longer time than usual to study and he obtained his licence to practise medicine in 1536.

From then on he worked as a respected doctor in Leuven – treating destitute people free of charge and taking more money from the wealthy in return.

He got married in 1534 and soon their son CORNELIS was born. He would later become a respected doctor and chair holder in Leuven, until he died at the age of 43 during a plague epidemic.

Parallel to his medical studies, REGNIER GEMMA worked his way into another field of science which had fascinated him from the first encounter and in which he became famous beyond the borders of his country during his lifetime: cartography.



In 1524, the Ingolstadt mathematician, astronomer and cartographer PETER APIAN had published his *Cosmographia* (*Cosmographicus liber Petri Apiani Mathematici studiose collectus*) – a treatise with illustrations on astronomy, geography, cartography, navigation and instrument making. It was one of the first European books to depict North America.

The 20-year-old GEMMA recognised the sales potential of such a book if it was combined with practical instructions and if the measuring instruments, maps and globes described in the book were also offered for sale.

In Leuven he met the engraver and goldsmith GASPARD VAN DER HEYDEN. In collaboration with him and a publisher in Antwerp, he had a corrected version printed under the Latin name GEMMA FRISIUS (with reference to his Frisian origin) just five years after the first edition: *Cosmographicus liber Petri Apiani, Mathematici, studiose correctus, ac erroribus vindicatus per Gemmam Phrysium*.

This work appeared in 30 editions within a few decades, mostly in Latin, but later also in Dutch, French and Spanish, as he realised that such a book would interest people who do not know Latin.

In 1530 GEMMA published a book written by himself, *De Principiis Astronomiae Cosmographicae*.

In the first part of the work, basic geographical and astronomical terms such as longitude and latitude, meridian, pole, etc. were listed and astronomical events such as solar and lunar eclipses were explained. The second part then included instructions on how to use the globe, which was offered for sale at the same time, while the third part dealt with the distant (partly newly discovered) countries and their inhabitants.

A remarkable chapter in this writing was one in which GEMMA was the first to describe the idea of how one could determine the longitude of a place with the help of a clock:

One would have to set the clock to the local time when leaving. By comparing the times at which a certain star can be observed, e.g. the Pole star, the longitude of the current position could then be determined: The difference in hours multiplied by 15 gives the difference in longitude.

The problem was that even the most accurate clocks of the time could deviate by 15 minutes or more per day from the correct time. Temperature fluctuations then increased these inaccuracies, and even CHRISTIAAN HUYGENS' extremely precise pendulum clock of 1656 turned out to be useless at sea, as it got out of time in heavy seas.

It was not until 1759 that the Scottish clockmaker JOHN HARRISON succeeded in building a clock that showed a deviation of only a few seconds during an 81-day voyage across the Atlantic.

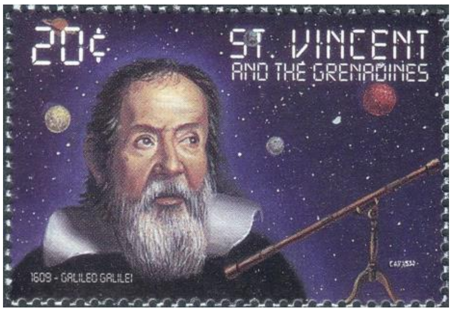
The problem that seafarers on the vast oceans had no way of determining an exact location had already led to wrong decisions with disastrous consequences on several occasions, which is why high premiums were offered in various countries for solving this *longitude problem*.

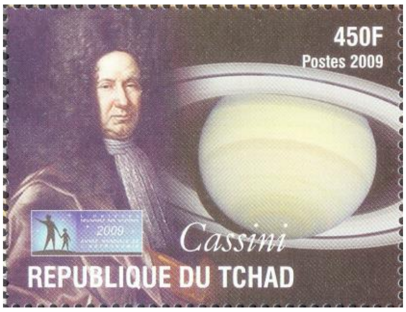
When GALILEO GALILEI discovered the moons of Jupiter in 1610 (*Sidera Medicea*), he believed that the precise recording of the orbital periods of these satellites could be used to determine the local time at any place on Earth. However, since observation was only possible at night and only when the sky was clear, and in addition, irregularities were found in the orbital periods, this idea was not pursued further at first.

GIOVANNI DOMENICO CASSINI suggested focusing on the times when Jupiter's inner moon Io emerges from the planet's shadow.

However, in 1676, together with Ole Rømer, he noticed clear differences – depending on whether the Earth was moving towards or away from Jupiter. Rømer concluded from this that the speed of light is finite and from the measurement data of Rømer and Cassini, Christiaan Huygens determined a value of (converted) approximately 212,000 km/s in 1678.

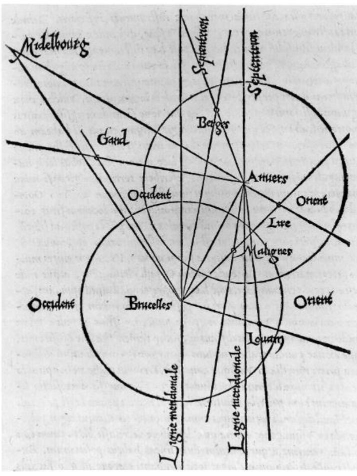
The irregularities in the orbital periods of the moons are related to their mutual attraction, as Joseph-Louis Lagrange (1766) and Pierre-Simon Laplace (1788) proved.





The next edition of the *Cosmographia* from 1533 contained an appendix (*Libellus de locorum*) in which Gemma described the basic construction of the instruments needed for land surveying in order to produce more accurate maps.

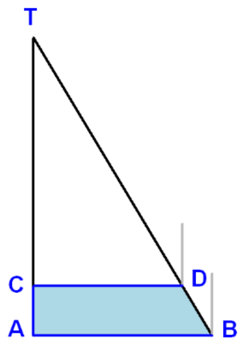
One of the instruments consisted in principle of a circular device divided into four quadrants. On each of these the 90 degrees of angle are marked. A rotating ruler with bearings is attached in the middle, and the other end of the ruler can be moved along the circle. With the help of a spirit level and a compass, this simple measuring device is aligned horizontally and towards the magnetic north pole, so that angle measurements can be made against the north direction (so-called magnetic bearing).



Gemma explained how this could be done using the example of places A (Antwerp) and B (Brussels), through which he drew meridians as well as lines of sight to various other places (cf. fig. left). If one knows the exact distance of A and B, then one can calculate the distances between all other targeted locations.

(Gemma had to admit, however, that the bearings given in the example could not be realised concretely because of the hills lying between the locations).

GEMMA then gave examples of different surveying methods:

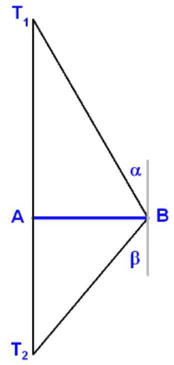


If one has a level terrain on which one can move freely in all directions, then the distance of a tower T from a point A can be determined as follows:

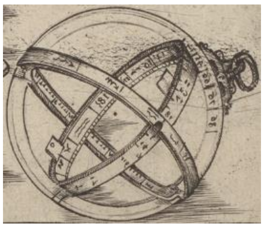
Perpendicular to the bearing AT, measure a distance AB; in B determine the bearing angle of the tower T. Then walk from A in the direction of T to any point C, from there parallel to AB until the tower T appears at the same bearing angle as in B, cf. fig. right.

The distance sought from T can then be calculated from the line lengths AB, AC and CD from the formula $|AT| = \frac{|AB| \cdot |AC|}{|AB| - |CD|}$

If one wants to determine the distance between two towers T_1 and T_2 (cf. fig. right), one can look for a point A that lies exactly on the connecting line T_1T_2 and then go from A perpendicular to T_1T_2 to any point B in order to take bearings on the towers from there.



GEMMA concluded that the spherical earth could not be represented by a planar map without distortion. However, in the case of a map for a province, the curvature of the earth does not matter.



In 1534 follows *Tractatus De Annulo Astronomicae* on the astronomical ring he invented –

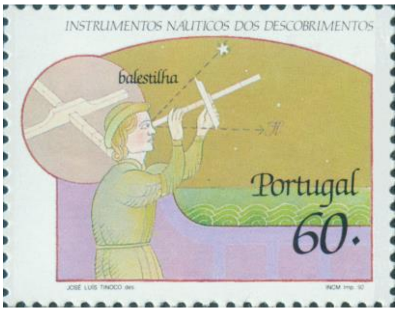
a portable scaled-down armillary sphere; this consisted of three rings representing the celestial equator, the declination and the meridian.

In the same year, an erudite and skilful assistant joined GEMMA's workshop: GERARDUS MERCATOR, who in future would be responsible for the engravings. Together with him, GEMMA produced – taking into account the latest findings – a much-acclaimed globe of the earth, as well as a celestial globe. The copyright to the globes was guaranteed by a privilege of Emperor Charles V.

He did not neglect his work as a doctor. From 1537 he taught at the University of Leuven and, secretly, together with his student VESALIUS, he carried out anatomical examinations on corpses.

In 1540 he wrote a book on arithmetic.

In the same year GEMMA published a map of the world, of which unfortunately no copy exists any more, but which became a model for the famous cartographers MERCATOR, ORTELIUS and BLAEU.



In *De Radio Astronomico* of 1545, he described the construction and improved functioning of a *Jacob's staff* (degree stick) of considerable size: the base staff with scale was 1.50 m long, the movable crossbar 0.75 m.

GEMMA's reputation as an instrument maker and as a map and globe maker spread throughout Europe. In 1548 the English mathematician (EUCLID translator), astronomer and astrologer JOHN DEE travelled specially to Leuven to purchase globes and astronomical instruments from him for the English royal family.

In the last years of his life, GEMMA FRISIUS suffered increasingly from kidney disease, which eventually led to his death.

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https://www.spektrum.de/wissen/gemma-frisius-wohltaeter/1947466

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