

# Biographical Encyclopedia of Astronomers

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Borelli, Giovanni Francesco Antonio Alfonso

Born Naples, (Italy), January 1608

Died Rome, (Italy), 31 December 1679

Giovanni Borelli was an early Italian Copernican, experimenter, and observer. Christened on 28 January 1608 in Naples, he was born to Miguel Alfonso, an itinerant soldier in the occupying Spanish army, and Laura Porrello (also called Borrelli in some records), a native of Naples. Giovanni and his brother Filippo later took the name Borelli, although why is unknown

The brothers met the controversial philosopher Tommaso Campanella around 1626 and both became his students. Filippo, who fled to Paris with Campanella in 1634, edited the latter's works and appears to have returned to Italy and entered the Dominican order, taking the name Tommaso. After 1628, Giovanni Borelli went instead to Rome, where he studied under Benedetto Castelli, who held Borelli in high esteem.

In 1635, Castelli recommended Borelli to fill the vacant mathematics chair in Messina and later, in 1640, recommended him, unsuccessfully, to Galileo Galilei for a similar chair at Pisa, one he eventually gained in 1656.

Borelli began his career in Messina inauspiciously, it appears, being at first a very unsuccessful lecturer, but improved considerably over time and attracted wide student interest. He also became. Despite his lack of published work, Borelli was central to the intellectual life of the university. In 1642, the Senate of Messina invited him to travel through Italy recruiting talented faculty for the university, a journey that brought him into contact with many of the leading figures of the Italian scientific community and broadly established his reputation and expanded his own education. He remained in Messina until 1656, publishing several works in mathematics and displaying a growing expertise in theoretical medicine, but not demonstrating any particular interest in either physics or astronomy. However, his Copernican interests were becoming known, because in 1650 he was passed over in a bid for the chair of mathematics in Bologna, which was given to Giovanni Cassini; his philosophical position may have been a factor. Eventually, in 1656, Borelli succeeded in obtaining the chair of mathematics at Pisa, previously occupied by Galileo and Castelli, relocating to Tuscany and beginning the most intellectually productive period of his life.

The Medicis, who controlled the university and the city, were deeply affected by and sympathetic to the Galilean scientific program, especially Princes Leopold and Ferdinand, who were the founders of the Accademia del Cimento. This was a group of dedicated empiricists that included Vincenzo Viviani, Galileo's last pupil, Carlo Rinaldi, and the Danish philosopher Nicholas Steno. After his arrival in Pisa, Borelli became central to its activities and was perhaps its most visible and contentious member; it lasted from 1657 through 1667. Although publishing anonymously, like the later Bourbaki collaboration whose members published only as a collective, it is clear that much of the Accademia's work was Borelli's. The works of the Accademia, finally collected and published in 1667 as the *Saggi di naturali esperienze fatte nell'accademia del cimento*, not only ranged over a broad experimental territory, mainly pneumatics, thermal physics, and fluids, but also included astronomy.

For instance, following Christiaan Huygens' announcement of the discovery of a ring system around Saturn in 1660, Borelli conducted what may be the first experimental study of observer

effects. He constructed a scale model of Saturn with an inclined ring that was observed at a distance with the unaided eye and lenses to simulate the planet's angular diameter and approximate illumination, showing that the model reproduced the explanation. At a distance of 23 m, the appearance to the unaided eye in daylight illumination was a sphere flanked by two stars; at 75 m with a small telescope, it displayed the rings and shadow clearly as Huygens had described. This also explained the results obtained by Galileo and others with more imperfect telescopes.

Finally, uninformed observers of the Accademia were asked to sketch the appearance, foreshadowing an experiment conducted at the start of the 20th century by Simon Newcomb for the Martian canals

Borelli displayed a lively interest in astronomy during his years in Tuscany. In an interesting prediction for the lunar eclipse of 16 June 1666, Borelli calculated that atmospheric refraction would permit the simultaneous observation of the Moon in eclipse, which occurred at sunset, and the rising Sun; an expedition organized by the Accademia to the island of Georgina in the Tyrrhenian Sea confirmed this and determined an atmospheric refraction of nearly  $1^\circ$ . A similar prediction for Venus, that on 21 and 22 April 1662 it would be both the morning and evening star, was not confirmed because of the weather and was not attempted again

Borelli also engaged in observations of comets C/1664 W1 and C/1665 F1. He demonstrated that the motion followed a curved orbit akin to a parabola, and that the comet's lack of parallax placed it above the Moon. Both were clearly Copernican results and sufficiently sensitive that the work, *Del movimento della cometa apparsa nel mesi di dicembre 1665*, was published in Pisa under a pseudonym, Pier Maria Mutoli

Borelli also established an observatory in San Miniato, near Florence, during the summer of 1665. The following year saw the publication of his *\*Theoricae medicorum planetarum ex causis physicis deductae\**, his most important work in astronomy. In it, he sought to explain the elliptical orbital motion of the Jovian moons through a combination of centripetal tendencies due to the ponderous nature of the satellites' rotationally driven torques—much as Johannes Kepler had done for the planets driven by solar rays and/or magnetic fields and centrifugal forces. In this work, he failed to appreciate the role of inertia requiring active tangential driving by the central body, but anticipated the importance of radial equilibrium between the body's gravitational tendency and its centrifugal deviation

In 1667, Borelli returned to Messina to renew his appointment as professor of mathematics, also taking an active role in scientific academies in Naples and Rome. He ultimately fled to Rome in 1672 with a pinch on his head—as Campanella had so many years before, following a political dispute with the ruling Spanish government in Messina. Borelli received the patronage of Queen Christina of Sweden, whose connections with René Descartes are well known, and who supported the publication of his final work on anatomy and musculature. Suffering serious financial difficulties in his last years, Borelli lodged with the order of Casa di San Pantaleo in Rome after 1677, teaching at their school, and died there

Borelli also had an international reputation as an important telescope maker. In his later years, his advice was sought by Jean Cassini, then director of the Paris Observatory, and Jean Picard. John Flamsteed procured a 90-ft focal length lens from him for the newly founded Royal Observatory at Greenwich in 1675.

*Steven N. Shore*

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