

# Biographical Encyclopedia of Astronomers

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## Bernoulli, Daniel

Born Groningen, the Netherlands, 8 February 1700

Died Basel, Switzerland, 17 March 1782

Daniel Bernoulli should rank among the founders of modern mathematical physics, and made important contributions in hydrodynamics, wave physics, and mathematical biology. Daniel was the son of Johann Bernoulli and the nephew of Jacob Bernoulli. Though the roots of the Bernoulli family were in Basel, Switzerland, and Daniel's father Johann would have dearly loved to teach at the university there, the chair in mathematics was held by Johann's older brother Jakob. Thus, Johann was teaching at the University of Groningen when Daniel was born.

Johann's father forced Johann to study medicine, and Johann rebelled by studying mathematics and physics with his older brother, Jakob. Now Johann forced Daniel to study philosophy and logic, and Daniel likewise rebelled by studying mathematics and physics with his older brother Nicholas. Thus, a second generation of Bernoulli brothers (Daniel and Nicholas) would pursue mathematics and physics

Bernoulli received his baccalaureate in 1715 and his master's in 1716, then went to study medicine in Heidelberg, Strasbourg, and finally Basel in 1720. A crucial meeting occurred when he went to Venice in 1724. There he met Christian Goldbach, who was sufficiently impressed by the young Bernoulli that he offered him a position at the newly established Russian Academy of Sciences in Saint Petersburg; an offer was also extended to Daniel's older brother, Nicholas. The Bernoulli brothers arrived in 1725. Unfortunately, Nicholas died of a fever the next year, and Daniel suggested that Goldbach offer an appointment to one of Daniel's friends from the University of Basel, Leonhard Euler

Isaac Newton's Principia was published in 1687, but the system of physics it contained was widely rejected outside England. Instead, most physicists adhered to René Descartes's system of vortices, where particles swept endlessly about the Sun, carrying the planets along like leaves in a stream. It had undergone many modifications since the time of Descartes, but its central tenets remained.

There were two main reasons why Newton's theory was not readily accepted. The primary issue was, as Albert Einstein pointed out, that gravity required the existence of a sort of "spooky action at a distance." The other was that Newton's physics could predict, but not explain. For example, the planets all orbit the Sun in the same direction and in very nearly the same plane. Newton's physics could just as easily explain planetary orbits that were not in the same direction and at varying angles of inclination. For Newton, this was not an issue: The fact that it could be otherwise but was not gave evidence for the existence of God

Rather than relying on such arguments, the Paris Academy offered as its prize question for 1732 the explanation of the fact that the planets orbited the Sun in, more or less, the same plane. The academy received no entrants worthy of the prize, so they posed the question again in 1734, with a double prize. Johann and Daniel entered. To explain the lack of extreme inclinations among the orbits of the planets, Daniel assumed the existence of a solar atmosphere, which was densest not at the surface of the Sun, but instead around the orbit of Jupiter. Further assuming that the solar atmosphere rotated with the Sun would imply that objects moving in

planes not parallel to the solar equator would face enormous resistance. (He does not explain details.) Thus, only orbits that are parallel or nearly parallel to the Sun's equator would exist

Unfortunately for Daniel, he and his father were judged equally worthy of the prize. Earlier, Johann's jealousy had poisoned his relationship with his brother Jakob. Now the fact that his son was ranked his equal would poison the relationship between father and son. Daniel himself (probably the only personable member of the mathematical Bernoullis) tried to mend the relationship, but Johann refused to be reconciled and banned him from the house in Basel, where he returned in 1734 to lecture in botany.

Despite his early training, Bernoulli did not remain a dogmatic Cartesian for long and was, in fact, one of the very first to apply the powerful techniques of Leibnizian calculus to the essentially correct axioms of Newton's physics. In 1743, he began to lecture in physiology, but it was not until 1750 that he was finally appointed to the chair of physics, a post he retained until 1776.

*Jeff Suzuki*

### **Selected References**

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