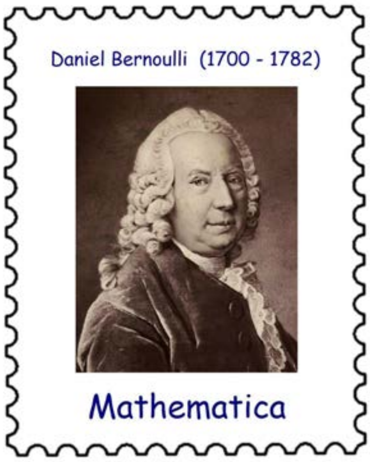
Daniel Bernoulli (February 8, 1700 – March 17, 1782)

by Heinz Klaus Strick, Germany



"It's hard to make money with mathematics."

Out of this conviction, the spice dealer Nicolaus Bernoulli had tried to prevent his sons from studying mathematics – in vain:

Jacob and Johann became famous mathematicians and did not become impoverished. And although Johann himself had not followed his father's advice, he still planned a career as a merchant for his second son Daniel – as his father had already done with him.

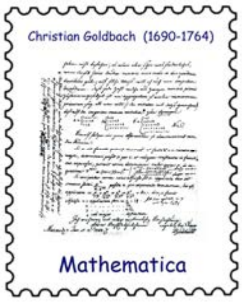
Before beginning his apprenticeship, Daniel was to complete his school education by attending lectures on philosophy and logic at the University of Basel, which he successfully completed in three years (with his master's examination in 1716).

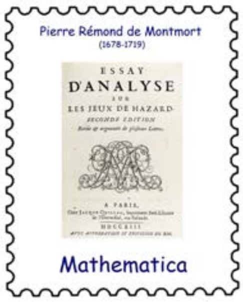
At home, Daniel witnessed the fierce priority dispute with the Newton camp – in particular, his brother Nicolaus (II), five years his senior, was busy writing letters to the other side. Inevitably, Daniel was also aware of the rapid progress being made in the theory of differential and integral calculus in those days.

Nevertheless, the father forbade his second son from studying mathematics, but accepted – rather angrily – that he would start studying medicine instead of commercial training. In 1720, after studies in Heidelberg and Strasbourg, Daniel finished his studies and wrote his doctoral thesis on the mechanics of breathing (*De respiratione*), inspired by his father's research on kinetic energy.

Daniel Bernoulli applied in vain for a chair in anatomy and botany at the University of Basel, which had become vacant. In his application for the next vacant chair (for logic) in Basel, he was again unlucky in the lottery which was used to decide the appointment.

In order to expand his practical knowledge in medicine, Daniel Bernoulli travelled – together with his brother Nicolaus – to Italy. On the way to Padua, where he wanted to visit a famous doctor, he fell ill and had to stay in Venice for a long time.





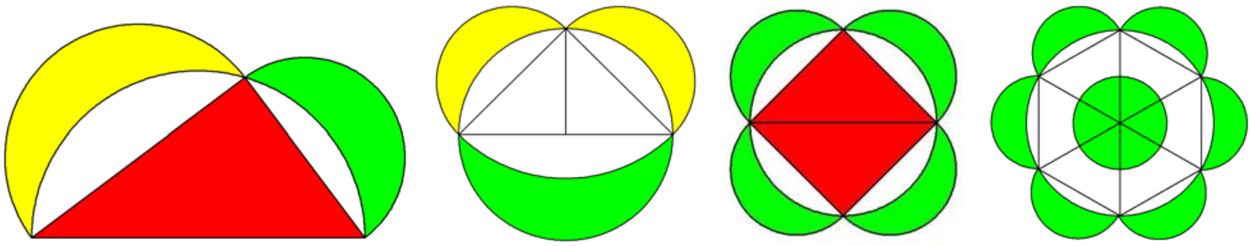
There he met Christian Goldbach, who helped him to publish his first mathematical work in 1724: The *Exercitationes quaedam mathematicae* (Mathematical exercises) consisted of four parts.

The first part dealt with the odds of winning in the *Faro* card game which was very popular at the time and which had already been described by Pierre Rémond De Montmort in 1708 in his *Essai d'Analyse sur les jeux de Hazard*.

In a second part he dealt with a contribution by Isaac Newton, who had established a (wrong) theory about the pressure conditions in running water – this indicated a later focus for his research.

The third part on the solution of so-called RICCATI 's differential equations, i.e. equations of the type $y'(x) = f(x) \cdot y^2(x) + g(x) \cdot y(x) + h(x)$ with given functions *f, g* and *h* (named after JACOPO FRANCESCO RICCATI, 1676-1754), received Europe-wide attention.

In the last part of the paper he dealt with *lunes*, i.e. areas enclosed by arcs.

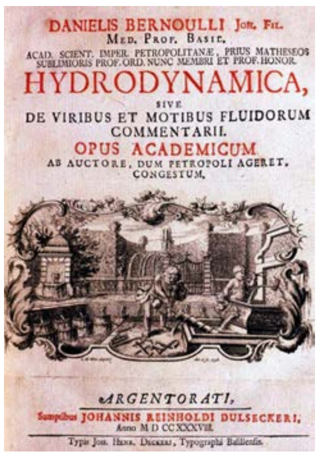


During his convalescence DANIEL BERNOULLI developed the idea of a special hourglass which could be used to measure time even on stormy seas and in 1725 he was awarded the prize of the Paris *Academy of Sciences*.

He had turned down the offer to take over the management of an *Academy of Sciences* in Genoa, which was still to be founded, when a double appointment was offered in St Petersburg: he and his brother NIKOLAUS were each to take over a chair in mathematics. In 1727 the two travelled to the Russian capital with great optimism, as they wanted to show the world through joint publications that there was a pair of BERNOULLI brothers who could cooperate with each other – in contrast to the jealous behaviour between their father JOHANN and his brother JACOB.
The dream was shattered when NICOLAUS fell ill eight months after arriving in St Petersburg and died a short time later.

DANIEL BERNOULLI succeeded in winning over LEONHARD EULER, the best of his father's pupils, to succeed his brother. But DANIEL also suffered from the harsh climatic conditions. Despite the extremely fruitful cooperation with EULER, the increase in his salary and the improvement of working conditions, he applied for vacant posts in Basel from 1731 and he preferred to take up the chair of botany again than to stay in cold St Petersburg any longer period. 1733 he returned to his home country.

1734 DANIEL again submitted a paper to the *Parisian Academy* (about the question of why the planetary orbits have similar inclinations), and won the first prize, but he had to share it with his father. JOHANN was outraged that of all things DANIEL's work was regarded as equal to his own, and from then on he denied his son access to the parental home.



DANIELIS BERNOULLI JOH. FIL.
MED. PROF. BASIL.
ACAD. SCIENT. IMPER. PETROPOLITANÆ, PRIUS MATHESEOS SUBLIMIORIS PROF. ORD. NUNC MEMBRI ET PROF. HONOR.
HYDRODYNAMICA,
SIVE
DE VIRIBUS ET MOTIBUS FLUIDORUM COMMENTARII.
OPUS ACADEMICUM
AB AUCTORE, DUM PETROPOLI AGERET, CONGESTUM.
ARGENTORATI,
Sumptibus JOHANNIS REINHOLDI DULSECKERI,
Anno M D CCXXXVIII.
Typis Joh. Henr. Deckeri, Typographi Basiliensis.

As if that were not enough, the father thought up a special form of "punishment" for his son: Shortly before his departure from St Petersburg, DANIEL had finished the manuscript for a book entitled *Hydrodynamica* and handed it over to a typesetter. Due to the long time it took to transmit messages and to make several corrections and additions, the work was not printed until 1738.

One year later JOHANN BERNOULLI's book *Hydraulica* was published, which had great similarities with DANIEL's *Hydrodynamica*. However, JOHANN claimed 1732 as the year of completion in order to show the world that his son was a plagiarist.

The gentle DANIEL, however, could not be blamed for not having made enough effort to show his respect for his father's scientific achievements. In the first line of the title page of the *Hydrodynamica* he puts beside his name as author also *Joh. Fil.*, meaning son of JOHANN.

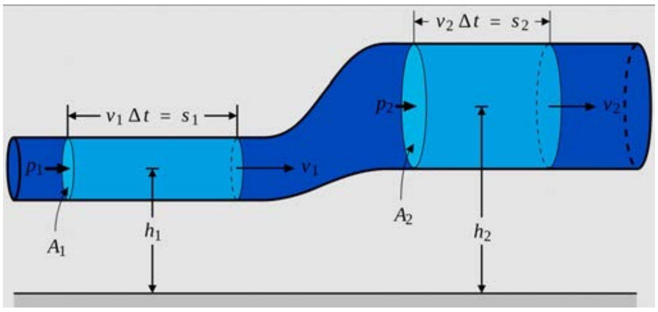
In 1743 DANIEL was finally able to give up the unloved chair of botany and take over a professorship of medicine, and then from 1750 to 1776 the chair of physics. From today's point of view it is remarkable that he not only lectured in physics, but also illustrated his teaching through experiments.

DANIEL BERNOULLI won the *Paris Academy* Science Prize ten times. In addition to the above-mentioned subjects, he won the prize for his work on the optimal shape of a ship's anchor, on the NEWTON theory of the cause of tides (together with EULER, with whom he was in constant correspondence), on questions of magnetism, on methods of measuring time at sea, on ocean currents and on forces acting on ships.

Because of his outstanding scientific achievements, DANIEL BERNOULLI was granted honorary memberships of numerous academies: Bologna, St Petersburg, Berlin, Paris, London, Bern, Turin, Zurich and Mannheim.

We still associate the name DANIEL BERNOULLI with the following terms today:

- The *BERNOULLI effect* from fluid mechanics:



(source: Wikipedia)

An increase in the flow velocity of a (incompressible, viscous-free) fluid is associated with a reduction in static pressure. This has the consequence, for example, that a hose from which water flows and which is held against a wall is drawn towards the wall (*the hydrostatic paradox*).

The total energy of the fluid elements, i.e. *dynamic pressure* + *hydrodynamic pressure* + *gravitational pressure*, remains constant (the so-called *BERNOULLI equation*).

- The *BERNOULLI principle* in decision theory:

NICOLAUS (I) BERNOULLI, a cousin of DANIEL's, was the originator of a problem that has entered the literature as the *St Petersburg paradox*: In a casino, a game is offered in which a (fair) coin is tossed until a tail appears; the payout doubles from round to round. How much should a gambler offer to play this game?

The expected value of the payout is infinitely large. So, paradoxically, a stake of *any* amount would be appropriate. DANIEL BERNOULLI recommended that one's participation in the game should be made dependent on what he defined as a *utility function*, that is the benefit to oneself.

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https://www.spektrum.de/wissen/daniel-bernoulli/1702908

Translated 2020 by John O'Connor, University of St Andrews

Here an important hint for philatelists who also like individual (not officially issued) stamps.
Enquiries at europablocks@web.de with the note: "Mathstamps".