MICHAIL OSTROGRADSKI (September 24, 1801 – January 1, 1862)

by HEINZ KLAUS STRICK, Germany

MICHAIL VASSILYEVICH OSROGRADSKI grew up together with two sisters and two brothers near Poltava, a small town situated between Kyiv and Kharkiv (today in Ukraine). Even though his parents owned a piece of land, the family belonged to the poorer part of the rural population.

Little MICHAIL was interested in everything that could be measured. He paced the fields to determine their size, he always carried a string wrapped around a stone to determine the depth of a well and he was also fascinated by water and windmills.

At the age of nine he transferred to a secondary school in Poltava. There he lived in an institution for "children from the impoverished nobility". Under the influence of his teacher, a former soldier in the Russian army, MICHAIL expressed the desire to pursue a military career.

However, since the low pay in the army could not lead to an improvement in the family's financial situation, the parents urged the boy to study at university – a prerequisite for later entry into the higher civil service.

After a preparatory year, MICHAIL OSTROGRADSKI began to study mathematics and physics at the University of Kharkiv in 1817 – still very unsure whether this was the right decision.

It is undoubtedly thanks to his two professors, ANDREI FEDOROVICH PAVLOVSKI and TIMOFEI FEDOROVICH OSSIPOWSKI, that the young student took a liking to the two subjects, but above all that they discovered his special talent and supported him comprehensively.

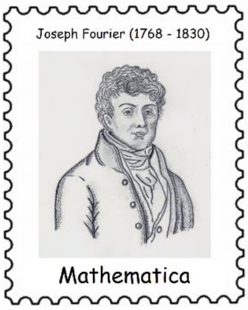
As early as 1820, OSROGRADSKI passed the final examination, but before the degree certificate could be issued, the Minister for Education and Religious Affairs, Prince ALEXANDER FYODOROVICH GALITZIN, intervened and annulled the examination. As part of his "crusade against ungodly and revolutionary aspirations", especially in the universities, his examiner (and university rector for many years) OSSIPOWSKI was removed from office.

OSSIPOWSKI was accused of not proclaiming the existence of God convincingly enough in the context of his lectures, as he was expected to do. And since OSSIPOWSKI violated this rule, he was also not allowed to examine his model student, OSTROGRADSKI.

Formally, the examination was annulled because (the nihilist) OSTROGRADSKI – like most of his fellow students – had not attended lectures on theology and philosophy.

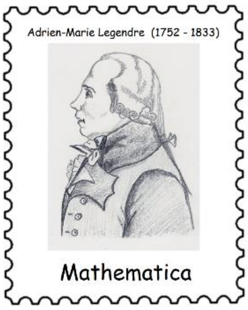
In fact, OSTROGRADSKI was offered the chance to take his exam with another professor, but he refused. Without a formal degree, he decided to continue his studies in Paris, the mathematics centre of the time.

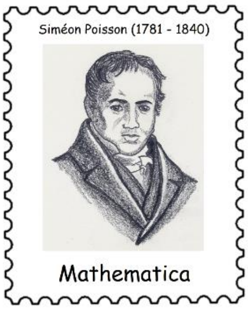
His father did not agree because of the additional financial burden, but nevertheless, the young man put his decision into practice.

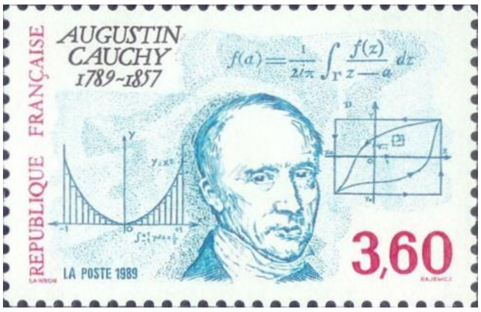


He attended lectures on mathematics, physics and astronomy at the *École Polytechnique*, the *Sorbonne* and the *Collège de France* with Louis Poinsot, Pierre-Simon Laplace, Joseph Fourier, Adrien-Marie Legendre, Siméon-Denis Poisson, Jacques Binet and Augustin-Louis Cauchy, and became friends with them.

In 1826 he was able to submit his first papers to the *Académie des Sciences*, among them *Démonstration d'un théorème du calcul intégral*, the proof of a theorem about multiple integrals, which today is called the *Gauss-Ostrogradski theorem* (a generalisation of the main theorem of differential and integral calculus for 3-dimensional space).







He developed a special relationship with Cauchy. When Ostrogradski's father – annoyed by his son's stay abroad – stopped transferring money and he could not pay his rent, Cauchy settled all the debts before it came to a court case, and got his highly gifted student a job as a teacher at the *Collège Henri IV* (today: *Lycée*). (Recent research in the records of the *Académie* meetings has shown that Cauchy took up a number of Ostrogradski's ideas and incorporated them into his later works.)

In 1828, Ostrogradski left Paris for St Petersburg, where he was received with joy by the scientists. However, at first all his activities were closely monitored by the security authorities.

He was given various opportunities to work as a teacher and lecturer – first at the Naval School, later also at the General Pedagogical Institute.

On another brief visit to Paris in 1830, he got caught up in the turmoil of the July Revolution. However, it was not the street fighting with barricades that had a considerable impact on his future life, but his careless handling of a phosphorus match. An injury eventually led to blindness in one eye.

Returning to St Petersburg, he was accepted as a member of the *St Petersburg Academy of Sciences* for his contributions to thermodynamics, double integrals and potential theory.

He set himself the ambitious goal of developing a general theory that would encompass the phenomena of hydrodynamics, heat, elasticity and electricity. He succeeded again and again in making progress along this path, as can be seen from the more than eighty papers he submitted.

However, although Ostrogradski was elected a corresponding member by some foreign academies, in retrospect one must conclude that during his lifetime the importance of his manifold contributions was not recognised in Western Europe. The same applied to his treatises on mathematics, of which only a few were printed in scientific journals in Western Europe.

One exception was the contribution *Mémoire sur le Calcul des Variations des Integrales Multiples* on the theory of partial differential equations, which appeared in Crelle 's Journal in 1836.

In 1845, Ostrogradski published a clever method for the determination of indefinite integrals for rational functions.

His approach: Write $\int \frac{p(x)}{q(x)}dx = \frac{r(x)}{s(x)} + \int \frac{t(x)}{u(x)}dx$, where the degree of the numerator functions is smaller than that of the denominator functions in each case, $s(x)$ is the greatest common divisor of $q(x)$ and $q'(x)$, and the denominator function $u(x)$ results from the equation $q(x) = s(x) \cdot u(x)$.

Example: Evaluate $\int \frac{2x^2+3}{(x^2+1)^2}dx$. Here $q(x) = (x^2+1)^2$, therefore $q'(x) = 4x \cdot (x^2+1)$, and $s(x) = x^2+1$ and therefore also $u(x) = x^2+1$. Thus the coefficients in the following equation are to be determined: $\int \frac{2x^2+3}{(x^2+1)^2}dx = \frac{Ax+B}{x^2+1} + \int \frac{Cx+D}{x^2+1}dx$.

Differentiating on both sides leads to $\frac{2x^2+3}{(x^2+1)^2} = \frac{(x^2+1)\cdot A - (Ax+B)\cdot 2x}{(x^2+1)^2} + \frac{Cx+D}{x^2+1}$.

After expanding the last fraction, the following equation for the numerator terms is obtained:
$2x^2+3 = Ax^2 + A - 2Ax^2 - 2Bx + Cx^3 + Cx + Dx^2 + D$.

Since this must be satisfied for all x, the result is: $C=0$, $2=-A+D$, $0=-2B+C$, $3=A+D$.
From this follows: $D=2.5$; $A=0.5$; $B=0$, thus
$\int \frac{2x^2+3}{(x^2+1)^2}dx = \frac{0.5x}{x^2+1} + \int \frac{2.5}{x^2+1}dx = \frac{0.5x}{x^2+1} + 2.5 \cdot \arctan(x) + const.$

In 1847, Ostrogradski was commissioned to supervise the teaching of mathematics at Russia's military universities. He carried out this task with great conscientiousness and wrote the textbooks used for teaching.

One of his admirers, the twenty years younger Pafnuty Lvovich Chebyshev, later regretted – looking back on the achievements of his role model – that the latter had been too preoccupied with the questions of teaching instead of continuing his research work and perhaps even completing it.

When Russia was forced to disband its Black Sea fleet in 1856 after the end of the Crimean War (which it lost), the Russian government was faced with the problem of finding temporary financial solutions for the officers. Ostrogradski was commissioned to develop a financial model for the establishment of a fund for early retirees and this was adopted unchanged.

In the summer of 1861, it was noticed that he had an abscess on his back. He was operated on and the abscess was removed, but his health rapidly deteriorated and he died. In accordance with his wishes, his body was buried in his family's grave in Poltava, for as often as he could, he had spent his summer holidays with his family in the old homeland.

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https://www.spektrum.de/wissen/michail-ostrogradski-1801-1862-mathematiker-wider-willen/1759354

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