SOFIA KOVALEVSKAYA (January 15, 1850 – February 10, 1891)

by Heinz Klaus Strick, Germany

SOFIA VASILYEVNA KOVALEVSKAYA was born in Moscow, the second daughter of VASILY VASILYEVICH KORVIN-KRUKOVSKY, a general in the Russian army, and his wife YELIZAVETA FEDOROVNA SCHUBERT, who was twenty years his junior. As was usual in well-to-do families of the nobility, the children's education began with an English governess and continued with private tutors.

SOFIA became fascinated with mathematics at an early age. She listened eagerly to the conversations between her father and uncle on mathematical subjects, never mind that she could not understand in any detail what they were talking about.

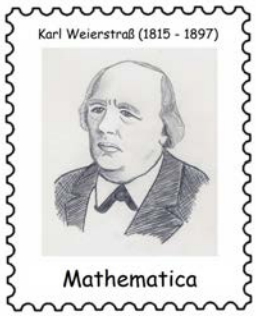
It has been reported that her curiosity was aroused by the temporary papering of the walls in the children's nursery (in the absence of ordinary wallpaper) with pages from the manuscript of a lecture on calculus given by MIKHAIL OSTROGRADSKY (1801-1861). When eventually one of her tutors initiated systematic instruction in mathematics, SOFIA neglected all her other subjects, which led her father to forbid her the study of mathematics. But SOFIA got hold of a book on algebra, which she read secretly at night.

One day, a neighbor, a physics professor named NIKOLAI NIKANOROVICH TYRTOV, gave the family a copy of his new physics textbook. The twelve-year-old SOFIA began to read it. She had trouble with the formulas involving trigonometric functions. However, she persisted and figured out their meaning from the context. Her neighbor was stunned when she asked him questions about his book that suggested that she had actually understood what she had read. TYRTOW attempted to convince the girl's father that his daughter absolutely must have further instruction in mathematics. But several years passed before the father again allowed his daughter to study the subject. If she were to obtain instruction in "higher" mathematics, she would have to leave home. But an unmarried woman could not do so without her father's consent. Since he was unwilling to give such consent, there was only one way out: marriage.

Shortly before her eighteenth birthday, SOFIA married VLADIMIR KOVALEVSKI. However, it was to be a "fictitious marriage," just for appearances, so that SOFIA could pursue her interests. The groom was one of the so-called nihilists, who were active in agitating for the rights of women to obtain an education and saw it a point of honor to "free Russia's daughters". The unsuspecting parents accepted the budding paleontologist as their daughter's husband.

In the following year, the newlyweds travelled to Heidelberg, so that SOFIA KOVALEVSKAYA could take up studies in mathematics and the natural sciences. However, at the time, women could not officially enroll in German universities. After many futile attempts, she was finally allowed to petition individual lecturers to "audit" their lectures. The professors, including LEO KÖNIGSBERGER (a student of KARL WEIERSTRASS), HERMANN HELMHOLTZ, and GUSTAV Robert KIRCHHOFF, quickly recognized the young woman's exceptional talent.

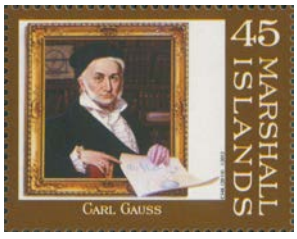
After three semesters, she moved to Berlin on the recommendation of KÖNIGSBERGER, in order to continue her studies under the supervision of KARL WEIERSTRASS himself, whose lectures on analysis had become renowned for their intellectual rigor. At first, WEIERSTRASS ignored the letters of recommendation that she had produced, but gave the "supplicant" a problem, which, to his great surprise, she was quickly able to solve. Since the university, despite WEIERSTRASS's petition, would not give permission for SOFIA even to audit the lectures, WEIERSTRASS saw only one way to help: he taught her twice a week in private sessions.



In 1874, SOFIA VASILYEVNA KOVALEVSKAYA completed three papers, which WEIERSTRASS judged sufficient for the granting of a doctoral degree. The first paper brought her research on the solvability of partial differential equations to a provisional conclusion. (Differential equations are equations that describe relationships between functions and their derivatives. To solve a differential equation means to find all functions that satisfy the conditions of the equation. In partial differential equations, several variables are involved.)

In the second paper, KOVALEVSKAYA dealt with so-called abelian integrals (named in honor of NIELS HENRIK ABEL) and provided methods for reducing these integrals to simpler integrals. In the third paper, she improved on a theory of PIERRE SIMON LAPLACE on the physics of the rings of Saturn.

WEIERSTRASS had a hard time finding a university in Germany that would recognize this work as the basis for granting a doctoral degree. Finally, the University of Göttingen expressed its willingness to do so and granted KOVALEVSKAYA the title of doctor in absentia, with the addition of *summa cum laude*. In support of his application, WEIERSTRASS went so far as to cite the great CARL FRIEDRICH GAUSS, who in 1837 expressed his regret that the German universities had failed to grant the mathematician SOPHIE GERMAIN a doctorate in her lifetime.



It was many more years before women were granted the right and opportunity to pursue scientific work. For example, the physician and neurologist PAUL MÖBIUS insisted that there was no originality in the ideas and scientific work of SOFIA KOVALEVSKAYA (this judgment appeared in the chapter "*On Women in Mathematics*" in a book that MÖBIUS published in 1900 with the title *On the Natural Aptitude for Mathematics*). When an error was found in one of KOVALEVSKAYA's later articles on the refraction of light, many voices were raised to claim that such an error could never have been made by a man. In fact, the cause of the error in that article was that she had adopted one of the experimental conditions of another scientist (a man) without having verified the specifics of his work.

Despite her academic title and a number of letters of recommendation from her sponsor, WEIERSTRASS was unable to find a university position for her. The series of rejections and disappointments plunged her into a six-year emotional crisis, in which she ceased work in mathematics. She returned to Russia, where her academic title, obtained in Germany, was not recognized. She was considered qualified at most to be a teacher of young girls.

What had begun as a fictitious marriage eventually became a real one. She gave birth to a daughter, but then later separated from her husband. VLADIMIR's suicide in 1883 came at first as a shock, but it also represented a liberation for her. She returned to the study of mathematics with great intensity to displace her feelings of guilt. As a widow, she was allowed to travel without restrictions, which earlier would have been possible only with the express permission of her father, and later her husband—even after their separation.

A breakthrough for KOVALEVSKAYA arrived when MAGNUS GÖSTA MITTAG-LEFFLER, the first professor of mathematics appointed at the newly founded University of Stockholm, a student of CHARLES HERMITE (Paris) and KARL WEIERSTRASS (Berlin), created for her in Stockholm a five-year position as lecturer in mathematics. During her first year, she lectured in German, but eventually she learned enough Swedish to be able to lecture in that language. In 1889, she finally obtained a professorship in mathematics, being the first woman in the modern history of science to do so. She gave lectures on mathematical analysis, was an editor of a mathematical journal, and organized international mathematical conferences.

In 1886, she was awarded the *Prix Bordin* of the *French Academy of Sciences*, having won a competition to which she had submitted her contribution anonymously. Judging the quality of her work to be unusually high, the jury raised the amount of the prize money from 3000 to 5000 francs.

In 1889, she won the prize of the *Swedish Academy*, and following the personal intervention of PAFNUTY LVOVICH CHEBYSHEV, she was named a corresponding member of the *Russian Academy of Sciences*, which in conservative tsarist Russia became possible only after a modification in the university statutes.

In the midst of a new and intensive creative period, SOFIA KOVALEVSKAYA died of a lung infection that had not been treated in a timely manner.

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