

## Sonya Krukovskaya

The first woman mathematician of modern times

Sofya\* Vasilievna Krukovskaya was born on 15th January, 1850 in Moscow in an aristocratic family. By nature, she was an intense and serious person. An early indication of her talents was her ability to make sense of the sine function all by herself. It was then, her conservative father agreed to allow her to take some calculus lessons from Prof Strannoliubsky in St. Petersburg.

Russian society being very conservative at that time, women had no hopes of higher education or a career. Many young women tried to go to the west but could travel only with the permission of their husbands or fathers. In some extreme cases, a young woman entered into a "marriage" for namesake with a liberal "husband" and the couple chaperoned a group of her friends to the west. Vladimir Kovalevsky, a liberal and publisher of many scientific texts "married" Sofya in 1868 and the couple escorted her sister Anyuta, to the west in early 1869.

Sofya and Vladimir settled down in Heidelberg where she studied for a year with du Bois-Reymond and Konigsberger, both students of Karl Weierstrass, one of the giants of mathematics. This too was possible only after her strenuous efforts at getting the administration to agree that she could attend courses with the permission of the professors. In the fall of 1870, she left for Berlin to seek out

her teacher's teacher, Weierstrass. As he was forbidden by university rules to allow her to attend his lectures, he started giving her private lessons. Thus Sofya was able to catch up on her mathematical education, in spite of turbulent events in her personal life. In a period of 18 months, she wrote 3 dissertations under Weierstrass's direction. He appealed to the somewhat more liberal University of Göttingen for her doctoral degree which she received in 1874 to become the first woman Ph.D.

After their return to Russia in 1875, Sofya and Vladimir (who had a Ph.D. in geology) were unable to find any suitable position and hence turned to real estate business investments which eventually failed. Meanwhile in 1878, her daughter, Fufa was born.

In March 1881, Tsar Alexander II was assassinated and the couple, with their radical ties, found it safer to move to the west. Sofya settled down in Berlin to work on Lamé's equations. Vladimir returned to Russia and was getting deeper into financial trouble and finally committed suicide in April 1883. This was a rude shock to Sofya. In spite of that, she managed to finish her work. Meanwhile Mittag-Leffler had arranged a post for her in Stockholm University. She felt that it was her moral



obligation to clear Vladimir of the charges against him. So she returned to Russia and managed to establish his innocence. Then leaving Fufa with her friend Julia she sailed to Stockholm in November 1883, to become the first woman professor of mathematics. The following years were quite productive mathematically. Her work on Euler's equations fetched her the Bordin Prize from the Paris Academy in 1888. But in February 1891, her life came to a sudden end after a brief illness.

In her thesis, she had proved an important theorem on the existence and uniqueness of an analytic solution for partial differential equations with analytic coefficients (now known as the Cauchy-Kovalevskaya theorem). Her thesis also contained results on degenerate Abelian integrals which reduce to elliptic integrals, and on the shape of Saturn's rings. The important work which fetched her the Bordin prize was on Euler's equations describing the motion of a heavy rigid body, with one point fixed like a top or a pendulum. Her other work includes the one on Lamé's equations for light refraction in crystals.

In the field of literature in the last five years of her life she produced a memoir of her childhood and adolescence, a novel *A Nihilist Girl*, two plays, a small body of verse, a collection of short stories and some essays.

Thus in spite of the uncertain political atmosphere and a turbulent personal life, Sofya Kovalevskaya managed to pursue a successful mathematical career thanks to her talents and determination. Of course, the influence of Weierstrass and the extraordinary efforts of Mittag-Leffler are equally important factors that helped her. She is recognized as the first woman mathematician of modern times, who through her achievements, opened many doors for other women in the field of mathematics.

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\*Sometime in her adult life, Sofya acquired the name Sonya by which she is better known.

### Suggested Reading

- E T Bell. *Men of Mathematics*. Simon and Schuster, 1937.
- B Stillman. *A Russian Childhood*. Springer Verlag, 1978 (translated, edited and introduced by Stillman from Sofya's original, *Memories of childhood in Russia*).
- A H Koblitz. *A convergence of lives, Sofya Kovalevskaya: scientist, writer, revolutionary*. Birkhäuser, 1983.
- Roger Cooke. *The mathematics of Sonya Kovalevskaya*. Springer Verlag, 1984.

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