

# Novikov, Petr Sergeevich | Encyclopedia.com

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(*b.* Moscow, Russia, 15 August 1901; *d.* Moscow, 9 January 1975)

*mathematics.*

Novikov was the son of Sergei Novikov, a merchant in Moscow, and his wife Alexandra. In September 1919 the young Novikov entered the physics and mathematics department of Moscow University. After serving in the Red Army between March 1920 and July 1922, he returned to the university and was graduated in 1925. During the next four years he was a postgraduate student under Nikolai N. Luzin. Subsequently Novikov taught mathematics at the Moscow Chemical Technological Institute, and in 1934 he was invited to join the newly organized Steklov Mathematical Institute. He worked there in the department of real function theory until 1957, when he organized the department of mathematical logic and became its head. In 1935 Novikov received the doctorate in mathematics, and four years later he became a full professor. In 1953 he was elected a corresponding member, and in 1960 a full member, of the Soviet Academy of Sciences.

In 1935 Novikov married Ludmila Vsevolodovna Keldysh, a well-known mathematician specializing in topology. They had five children. One of their sons, Sergei Petrovich, is president of the Moscow Mathematical Society.

While still a student, Novikov began to work on descriptive set theory. Very soon he became one of the most active members of Luzin's school of descriptive set theory. In his paper "Sur les fonctions implicites mesurables" (1931) Novikov investigated the problem of whether the equations  $f_i(x, y) = 0$  and  $(1 \leq i \leq q)$  with Borel functions  $f_i$  can implicitly define a Borel function  $y = f(x)$ . He discovered a new method that is referred to as the index comparison principle. Using a generalization of this method, he proved, in his 1935 paper, that for the second projective class of sets the following two separability propositions hold: (1) any two  $CA_2$ -sets are separable by  $B_2$ -sets if they are disjoint; (2) there exist two disjoint  $A_2$ -sets that are nonseparable by  $B_2$ -sets. These propositions unexpectedly turned out to be dual to the known laws for the first projective class.

In his 1938 paper on mathematical physics, Novikov proved that any two solids having the same constant density must coincide if they both are star-shaped relative to a common point and have the same external gravitational potential. This pioneering result became the basis of many studies by other authors.

In the late 1930's Novikov began to study mathematical logic and the theory of algorithms. In the paper "On the Consistency of Certain Logical Calculus" (1943), he developed a method of providing the consistency based on a notion of "regularity". He also, in the same paper, proved the consistency for the formal arithmetic with recursive definitions using this method. In 1951 Novikov proved the consistency of two propositions in the Gödel system  $\Sigma$  of axiomatic set theory: (1) there exists a  $CA$ -set without perfect subsets; and (2) there exists a  $B_2$ -set that is not Lebesgue-measurable. This proof was based on Gö's method published in 1940.

The following word problem had been proposed by Max Dehn in 1912: Let a group  $G$  be defined by a finite number of generators and defining relations. For an arbitrary word  $W$  in the generators of  $G$ , decide in a finite number of steps whether or not  $W$  defines the identity element of  $G$ .

In 1952 Novikov constructed a finitely defined group  $H$  with an unsolvable word problem, that is, a group with no algorithm to solve the word problem for  $H$ . This result was first announced in his 1952 paper "Ob algoritmicheskoi nerazreshimosti problemy tozhdestva" ("On the Algorithmic Unsolvability of the Word Problem"). The complete proof was published three years later. In 1957 William W. Boone gave another example of a group with an unsolvable word problem, and therefore this result is called the Novikov-Boone theorem. Important corollaries derived from this theorem have suggested that there are many unsolvable algorithmic problems in fundamental branches of classical mathematics. Novikov received the Lenin Prize for this significant achievement in 1957.

Novikov's last important result, proved jointly with S. I. Adian, was a negative solution of the Burnside problem of periodic groups, proposed in 1902. In 1959 Novikov announced the existence of infinite, finitely generated periodic groups of any given exponent  $n \geq 72$ . The complete proof of the result for odd exponents  $n \geq 4, 381$  was published in a joint article in 1968. In my book, *The Burnside Problem and Identities in Groups* (1979), there is an exposition of the Novikov-Adian method for any odd exponent  $n \geq 665$  and many applications.

The exceptional influence of Novikov on the advancement of mathematics was also due to his lectures at Moscow University and at the Moscow State Teachers Training Institute, where he chaired the department of analysis from 1944 to 1972. He

founded a large school in mathematical logic and its applications in the USSR; his book *Elements of Mathematical Logic* (1959) was the first original textbook on the subject in the country. His second book, *Constructive Mathematical Logic from the Point of View of Classical Logic* (1977), has exerted a considerable influence on the development of proof theory.

Novikov retired from the State Teachers Training Institute in 1972 and from the Steklov Mathematical Institute in 1973. He was ill for the last three years of his life.

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S. I. Adian