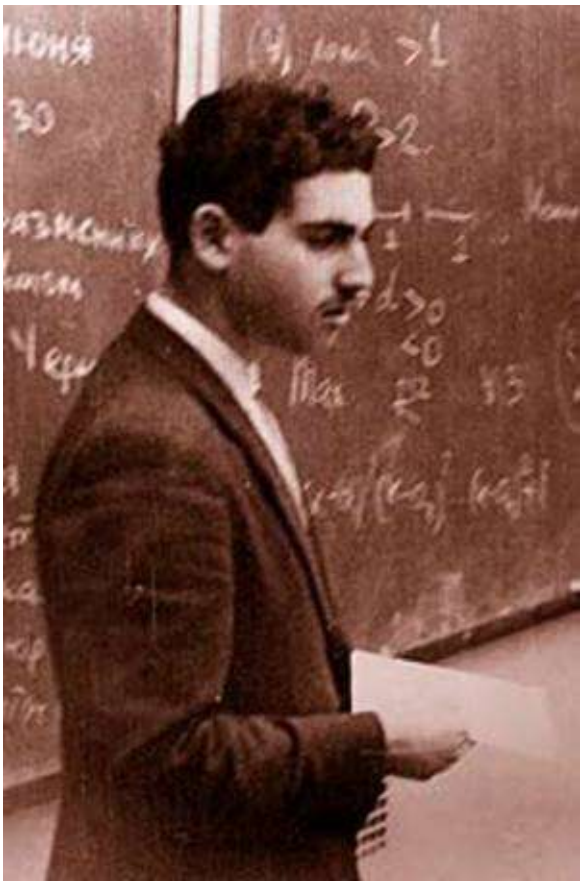
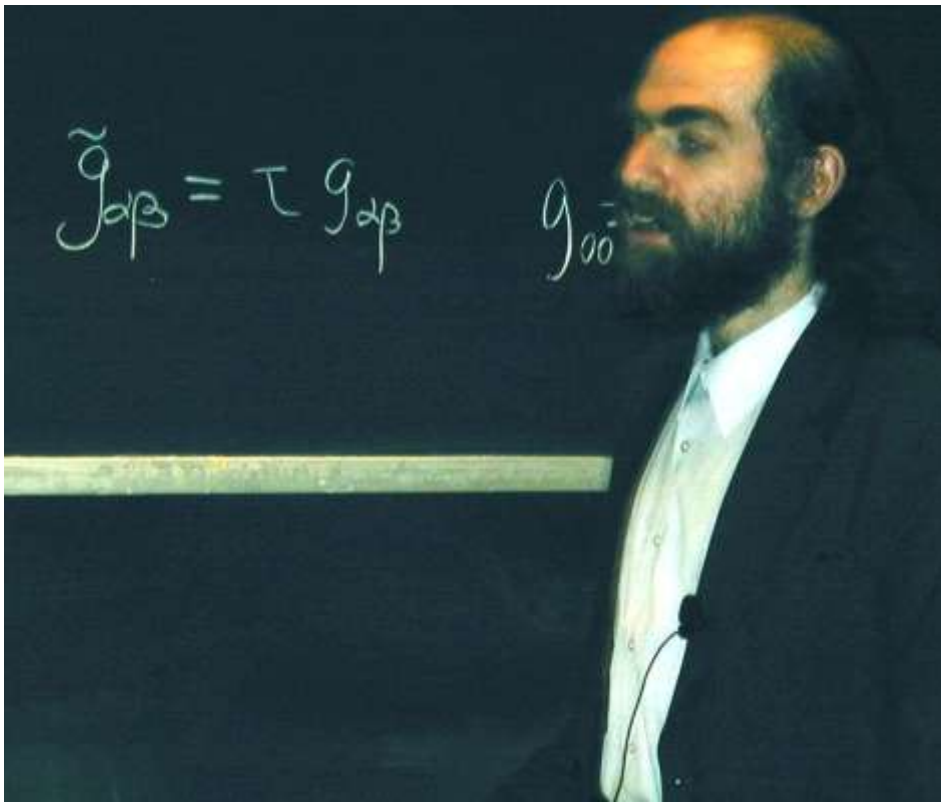
Grigori Perelman





Biography

Grigori Perelman was born in Leningrad, Soviet Union (now Saint Petersburg, Russia) on 13 June 1966, to Jewish parents, Yakov (who now lives in Israel) and Lubov. Grigori's mother Lubov gave up graduate work in mathematics to raise him. Grigori's mathematical talent became apparent at the age of ten, and his mother enrolled him in Sergei Rukshin's after-school math training program.

His mathematical education continued at the Leningrad Secondary School №239, a specialized school with advanced mathematics and physics programs. Grigori excelled in all subjects except physical education. In 1982, as a member of the Soviet Union team competing in the International Mathematical Olympiad, an international competition for high school students, he won a gold medal, achieving a perfect score. In the late 1980s, Perelman went on to earn a Candidate of Sciences degree (the Soviet equivalent to the Ph.D.) at the School of Mathematics and Mechanics of the Leningrad State University, one of the leading universities in the former Soviet Union. His dissertation was titled "Saddle surfaces in Euclidean spaces."

After graduation, Perelman began work at the renowned Leningrad Department of Steklov Institute of Mathematics of the USSR Academy of Sciences, where his advisors were Aleksandr Aleksandrov and Yuri Burago. In the late 1980s and early 1990s, Perelman held research positions at several universities in the United States. In 1991 Perelman won the Young Mathematician Prize of the St. Petersburg Mathematical Society for his work on Aleksandrov's spaces of curvature bounded from below . In 1992, he was invited to spend a semester each at the Courant Institute in New York University and State University of New York at Stony Brook where he began work on manifolds with lower bounds on Ricci curvature. From there, he accepted a two-year Miller Research Fellowship at the University of California, Berkeley in 1993. After having proved the soul conjecture in 1994, he was offered jobs at several top universities in the US, including Princeton and Stanford, but he rejected them all and returned to the Steklov Institute in Saint Petersburg in the summer of 1995 for a research-only position.

As of the spring of 2003, Perelman no longer worked at the Steklov Institute. His friends are said to have stated that he currently finds mathematics a painful topic to discuss; some even say that he has abandoned mathematics entirely. According to a 2006 interview, Perelman was then unemployed, living with his mother in Saint Petersburg.

Perelman is quoted in an article in The New Yorker saying that he is disappointed with the ethical standards of the field of mathematics. The article implies that Perelman refers particularly to the efforts of Fields medalist Shing-Tung Yau to downplay Perelman's role in the proof and play up the work of Cao and Zhu. Perelman added, "I can't say I'm outraged.

Other people do worse. Of course, there are many mathematicians who are more or less honest. But almost all of them are conformists. They are more or less honest, but they tolerate those who are not honest." He has also said that "It is not people who break ethical standards who are regarded as aliens. It is people like me who are isolated."

This, combined with the possibility of being awarded a Fields medal, led him to quit professional mathematics. He has said that "As long as I was not conspicuous, I had a choice. Either to make some ugly thing or, if I didn't do this kind of thing, to be treated as a pet. Now, when I become a very conspicuous person, I cannot stay a pet and say nothing. That is why I had to quit." (The *New Yorker* authors explained Perelman's reference to "some ugly thing" as "a fuss" on Perelman's part about the ethical breaches he perceived).

It is uncertain whether his resignation from Steklov and subsequent seclusion mean that he has ceased to practice mathematics. Fellow countryman and mathematician Yakov Eliashberg said that, in 2007, Perelman confided to him that he was working on other things but it was too premature to talk about it. He is said to have been interested in the past in the Navier–Stokes equations and the set of problems related to them that also constitutes a Millennium Prize, and there has been speculation that he may be working on them now.

Perelman avoided journalists and other media people. Masha Gessen, the author of a book about him, found it challenging to write about a person she never met.

A recent Russian documentary about Perelman in which his work is discussed by several leading mathematicians including Mikhail Gromov was released in 2011 under the title "Иноходец. Урок Перельмана", "A pacer. A lesson from Perelman".

In April 2011 Aleksandr Zabrovsky, producer of "President-Film" studio, claimed to have held an interview with Perelman and agreed to shoot a film about him, under the tentative title *The Formula of the Universe*. Zabrovsky says that in the interview, Perelman explained why he rejected the one million prize:

I've learned how to calculate the voids; along with my colleagues we are getting to know the mechanisms for filling in the social and economic "voids". Voids are everywhere.

They can be calculated, and this gives us great opportunities ... I know how to control the Universe. So tell me — why should I chase a million?

A number of journalistsbelieve that Zabrovky's interview is most likely a fake, pointing to contradictions in statements supposedly made by Perelman.

He has a younger sister, Elena, who is also a scientist. She received a Ph.D. from Weizmann Institute of Science in Israel and is a biostatistician at Karolinska Institutet, in Stockholm, Sweden.

Perelman is also a talented violinist and a strong table tennis player. He could go to any university of the country without examination, but he chose the Mechanics and Mathematics, although he could go at the conservatory.

Scientific contribution

The Poincaré conjecture, proposed by French mathematician Henri Poincaré in 1904, was the most famous open problem in topology. Any loop on a three-dimensional sphere—as exemplified by the set of points at a distance of 1 from the origin in four-dimensional Euclidean space—can be contracted to a point. The Poincaré conjecture asserts that any closed three-dimensional manifold such that any loop can be contracted to a point is topologically a three-dimensional sphere. The analogous result has been known to be true in dimensions greater than or equal to five since 1960 (work of Stephen Smale). The four-dimensional case resisted longer, finally being solved in 1982 by Michael Freedman. But the case of three-manifolds turned out to be the hardest of them all. Roughly speaking, this is because in topologically manipulating a three-manifold, there are too few dimensions to move "problematic regions" out of the way without interfering with something else.

Chronography

In 1999, the Clay Mathematics Institute announced the Millennium Prize Problems: $1,000,000 prizes for the proof of any of seven conjectures, including the Poincaré conjecture. There was a wide agreement that a successful proof of any of these would constitute a landmark event in the history of mathematics.

*In November 2002, Perelman posted the first of a series of eprints to the arXiv, in which he claimed to have outlined a proof of the geometrization conjecture, of which the Poincaré conjecture is a particular case.

Perelman modified Richard Hamilton's program for a proof of the conjecture, in which the central idea is the notion of the Ricci flow. Hamilton's basic idea is to formulate a "dynamical process" in which a given three-manifold is geometrically distorted, such that this distortion process is governed by a differential equation analogous to the heat equation. The heat equation describes the behavior of scalar quantities such as temperature; it ensures that concentrations of elevated temperature will spread out until a uniform temperature is achieved throughout an object. Similarly, the Ricci flow describes the behavior of a tensorial quantity, the Ricci curvature tensor. Hamilton's hope was that under the Ricci flow, concentrations of large curvature will spread out until a uniform curvature is achieved over the entire three-manifold. If so, if one starts with any three-manifold and lets the Ricci flow occur, eventually one should in principle obtain a kind of "normal form". According to William Thurston, this normal form must take one of a small number of possibilities, each having a different kind of geometry, called Thurston model geometries.

This is similar to formulating a dynamical process that gradually "perturbs" a given square matrix, and that is guaranteed to result after a finite time in its rational canonical form.

Hamilton's idea attracted a great deal of attention, but no one could prove that the process would not be impeded by developing "singularities", until Perelman's eprints sketched a program for overcoming these obstacles. According to Perelman, a modification of the standard Ricci flow, called *Ricci flow with surgery*, can systematically excise singular regions as they develop, in a controlled way.

We know that singularities (including those that, roughly speaking, occur after the flow has continued for an infinite amount of time) must occur in many cases. However, any singularity that develops in a finite time is essentially a "pinching" along certain spheres corresponding to the prime decomposition of the 3-manifold. Furthermore, any "infinite

time" singularities result from certain collapsing pieces of the JSJ decomposition. Perelman's work proves this claim and thus proves the geometrization conjecture.

*Since 2003, Perelman's program has attracted increasing attention from the mathematical community.

*In April 2003, he accepted an invitation to visit Massachusetts Institute of Technology, Princeton University, State University of New York at Stony Brook, Columbia University and New York University, where he gave a series of talks on his work.

Three independent groups of scholars have verified that Perelman's papers contain all the essentials for a complete proof of the geometrization conjecture:

*On 25 May 2006, Bruce Kleiner and John Lot, both of the University of Michigan, posted a paper on arXiv that fills in the details of Perelman's proof of the Geometrization conjecture. John Lott said in ICM2006, "It has taken us some time to examine Perelman's work. This is partly due to the originality of Perelman's work and partly to the technical sophistication of his arguments. All indications are that his arguments are correct."

*In May 2006, a committee of nine mathematicians voted to award Perelman a Fields Medal for his work on the Poincaré conjecture. The Fields Medal is the highest award in mathematics; two to four medals are awarded every four years. However, Perelman declined to accept the prize. Sir John Ball, president of the International Mathematical Union, approached Perelman in Saint Petersburg in June 2006 to persuade him to accept the prize. After 10 hours of persuasion over two days, Ball gave up. Two weeks later, Perelman summed up the conversation as follows: "He proposed to me three alternatives: accept and come; accept and don't come, and we will send you the medal later; third, I don't accept the prize. From the very beginning, I told him I have chosen the third one... [the prize] was completely irrelevant for me. Everybody understood that if the proof is correct, then no other recognition is needed." "'I'm not interested in money or fame,' he is quoted to have said at the time. 'I don't want to be on display like an animal in a zoo. I'm not a hero of mathematics. I'm not even that successful; that is why I don't want to have everybody looking at me.'" Nevertheless, on 22 August 2006, Perelman was publicly offered the medal at the International Congress of Mathematicians in Madrid "for his contributions to geometry and

his revolutionary insights into the analytical and geometric structure of the Ricci flow." He did not attend the ceremony, and declined to accept the medal, making him the first person to decline this prestigious prize.

*In June 2006, the Asian Journal of Mathematics published a paper by Xi-Ping Zhu of Sun Yat-sen University in China and Huai-Dong Cao of Lehigh University in Pennsylvania, giving a complete description of Perelman's proof of the Poincaré and the geometrization conjectures. The June 2006 paper claimed: "This proof should be considered as the crowning achievement of the Hamilton-Perelman theory of Ricci flow."

*In July 2006, John Morgan of Columbia University and Gang Tian of the Massachusetts Institute of Technology posted a paper on the arXiv titled, "Ricci Flow and the Poincaré Conjecture". In this paper, they provide a detailed version of Perelman's proof of the Poincaré conjecture. On 24 August 2006, Morgan delivered a lecture at the ICM in Madrid on the Poincaré conjecture. This was followed up with the paper on the arXiv, "Completion of the Proof of the Geometrization Conjecture" on 24 September 2008.

*In November 2006, Cao and Zhu published an erratum disclosing that they had failed to cite properly the previous work of Kleiner and Lott published in 2003. In the same issue, the *AJM* editorial board issued an apology for what it called "incautions" in the Cao–Zhu paper.

*On December 3, 2006, Cao and Zhu retracted the original version of their paper, which was titled “A Complete Proof of the Poincaré and Geometrization Conjectures — Application of the Hamilton–Perelman Theory of the Ricci Flow” and posted a revised version, renamed, more modestly, "Hamilton–Perelman's Proof of the Poincaré Conjecture and the Geometrization Conjecture". Rather than the grand claim of the original abstract, "we give a complete proof", suggesting the proof is by the authors, the revised abstract states: "we give a detailed exposition of a complete proof". The authors also removed the phrase "crowning achievement" from the abstract.

He had previously turned down a prestigious prize from the European Mathematical Society, allegedly saying that he felt the prize committee was unqualified to assess his work, even positively.

*On 18 March 2010, Perelman was awarded a Millennium Prize for solving the problem. On June 8, 2010, he did not attend a ceremony in his honor at the Institut Océanographique, Paris to accept his $1 million prize. According to Interfax, Perelman refused to accept the Millennium prize in July 2010. He considered the decision of Clay Institute unfair for not sharing the prize with Richard Hamilton, and stated that "the main reason is my disagreement with the organized mathematical community. I don't like their decisions, I consider them unjust."

*Perelman's proof was rated one of the top cited articles in Math-Physics in 2008.

Приложение

Григорий Яковлевич Перельман

Биография

Григорий Перельман родился 13 июня 1966 года в Ленинграде. Его отец Яков был инженером-электриком. Мать Любовь осталась в Санкт-Петербурге, работала учителем математики в ПТУ. Именно мать, игравшая на скрипке, привила будущему математику любовь к классической музыке. Математический талант Перельмана проявился, когда ему было 10 лет. Его мать записала его заниматься в математическом центре при Дворце Пионеров под руководством доцента РГПУ Сергея Рукшина, чьи ученики завоевали множество наград на математических олимпиадах.

До 9 класса Перельман учился в средней школе на окраине города, однако в 5 классе начал заниматься в математическом центре при Дворце Пионеров под руководством доцента РГПУ Сергея Рукшина, чьи ученики завоевали множество наград на математических олимпиадах. В 1982 году в составе команды советских школьников завоевал золотую медаль на Международной математической олимпиаде в Будапеште, получив полный балл за безукоризненное решение всех задач. Перельман окончил 239-ю физико-математическую школу города Ленинграда. Хорошо играл в настольный теннис, посещал музыкальную школу, обладал грамотным письмом и речью. Золотую медаль не получил только из-за физкультуры, не сдав нормы ГТО. В конце 1980 года, Перельман продолжал работу над кандидатской диссертацией в школе математики и механики Ленинградского государственного университета, одного из ведущих университетов в странах бывшего Советского Союза. Его диссертация называлась "Поверхности седла в Евклидовых пространствах".

Был без экзаменов зачислен на математико-механический факультет Ленинградского государственного университета. Побеждал на факультетских, городских и всесоюзных студенческих математических олимпиадах. Все годы учился только на «отлично». За успехи в учёбе получал Ленинскую стипендию. Окончив с отличием университет, поступил в аспирантуру (руководитель — академик А. Д. Александров) при Ленинградском отделении Математического института им. В. А. Стеклова (ЛОМИ — до 1992 г.; затем — ПОМИ). Защитив в 1990 году кандидатскую диссертацию, остался работать в институте старшим научным сотрудником.

В начале 1990-х годов Перельман приехал в США, где работал научным сотрудником в разных университетах. Удивлял коллег аскетичностью быта, любимой едой были молоко, хлеб и сыр. В 1996 году вернулся в Санкт-Петербург, где продолжил работу в ПОМИ. В декабре 2005 года он ушёл с поста ведущего научного сотрудника лаборатории математической физики, уволился из ПОМИ и практически полностью прервал контакты с коллегами.

К дальнейшей научной карьере интереса не проявлял. В настоящее время живёт в Купчино в одной квартире с матерью, ведёт достаточно замкнутый образ жизни, игнорирует прессу.

Научный вклад

В 1994 году доказал гипотезу о душе.

Будучи представителем ленинградской геометрической школы, развил и применил сугубо ленинградскую теорию пространств Александрова для анализа потоков Риччи. В 2002 году Перельман впервые опубликовал свою новаторскую работу, посвящённую решению одного из частных случаев гипотезы геометризации Уильяма Тёрстона, из которой следует справедливость знаменитой гипотезы Пуанкаре, сформулированной французским математиком, физиком и философом Анри Пуанкаре в 1904 году. Описанный учёным метод изучения потока Риччи получил название теории Гамильтона — Перельмана.

Хронография

В 1996 году был удостоен премии Европейского математического общества для молодых математиков, но отказался её получать.

В 2006 году Григорию Перельману за решение гипотезы Пуанкаре присуждена международная премия «Медаль Филдса», однако он отказался и от неё.

В 2006 году журнал Science назвал доказательство теоремы Пуанкаре научным «прорывом года.Это первая работа по математике, заслужившая такое звание.

В 2006 году Сильвия Назар и Дэвид Грубер опубликовали статью «Manifold Destiny», которая рассказывает о Григории Перельмане и математическом сообществе и содержит редкое интервью с ним самим.

В 2007 году британская газета The Daily Telegraph опубликовала список «Сто ныне живущих гениев», в котором Григорий Перельман занимает 9-е место. Кроме Перельмана в этот список попали всего лишь 2 россиянина — Гарри Каспаров (25-е место) и Михаил Калашников (83-е место).

В марте 2010 года Математический институт Клэя присудил Григорию Перельману премию в размере одного миллиона долларов США за доказательство гипотезы Пуанкаре, что стало первым в истории присуждением премии за решение одной из Проблем тысячелетия.

В июне 2010 года Перельман проигнорировал математическую конференцию в Париже, на которой предполагалось вручение «Премии тысячелетия», а 1 июля 2010 года публично заявил о своём отказе от премии.