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# Maths solution tops science class

**By Paul Rincon**
Science reporter, BBC News

**A solution to one of the most difficult problems in mathematics was the most important advance of 2006, according to the prestigious journal Science.**

Perelman's proof has caused a sensation

Grigory Perelman's proof of the century-old Poincare Conjecture has caused a sensation, and not just because of the brilliance of the work.

In August, the Russian became the first person to turn down a Fields Medal, the highest honour in mathematics.

He also seems likely to turn down a $1m prize offered by a US maths institute.

Dr Perelman is said to despise self-promotion and describes himself as isolated from the rest of the mathematical community.

But his work has set the field alight with excitement - and controversy.

> **"The best piece of mathematics we have seen in the last 10 years"**
>
> Terence Tao, UCLA

Terence Tao, professor of mathematics at the University of California, Los Angeles, called Perelman's result "the best piece of mathematics we have seen in the last 10 years".

Timofey Shilkin, a former colleague of Perelman at the Steklov Mathematics Institute in St Petersburg, Russia, told BBC News: "He definitely deserves the Fields Medal - that is my personal opinion. I am completely sure he is a genius."

### 'Excellent mathematician'

He added: "I'm afraid he is quite a self-enclosed person. We know about him approximately the same as you know - not too much.

"I met him when he was a member of our group and our

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contacts were about once a week, but we had only short discussions.

"I know nothing about his personal life; I know only that he is an excellent mathematician."


Grigory Perelman shuns the spotlight

The reclusive Dr Perelman left the Steklov Institute in January, and was last said to be unemployed and living with his mother in her apartment in St Petersburg.

For several years he worked, for the most part, alone on the Poincare Conjecture. Then, in 2002, he posted on the internet the first of three papers outlining a proof of the problem.

The Poincare is a central question in topology, the study of the geometrical properties of objects that do not change when they are stretched, distorted or shrunk.

The surface of the Earth is what topology describes as a two-dimensional sphere. If one were to encircle it with a lasso of string, it could be pulled tight to a point.

On the surface of a doughnut, however, a lasso passing through the hole in the centre cannot be shrunk to a point without cutting through the surface.

**Checking the work**

Since the 19th Century, mathematicians have known that the sphere is the only enclosed two-dimensional space with this property; but they were uncertain about objects with more dimensions.

The Poincare Conjecture says that a three-dimensional sphere is the only enclosed three-dimensional space with no holes.

Proof of the Conjecture eluded mathematicians until Perelman posted his work on the website arXiv.org.

This is a so-called pre-print server, where researchers upload study papers for informal feedback before they submit them to a peer-reviewed journal.

Feuding within the mathematical community now threatens to overshadow Dr Perelman's achievement.

The Russian had detailed a way to kick down the roadblock that had stymied a solution to the problem. It was then up to others to check his proof.

It was at this stage of the process - when mathematicians pored over Perelman's work to assess its accuracy - that much bad feeling started to rise to the surface.

**'Complete proof'**

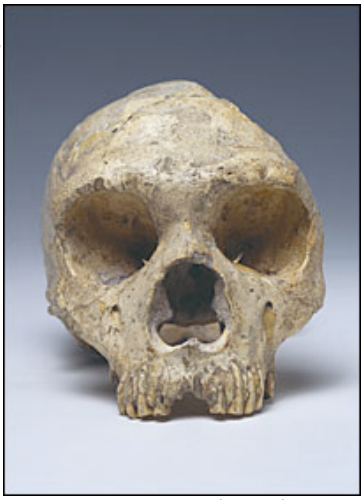
In 2005, a Chinese team consisting of Huai-Dong Cao of Lehigh University and Xi-Ping Zhu of Zhongshan University published what they claimed was "the first written account of a complete proof of the Poincare Conjecture".

Cao and Zhu took on the task of checking Perelman's proof at the behest of their mentor Shing-Tung Yau, a Chinese-born professor of mathematics at Harvard University, US.

Shortly after the Cao-Zhu paper was published, Professor Yau gave a speech in which he was reported as having said: "In Perelman's work, many key ideas of proofs are sketched or outlined, but complete details of the proofs are often missing."

This drew the ire of others in the field, who said that Yau's promotion of his proteges' work went too far.

In a rare interview, Perelman told the New Yorker magazine: "It is not clear to me what new contribution did they make."



2006 saw progress in understanding Neanderthal DNA (*Copyright: Natural History Museum*)

However, speaking to the New York Times newspaper in October, Professor Yau denied having said there were gaps in Dr Perelman's work.

Science magazine also named its "breakdown" of the year: the scandal involving South Korean cloning pioneer Hwang Woo-suk, whose report of the production of stem cells from a cloned human embryo was found to have been faked.

**Science magazine's breakthroughs of 2006**

- **1. The Poincare Conjecture**. Reclusive Russian mathematician Grigory Perelman apparently solved the venerable mathematical problem.
- **2. Digging out fossil DNA**. Researchers used new techniques to sequence more than one million bases of nuclear DNA from a Neanderthal.
- **3. Shrinking Ice**. Glaciologists discovered that the world's two great ice sheets were indeed losing water to the oceans - at an accelerating pace.
- **4. From sea to land**. Details emerged of a 375-million-year-old fish that fills an evolutionary gap between sea creatures and land animals.
- **5. The Ultimate Camouflage**. A British-American team built a "metamaterials" cloaking device, that rendered an object invisible to microwaves.
- **6. Ray of Hope**. Clinical trials show the drug ranizumab improved the vision of about one-third of patients with an age-related condition that causes degeneration in vision.
- **7. The road to speciation**. Studies on the fruit fly and

on butterflies aided our understanding of how species arise.

- **8. Beyond the light barrier**. New microscopy techniques allowed biologists to get a clearer view of the fine structure of cells and proteins.
- **9. The Persistence of Memory**. Neuroscientists provided insights into how the brain records new memories.
- **10. Small molecules**. Researchers reported a new class of small RNA molecules that shut down gene expression.

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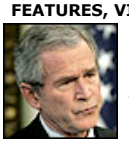

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