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## Thatcher's tax cutter

### SCIENCE AND TECHNOLOGY

#### Fermat's lost proof

#### The last laugh

THE biggest tease in the history of mathematics is a comment written by a seventeenth-century French judge in the margin of a third-century Greek text. Pierre de Fermat, a mathematical genius who published nothing in his lifetime, liked to set problems for other mathematicians. All except one of them have since been solved. But Fermat's so-called "last theorem", scribbled in his copy of Diophantus's *Arithmetica*, still prompts more loony letters to famous mathematicians than any other puzzle. Fermat wrote that he had a "wonderful" proof of his theorem but that the margin was too small to contain it—an irresistible lure.

Rumour has it that a proof has at last been found by Dr Yoichi Miyaoka of Tokyo Metropolitan University. This has been heralded as a great breakthrough. Perhaps, but it is also bad news. To see why, look first at the theorem.

It is about sums containing powers, such as  $2^2$ ,  $2^3$ ,  $2^4$ , and so on. The sum of two squared numbers can itself be a square: for example,  $3^2 + 4^2 = 5^2$ . But can the sum of two cubes be a cube, the sum of two numbers to the fourth power be a number to the fourth power, and so on? Fermat's last theorem says not. That is, it asserts that there is no whole-number power,  $N$ , bigger than two, which satisfies the equation  $x^N + y^N = z^N$  (where  $x$ ,  $y$  and  $z$  are whole numbers). No counter-examples have been found so far; but there are infinitely many numbers out there, so the challenge is to prove that there could not be any counter-examples.

To find such a proof, modern mathematicians divide and conquer. They split the problem into parts, and several groups attack it from different sides. A combination

of clever formulas and brute number-crunching has already shown that Fermat's theorem is true for all powers—that is, values of  $N$ —up to 150,000. In 1983 Dr Gerd Faltings, now at Princeton University, showed that even if there are any counter-examples to it above 150,000, there are only finitely many of them. And a group of results in a different branch of mathematics, algebraic geometry, showed that if certain conjectures are true, then there are no counter-examples to Fermat's last theorem above a certain large (but unspecified) number.

Dr Miyaoka set to work on those conjectures. Notes of a talk he gave at the Max Planck Institute for Mathematics in Bonn on February 26th are now being checked by Dr Faltings, among others. Dr Miyaoka's work does not mention Fermat but it does try to prove one of the conjectures. If he is right—and has also proved that any counter-examples to Fermat's theorem would have to be below 150,000—then Fermat's game is up. If he is right and the number is, disappointingly, way above 150,000, his work will nevertheless have brought a solution closer.

The fun of all this lies in the chase. It does not matter at all whether Fermat's last theorem is true or false. But developing the tools to prove it one way or the other has given a boost to several areas of mathematics (usually indirectly). One of them is the work on prime numbers that has shaped the science of codes.

If Fermat's last theorem really has been dispatched, mathematicians will have to look elsewhere for their challenges. Not so the unorthodox, whose new "proofs" would continue to clog professors' letterboxes. Dr Miyaoka's work, and the earlier results he built on, use concepts and techniques that did not exist in Fermat's time. So if Fermat did have his own proof, it has yet to be found.

Could there be a simpler way to Fer-

mat's last theorem, using only seventeenth-century methods? Nobody can be sure. In 1978 Dr Roger Apéry at Caen University in France solved a problem in a similar field, set by Euler, which had foxed mathematicians since the eighteenth century. Dr Apéry's proof astounded his peers—not least because it used only eighteenth-century ideas.

#### Psychoactive drugs

#### Ignorance of bliss

ECSTASY poses problems. The drug rejoicing in that name, a cross between mescaline and amphetamine, has both pleasant and unpleasant effects. It seems to warrant its name, but can leave a nasty hangover and may also damage people's brains. Caution—and America's Drug Enforcement Administration (DEA)—therefore speak against it. Both may be speaking too soon.

The drug (known to pharmacologists as MDMA) was patented in 1914 by a German drug company, Merck, as an appetite suppressant. Its legal troubles began in 1984 after American students cooked it up in makeshift laboratories and found other uses for it. (In a survey last year 143 out of 369 students at Stanford University in California said they had taken the drug.) The DEA wanted to put it in the same most-restricted class of substances as heroin and LSD—schedule I. After four years of legal to-ing and fro-ing, the DEA has got its way.

The case against MDMA has two main planks. First, there have been no controlled trials to support the argument of some psychiatrists who say that it helps psychotherapy by "unblocking" inhibitions. Classifying the drug as schedule I means that there probably never will be (more on this later). Secondly, recent studies by Dr George Ricaurte and others at the Institute for Medical Research in San Jose, California, show that MDMA damages monkeys' brains. Earlier work showed much the same for rats.

Dr Ricaurte found that monkeys who took an oral dose of MDMA—corresponding to two-three times the dose taken by people—had some damage to the nerve-endings that release serotonin as a chemical messenger in the brain. About 30% less serotonin was coursing around. The damage to monkeys was still evident after two weeks, and was much worse if MDMA was injected.

The flow of serotonin plays a role in the regulation of sleep, in the perception of pain, and is partly responsible for mood. It was no surprise to discover that MDMA works by affecting it. Dr Ricaurte points out that it is not clear whether the damage is permanent. He has some preliminary results which suggest that monkeys' brains recover, at least partially. He is now studying some chemically related drugs with similar effects



Fermat's party may be over...



...poooped by Miyaoka

### SCIENCE AND TECHNOLOGY

#### on mood that may be less harmful.

One close relative of MDMA, known as Eve—MDMA is sometimes called Adam—has already been shown to be less toxic to rats than MDMA. Because of a "designer-drug" law passed in 1986, Eve is banned too. The law is designed to catch drugs whose chemical structure varies slightly from that of a banned drug but which are intended to produce the same effects.

There is no direct evidence that MDMA damages people's brains. But nobody doubts that at certain doses it does, at least temporarily. According to Dr Ricaurte, the unanswered question is: what size and frequency of dose are safe for people? So long as MDMA and its relatives remain schedule I drugs,



hard evidence of any benefits to be weighed against their risks is unlikely to emerge. Schedule III drugs—the classification MDMA briefly enjoyed—remain controlled substances, yet can be tested on people. It is practically impossible to get clinical trials authorised for a schedule I substance.

The application procedure is tortuously bureaucratic and designed to fail. Dr Albert Kurland at the Maryland Psychiatric Research Centre applied for permission to do research on LSD. Three years of paperwork later there is no end in sight. Only drug companies have the time and people to help a drug over such hurdles. But the patent on MDMA has expired, so no company will find such effort worthwhile. Whether MDMA, or—more likely—some related substance, truly deserves its popular name will remain a mystery for some time yet.

#### Environmentalism in Japan

### How the air fares

TOKYO

IN THE grimy 1970s Japanese policemen wore gas masks to protect themselves from nitrogen and carbon oxides belched out by Tokyo's endless traffic. Fish wisely avoided the Sumida river, which winds through a 300-mile corridor that turns out nearly 10% of the world's manufactured goods. Is Japan in the 1980s getting any cleaner, or any more green-minded?

Not until 1971 was an environmental agency set up, by which time it had a backlog of environmental disasters to cope with. The most infamous is Minamata Disease, a form of mercury poisoning that killed about 1,000 people and permanently injured some 2,000 others in two outbreaks. Symptoms were noticed as early as 1953. But the ministry of health and welfare refused to accept a link between the disease and waste-dumping by two chemicals companies. It took another 20 years for the victims to get proper compensation. Not until this month were the president of Chisso Corporation and his plant manager in Minamata Bay found guilty of criminal negligence.

Minamata disease is just one of several blights. Cadmium poisoning, caused by waste from a factory in Toyama, killed more than 120 people in the late 1950s; dumped arsenic trioxide made 142 people ill in 1975. Lawsuits from these cases continue. Six different Minamata cases are still struck in Japan's archaic legal system, partly because class actions do not exist in Japanese law.

Some 150,000 people are officially acknowledged to suffer from "Class I" pollution. This means that their lungs have been ruined by years of breathing the air in Tokyo, Osaka and—just of all—Kawasaki, an industrial city just outside Tokyo. They get compensation from a fund that draws 80% of its cash from factories that emit sulphur- and nitrogen-oxide.

As of this month no new victims will be allowed to register for the fund. The government claims that the 41 areas designated as "polluted" have been cleaned up in the ten years since the system was introduced. It also claims that the system was being abused. Locals disagree: a polluter priest from the city claims that 80% of Japan's prefectural and local governments oppose the central government's decision.

#### Mixed progress

Greens get nowhere in Japan. There are no national pressure groups like Greenpeace or Friends of the Earth, and no Green political party. The ruling Liberal Democratic Party has largely hijacked environmentalism for itself. In 1970 it passed no fewer than 14 environmental laws.

The most successful campaign has been against sulphur-dioxide emissions, which are mainly produced by easy-to-monitor power-plants and petrochemical works. Since 1971 the number of desulphurising units—which are fitted to chimneys to filter out sulphur oxides from the gases released when fossil fuels are burned—has shot up nearly ten-fold. The capacity of oil-desulphurising plants has trebled. And the concentration of sulphur-dioxide in the atmosphere has been cut by around two-thirds. Mr Masayoshi Takemura, who runs the parliamentary committee on the environment, thinks that although Japan lags behind other rich countries in protecting its lakes and streams, it is well ahead of the pack when it comes to the air.

Yet the campaign against nitrogen oxides (NOx)—which come from the exhaust gases of cars and lorries and from fertilisers—is less successful. Since 1973 Japan has made increasingly efficient catalytic converters compulsory for cars. As a result, cars in Japan produce on average just 8% of the NOx that they produced 15 years ago. But there are more than twice as many cars on the roads today, most of them in Tokyo. And diesel-powered lorries have cut their emissions by only about 50%.

Last year three-quarters of the road-side NOx monitors in Tokyo, Osaka and Kawasaki exceeded their target limits. The targets were sharply raised in 1978 in the forlorn hope that they would not be exceeded. In the past ten years there has been practically no improvement in the NOx figures. In 1987 they even got a bit worse. The problem with all of Japan's pollution targets is that they are merely guidelines. Last December a court ruled against plaintiffs who argued that the government's failure to cut various kinds of pollution was damaging their health. The court held that the targets have no legal standing.

Japan's lakes and rivers are still notoriously devoid of fish. Mr Takemura used to be governor of a province that fronts Lake Biwa, Japan's largest lake. Despite trying to enforce pollution standards ten times as stringent as the national ones, he has seen little improvement. Red tide—caused by the death of plankton—is now a frequent problem. It smells nasty and is bad for fish. Well under half of Japan's lakes comply with environmental standards and there has been little improvement in the past decade.

One problem that Japan does not yet have to face is acid rain. The prevailing south-westerly winds blow most pollution out into the Pacific ocean. Also, Japan's soil is slightly alkaline, which helps to counteract acidity. Even so, in the past few years there have been reports from the hills north-west of Tokyo of rain acid enough to irritate the eyes, and also of unexplained tree deaths.