MATHEMATICS

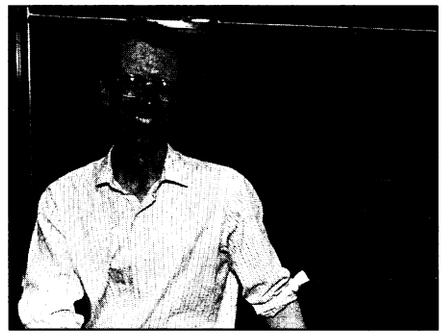
Is the Fix in on Fermat's Last Theorem?

Andrew Wiles is back for a second try at mathematics' $64,000 question: Fermat's Last Theorem. Last year, Wiles, a number theorist at Princeton University, unveiled a proof of the theorem, which has defeated mathematicians for the past 350 years, but other mathematicians quickly found a gap in his work. Now Wiles has returned with a new proof and a patch for the gap. And his colleagues are optimistic that this time around the entire proof is correct.

Wiles first unveiled his proof of the theorem, widely regarded as the most famous problem in mathematics, on 23 June 1993, at a conference at Cambridge University, where he received his Ph.D. in 1977. The theory he outlined impressed mathematicians with the wealth of new ideas it contained, especially regarding the Taniyama-Shimura conjecture, an assertion in the theory of elliptic curves that had been fingered as the key to solving Fermat's conundrum (*Science*, July 1993, p. 32). Many of his colleagues were confident that Fermat's famous statement—that the equation $x^n + y^n = z^n$ has no solutions in positive integers x, y, and z when the exponent n is greater than 2—had finally been proven true.

However, reviewers found a significant gap near the end of Wiles's proof. The problem occurred in Wiles's construction of a mathematical object known as an Euler system, which is a relatively new and largely unexplored idea. Wiles's Euler system was intended to prove a sizable chunk of the Taniyama-Shimura conjecture—enough to put a wrap on Fermat's Last Theorem—but the system he had come up with turned out not to work in quite the right way. And Wiles, at the time, was unable to fix it.

But last week, Wiles sent 20 mathematicians two manuscripts that purport to give a complete, correct proof. One, weighing in at 134 pages, details the theory he presented last year. The second, written jointly with former student Richard Taylor of Cambridge University and running just 17 pages, fills the gap in the original argument by taking a different approach to the final, crucial step. To do this, Wiles went back to an earlier, more algebraic idea which he had previously abandoned in favor of the Euler system approach.



DENISE APPLEWHITE/PRINCETON UNIVERSITY

Second time a charm? Andrew Wiles has just released a second, improved version of his proof for Fermat's Last Theorem.

Those who have seen the new material say Wiles's algebra gives a shorter, more direct proof than the unsuccessful Euler-system procedure. "It is definitely promising," says Karl Rubin, a number theorist at Ohio State University, who was also one of the reviewers of the original manuscript. "While it is wise to be cautious for a while longer, there is certainly reason for optimism."

Before last week's release, which was first reported by *The New York Times*, Wiles had both manuscripts checked over privately by several experts, who have not found any errors. Now the proofs are rapidly circulating among the larger community. "If there's a problem, we'll know it fairly soon," says Rubin. The review process should be speeded up in part because mathematicians have had a year to familiarize themselves with Wiles's basic approach, which is the content of the longer manuscript. "There's not a lot of doubt about that part," says Simon Kochen, who was chair of the Princeton math department at the time of Wiles's original announcement. "What we're really talking about is the new portion, this small paper that he's written with Taylor."

Rubin and Kochen both estimate that the initial review process should take just a few weeks, but caution that final acceptance of Wiles's proof—assuming no new gap is found—will take months longer. Nevertheless, says Kochen, "the exuberance is back."

–Barry A. Cipra

POSTGRADUATE EDUCATION

Britain Takes First Step in Ph.D. Reform

Ask anybody who has a Ph.D. from a British university to describe his or her postgraduate training, and you will probably be told it was pretty much a matter of sink or swim. Compared to U.S. and many mainland European Ph.D. students, who attend courses and receive carefully structured research training, British Ph.D. students are typically thrown into the deep end of a research project and are expected to turn in a thesis in the space of a mere 3 years.

Last year, however, the U.K. government's Office of Science and Technology (OST) declared that it was going to try to make the waters more hospitable (*Science*, 4 June 1993, p. 1419). After months of delay, OST released details of its plan last week. It has asked the U.K. research councils to award some 250 one-year grants next year for students to take a new "Master of Research" qualification, as a pilot scheme for more widespread reform. The M.Res. will provide broad training in research and related skills, such as communication and a working knowledge of intellectual property law. It is designed to prepare students for a Ph.D. or for immediate employment in industry. "Universities will welcome this," says Ted Nield, spokesperson for the Committee of Vice-Chancellors and Principals, which represents the heads of Britain's universities.

That response will come as a relief to OST: When it asked for comments on its M.Res. proposals in February, it received a lukewarm reaction. What's changed is not the basic M.Res. proposal, but the fact that OST has backed away from a controversial proposal that all students enrolling for publicly-funded Ph.D.s must first complete an M.Res. "There will be no requirement for all research students funded by the research councils to complete a master's year," science minister David Hunt told the House of Commons last week.

That's important, says Philip Wright of the Confederation of British Industry's technology group, because different employers are looking for subtly different types of postgraduate scientists: While engineering companies might be interested in taking on students direct from an M.Res., he says, biotechnology and drug firms require Ph.D.s and see little advantage in the extra M.Res. year. "There should be a variety of provisions," agrees physicist Joe Vinen of the University of Birmingham, who examined the M.Res. proposal for the Royal Society.

Nevertheless, many policy-makers argue that adding a year to postgraduate training will be a useful step toward harmonizing Britain's Ph.D. programs with those in other European countries, where students typically spend several years longer working toward their Ph.Ds. Given the increasing tendency for European postdocs to spend several years working in another country, some researchers fear that less-experienced young British scientists will find themselves at a disadvantage. "I think the new developments ... will make the British Ph.D. more competitive," says Tom Blundell, chief executive of the Biotechnology and Biological Sciences Research Council.

–Peter Aldhous