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A Very Short Proof of Fermat's Last Theorem

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Statement of the Theorem and Brief History

Fermat's Last Theorem was originally stated by the 17th century mathematician Pierre de Fermat (1601-65). In the margin of an ancient Greek text on number theory that he was studying, he wrote:

"There are no positive integers such that $x^n + y^n = z^n$ for n greater than 2. I've found a remarkable proof of this fact, but there is not enough space in the margin [of the text] to write it."

For more than 300 years, no one was able to find a proof using the mathematical tools at Fermat's disposal, or using any other, far more advanced, tools either, although the attempts produced numerous results, and at least one new branch of algebra, namely, ideal theory. Then in summer of 1993, a proof was announced by Princeton University mathematics professor Andrew Wiles. (Actually, Wiles announced a proof of a special case of the Shimura-Taniyama Conjecture — a special case that implies FLT.) Wiles' proof was more than 100 pages long and had required more than seven years of dedicated effort. A gap in the proof was discovered later that summer, but Wiles, working with Richard Taylor, was able to fill it by the end of Sept. 1994.

A Proof Using the Pythagorean Theorem

1. Any two straight lines of non-zero finite length can be the legs of a right triangle.
2. The Pythagorean theorem applies to all right triangles.
3. Let a, b be any positive integers, and k a positive integer, where $3 \leq k$.

Then $a^{k/2}$ and $b^{k/2}$ can be the legs of a right triangle. Therefore, by the Pythagorean Theo rem,

(1)

$$(a^{k/2})^2 + (b^{k/2})^2 = c^2$$

and thus

(2)

$$a^k + b^k = c^2$$

4. Assume a counterexample $x^p + y^p = z^p$ to Fermat's Last Theorem exists, where $(x, y) = (x, z) = (y, z) = 1$ and p is the smallest such prime p. (Prior to the proof of FLT in the early 1990s, it was known that p would have to be greater than 4,000,000.)

5. Then we can write

$$(x^{(p/2)})^2 + (y^{(p/2)})^2 = c^2, \text{ i.e.,}$$

(3)

$$x^p + y^p = c^2.$$

6. So z^p must equal c^2. We know that c^2 is a positive integer because it is the sum of the positive integers x^p and y^p. It can't be a prime because z^p is not a prime. So, it must be a composite.

There are now two possibilities:

(1) $c^2 = (z^{(p/2)})^2 = (z^{(p/2)})(z^{(p/2)})$. But this is false because $(z^{(p/2)})^2$ is not a product of primes, as required by a composite integer.

(2) $c^2 = (n)(n)$, where n is a positive integer. But this too is false because z^p is not a square of an integer.

So z^p does not equal c^2, and our assumed counterexample to FLT is false. Hence FLT is true.

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