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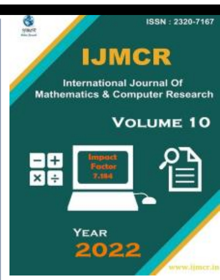

An Important Conclusion for Fermat's Last Theorem

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ARTICLE INFO	ABSTRACT
Published Online: 02 August 2022 Corresponding Author: **Alkis Mazaris**	Fermat's Last Theorem is perhaps the only most famous mathematical problem of all times. Although finally proved, but the Theorem never stopped being a challenge mainly because the first proof didn't used mathematics known in Fermat's era. In the present work we arrive at a very important conclusion for the Theorem. If this conclusion is taken into account, the formulation of the Theorem should be different.

KEYWORDS: Fermat, Fermat's Last Theorem, diophantine's equations

INTRODUCTION

Studying the Theorem using only mathematics that was known at the time of Fermat, we reached a very important conclusion:

The wording of the theorem should be different. The work employs the wellknown technique of the proof by contradiction and is structured in 2 parts, leading to the final result.

We accept that $a^v + b^v = c^v$ holds and in first part we arrive in a conclusion using the idea of the definition of the zero-sequence of numbers. In the second part using the result of part 1 in $\left(\frac{a}{c}\right)^v + \left(\frac{b}{c}\right)^v = 1$ formula that is equivalent to $a^v + b^v = c^v$ if c is not zero, we arrive at a contradiction.

A NOVEL APPROACH USING CLASSIC METHOD

Fermat's last theorem states that:

If a, b, c is non-zero natural number, there is no natural number $v > 2$ such that $a^v + b^v = c^v$.

We will assume that there are a, b, c, non-zero natural numbers such that:

$$a^v + b^v = c^v \qquad (1)$$

Also let's assume that

$$a \geq b \qquad (2)$$

It is very easy to prove that: $c > a \geq$ (Appendix A)

Dividing all members of the relation (1) by c^v we will have:

$$\left(\frac{a}{c}\right)^v + \left(\frac{b}{c}\right)^v = 1 \qquad (3)$$

Part 1

Let us now consider the sequence of numbers $d_n = \left(\frac{a}{c}\right)^n$ like this:

a, c constant non-zero natural numbers $c > a$ and n is any non-zero natural number. It is very easy to prove that; this sequence is a zero-sequence of numbers (Appendix B). By the definition of the zero-sequence (Appendix C) it holds that: for every $\varepsilon > 0$ there is $n_0 \in N^*$:

For every $n > n_0$ holds: $\left(\frac{a}{c}\right)^n < \varepsilon$

So, for $\varepsilon = \frac{1}{2}$ there is $n_0 \in N^*$ (we will calculate n_0):

For every $n > n_0$ holds:

$$\left(\frac{a}{c}\right)^v < \frac{1}{2} \qquad (4)$$

Calculation of n_0

$$\left(\frac{a}{c}\right)^v < \frac{1}{2}$$

$$\ln\left(\frac{a}{c}\right)^v < \ln\frac{1}{2}$$

$$n \ln\frac{a}{c} < \ln\frac{1}{2}$$

$$n > \frac{\ln\frac{1}{2}}{\ln\frac{a}{c}} \qquad \left(\frac{a}{c} < 1\right)$$

Finally: $$n > \frac{\ln 2}{\ln\frac{c}{a}} \qquad (5)$$

So: $n_0 = \left[\frac{\ln 2}{\ln\frac{c}{a}}\right]$ (integral or integer part of $\frac{\ln 2}{\ln\frac{c}{a}}$)

We reached to the following:

CONCLUSION A: When $n > n_0 = \left[\frac{\ln 2}{\ln\frac{c}{a}}\right]$ then

$$\left(\frac{a}{c}\right)^n < \frac{1}{2}, \quad c > a$$

Part 2

Now let's get back to the relation (3)

$$\left(\frac{a}{c}\right)^v + \left(\frac{b}{c}\right)^v = 1$$

We study the quantity $\left(\frac{a}{c}\right)^v, c > a, \quad c, a, v \epsilon N^*$

According to CONCLUSION A:

When $v > v_0 = \left[\frac{\ln 2}{\ln\frac{c}{a}}\right]$ then $\left(\frac{a}{c}\right)^v < \frac{1}{2}$, $c > a$

In this case, because $\left(\frac{a}{c}\right)^v > \left(\frac{b}{c}\right)^v$ (it holds $a \geq b$)

We will have: $\left(\frac{a}{c}\right)^v + \left(\frac{b}{c}\right)^v < \frac{1}{2} + \frac{1}{2} = 1$

It means finally: $\left(\frac{a}{c}\right)^v + \left(\frac{b}{c}\right)^v < 1$ it is contradiction

Because we have accepted that

$$\left(\frac{a}{c}\right)^v + \left(\frac{b}{c}\right)^v = 1$$

Therefore the relation $\left(\frac{a}{c}\right)^v + \left(\frac{b}{c}\right)^v = 1$ to be valid, it must be $v \leq n_0 = \left[\frac{\ln 2}{\ln\frac{c}{a}}\right]$

(integral or integer part of a number).

But the relations:

$\left(\frac{a}{c}\right)^v + \left(\frac{b}{c}\right)^v = 1$ and $a^v + b^v = c^v$ are equivalent because $c \neq 0$, so we reached to CONCLUSION B.

CONCLUSION B:

The relation $a^v + b^v = c^v$ it could be right only if $v \leq n_0 = \left[\frac{\ln 2}{\ln\frac{c}{a}}\right]$ (integral or integer part)

RESULTS

In Part 1 we reached the CONCLUSION A

In Part 2 we used CONCLUSION A in the relation $\left(\frac{a}{c}\right)^v + \left(\frac{b}{c}\right)^v = 1$ to reach CONCLUSION B

DISCUSSION and CONCLUSION

1. According to CONCLUSION B the formulation of FLT should have been: if a, b, c are non-zero natural numbers, there is no natural number $v > 2$, $v \leq \left[\frac{\ln 2}{\ln\frac{c}{a}}\right]$ such that: $a^v + b^v = c^v$

It is a very important conclusion

Suppose looking for number v such that: $4^v + 5^v = 6^v$, $v > 2$ We can looking for only v such that:

$$v \leq \left[\frac{\ln 2}{\ln\frac{6}{5}}\right] = \left[\frac{\ln 2}{\ln 1{,}2}\right] = [3{,}8017 \ldots] = 3$$

and not for any natural number v.

2. Pythagorean theorem:

Ex. $3^2 + 4^2 = 5^2$

It must be $2 \leq \left[\frac{\ln 2}{\ln\frac{5}{4}}\right] = \left[\frac{\ln 2}{\ln 1{,}25}\right] = [3{,}1062 \ldots] = 3$ whichever applies

3. Simple addition of natural numbers:

Ex. $4^1 + 2^1 = 6^1$

It must be $1 \leq \left[\frac{\ln 2}{\ln\frac{6}{4}}\right] = \left[\frac{\ln 2}{\ln 1{,}5}\right] = [1{,}7095 \ldots] = 1$

whichever applies

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Conflict of interest

The author declares that there is no conflict of interest

APPENDIX A

If it holds $^v + b^v = c^v$, $a, b, c, v \in N^*$ and $a \geq b$ then $c > a \geq b$ Proof:

The minimum price for $b = 1$ So: $a^v + 1^v = c^v$

$a^v + 1 = c^v$

It means that $c^v > a^v$

So: $c > a$

And $c > a \geq b$

APPENDIX B

Because of Appendix A, $c > a$. Consider ε to be an arbitrary small number such that $\left(\frac{a}{c}\right)^v < \varepsilon$.

Then $\ln\left(\frac{a}{c}\right)^v < \ln\varepsilon$ and finally $v > \frac{\ln\varepsilon}{\ln\frac{a}{c}}$, $(c > a)$

If k_1 is the lower-value natural number that satisfy:

$k_1 > \frac{\ln\varepsilon}{\ln\frac{a}{c}}$ then for every natural number $v > k_1$ it holds $\left(\frac{a}{c}\right)^v < \varepsilon$

APPENDIX C

Definition: Let's assume a sequence of number like this:

$$d_n = \left(\frac{a}{c}\right)^n, c > a, \ c, a \in N^*$$

$n \in N^*$ any non-zero natural number the d_n sequence is a zero-sequence of numbers when for every $\varepsilon > 0$ there is natural number n_0 non zero:

$|d_n| < \varepsilon$ for every natural non-zero n: ($|d_n|$: absolute value of modulus)

$n > n_0$

when the number of sequence are positive number $|d_n| = d_n$.

This happened in case we study.

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