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RESEARCH ARTICLE

SOURCE AND PROOF OF FERMAT'S LAST THEOREM

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ABSTRACT

This Paper provides a solution to Fermat's Last theorem alongwith the source from which the said Theorem gets derived.

INTRODUCTION

The paper presents unique proof and source of more than 350 year old well known problem conjectured by Pierre de Fermat. The purpose of this Paper is to provide source and solution to Fermat's Last theorem in simple manner.

Fermat's Last theorem and its Source and Proof

Introduction to Fermat's Last Theorem-

The Fermat's Last theorem is submitted as hereunder:-

To Prove-

$a^n + b^n = c^n$ is not true for n>2 where a,b,c are non-zero positive integers ……………………(1)

Proof:

The following proof validates the given Fermat Theorem given as above -

Let x, y and z be three non-zero integers such that z>x>y.

Let there be three derived integers- z^n , $(x+y)^n$ and $(x-y)^n$ such that

z^n is an integer that is equidistant from both the abovesaid integers ie. $(x+y)^n$ and $(x-y)^n$ on the positive number line. Thus z^n lies exactly in the middle of the two integers ie. $(x+y)^n$ and $(x-y)^n$ on the abovesaid number line.

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Mathematically it means –

$z^n – (x-y)^n = (x+y)^n - z^n$ ……………..……….. (2)

On solving the above equation, we get –

$2z^n = (x+y)^n + (x-y)^n$ ……...……………..(3)

The abovesaid equation (3) is the basic equation from which the Fermat's theorem is derived and can be proved..

CASE A:

In the above equation (3) , putting n = 2, we get-

$2z^2 = (x+y)^2 + (x-y)^2$ ……………………………(4)

$= x^2 + 2xy + y^2 + x^2 – 2xy + y^2$ ……………..……(5)

Thus, we get

$2z^2 = 2x^2 + 2y^2$
i.e. $z^2 = x^2 + y^2$
i.e. $x^2 + y^2 = z^2$ ……….………………………(6)

The abovesaid equation (6) is evolved only when equation (4) is satisfied. Thus there may exist three integers such that they satisfy the relation as depicted in Equation (6).

By substituting z = c, x = a and y=b in equation (6) we get

$a^2 + b^2 = c^2$ ……………………………….(7)

CASE B: Let us evaluate Equation (3) when n = even number > 2 and submitted as under-

$$2z^n = (x+y)^n + (x-y)^n \quad \ldots\ldots\ldots\ldots\ldots\ldots..(3)$$

For all n>2 and n = even number, above equation (3) is expanded using Binomial

Expansion [1] and thereafter simplified as hereunder:

$$2z^n = (x^n + {}^nC_1x^{n-1}y + {}^nC_2x^{n-2}y^2 + \ldots + {}^nC_{n-2}x^2y^{n-2} + {}^nC_{n-1}xy^{n-1} + y^n) + (x^n - {}^nC_1x^{n-1}y + {}^nC_2x^{n-2}y^2 - \ldots\ldots + {}^nC_{n-2}x^2y^{n-2} - {}^nC_{n-1}xy^{n-1} + y^n)$$
$$= (2x^n + 2\,{}^nC_2x^{n-2}y^2 + \ldots\ldots\ldots\ldots + 2\,{}^nC_{n-2}x^2y^{n-2} + 2y^n) \quad \ldots\ldots\ldots\ldots(8)$$

Thus, on dividing above equation by both sides by 2 we get,

$$z^n = x^n + y^n + {}^nC_2x^{n-2}y^2 + \ldots\ldots\ldots\ldots + {}^nC_{n-2}x^2y^{n-2} \quad \ldots...(9)$$

Putting $k = {}^nC_2x^{n-2}y^2 + \ldots\ldots\ldots\ldots + {}^nC_{n-2}x^2y^{n-2}$ in above equation, we have—

$$z^n = x^n + y^n + k \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(10)$$

It may be noted that k>0 as x>y >0 and all its terms are positive.

CASE C:

Let us evaluate Equation (2) when n= odd number as under-

$$2z^n = (x+y)^n + (x-y)^n \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(3)$$

For all n>2 and n = odd, the above equation (3) is expanded by using Binomial

Expansion [1] and simplified thereafter as under:

$$2z^n = (x^n + {}^nC_1x^{n-1}y + {}^nC_2x^{n-2}y^2 + \ldots + {}^nC_{n-2}x^2y^{n-2} + {}^nC_{n-1}xy^{n-1} + y^n) + (x^n - {}^nC_1x^{n-1}y + {}^nC_2x^{n-2}y^2 - \ldots\ldots - {}^nC_{n-2}x^2y^{n-2} + {}^nC_{n-1}xy^{n-1} - y^n)$$
$$= (2x^n + 2\,{}^nC_2x^{n-2}y^2 + \ldots\ldots\ldots\ldots + 2\,{}^nC_{n-1}xy^{n-1}) \quad \ldots\ldots\ldots\ldots(11)$$

Thus on dividing both sides of above equation (11) by 2 we get-

$$z^n = x^n + ({}^nC_2x^{n-2}y^2 + \ldots\ldots\ldots\ldots + {}^nC_{n-1}xy^{n-1}) \quad \ldots\ldots\ldots\ldots(12)$$

By adding and subtracting y^n on R.H.S. of above equation , we get

$$z^n = x^n + y^n + {}^nC_2x^{n-2}y^2 + \ldots\ldots\ldots\ldots + {}^nC_{n-1}xy^{n-1} - y^n \quad \ldots\ldots.(13)$$

Putting $p = {}^nC_2x^{n-2}y^2 + \ldots\ldots\ldots\ldots + {}^nC_{n-1}xy^{n-1} - y^n$ in above equation we get—

$$z^n = x^n + y^n + p \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(14)$$

It may be noted that each term of p being greater than y^n as x>y , p> 0;

Conclusion of Proof

The abovesaid equation (10) in CASE B and Equation (14) in CASE C are only evolved when Equation (3) is satisfied. Thus there exists three integers such that they satisfy the relation as depicted in Equation (10) and Equation (14).

Now by putting z=c, x=a and y = b in above equations (10) and (14), we have-

$$c^n = a^n + b^n + k \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(15)$$

$$c^n = a^n + b^n + p \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(16)$$

or

$$a^n + b^n + k = c^n \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(17)$$

$$a^n + b^n + p = c^n \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(18)$$

Both the above equations can be jointly written as-

$a^n + b^n < c^n$ since k>0 and p>0;

Thus $(a^n + b^n)$ is not equal to c^n for all n>2;

Thus the Fermat's Last Theorem that $a^n + b^n = c^n$ is not true for n>2 where a,b,c are non- zero Positive Integers, is proved .

Conclusion

The Fermat's Last theorem, well-known centuries old problem, known to student community, Scientists, Mathematicians and others, has its source in basic Equation (3) which is - $2z^n = (x+y)^n + (x-y)^n$ and proved as hereinabove submitted.

REFERENCES

The Binomial Expansion Formula is sourced from Second Edition of Book named as "A NEW INTERMEDIATE ALGEBRA" by B.R.Gangwar and R.C.Gaur published in the Year 1957.

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