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RESEARCH ARTICLE

Solution of Beal's Conjecture in the Paradigm of Quantum Mathematics

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ABSTRACT

The article gives a tight review of the author's work dedicated to a new trend in modern mathematics called quantum computing mathematics. Quantum computing methods are interpreted extendedly as relating to quantum mathematical information (quantum mathematics). Mathematical information quanta are whole numbers (integers) characterizing principal integrity of relevant mathematical objects. This approach was applied to solving Beal's conjecture (generalized Fermat's last theorem) that allowed not only to prove the famous problem but unmask excessive formalism of traditional quantum theories. It was revealed also that Fermat's method of infinite descent was, in fact, the first case of exact application of quantum ideology in pure mathematics.

Key words: Arithmetic geometry, Beal's conjecture, Fermat's last theorem, Partitions, Quantum mathematics

INTRODUCTION

Beal's conjecture[1] deals with arbitrary positive whole powers of natural numbers except the second combined in one equation similar to the well-known equation of Fermat's last theorem. Among all well-known mathematics conjectures, Beal's conjecture is occupying a peculiar place being a formal generalization of Fermat's last theorem; the Beal proposition can be solved by the ancient Greek arithmetic geometry methods applied successfully as well to the Fermat problem and expanded with Fermat's method of infinite descent. Pierre de Fermat formulated his proposition on the margin of Diophantus's Arithmetic (near the task 8 of the book II). The eighth problem of the second book asks to separate a square into two squares in whole numbers. It was known long ago that this problem has an infinite set of solutions. However, Fermat generalized the task in case of any whole power above the second and pointed out at impossibility of such partition in whole numbers claiming here that he found a "miraculous" proof of this proposition.

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To reconstruct Fermat's proof, it is necessary to understand what Fermat meant by his recording on the margins of Diophantus's book. Hence, at the very beginning, it is a question of fundamental approach to this problem-solving by Fermat. Psychologically, we can assume that Fermat applied a phenomenological approach when each power of natural numbers was considered as an amount of indivisible multidimensional unit cubes in multidimensional arithmetic space. Thus, the task was analogous to the ancient receipt of alchemy: First, resolve the power into elementary units and then put them together in a required manner. "Pure" mathematical unit can be chosen as such elementary unit.

How could Fermat solve this unique problem straight off and without a shadow of doubt? The sole reason for it is that he saw the mental picture of his proof. Such a picture emerged in his consciousness during his insight allowing him to investigate instantly all necessary details of solution.[2] Visual image of the problem must have had a geometrical form, which apparently could not take its place on narrow margins. This geometric pattern serves as general illustration for Euclid's theorem about proportional means, from which formulation of Pythagorean theorem and Fermat's proposition (called Fermat's last

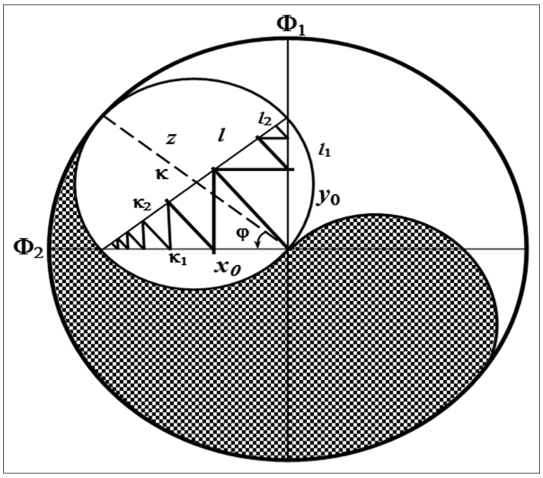

Figure 1: The image of Beal's conjecture mathematical quantum (the designations are explained in the text)

theorem later on) could be easily derived. Figure 1 taken from[2] shows stylized design of Euclid's geometrical theorem on the fractal surface of similar right angle triangles at an instantaneous position of the small diameter of Figure 1 shifting from state Φ1 to state Φ2 .

Mental perception of n-th degrees of whole powers can be related to Cartesian product of whole numbers from n-dimensional arithmetic space, and then, each n-th power could be represented as a collection of n-dimensional unit cubes transferred from the state Φ_1 to the state Φ_2 one by one on the diagram of Figure 1. This procedure serves as well for finding Pythagorean triples by the method of sorting square units one by one in Pythagorean equation. This method can be applied also to the equation of generalized Fermat's last theorem to show that splitting of n-th power of whole numbers into two other powers with $n>2$ is impossible. As it will be seen further, the bases of whole powers in Beal's conjecture can consist only of Pythagorean triples in the form of Pythagorean partitions to satisfy quantum splitting of whole powers into other ones.

Solution of Beal's conjecture and Fermat's last theorem

Let us write hypothetical Beal's conjecture equality in the following way:

$$z^n=x^n+y^n \tag{1}$$

With positive integers x, y, z having a common factor and exponent n taking simultaneously the next spectrum of values: $n=(p, q, m)$, where integers p, q, m at least 3 and n has one independent value for each term. Hence, we suppose at the beginning that equality (1) exists and partitions of the type (1) can be obtained. This method of proving is related to plausible reasoning and called the rule of contraries.

Consider equality (1) as a partition of whole number z^n into two non-zero whole parts x^n and y^n consisting of whole numbers. The bases of whole powers can also be splitted only into whole parts; otherwise, equality (1) cannot exist by construction in quantum paradigm.

(1) resembles Pythagorean equation in real numbers, if we could bring powers in (1) to the degree 2 with whole parts in the similar partition: $z^2=x^n/z^{n-2}+y^n/z^{n-2}$. To produce such scaling, the notion of right-angled numbers was introduced (these numbers are different from so-called right angle triangle numbers representing Pythagorean triples).

Definition: Right-angled number is such a non-negative real number, the square of which is a whole non-negative number.

The set of right-angled numbers P={0, 1, √2, √3, 2, √5,…} is countable. The system of right-angled numbers P=⟨P, +, 0, 1⟩ is defined by operations of addition and multiplication and two singled out elements (zero and unit). The system P is non-closed in relation to addition. Notice that the set of non-negative whole numbers is a subset of the set of right-angled numbers. Then, consider (1) on the two-dimensional lattice of right-angled numbers with coordinates x_o, y_o, and that which we call the norms of a right-angled number z assigned to different pairs (x_o, y_o) and differing from each other by the value of its summands: $z^2=x_o{}^2+y_o{}^2$. The norm of non-zero right-angled numbers is always whole and cannot be <1.

For the purpose of reducing (1) to the view of Pythagorean equation in the system of right-angled numbers, one can rewrite (1) as an equality for some coprime x', y', z', and common whole factor $d:(x'd)^p+(y'd)^q=(z'd)^m$ and fulfill scaling down:

$$(z'd)^2=(x'd)^p/(z'd)^{m-2}+(y'd)^q/(z'd)^{m-2}$$

$$=(x')^p d^{p-m+2}/(z')^{m-2}+$$

$$(y')^q d^{q-m+2}/(z')^{m-2}=x_o{}^2+y_o{}^2$$

(Where, $x_o{}^2$ and $y_o{}^2$ with appropriate d are squares of some right-angled numbers x_o and y_o.

It assumes the following view of (1) after fulfilling scaling up:

$$z^m=x^p+y^q=z^{m-2}\left(x_o{}^2+y_o{}^2\right) \tag{2}$$

Let us apply now the ancient method of making powers using Euclid's geometrical theorem and produce two chains of proportions connected with each other with some equality presenting integer z as a sum of two whole numbers:

$$z/x_o=x_o/k=k/k_1=\ldots=k_{m-3}/k_{m-2} \quad (3)$$
$$z/y_o=y_o/l=l/l_1=\ldots=l_{m-3/}l_{m-2}$$

Where, z, x_o, and y_o are right-angled numbers from (2), m natural index at least 3, and $z=k+l$; k and l are some whole parts of z taken from the method of scaling down.

From proportions (2) one can obtain the next formulae:

$$x_o^{\,2}=kz=(k_1z/x_o)z,\quad x_o^{\,3}=k_1z^2=(k_2z/x_o)z^2,\ldots,\quad x_o^{\,m}=k_{m-2}z^{m-1}, \quad (4)$$
$$y_o^{\,2}=lz=(l_1z/y_o)z,\ y_o^{\,3}=l_1z^2=(l_2z/y_o)z^2,\ldots,\ y_o^{\,m}=l_{m-2}z^{m-1}$$

Where, integers k and l are found from the basic equality (1):

$z=(z'd)=(x'd)^p/(z'd)^{m-1}+(y'd)^q/(z'd)^{m-1}=(x')^pd^{p-m+1}/(z')^{m-1}+(y')^qd^{q-m+1}/(z')^{m-1}=k+l$

If exponents p and q more or equal m, then numbers k and l are whole with $d=(z')^{m-1}$ as a minimum (d can be some whole number divisible by this minimum).

From (2) and (4) we get equal similar partitions of z^n into two whole parts:

$$z^m=x^p+y^q=z^{m-2}(x_o^{\,2}+y_o^{\,2})=x^m+y^m, \quad (5)$$

Hence, $x^p=(x^{p/m})^m=x^m$, $y^q=(y^{q/m})^m=y^m$ with whole x, y by construction (for simplicity we do not change here the designations for x, y although exponents p and q can differ from m; moreover, irrational numbers $x^{p/m}$ and $y^{q/m}$ do not fit in Procrustean bed of quantum paradigm). Square roots of x^m, y^m are proportional means between $x_o^{\,2}$ and z^{m-2}, $y_o^{\,2}$ and z^{m-2} describing a bigger right angle triangle defined by the hidden Pythagorean equality $z^m=x^m+y^m$ found from the relations: $x^m=kz^{m-1}$, $y^m=lz^{m-1}$. This implicit triangle is similar to that with sides z, x_o, y_o represented by equality $z^2=x_o^{\,2}+y_o^{\,2}$.

Hence, (1) comes to the Fermat equality (Pythagorean equality in right-angled numbers) that is equivalent to hypothetical phenomenological equality (1);

$$z^m=x^m+y^m,\ m\geq 3 \quad (6)$$

With whole $x=x'd$, $y=y'd$, $z=z'd$, and some whole factor d that can be expanded into the product of prime factors. One can now prove Fermat's last theorem using the same methods as above to obtain solution of the Beal conjecture in full and one measure.

Let us write Fermat's last theorem in its usual form of hypothetical equation:

$$z^n=x^n+y^n,\ n>2,\ x, y, z \text{ integers.} \quad (7)$$

Suppose that one solution at least was found. Then, we shall try to construct such a solution and make certain of its impossibility. We shall work in the system of right-angled numbers.

To get powers of whole numbers presented in (7), let us produce two chains of continued proportions connected with each other by the norm $z^2=x_0^{\,2}+y_0^{\,2}$:

$$z/x_0=x_0/k=k/k_1=\ldots=k_{n-3/}k_{n-2}$$
$$z/y_0=y_0/l=l/l_1=\ldots=l_{n-3}/l_{n-2} \quad (8)$$

where, natural indices of the last terms of each chain in (8) are obtained from $n>2$. Continued proportions (8) yield the following formulae:

$$kz=x_0^{\,2},\ k_1z=x_0k,\ k_2z=x_0k_1,\ldots,\ k_{n-2}z=x_0k_{n-3} \quad (9)$$
$$lz=y_0^{\,2}, l_1z=y_0l, l_2z=y_0l_1,\ldots,\ l_{n-2}z=y_0l_{n-3}$$
$$x_0^{\,2}=kz=(k_1z/x_0)z,\ x_0^{\,3}=k_1z^2=(k_2z/x_0)z^2,\ldots,\ x_0^{\,n}=k_{n-2}z^n \quad (10)$$
$$y_0^{\,2}=lz=(l_1z/y_0)z,\ y_0^{\,3}=l_1z^2=(l_2z/y_0)z^2,\ldots,\ y_0^{\,n}=l_{n-2}z^{n-1}$$

It is necessary to fix now the norm for the partition z^n into two like powers in (7). As in the case of Beal's conjecture, let us assume that z, x, and y in presupposed equality (7) have a common factor d:

$z=(z'd)$, $x=(x'd)$, and $y=(y'd)$, where z', x', and y' coprime. Thereupon divide equality (7) by z^{n-1} and get: $z=(z'd)=(x'd)^n/(z'd)^{n-1}+(y'd)^n/(z'd)^{n-1}=k+l$, where k and l integers with $d=(z')^{n-1}$ as a minimum. From this and (9)-(10), it follows that $z^2=x_0^{\,2}+y_0^{\,2}$ and $z^n=z^{n-2}\,(x_0^{\,2}+y_0^{\,2})$ are a scaled-up modification of the norm $z^2=x_0^{\,2}+y_0^{\,2}$.

Further, one can obtain a singular partition of z^n into three terms from (10) for the given norm when $n>2$:

$$z^n=x_0^{\,n}+y_0^{\,n}+\lambda_n \quad (11)$$

Where, $\lambda_n=z^{n-1}[(k-k_{n-2})+(l-l_{n-2})]$ is a remainder after subtracting $x_0^{\,n}$ and $y_0^{\,n}$ out of z^n such that $\lambda_n>0$ when $n>2$ and $x_0y_0\neq 0$, $\lambda_n=0$ when $n=2$ and $x_0 y_0\neq 0$, $x_0, y_0, \in[0, z]$, $z\in(0, \infty)$.

Thus, there exists one-to-one correspondence between each pair of numbers (x_0, y_0) with norm $z^2=x_0^{\,2}+y_0^{\,2}$ from two-dimensional arithmetic space and each corresponding partition of any whole power with $n>2$ of integer z from n-dimensional arithmetic space into the sum of the same powers of numbers x_0, y_0, and remainder λ_n from (11). Isomorphism (one-to-one correspondence) between the set of points of two-dimensional Euclidean space with position vector length z and coordinates x_0, y_0, the set of partitions of z^2 into squares, and the sets of partitions (11) for any whole $n>2$ can be written as follows:

$$\{z \Rightarrow (xo,\ yo)\} \ \leftrightarrow \ \left\{z^2 = x_0{}^2 + y_0{}^2\right\} \ \leftrightarrow$$
$$\left\{z^n = x_0{}^n + y_0{}^n + \lambda_n\right\}$$

Where sets of partitions are generated by the next power similarities:

$$z \leftrightarrow z^2 \leftrightarrow z^n,\ x_0 \leftrightarrow x_0^2 \leftrightarrow x_0^n,\ y_0 \leftrightarrow y_0^2 \leftrightarrow y_0^n$$

Partitions (11) can be reduced to the norm, from which they were obtained:

$$z^n = x_0{}^n + y_0{}^n + \lambda_n = z^{n-2}\left(x_0{}^2 + y_0{}^2\right) = x^n + y^n \quad (12)$$

Formula (12) represents by itself a combinatorial equality of two partitions in three and two terms because of the one-to-one correspondence between pairs (x_0, y_0) and presupposed partition (7). It means that partition (11) coincides with partition (7) if the latter exists. In the case of right-angled numbers, this equality is realized only if x_0, y_0 integers. Algorithm of such correspondence is given in the next formula (13). Thus, scaling invariance of the norm $z^2 = (x_0{}^2 + y_0{}^2)$ leads to the following equalities of different fragments of partitions (12):

$$x_0{}^n + y_0{}^n = \left(x^n or\ y^n\right) \quad (13)$$

and correspondingly λ_n=(y^n or x^n). It can be noticed that $x_0{}^n \neq z^{n-2}\, y_0{}^2 = y^n$ and $y_0{}^n \neq z^{n-2}\, x_0{}^2 = x^n$ because of the lack of coincidence of decompositions in factorization of numbers $x_0{}^n$ and y^n, $y_0{}^n$ and x^n. Obviously, $x_0{}^n \neq z^{n-2}\, x_0{}^2$ and $y_0{}^n \neq z^{n-2}\, y_0{}^2$. One can show also that x_0 and y_0 cannot be irrational in (13) on account of integer partition of z^n into x^n and y^n when $n>2$.[2]

Let us come back to the assumption at the beginning of the proof that integer solution (7) exists. This assumption is substantiated only if there is a concrete solution (13) in whole numbers. To check the validity of (13), it is necessary to construct it with the same reasoning as before since equations (7) and (13) are identical by their properties. This procedure can be continued to infinity in the direction of decreasing whole numbers under condition that sequence of different chained equalities never stops and numbers $x_0{}^2$ and $y_0{}^2$ in (12) will be always whole. If it is not so, i.e., $x_0{}^2$ and $y_0{}^2$ in chained equalities (13) turn out to be fractions, then this means that solution (7) does not exist in the system of right-angled numbers (the base z can be split only into whole numbers by assumption). On the other hand, infinite sequence of chained equalities (13) leads to infinite decreasing of positive whole numbers that are impossible and, therefore, assuming that there exists an integer solution of (7) when $n>2$ is not true. Thus, the theorem is proved both for all even and for all odd degrees of whole numbers and for any finite whole *x, y, z, and d*.

CONCLUSION

Beal's conjecture solution contains in itself the description of a new hypothetical mathematical object with simple properties conditioned only by its intrinsic structure. This mathematical object represents by itself a quantum of mathematical information displayed in Figure 1 and pictured as dichotomic vector having two independent states Φ_1 and Φ_2 in two-dimensional information space. Being applied to Beal's conjecture, these states can be written as follows: Φ_1=|0+z^n>, Φ_2=|x^n+y^n>, The dichotomic vector symbolized by a small diameter turns as if inside out in one-dimensional space of human visual perception, but, in fact, it carries out two independent rotations in two-dimensional information space of human mental perception preserving its orientation in the range of values from 0 to 1.

Conception of quantum information can be related not only to specific mathematical objects but also to the content of other sciences using mathematical items and methods in research of their specific quantum objects and their transfer. Thus, quantum mathematics unites all other relevant sciences (quantum physics, quantum chemistry, quantum biology, quantum psychology, etc.) from the point of view of unified quantum information space. The doubling of dimension of quantum information transfers opens the way to discover new possibilities of motion and transformation in inner quantum space resulting also in outer space of perception and producing such unusual effects as levitation, teleportation, and other superphenomena. Perhaps, superprecise technologies of the ancients were based on technical application of quantum information principles being the main secret of highly developed lost civilizations.

This review of quantum solution of Beal's conjecture rests also on the author's previous works having done essential contribution to this problem-solving.[3-7]

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