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YET ANOTHER PROOF FOR BAUDHAYANA THEOREM (PYTHAGOREAN THEOREM) OR THE DIAGONAL LENGTH IN TERMS OF PI

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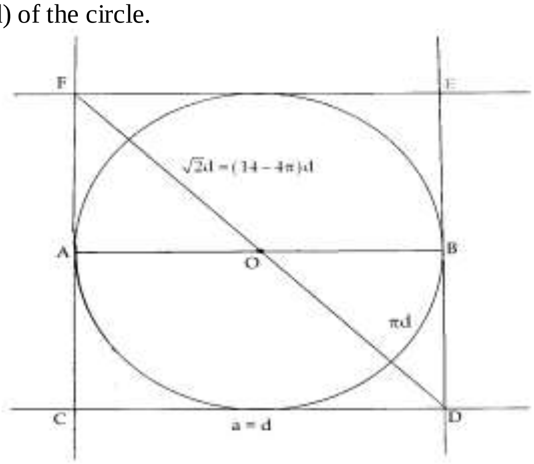
ABSTRACT
There are around 370 proofs for the Pythagorean theorem. In this paper Pi of the circle demarcates a length equal to the diagonal of its superscribed square and gives value in terms of the real Pi. It is also one more proof to identify the real Pi value.

KEYWORDS: Circle, circumference, diameter, diagonal, Pi constant, side, square;.

INTRODUCTION
Pythagorean theorem is 2500 years old. However, on survey of the literature it is found authoritatively that this concept is **much older** and was referred in ancient Indian literature. The current thinking in the mathematical circles is that the square, square root two etc. are **unrelated to the circle** and its π number. In this work, the length of the diagonal of square is derived from the inscribed circle's circumference. It is **revolutionary in its nature** and any concept which is very radical from the accepted norms will **invite vehement opposition.** This paper in its manuscript form when it was sent to the honourable Professors for comments, it was said that it is lacking in proof. This author humbly submits, the opinion of one author from Madras University, India, the role of intuition, in the mathematical world.

"Ramanujan had no formal education in Mathematics. He left his proofs lacking rigour. But pioneers and path-finders, exploring boldly new terrains of mathematical thought, permit themselves a freedom in their attack on a mathematical problem. Their intuition often provides them with an innate feeling for what is correct and what is not" (Page No-192).
*- **T.S. Bhanu Murthy**, A Modern Introduction to Ancient Indian Mathematics, 2nd Edn. New Age International Publishers, 2009, New Delhi.*

Procedure:
Draw a circle with diameter d. Four equidistant tangents on the circle result in the creation of a square and it's two diagonals. The length of the diagonal is easy to find out. In this construction the diagonal length can **also** be obtained in terms of the circumference (πd) of the circle.



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Centre = O
Diameter = AB = d = a
Square = CDEF
Side = CD = a = d
Diagonal DF = $\sqrt{2}$ d = $\sqrt{2}$ a
Diagonal = Known value = $\sqrt{2}$ d = $\sqrt{2}$ a

Proposed value in terms of π = (14 – 4π)d

When (14 – 4π)d = $\sqrt{2}$ d

then $$\pi = \frac{14-\sqrt{2}}{4}$$

The sum of the 4 lengths of the inscribed circle's circumferences (4πd), when deducted from the sum of the lengths of 14 sides of its circumscribed square, the length which remains after deduction, is equal to, the diagonal of that square.

14 sides (14 a = 14d) – 4πd = Diagonal $\left(\sqrt{2}\text{d} = \sqrt{2}\text{a}\right)$

The circumference, thus, demarcates a **diagonal length** on the sides of its circumscribed square. This concept can either be taken as yet another proof for Pythagorean theorem or an alternative to Pythagorean theorem and also a proof for the **exactness** of the length of the circumference of its inscribed circle (πd).

The square is created here as 4 equidistant tangents of the circle. It is another evidence that $\sqrt{2}$ is also created by the circle along with the square. In other words, $\sqrt{2}$ **is a hidden component of the circle.** God has been very kind this afternoon of 03.12.2015, though this author has been seeing the above diagram from March 1998, thousands of times, but never even dreamt of this idea. Kindly share this mathematical truth and **thank God,** please !

Post script

The author of Pythagorean theorem was Pythagoras who was born in Samos around 572 B.C. There is one **recorded** evidence that **this idea** was there around 200 years earlier to Pythagoras and can be looked at the following extract of the book of Bibhutibhushan Datta and Avadesh Narayan Singh (2015), **History of Hindu Mathematics,** Vol. II, Page Nos. 204, 205 & 206, Bharatiya Kala Prakasam, Delhi. (Archimedes was killed by a foreign solider. It is understandable. Hippasus of Metapontum was drowned by fellow Pythagoreans. If this were to be a true one the integrity of the Pythagorean school itself becomes doubtful. Real **truth seekers never harm** even criminals leave alone fellow scholars). Naming of this great concept in the honour of Pythagoras may kindly be rectified; and **requested the Mathematical establishment** by this author, to **rename** in the honour of Baudhayana of 800 B.C. For more details of the work of this author, log in www.rsjreddy.webnode.com

20. RATIONAL TRIANGLES

Rational Right Triangles: Early Solutions. The earliest Hindu solutions of the equation

$$x^2 + y^2 = z^2 \tag{1}$$

are found in the *Sulba*. Baudhâyana (*c.* 800 B.C.), Âpastamba and Kâtyâyana (*c.* 500 B.C.)[1] give a method for the transformation of a rectangle into a square, which is the equivalent of the algebraical identity

$$mn = \left(m - \frac{m-n}{2}\right)^2 - \left(\frac{m-n}{2}\right)^2,$$

where m, n are any two arbitrary numbers. Thus we get

$$(\sqrt{mn})^2 + \left(\frac{m-n}{2}\right)^2 = \left(\frac{m+n}{2}\right)^2.$$

Substituting p^2, q^2 for m, n respectively, in order to eliminate the irrational quantities, we get

$$p^2q^2 + \left(\frac{p^2-q^2}{2}\right)^2 = \left(\frac{p^2+q^2}{2}\right)^2,$$

which gives a rational solution of (1).

For finding a square equal to the sum of a number of other squares of the same size, Kâtyâyana gives a very elegant and simple method which furnishes us with another solution of the rational right triangle. Kâtyâyana says:

"As many squares (of equal size) as you wish to combine into one, the transverse line will be (equal to) one less than that; twice a side will be (equal to) one more than that; (thus) form (an isosceles) triangle. Its arrow (*i.e.*, altitude) will do that."[2]

[1] *BŚl*, i. 58; *ApŚl*, ii. 7; *KŚl*, iii. 2. For details of the construction see Datta, *Śulba*, pp. 83f, 178f.
[2] *KŚl*, vi. 5; Compare also its *Pariśiṣṭa*, verses 40-1.

Thus for combining n squares of sides a each, we form the isosceles triangle ABC, such that $AB=AC=(n+1)a/2$,

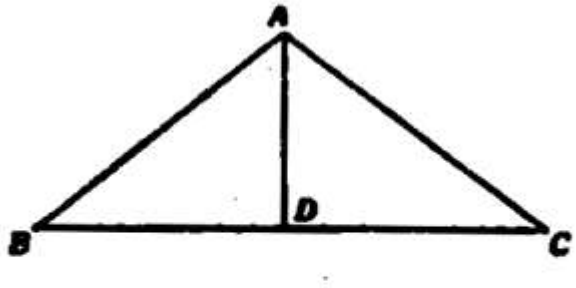

Fig. 2

and $BC=(n-1)a$. Then $AD^2=na^2$. This gives the formula

$$a^2(\sqrt{n})^2+a^2\left(\frac{n-1}{2}\right)^2=a^2\left(\frac{n+1}{2}\right)^2$$

Putting m^2 for n in order to make the sides of the right-angled triangle free from the radical, we have

$$m^2a^2+\left(\frac{m^2-1}{2}\right)^2a^2=\left(\frac{m^2+1}{2}\right)a^2,$$

which gives a rational solution of (1).

Tacit assumption of the following further generalisation is met with in certain constructions described by Āpastamba :[1]

If the sides of a rational right triangle be increased by any rational multiple of them, the resulting figure will be a right triangle.

In particular, he notes

$$3^2+4^2=5^2,$$
$$(3+3\cdot3)^2+(4+4\cdot3)^2=(5+5\cdot3)^2,$$
$$(3+3\cdot4)^2+(4+4\cdot4)^2=(5+5\cdot4)^2;$$

[1] *ApŚl*, v. 3, 4. Also compare Datta, *Śulba*, pp. 65f

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$$5^2 + 12^2 = 13^2,$$
$$(5 + 5.2)^2 + (12 + 12.2)^2 = (13 + 13.2)^2.$$

Âpastamba also derives from a known right-angled triangle several others by changing the unit of measure of its sides and vice versa.[1] In other words, he recognised the principle that if (α, β, γ) be a rational solution of $x^2 + y^2 = z^2$, then other rational solutions of it will be given by $(l\alpha, l\beta, l\gamma)$, where l is any rational number. This is clearly in evidence in the formula of Kâtyâyana in which a is any quantity. It is now known that all rational solutions of $x^2 + y^2 = z^2$ can be obtained without duplication in this way.

Later Rational Solutions. Brahmagupta (628) says:

"The square of the optional (*iṣṭa*) side is divided and then diminished by an optional number; half the result is the upright, and that increased by the optional number gives the hypotenuse of a rectangle."[2]

In other words, if m, n be any two rational numbers, then the sides of a right triangle will be

$$m, \ \tfrac{1}{2}\left(\frac{m^2}{n} - n\right), \ \tfrac{1}{2}\left(\frac{m^2}{n} + n\right).$$

The Sanskrit word *iṣṭa* can be interpreted as implying "given" as well as "optional". With the former meaning the rule will state how to find rational right triangles having a given leg. Such is, in fact, the interpretation which has been given to a similar rule of Bhâskara II.[3]

[1] Datta, *Sulba*, p. 179. [2] *BrSpSi*, xii. 35.
[3] *Vide infra* p. 211; H. T. Colebrooke, *Algebra with Arithmetic and Mensuration from the Sanscrit of Brahmegupta and Bhascara*, London, 1817, (referred to hereafter as, Colebrooke, *Hindu Algebra*), p. 61 footnote.

CONCLUSION

In this paper, there is yet another proof for Bhaudhayana theorem popularly known as Pythagorean theorem. The exact diagonal length is derived from the **exact** length of the inscribed circle's circumference. This way, a well established Baudhayana theorem **supports the March 1998 π value, as the True π value.**

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