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Re-Evaluating the Value of π and Emerging New Concepts for Measuring Areas and Volumes Based on Translations and Rotations of Straight Lines, Planes, and Circles

Nishant Sahdev, Chinmoy Bhattacharya

Abstract: The universal constant π has been assigned a non-converging value of approximately 3.145..., and this non-repeating, non-terminating decimal extends to millions—even trillions—of digits beyond the decimal point, as calculated by the most advanced computational methods. However, for thousands of years, mathematicians across different civilizations have attempted to determine the value of this fundamental constant in various ways. In geometry, angles are commonly expressed in terms of π radians, and π appears prominently in the formulas used to calculate the areas and volumes of curved geometrical figures such as circles, ellipses, spheres, cones, pyramids, and cylinders. Thus, π has become an integral part of how we measure areas and volumes. Ancient scientists, in their efforts to understand and quantify the dimensions of curved or non-linear topological objects, sensed a recurring spatial constant underlying these forms. Over time, this invariant quantity came to be known as "pi." The pursuit of its exact value has become a continuous endeavour spanning millennia, with each generation refining its estimation using increasingly sophisticated tools and methods. In this article, it is first emphasised that, although the mathematical parameters of area and volume have traditionally been expressed through formulas involving length, breadth, and height, their more profound physical significance has not been adequately explored. This work attempts to redefine area and volume fundamentally in terms of distance or length alone, offering new mathematical formulations for the areas and volumes of basic geometric shapes such as squares, cubes, circles, spheres, and others. Another critical shortcoming of conventional mathematics lies in its neglect of the reciprocal or inverse space of the universe when evaluating the value of π. In recent research, it has been proposed that π itself represents a circle whose radius corresponds to the smallest conceivable length in the universe. Furthermore, the existence of an inverse π—always in conjugation and equilibrium with π—is posited as essential for maintaining the balance of forces in the universe. Accordingly, this article presents a novel derivation of π by simultaneously considering both the cosmos' direct space and the reciprocal (or inverse) space.

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*Correspondence Author(s)

Nishant Sahdev, Department of Research & Development, Austin Paints & Chemicals Pvt. Ltd., Ambika Mukherjee Road, Belghoria, Kolkata (West Bengal), India. Email ID: nishantsahdev.onco@gmail.com, ORCID ID: 0009-0007-2249-1006

Chinmoy Bhattacharya*, Department of Research & Development, Austin Paints & Chemicals Pvt. Ltd., Ambika Mukherjee Road, Belghoria, Kolkata (West Bengal), India. Email ID: chinmoy00123@gmail.com, ORCID ID: 0000-0002-1962-0758

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I. INTRODUCTION

At the back of the minds of the researchers behind this article, the long-standing misconceptions, illogical philosophies, and the overlooked areas of classical mathematics and geometry were always present — and they served as the driving force behind this research work.

i. The areas of different geometric figures are calculated as $(\text{length})^2$, which is referred to as the 'unit square concept' of area. However, there is no justified or rational mathematical logic or proof supporting this concept.

ii. The volumes of different geometric figures are calculated as $(\text{length})^3$, which is referred to as the 'unit cube concept' of volume. However, there is no justified or rational mathematical logic or proof supporting this concept.

iii. The neglect of the reciprocal or inverse space of the universe in evaluating the value of π has been a significant oversight. In recent research, it has been proposed that π itself represents a circle whose radius corresponds to the smallest conceivable length in the universe. Furthermore, the existence of an inverse π — always in conjugation and equilibrium with π — is posited as essential for maintaining the balance of forces in the universe. Accordingly, this article presents a novel derivation of π by simultaneously considering both the direct space and the reciprocal (or inverse) space of the cosmos, finding its value to be exactly 3.

iv. The value of π has conventionally been obtained through practical experiments by dividing the circumference of a circle by its diameter. The fundamental mistake lies precisely here: the rotational or curved length of the circumference has been measured using a linear measuring scale, which is incorrect. The scales of measurement for curved (or rotational) length and linear length must be different. A curved length is a compressed or "squeezed" one, and when it is unfolded or straightened, it becomes a linear length. Across the world, people have continued making the same mistake for thousands of years— measuring the curved length of a circle's circumference using a linear scale. As established in this research article, for every 1° arc length on the circumference of a circle of unit radius (circumference = 2π), the linear length is greater than the curved length by 0.0008. Half of the circumference of such a circle is π. Now, for a 180° angle, the difference in the circumference's length comes out to be 0.145 (0.0008 × 180), considering the value of π to be precisely 3 as established in this article, and 3.145 according to the conventional linear measurement, based on the value of π. This difference of 0.145 corresponds to the difference between the traditional value of π (3.145…) and the re-evaluated value proposed in this research article, which is precisely 3.

v. Circles, spheres, ellipsoids, and similar shapes belong to the class of geometries known as 'closed-loop geometries.' However, their mathematical formulas contain the parameter π, which is non-converging, and as a result, the areas and volumes of these figures also become non-converging. This is not acceptable, since closed-loop geometries cannot have non-converging areas or volumes.

vi. There does exist a 'smallest length' in the universe, yet distances are still often expressed in the form of decimals. If the concept of a 'smallest possible length' is genuine, then any distance would be an integral multiple of this fundamental length.

vii. The topology of the 'multiplicative inverse' of circles or spheres is a missing area in geometry and mathematics, and it has never been explored before this research work.

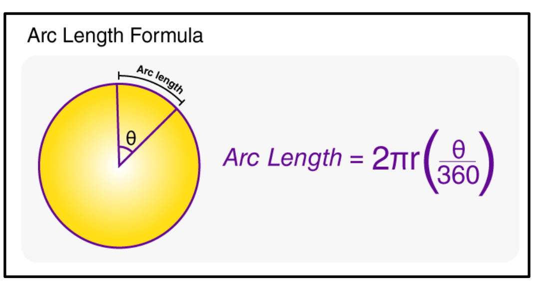
A. The value of π is non-converging, with an approximate magnitude of π ≈ 3.145. The 2π radian is equal to a 360-degree angle, and the general representation of an angle θ is [1].

$$\theta\ (in\ radian) = \frac{[\pi \text{ x } \theta \text{ (in degree)}]}{360} \quad \dots \quad (1)$$

So, if θ is, for example, 30 degrees, in radian scale it would be (π/12) radian.

B. If the arc length of a circle is s and it subtends an angle θ at the centre of the circle, with radius r, [1].

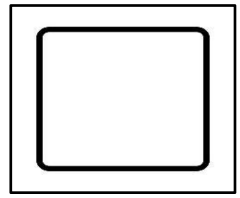
$$s = r\theta \quad \dots \quad (2)$$



[Fig.1a: The Arc Lengths of a Circle of Radius r as a Function of Angle θ]

C. The area (A) of a square of length x is, [1].

$$A = x^2 \quad \dots \quad (3)$$



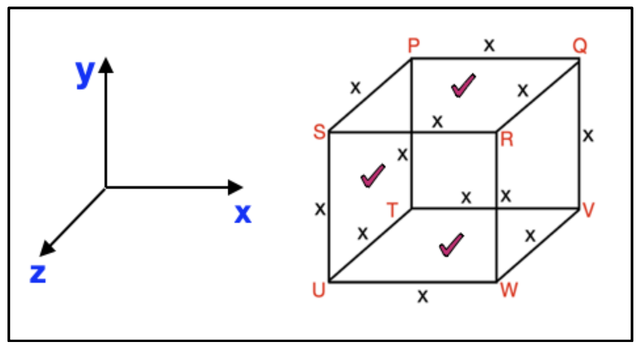
[Fig.1b: The Area of a Square of Each Side Length x]

D. The area (A) of a rectangle of length = x and breadth = y is, [1].

$$A = (length\ x\ breadth) = [xy] \quad \dots \quad (4)$$

E. The volume (V) of a cube of length x is, [1].

$$V = x^3 \quad \dots \quad (5)$$



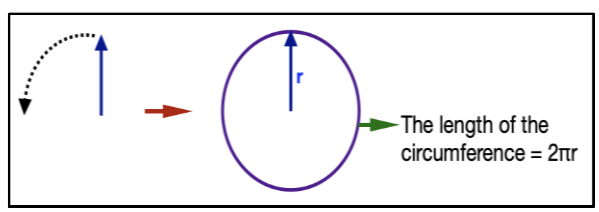
[Fig.1c: The Volume of a Cube of Length x]

F. The volume (V) of a rectangular cube of length, breadth and height being x, y and z respectively, is [1].

$$V = xyz \quad \dots \quad (6)$$

G. The circumference length (C) of a circle of radius r is, [1].

$$C = 2\pi r \quad \dots \quad (7)$$



[Fig.1d: The Circumference of a Circle of Radius r]

H. The area of a circle (A) of radius r is, [1].

$$A = \pi r^2 \quad \dots \quad (8)$$

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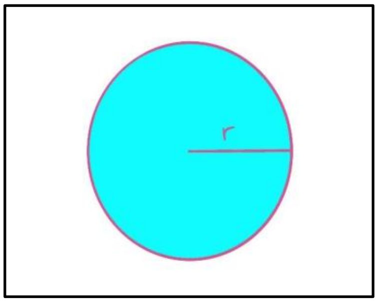
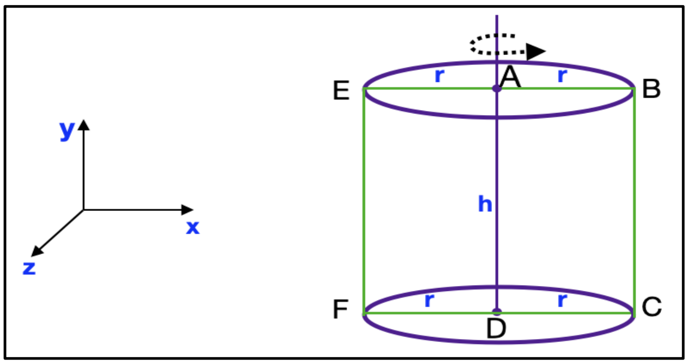


[Fig.1e: The Area of a Circle of Radius r]

I. The volume (V) of a cylinder of base radius r and height h is, [1].

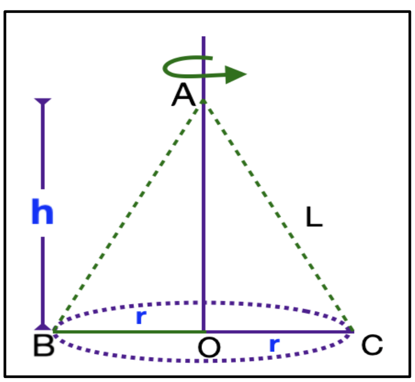
$$V = \pi r^2 h \quad \dots \quad (9)$$



[Fig.1f: The Volume of a Cylinder of Radius r and Height h]

J. The volume (V) of a cone of base radius r and height h is, [1].

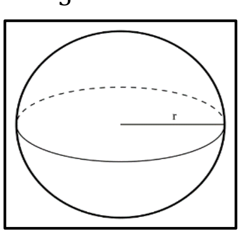
$$V = \frac{1}{3[\pi r^2 h]} \quad \dots \quad (10)$$



[Fig.1g: The Volume of a Cone of Radius r and Height h]

K. The volume (V) of a sphere of radius r is, [1].

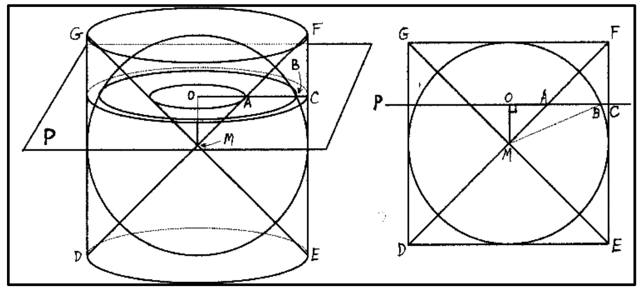
$$V = \frac{4}{3}[\pi r^3] \quad \dots \quad (11)$$



[Fig.1h: The Volume of a Sphere of Radius r]

L. The ratio of the volume of a cone (of radius r height r), a cylinder (of radius r and height r) and a sphere (of radius r) is [2].

$$V_{cone} : V_{cylinder} : V_{sphere} = 1:2:3 \quad \dots \quad (12)$$



[Fig.1i: Archimedes' Presentation of the Ratio of the Volumes of a Cone, a Cylinder and a Sphere]

M. The square root of (-1) is imaginary and is represented by i $= \sqrt{-1}$ ... (13)

The first important point to note from the above guidelines is that, according to guideline (ii), angles expressed in radians attain a non-converging value due to their dependence on π. However, this is problematic, as angles—being finite geometric entities—should not possess a non-converging or infinite nature. Secondly, regarding guideline (iv), while the area of a square is expressed as the square of its length, i.e., $(\text{length})^2$, the underlying rationale for why area is defined this way has not been adequately explained in conventional mathematics.

The above guidelines are being tabulated in Table 1a below:

Table 1a: Guidelines of Conventional Mensuration and Mathematics

S/No.	Guideline On	Guideline Detail
1.	π parameter	Non, having a value of 3.145….
2.	Arc Length of circles (s)	S = r θ r is the radius of the circle and θ (*in radian*) = [π x θ (in degree)]/360
3.	Square of side length x	Perimeter = 4x Area = x^2
4.	Rectangle of length = x and breadth =y	Perimeter = 2(x +y) Area = xy
5.	Homogeneous cube of side length x	Total Surface area = $6x^2$ Volume = x^3
6.	Circle of radius r	Circumference = 4πr Area = πr^2
7.	Cylinder of height h and radius of the base r	Total surface area = 2πr (r + h) Volume = $\pi r^2 h$
8.	Cone of height h and radius of the base r	Volume = $(\pi r^2 h/3)$
9.	Sphere of radius r	Surface area = $4\pi r^2$ Volume = $4\pi r^3$
10.	Inter-relationship between the volume of a cone, a cylinder and a sphere (radius r and height h)	V_{cone}: $V_{cylinder}$: V_{sphere} = 1:2:3
11.	Imaginary number (**i**)	**i** = √(-1)

The Following new Concepts Should be Considered to Understand Why Area is Expressed as the Square of Length, i.e., $(\text{Length})^2$:

i) There does not exist any truly fractional distance in the physical universe. For instance, consider an arbitrary distance of 1.23456 kilometres, which appears to be a fraction in the kilometre scale. However, if we scale down the unit of measurement to hectometers, the same distance becomes 12.3456 hectometers—still a fraction. Continuing this process of scaling down, when the unit is reduced to millimetres (noting that 1km = 105 mm), the distance transforms into 1,234,560 millimetres, which is now an integer value. This example illustrates that any length, which appears as a fractional value at one scale, becomes a whole number at a sufficiently smaller scale. Therefore, through continued unit reduction, any fractional distance ultimately resolves into an integer multiple of a fundamental, indivisible unit of length—the smallest measurable length in the universe. Let this smallest possible length be denoted by dx. Then, any arbitrary length x must be an integral multiple of dx, such that:

$$x = ndx \text{ [n is a whole number] } \dots \quad (14)$$

Therefore, the idea of a 'fraction' is, in reality, a conceptual convenience rather than a physical truth. Yet, it continues to play a crucial role in mathematics and daily life due to its practical usefulness.

ii) In the physical universe, only the operations of addition and subtraction fundamentally exist. This assertion can be substantiated by examining how multiplication and division can be interpreted as repeated addition or subtraction.

7 times of 5, (5 + 5 + 5 + 5 + 5 + 5 +5) = 35 Or 5 times of 7, (7 + 7 + 7 + 7 +7) = 35

Hence, multiplication is nothing but addition.

The operation of division can also be fundamentally interpreted as a process of repeated subtraction. For example, when the number 20 is divided by 4, the result is 5. The physical significance of this operation is that one repeatedly subtracts a constant quantity (in this case, 4) from the original number (20) until the remainder reaches zero.

1st step	(20 - 4) = 16
2nd step	(16 - 4) = 12
3rd step	(12 - 4) = 8
4th step	(8 - 4) = 4
5th step	(4 - 4) = 0

Hence, as shown, 5 is the result of division.

iii) For a polynomial of the form below, where a, b, c, and d are constants (known as coefficients) with no physical dimensions:

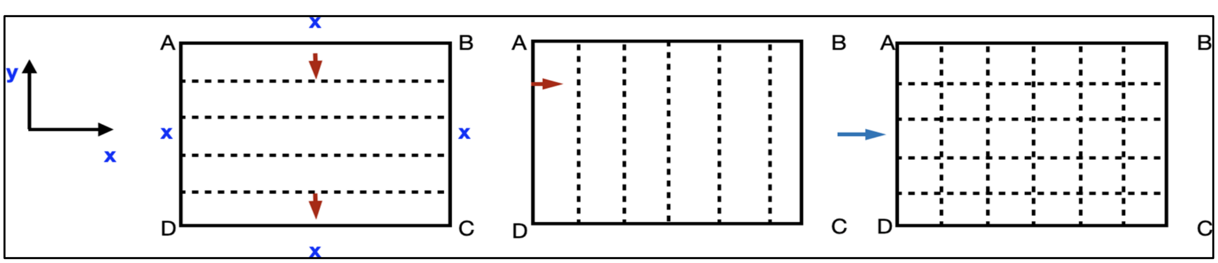
$$y = ax^3 + bx^2 + cx + d \; \dots \quad (14a)$$

It is worth noting that if the variable x stands for distance or length, then the first, second, third, and last terms on the right-hand side of equation (14a) would represent volume, area, length, and a dimensionless quantity, respectively. So, the question arises: how can these terms be added together? The answer is that whether it is area or volume, they are ultimately forms of 'distance'; otherwise, they could not be added. If the values of a, b, c, and d, are 1, 2, 3, and 4, respectively, then the above polynomial can be expressed as:

$$\text{Total Distance or length}, y = 1.(x.x.x) + 2\,(x.x) + 3\,(x) + 4.1 \; \dots \quad (14b)$$

In equation (14b), the unit of the last term on the right-hand side represents the smallest possible length. So, dimensionally, the left-hand side and the right-hand side are the same, both representing distance. Why x^3, x^2, and x all stand for length is explained below.

iv) The following discussion pertains to guidelines (iv) to (vii) concerning the calculation of areas and volumes. To understand these, refer to Figures 1, 2, and 3 below.



[Fig.1j: Translation of Line Segments AB & AD Along the y & x Direction and Generating Overlapping Distance in a Square Geometry]

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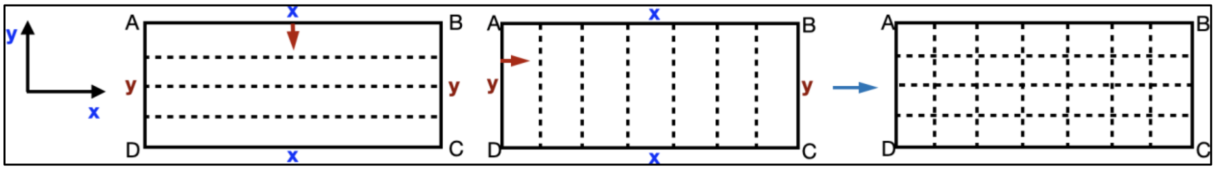
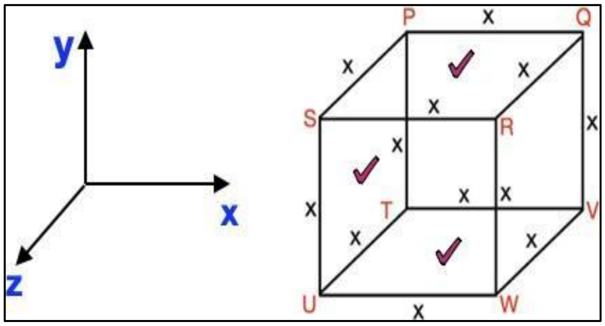


[Fig.2: Translation of Line Segments AB & AD Generating Overlapping Distance in a Rectangular Geometry]



[Fig.3: Geometrical Presentation of a Homogeneous Cube of Length x]

In Figure 1i, it is shown that in a square, the line segment AB of length x (along the direction of the x-axis) translates toward the opposite line segment CD through points A and B (along lines AD and BC) x number of times (or its own number of times). Since in each translation it travels a distance x, the total distance travelled is:

x, x, x, x,
x times for AD
x, x, x, x,
x times for BC

$$Hence\ total\ distance\ covered\ =\ 2(x.x) = 2x^2\ \ ...\ \ (15)$$

Now, there has to be a distinction between *length* and *area*. In the case of length, there is no overlapping of distances. However, in the case of an area, there must be some overlapping of distances. What exactly is this overlapping? This concept is illustrated in Figure 3a. The line AD, oriented along the y-axis, travels x times toward the opposite line BC—resulting in an overlap with the area described in equation (15)—such that the total distance travelled by AD would be:

x, x, x, x,
x times = x^2 along AB

x, x, x, x … … … … … … … x times for CD

$$= 2x^2\ \ ...\ \ (16)$$

The area of a square would be the sum of equations (15) and (16), such that:

$$\text{The area of square ABCD} = (2x^2 + 2x^2)$$
$$= 4x^2\ \ ...\ \ (17)$$

The circumference or perimeter of the square is the total distance around its four sides, which is 4 times the side length.

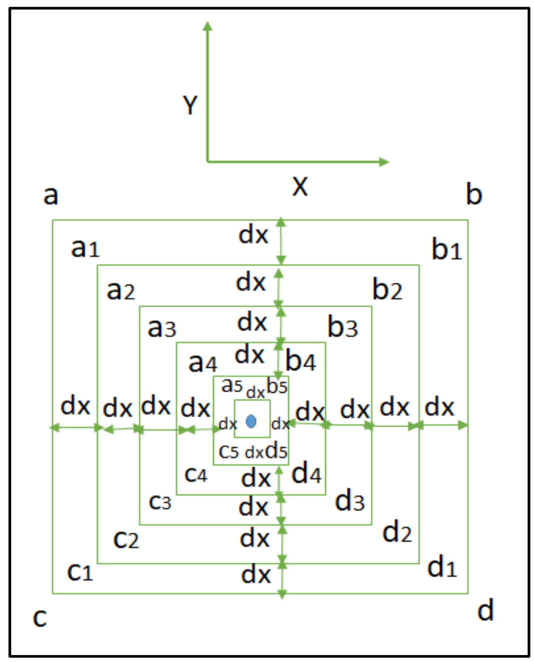
The mathematical formula for the circumference of a square = 4x … (17a)

In the case of a rectangle, as shown above in Figure 2, with length = x and breadth = y, the line x would translate along the line y, x times. Conversely, the line y would translate along the line x, y times, such that the total distance travelled would be:

Line x, y, y, y, y, 2x times = 2 xy
Line y, x, x, x, x, 2y times = 2xy

$$\text{So, the area of the said rectangle}$$
$$= (2xy + 2xy)$$
$$= 4xy\ \ ...\ \ (18)$$

The above derivation of the area of a square regarding translations of the sides of the square along each other could also be derived in the following manner, as shown in Figure 3a below.



[Fig.3a: The Consecutive Decreases in the Area of a Square Upon the Reduction of Length and Breadth Each by an Infinitesimal Small Distance dx (Smallest Possible unit Length of the Universe), the Planck Length [4] and the Area of the Square Converging to Zero]

As shown in Figure 3a, for example, a person is walking along the perimeter of a square with each side length x. After completing the first round of walking, the person starts the second round along the sides, but the length of each side of the square becomes (x-dx). Here, dx stands for the smallest possible unit length of the universe. In the 3rd round of walking, the person walks through a square whose length of each side is (x-2dx). Suppose the walk continues like this; for example, in the xth round, four rounds off the walk. In that case, the person reaches a central point as shown in Figure 4.3a. and the total distance is measured from there. The area of the square formed by the person walking from the 1st round to the 2nd round to the 3rd round ... to the xth round is calculated. The total distance walked by the person up to the xth round of walk is, Total Distance $= S = [4x + 4(x - dx) + 4(x - 2dx) + 4(x - 3dx) + 4(x - 4dx) + \dots\dots\dots + 4(x - xdx)] \dots (18a)$

Splitting equation …, one gets,

$$S = (4x + 4x + 4x + 4x + \cdots \dots\dots\dots.\text{x no of terms}) - 4dx\,[\{1 + 2 + 3 + \dots.\ (x - 1)\ \text{no. of terms}\}]$$

$$= 4x^2 - 4dx.\frac{x-1}{2}[2 + (x - 2)]$$

$$= 4x^2 - 4dx.\frac{x-1}{2}[(x)]$$

$$= 4x^2 - \frac{4dx.x^2}{2}[1, \text{neglected}] \dots \quad (18b)$$

$$= 4x^2 - 2x^2dx$$

$$= 4x^2[\text{dx containing term neglected}] \dots \quad (18c)$$

[The smallest possible length of the universe (dx) is one Planck length and in meter scale its value is 1.6 x 10^{-36}m and so the value of the second term of equation (18b) for a tremendous value of x (in the order of diameter of the earth, 10^7meter, the value of the said second term would be, (2 x 10^{14} x 1.6 x 10^{-36}) meter = (3 x 10^{-22}) meter and hence it could be neglected. However, for a value of x being considerably very low, as for example, x = 0.001 meter, the value of the second term would be about to be (3 x 10^{-42}) while the value of the 1st term of equation (18b) would be (4x 10^{-6}) and which is 10^{36} times than the first term].

In Figure 3, a homogeneous cube is shown, with each side having length x. From the figure, it can be observed that there are 3 squares along each of the x, y, and z directions, as indicated by the tick marks. Each square has an area of $4x^2$, and the translations of the square would take place in the following manner:

The distance travelled by a square of area $4x^2$ along the x-axis along a length x

$$= (4x^2 time\ 2x)$$
$$= (2x, ex, 3x, \quad 4x^2 time)$$
$$= 4x^2.2x$$
$$= 8x^3 \dots (19)$$

The distance travelled by a square of area $4x^2$ along the y-axis along a length 2x

$$= (4x^2 time\ 2x)$$
$$= (2x, 2x, 2x, \quad 4x^2 time)$$
$$= 4x^2.2x$$
$$= 8x^3 \dots (20)$$

The distance travelled by a square of area $4x^2$ along the z-axis along a length x

$$= (4x^2 time\ 2x)$$
$$= (2x, 2x, 2x, \quad 4x^2 time)$$
$$= 4x^2.2x$$
$$= 8x^3 \dots (21)$$

So, the volume of the cube would be the summation of the distances of equations (19), (20) and (21) and hence the volume would be,

$$\text{Volume of the cube} = (8x^3 + 8x^3 + 8x^3 \dots (22)$$

$$\text{The total surface area of the cube} = 6 \text{ x } 4x^2 = 24x^2 \dots (22a)$$

[To note that each of the 6 surfaces of the cube, there would be two numbers of surfaces, the outer surface and the inner surface. In conventional mensuration only one surface is being considered].

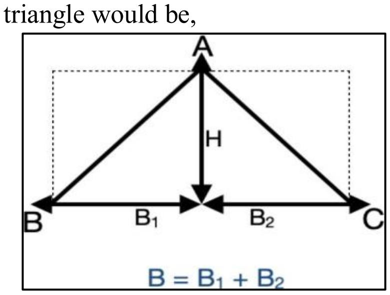
Some people may find the newly proposed mathematical formulas difficult to accept or justify. To address this, the following pointwise discussion aims to clearly demonstrate the extent to which the existing mathematical formulas for areas and volumes may be flawed or incomplete.

i) Area and volume are all concepts of overlapping of space along x, y and z directions.
ii) The areas and volumes are the summation of overlapped distances only, so areas and volumes are ultimately converged to distance only. In the broadest sense, every physical variable of the universe is 'distance' only or a multiple of 'distance or length'.
iii) The mathematical operations are only two: 'addition or summation' and 'subtraction' in the universe. Any mathematical operation has to be shown either in the form of 'summation' or 'subtraction'.
iv) Once people are convinced by the points mentioned above, the justifiability of the conventional mathematical formulas can be examined. The conventional formulas for the perimeter and area of a square with each side of length x are 4x and $x^{2,}$ respectively. Now when x is taken to be 1, the perimeter turns out to be four and area be 1. Since the perimeter and area both are distances only, and area is the summation of the overlapping distances over the x and y directions, how come the area is less than the perimeter of a square? The newly derived formula of the area of a square is $4x^2$ (instead of x^2 of the conventional formula), and the formula of perimeter remains the same (4x). For a value of x = 1, the area becomes 4, and the perimeter is also 4. This is a believable and convincing result. When x = 2, the perimeter would be

(4 x 2) = 8 and the area becomes 4 x 2^2 = 16. In the case of x = 1, the perimeter and area of a square are the same only because 1x1 = 1. For any value of x greater than 1, the area is always greater than the perimeter. As per the conventional formula, when x = 2, the perimeter and area are obtained to be 8 and 4, respectively. So, the perimeter being larger than the area by magnitude is not acceptable.

v) For a homogeneous cube of length x, the conventional mathematical formulas of surface area and volume are $6x^2$ and $x^{3,}$ respectively. When x = 1, the surface area becomes six and the volume becomes 1. According to the newly developed formula, the formulas for surface area and volume are $24x^2$ and $24x^{3,}$ respectively. When x = 1, the surface area and volume become both 24. When x = 2, the surface area becomes 96, and the volume becomes 192, according to the newly developed formula. According to the conventional formula, when x = 2, the surface area and volume are 24 and 8, respectively. Therefore, the volume being less than the surface area is not acceptable again.

For a triangle as shown in Figure 3b below, the base length B = (B_1 + B_2). Now, the area of the rectangle on the left side of the figure is $4B_1H$ (H is the height of the triangle). So, the area of the triangle portion on the left side would be half of the rectangle and would be $2(B_1H)$. Similarly, the area of the triangular section on the right side would be B_2H. So, the area of the entire triangle would be,



[Fig.3b: Geometrical Presentation of a Typical Scalene Triangle of Base Length B and Height H]

$$\text{Area of the triangle ABC} = (2B_1\text{H} + 2B_2\text{H}) = 2\text{H}\,(B_1 + B_2) = 2\text{BH} = 2(\text{Base x height}) \quad \dots \quad (22b)$$

Hence, the mathematical formula for the area of a triangle would be,

$$\text{A (triangle)} = 2\text{ (base x height)} \quad \dots \quad (22c)$$

So, in conclusion,

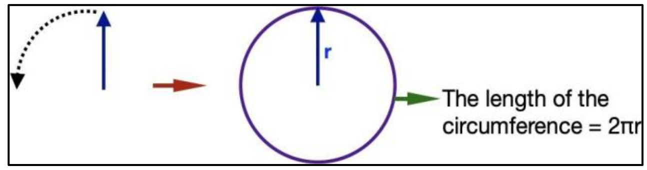
i) A square or a rectangle contains two numbers of square or rectangle (of the conventional geometry) in it, each of which is $4x^2$ or 4xy for square and rectangle, respectively. So, the actual area becomes $4x^2$ and 4xy, respectively, for a square and a rectangle.

ii) A Cube contains three cubes (of the conventional geometry), and a rectangular cube contains three rectangular cubes in it. The volume would be $8x^3$ and 8xyz for the regular and rectangular cubes, respectively. So, the total volume would be $24x^3$ and 24xyz, respectively.

iii) A triangle contains two triangles and its area is 2 (base x height).

II. NON-LINEAR GEOMETRY

In non-linear geometry, the universal parameter π plays a central role—for example, in computing the circumference of circles, the areas of circles, and the volumes of cylinders and spheres, etc. In Figure 4 below, the derivation of the circumference of a circle is shown.



[Fig.4: Rotation of a Line Segment r Through 2π Radians, Resulting in the Evolution of the Circumference of a Circle]

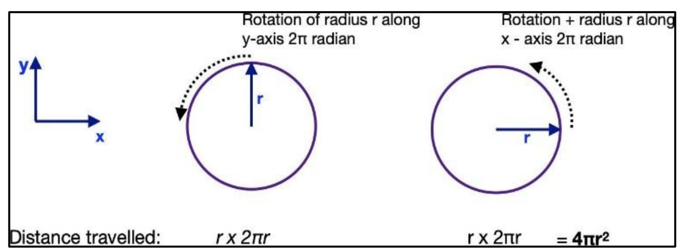
In Figure 4, a circle of radius r is shown. Since the circumference is a length, the concept of overlapping distances—previously discussed in the context of *area* and *volume*—does not apply here. As shown in Figure 4, when the radius r completes one full rotation along the circumference, it travels through an angular distance of 2π radians. Now, if the radius r rotates r times along the circumference, then the total distance travelled would be:

$$2\pi, 2\pi, 2\pi, 2\pi$$

r times and hence the total length travelled for this entire journey would be (2π x r) = $2\pi r$ and hence,

$$\text{The circumference of a circle of radius r} = 2\pi\text{r} \quad \dots \quad (23)$$

In Figure 5, the radii of a circle (r) are shown along both directions in 2D space.



[Fig.5: Rotation of the Radius r of a Circle Along the x and y Directions by 2π Radians]

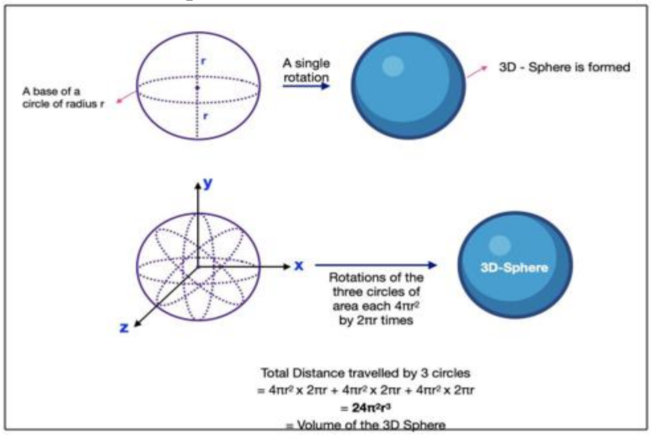
When the radius r rotates along the x-axis r times through the circumference of length $2\pi r$, the distance travelled,

$$2\pi\text{r}, 2\pi\text{r}, 2\pi\text{r}, \text{r times}$$

$$\text{Hence the total distance travelled would be, (r x } 2\pi\text{r)} = 2\pi r^2 \quad \dots \quad (24)$$

For the rotation of the radius r along the y direction, another area $2\pi r^2$ will be added to equation (24). So, the mathematical formula of the area of a circle would be $=$ $2 \text{ x } 2\pi\, r^2 = 4\pi r^2 \quad \dots \quad (25)$

For a sphere of radius r, a circle of area $4\pi r^2$, if it makes a single end-to-end rotation in a 3D plane (through the circumference of the circle $2\pi r$), as shown in Figure 6, the distance travelled would be $2\pi r$. Now, if the said end-to-end rotation does take place $4\pi r^2$ times.



[Fig.6: Formation of a 3D Sphere Arising Out of the Rotation of 3 Circles (xy, yz & xz planes) through a Circular Plane of Length 2πr]

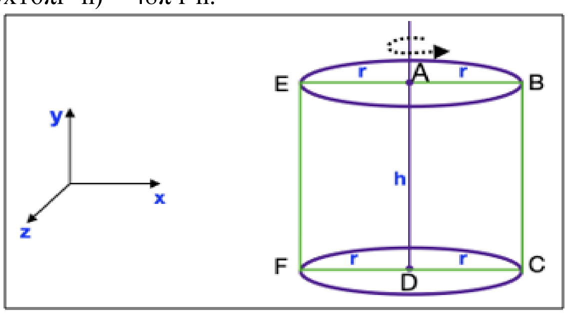
Distance travelled = $(4\pi r^2) \times (2\pi r) = 8\pi^2 r^3$

So, the rotation of the radius r along the x, y and z directions has to be considered. So, the volume would be 3 times $8\pi^2 r^3$.

Hence, the mathematical formula of a Sphere of radius r would be = $24\pi^2 r^3$ … (26)

[It is important to note that a two-dimensional plane must possess a thickness equal to the smallest possible length in the universe; otherwise, the plane would not physically exist. Under such a condition, both an outer surface area and an inner surface area must co-exist.]

For a cylinder of base radius 2r and height h, as shown in Figure 6a, there does exist a rectangle of length 2r and breadth h. So, the area of the rectangle would be $(4 \times 2r \times h) = 8rh$. This rectangle rotates on its axes once; the distance travelled would be $2\pi r$. Now, when the said rectangle would rotate 4π times, the total length travelled would be $(2\pi r \times 8rh) = 16\pi r^2 h$. One needs to consider the rectangles in the cylinder (along x-y, x-z & y-z respectively), and each will contribute $16\pi r^2 h$, and hence it will be $(3 \times 16\pi r^2 h) = 48\pi r^2 h$.



[Fig.6a: Topological Presentation of the Formation of a Cylinder Upon the Rotation of a Rectangular Plane BEFC by 360-Degree Rotation on Axes AD]

So, the mathematical formula of the volume of a cylinder would be, $V = 48\pi r^2 h$ … (27)

A cylinder has two circular bases, each contributing $4\pi r^2$ to its surface area. The curved surface of the cylinder can be considered as a rectangle with length $2\pi r^2$ and width h. So, its area would be:

The contribution to the base circles to the surface area = $2 \times 4\pi r^2 = 8\pi r^2$ … (27a)

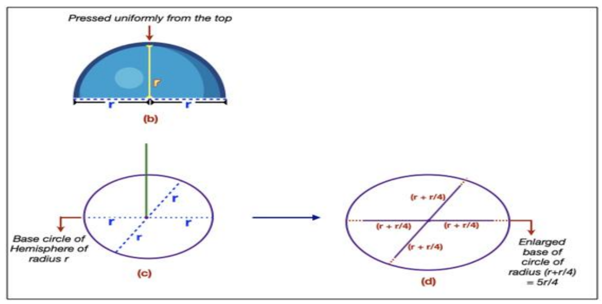
The contribution of the curved surface = $8\pi hr$ … (27b)

So, the mathematical formula of the total surface area of a cylinder would be

$$= 8\pi r^2 + 8\pi rh$$

$$= 8\pi r(r + h) \quad \dots \quad (27c)$$

The volume of a sphere of radius r is composed of two hemispheres, each of height r, as shown in Figure 6b. If one of these hemispheres is uniformly and homogeneously compressed from the top and merged with the ground level, it will form a flat circular shape. The radius of this new circle becomes r+r/4, since the height rrr gets equally distributed among the four radii, as shown in Figure 6c. Therefore, the radius of the newly formed circle is (5r/4). This transformation is illustrated in Figures 6b and 6c. The area of the circle with radius (5r/4), according to the newly derived formula in this article, would be:



[Fig.6 (b, c & d): Topological Presentation of the Formation of a Circle Upon Merging a Hemisphere to the Ground by Pressing from the Top as Being Shown]

Surface area of one hemisphere

$$= \text{area of the new circle}$$

$$= 4\pi \left(\frac{5r}{4}\right)^2 = 6.25\pi r^2$$

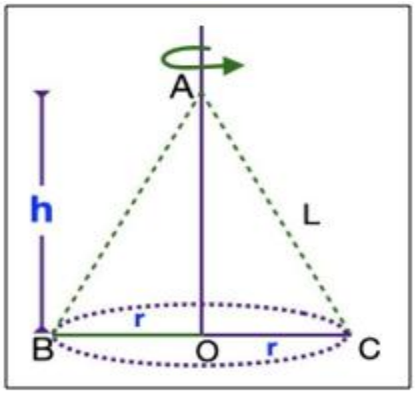
So the total surface area of the entire sphere would be

$$= 2\text{x}6.5\pi r^2 = 12.5\pi r^2 \quad \dots \quad (27d), so$$

the mathematical formula of the surface area of a sphere is

$$= 12.5\pi r^2 \quad \dots \quad (27e)$$

A cone, as shown in Figure 7, contains a central triangle with base radius r, height h, and slant length L. The surface area of the cone would be the sum of the area of the base circle and the curved surface area. The circumference (or length) of the base circle is $2\pi r$, which consists of 2πr segments, each corresponding to the smallest possible length in the universe. Each such smallest segment forms a triangle whose height is L. Therefore, the total area of the entire curved surface of the cone is the summation of an infinite number of such smallest triangle areas.



[Fig.7: Formation of a Cone Upon Rotation of the Base of a Triangle ABC by 2π Radians (BC = r, AB = h)]

Now the area of each of such smallest-to-smallest triangles would be, as per the newly developed formula of a triangle, which is, 2(base x height) = 2(1 x L) = 2L [where 1 is the smallest possible unit base length and L is the height and for such a small length, the linear length and the curved length would virtually be the same).

So, the curved surface area would be 2πr times 2L,

$$\text{So, the curved surface area} = (2\pi r \text{ x } 2L)$$
$$= 4\pi rL \ \ldots \ (28)$$

$$\text{Now the area of the base circle, as per new formula}$$
$$= 4\pi r^2 \ \ldots \ (29)$$

So, the total surface area of the cone would be,

$$= 4\pi r^2 + 4\pi rL$$
$$Or, = 4\pi r\,(r + L) \ \ldots \ (30)$$

Now, the volume of the cone, as shown in Figure 7, can be understood by considering a triangle with a base length of 2r and height h, which rotates through a circular path of length 2πr by 360 degrees.

$$\text{The area of the triangle} = 2\,(2r \text{ x } h) = 4rh \ \ldots \ (31)$$

So, the triangle would rotate 4rh times through the circular path of length 2πr, and one has to consider three such rotating triangles along the x–y, x–z, and y–z planes.The volume of the cone would be =

$$3 \text{ x } 4rh \text{ x } 2\pi r = 24\pi r^2 h \ \ldots \ (32)$$

The following Table 1b shows the derived new formulas for the area and volumes of various geometrical figures compared to the conventional formulas.

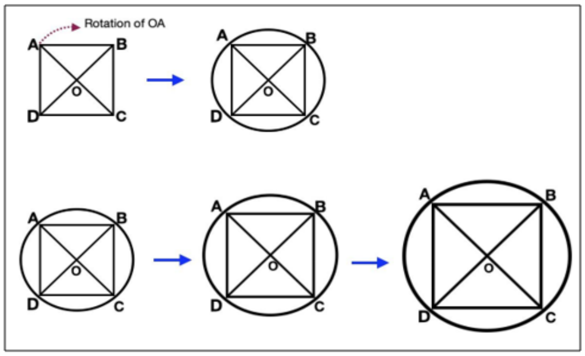
Table 1b: The Newly Derived Formulas of the Geometrical Figures Vis-à-Vis the Conventional Formulas

Geometrical Figure	Conventional Mathematical Formula of Area / Surface Area / Perimeter / Circumference	Newly Developed Mathematical Formula of Area / Surface Area / Perimeter / Circumference	Conventional Mathematical Formula of Volume	Newly Developed Mathematical Formula for Volume
Square of each side of length x	Perimeter = 4x	Perimeter = 4x (retained the conventional formula)	-	-
	Area = x^2	Area = $4x^2$		
Rectangle of sides x and y	Perimeter = 2(x + y)	Perimeter = 2(x + y) (retained back the conventional formula)	-	-
	Area = xy	Area = 4xy		
Triangle of base length B and height h	Area = ½ (B × h)	Area = 2 (B × h)	-	-
Homogeneous Cube of length x	Surface Area = $6x^2$	Surface Area = $24x^2$	Volume = x^3	Volume = $24x^3$
Rectangular Cube of side length, breadth and height x, y & z, respectively	Surface Area = 6(xy + xz + yz)	Surface Area = 24(xy + xz + yz)	Volume = xyz	Volume = 24xyz
Circle of radius r	Circumference = 2πr	Circumference = 2πr (retained)	-	-
	Area = πr^2	Area = $4\pi r^2$		
Cylinder of radius r and height h	Surface Area = 2πr(r + h)	Surface Area = 8πr(r + h)	Volume = $\pi r^2 h$	Volume = $48\pi r^2 h$
Sphere of radius r	Surface Area = $4\pi r^2$	Surface Area = $12.5\pi r^2$	Volume = $(4/3)\pi r^3$	Volume = $24\pi^2 r^3$
Cone of radius r, height h & slant length L	Surface Area = $\pi r^2 + \pi rL$ = πr(r + L)	Surface Area = $4\pi r^2 + 4\pi rL$ = 4πr(r + L)	Volume = $(1/3)\pi r^2 h$	Volume = $24(\pi r^2 h)$

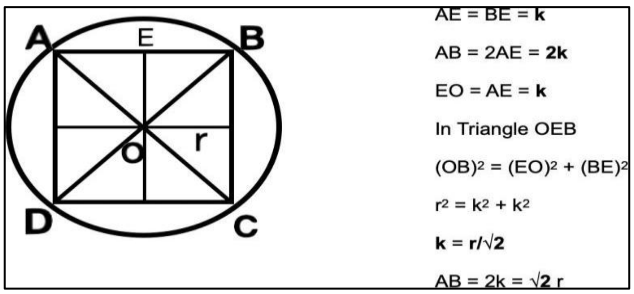
In the end, the question arises: how can a rotation occur π times, an integral multiple of π times, or nπr times—especially when π itself is a non-converging value? The next section of this article will address and answer this question.

III. DETERMINATION OF THE VALUE OF Π

The area of a square with each side length being √2r and the length of the diagonal being r forms an outer circle with radius r as shown in Figure 7a & 7b below. In fact, half of the diagonal segment length is the length of OA as it rotates by 360 degrees in the plane of the square to form the outer circle. The higher the area of the square (or the higher the value of r), the greater the area of the outer circle, as shown in Figures 7a & 7b.



[Fig.7a: Topological Presentation of the Formation of a Circle from the Rotation of the Diagonal Segment Length OA of a Square ABCD]



[Fig.7b: The Mathematical Relation Between the Radius (r) of a Circle and the Length of each Side (k) of the Inscribed Square ABCD]

So, the area of the outer circle is α, the area of the square (32a)

[The conventional mathematical formula of the area of a square is (length of side)^{2,} and the mathematical formula of the area of a circle is πr^2 of radius r]

So, it follows from (32a),

$$\text{Area of the outer circle of radius r } \alpha \left(\sqrt{2}\mathrm{r}\right)^2 [= 2r^2] \ \dots \quad (32b)$$

$$\text{Or, Area of the outer circle of radius r}$$

$$= \mathrm{k} \times (2r^2) \ \dots \quad (32c)$$

[k is a proportionality constant]

It follows from equation (32c),

k = [(Area of the outer circle of radius r)/ $2r^2$]

or, k = constant of proportionality = [(Area of the outer circle of radius r)/ (Area of the circle inscribed in the square] (32d)

Now, since the area of a circle of radius r is πr^2, as follows from equation (32d),

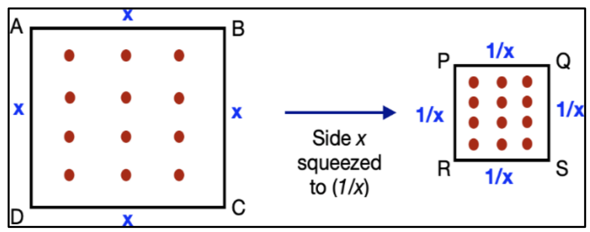
$$\pi = 2\mathrm{k} \ \dots \quad (32e)$$

So, π is being more fundamentally related to the ratio between two areas (A circle of radius r and the area of its inscribed square) rather than defining it in terms of the ratio of the length of the circumference of a circle (of radius r) to its diameter 2r. In the case of defining π regarding two different lengths, as said, the circumference is a rotational or curved length, and the diameter is a linear length. Since no measuring scale for the rotational or curved length is available, both are measured using only a linear scale. As a result, people are left with an erroneous value of π, a non-converging value of 3.145…

So, in this article, the value of π has been determined by measuring area and considering the negative curvature of the space (in the form of the reciprocal of π), applying the concept of multiplicative inverses in mathematics.

The value of π can be determined only through the concept of the multiplicative inverse of a variable or a function. The multiplicative inverse of a variable x is (1/x). The definition of a multiplicative inverse is that if the product of two variables, such as x and y, is unity (meaning xy = 1), x is called the multiplicative inverse of y, and vice versa. This means the numerator and the denominator of the multiplication (xy) have to be the same. So xy = (x. 1/x) = 1.

For a line segment of length *x*, its multiplicative inverse would be a straight line of length *(1/x)*. If *x* = 10, then the length of its multiplicative inverse would be a straight line of length 0.1. For a square area x^2, the multiplicative inverse would also be a square, whose each side would be *(1/x)*. This is shown in Figure 8 below.



[Fig.8: A square ABCD is Squeezed, and a Squeezed Square is Formed, but the Number of Points Within the Square Remains the Same]

In Figure 8, each side x is being squeezed, and the area remains the same, but it appears in inverse form as *($1/x^2$)*. In geometry, this is the rule: in a geometric operation, if no area is being added or subtracted from a figure to start with, the area has to remain the same. This is called the *conservation of area or volume* in geometry. So, in the operation shown in Figure 8, the lengths along the *x* and *y* directions have been squeezed (such that they attain their reciprocal lengths), but the number of points in the square before squeezing remains the same as after squeezing. Such a squeezed area *($1/x^2$)* acts in the inverse manner of the original area x^2, such that the product of the two is unity.

For a circle of area πr^2, determining its inverse form is not straightforward since *π* is present and imparts curvature. Now, the geometry of the inverse of *π* is not known to us. A model is used here to obtain an 'inverse geometry' of a part of the circle by using four circles and one central circle, as shown in Figures 9 and 10 below.

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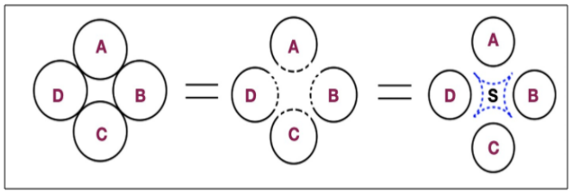
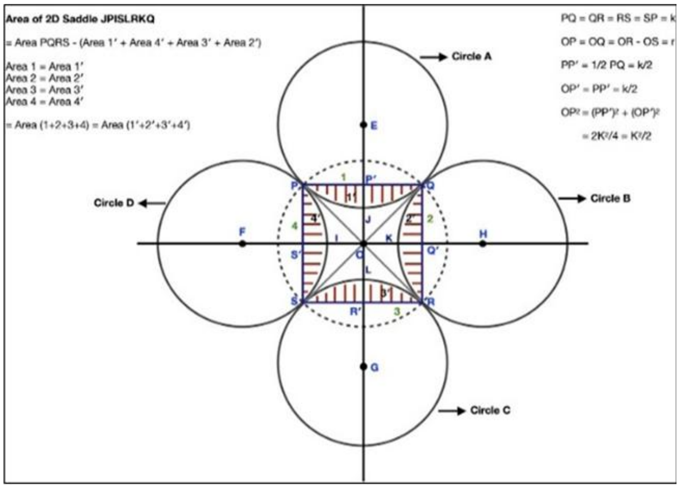


[Fig.9: The 'Inversion' Process of Space Geometry is Shown Topologically. An Equal Length from each of the circle's A, B, C, and D is cut out, and a 2D Saddle S is Formed in the Central Region of the Combination of the four Circles]



[Fig.10: Geometrical Cum Mathematical Determination of the Area of the Inverse Saddle Formed at the Centre]

As illustrated in Figure 10, four circles come in some entanglement with each other, and certain equal areas of each circle are being cut out. Another four numbers of smaller circles are formed, along with an inverse 2D saddle being formed. In Figure 9, the process of inversion has been shown more explicitly: four circles—labelled A, B, C, and D with centres at E, H, G, and F, respectively—each having radius r, undergo a molecular entanglement. This interaction results in the formation of a 2D saddle, denoted as JPISLRQ. An inner, imaginary circle PQRS, also with radius r, is shown for reference.

Each of the four outer circles has two symmetrical segments: the upper segments (areas 1, 2, 3, and 4) and the lower segments (areas 1′, 2′, 3′, and 4′), which are shaded or lined in the figure. Notably, area 1 = area 1′, area 2 = area 2′, and so on, indicating perfect symmetry.

From each of the four circles, identical lower segments (areas 1′ through 4′) are removed. These removed segments are then used to form four new circles of equal area. The total of the removed areas—that is, area 1′ + area 2′ + area 3′ + area 4′—is effectively transferred to the 2D saddle geometry.

However, as this area transitions into the inverse space domain, a squeezing effect occurs—reflecting a topological compression associated with the inverse curvature of the saddle. The mathematical formulation of this transformation is presented below.

$$\text{The area of the inner circle} = \pi r^2 \quad \dots \quad (33)$$

If the length of each side of the square PQRS is taken to be k, then the lengths PP and OP (as indicated in Figure 4) are each equal to k/2. Therefore, we can deduce the following:

$$OP^2 = (PP)^2 + (OP)^2 = (k/2P)^2 + (k/2)^2$$

$$\text{Or, } r^2 = \frac{K^2}{2}$$

$$\text{Or, } \quad k = r2^{\frac{1}{2}} \dots \quad (34)$$

$$\text{Or, } \quad K^2 = \text{area of the Square}$$
$$= (2r^2) \quad \dots \quad (35)$$

Now the Area of the saddle is = [Area of the square PQRS – sum of the area of the four numbers of lined portion (1' + 2' + 3' + 4'), since sum of area (1 + 2 + 3 + 4) = sum of area (1' + 2' + 3' + 4') and since sum of area (1' + 2' + 3' + 4') = [area of the inner circle – area of the square PQRS].

$$= (\pi r^2 - 2r^2) \quad \dots \quad (36)$$

So, the Area of the 2D saddle = (area of square PQRS – sum of the areas of the four numbered portions)

$$= [2r^2 - (\pi r^2 - 2r^2)] = [r^2(4 - \pi)] \quad \dots \quad (37)$$

Now the total area of the non-lined portion = Area (1 +2 + 3 + 4) = (πr^2 - $2r^2$), and from each of the four numbers of outer circles ¼ th of the area of the total lined portion is being cut out

The area of each of the new circles, as shown in Figure 1C = [(πr^2 - (πr^2 - $2r^2$)/4]

$$= r^2\left[\frac{3\pi + 2}{4}\right] \quad \dots \quad (38)$$

So, the total area of all four new circles formed = r^2[(3π +2)] (39).

Now, (total of 4 new circles/area of the formed 2D saddle JPISLRQ (= $0.86r^2$)

$$= \left[\frac{r^2(3\pi + 2)}{r^2(4 - \pi)}\right] = \left[\frac{3\pi + 2}{(4 - \pi)}\right]$$
$$= \text{constant} \quad \dots \quad (40)$$

(40). Now the (area of each of the new circles formed) / (area of the 2D saddle formed)

$$= \frac{\left[r^2\left[\frac{3\pi + 2}{4}\right]\right)}{\left[r^2(4 - \pi)\right)} = \left[\frac{3\pi + 2}{4(4 - \pi)}\right] = \text{constant} \quad \dots \quad (41)$$

Another interesting correlation between the 'Total area of the four numbers of non- lined portion'(i.e. the Total cut-out Area from the four numbers of outer circles in Figure 10) and the 'Inverse area of the saddle' has to be the same because the former have passed into the inverse area and would act in the inverse mathematical sense and hence the numerator and the denominator of the product of equation.

(36) and the reciprocal of equation (37) has to be of the same magnitude since they are 'Multiplicative inverses' of each other. From equations (36) and (37), it can be written,

[('Total area of the four

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numbers of non-lined portion') x ('Area of the saddle in the inverse magnitude')]

$$= [(\pi r^2 - 2r^2)] \text{x} \left[\frac{1}{r^2(4-\pi)}\right] = \left[\left(\frac{\pi - 2}{4-\pi}\right)\right]$$

$$= constant = 1. \quad \ldots \quad (42) or,$$

$$Or, \ \pi = 3.0 \quad \ldots (43)$$

As mentioned earlier, in the product of a number (for example, x) and its multiplicative inverse ($1/x$), the numerator is equal to the denominator in the product form ($x \times 1/x$).

Following this logic, the numerator and the denominator of equation (37) must be equal, and hence—

$$[(\pi - 2)] = [(4 - \pi)]$$

$$Or, \quad 2\pi = 6$$

$$Or, \ \pi = 3 \quad \ldots \quad (44)$$

So, π is precisely equal to 3, and hence the equation below (where θ is in degrees on the RHS of the equation) will always yield a converging value of the angle, since π is converging.

$$\theta = (\text{angle in radian}) = \frac{[\pi \text{ x } \theta]}{180} \quad \ldots \quad (45)$$

Since 2π radian = 360 degrees, so 1 radian with the newly found value of π (= 3) would be,

$$1 \text{ radian} = \left(\frac{360}{2\pi}\right) = 60 \text{ degrees.} \ldots \quad (46)\ SO$$

a circle would be divided into 6 radians, each of which will be 60 degrees and hence,

$$6 \text{ radian} = 360 \text{ degree} \quad \ldots \quad (47)$$

A. The Physical Interpretation of π is as follows: The physical significance of π being equal to 3 is that the ratio of the area of a circle of radius r and the area of the inscribed square of the circle is always 1.5 or (π/2). To state in another way, when a square of each side length √2r (area = $2r^2$) forms an outer circle upon rotation of a half-length segment of any diagonal of the square, its area is swollen by 1.5 times or (π/2) times since the area of the formed outer circle becomes πr^2 or $3r^2$.

i. A circle of radius r has a circumference of 2πr. This means the total length or distance of the circumference is 2πr (= 6r).
ii. The radius r has to rotate 2π (=6) times to form a full circle.
iii. The radius r has to rotate π (=3) times to form a half circle.
iv. So, π is a dimensionless parameter and serves as a measure of the extent of rotation of a straight-line segment of length r, being responsible for subtending variable angles at the centre of rotation. When the subtended angle is 30 degrees, it corresponds to a rotation of (π/6) times; when the angle is 60 degrees, it is (π/3) times. Likewise, a π rotation corresponds to 180 degrees, and a 2π rotation covers the full 360 degrees.
v. In any scale of measurement, if the lowest length is 1, then the minimum linear perimeter, area, and volume would be 4, 4, and 24, respectively. In the case of the non-linear regions—such as for circles and spheres—the minimum circumference, area, and volume (with respect to a circle and a sphere, in any scale of measurement) would be 6, 12, and 216, respectively. It should be noted here that the values for the linear square (4, 4, and 12) and the non-linear values (6, 12, and 216) all represent 'distances' or 'lengths' only.

Considering the value of π = 3, the areas and volumes of conical enclosed geometrical shapes—namely, the circle, sphere, cylinder, and cone—are presented in Table 2 below. The table includes both the newly derived formulas and the corresponding conventional formulas for comparison.

Table II: The Areas and Volumes of the Conical Geometries Based on the Value of π = 3

Geometrical Figure	**Conventional Mathematical Formula of area/Surface area/Perimeter /Circumference**	**Newly Developed Mathematical Formula for area/Surface/Perimeter/Circumference**	**The Conventional Mathematical Formula of Volume**	**A Newly Developed Mathematical Formula for Volume**
Circle of radius r	Circumference $= 2\pi r = 6r$	Circumference = 6r (retained) Area $= 4\pi r^2 = 12r^2$	-	-
Cylinder of radius r and height h	Surface area $= 2\pi r(r + h)$ $= 6r(r + h)$	Surface area $= 8\pi r(r + h)$ $= 24r(r + h)$	Volume $= \pi r^2 h$ $= 3r^2 h$	Volume $= 48\pi r^2 h$ $=$ $144\ r^2 h$
Sphere of radius r	Surface area $= 4\pi r^2 = 12r^2$	Surface area $= 12.5\ \pi r^2 = 37.5\ r^2$	Volume $4/3\ (\pi r^3) = 4r^3$	Volume $= 24\pi^2 r^3$ $216\ r^3$
Cone of radius r, height h & slanting length L	Surface area $= \pi r^2 + \pi rL = \pi r(r + L) = 3r(r + L)$	Surface area $= 4\pi r^2 + 4\pi rL$ $= 4\pi r(r + L) = 12r(r + L)$	Volume $= 1/3\ (\pi r^2 h) = r^2 h$	Volume $= 24\ (\pi r^2 h)$ $= 72\ r^2 h$

Table III: Comparison of the Circumference, Surface Areas, and Volumes of the Circle, Sphere, Cylinder, and Cone, taking r = h = 1 and π = 3 for the Formulas in Table 2 (With L for the Cone Taken as √2)

Geometrical Figure	Circumference CF	Circumference NF	Surface Area / Area CF	Surface Area / Area NF	Volume CF	Volume NF	Comment
Circle	6	6	3	12	-	-	**Conventional Formula:** The area of a circle is less than the circumference of the circle, which is not acceptable. New formulas: the area of the circle is greater than the circumference, which is justified.
Sphere	-	-	12	37.5	4	216	**Conventional Formula:** The volume of a sphere is less than the surface area of the sphere, which is not acceptable. New formulas: volume of the sphere is greater than the surface area, which is justified.
Cylinder	-	-	12	48	3	144	**Conventional Formula:** The surface area of a cylinder is less than the volume of the cylinder, which is not acceptable. New formulas: surface area of the cylinder is less than the volume, which is justified.
Cone	-	-	7.2	28.9	1	72	**Conventional Formula:** The surface area of a cone is larger than the volume of the cone, which is not acceptable. New formulas: the surface area of the cone is less than the volume, which is justified.

A. ‘Space Quantum’ or ‘Space Quantization’ Concept of π Parameter of the Universe

A unit-length vector along the x-direction (in any desired scale) rotates in space by 360 degrees, tracing out the circumference of a circle. However, this rotation is quantized, meaning it occurs in discrete steps of 1°, 2°, 3°, ..., up to 360°. Thus, a full rotation of 360° implies 360 quantised steps. For a 30° rotation, the vector undergoes 30 such steps. Assuming π = 3, the number of integral rotations corresponding to 30° becomes 10π. Therefore, for a complete 360° rotation, the total number of integral rotations is 120π.

The rotations are quantised with respect to the π parameter. Each integral rotation regarding π would be (10π /30) = (π/3). In the first rotation of 1 degree or (π/3), it will create an arc of length 0.0166 [since the total arc length of a circle is 2πr, 360-degree rotation = 2πr, so 1-degree rotation is 0.0166r, and since r = 1 for 1-degree rotation, the arc length would be 0.0166]. So, for a 360-degree rotation, the total arc length would be (360 x 0.0166) = 6. So, for a rotation of 60 degrees or 20π, the arc length would be 1.

In 2 dimensions, the area of a circle of radius r is $4\pi r^2$, as shown by the fact that it arises from 2π times the rotation of the radius along the x and y axes over a circumference of 2πr. To produce a unit area of space, let the times of rotation be p, such that (p x 2πr = 1). Now, when r = 1, the value of p turns out to be 0.166.

Hence, 0.166 times rotation (or 0.055π times rotation) of a circle of radius one over a circumference of 2π will create a unit area of space.

In 3 dimensions, the volume of a sphere of radius r is $24\pi^2r^3$. This arises out of $12\pi r^2$ rotations of a circle of radius r over a circumference 2πr. Now, let the times of rotation be p such that the volume created would be unity in space. So (p x 2πr) = 1. Taking r = 1, π =3, the value of p would be 0.166 (= 0.055π times). Hence, 0.055π times the rotation of a circle of radius one over a circumference of 2π (= 6) will create a unit volume in space.

So, it can be concluded that the entire space of the universe regarding length, area and volume is being quantized with respect to π [3] Hence π stands out to be the index of space quantization.

IV. CONCLUSION

The following conclusions are being drawn from this research article,

A. The areas and volumes are length and distances only.
B. The area is the overlapping of lengths in 2 dimensions
C. The volume is the overlapping of lengths in 3 dimensions.
D. The linear areas and volumes are evolving from the translations of line segments and the squares.
E. The curved areas and volumes are evolving from the rotations of line segments, circles, triangles, or squares.
F. The mathematical formulas of the areas and volumes of familiar geometrical figures like square, circle, sphere, cylinder, cones, etc., are to be calculated as per the new formulas derived in this article.
G. π is a converging dimensionless parameter having a value of precisely 3.
H. The introductory textbooks of mathematics, geometry and mensuration have to be updated immediately, especially for the students.

DECLARATION STATEMENT

This article is dedicated to
the late parents, Mrs Aruna Bhattacharya and Mr Krishna Pada Bhattacharya, of the corresponding author.

After aggregating input from all authors, I must verify the accuracy of the following information as the article's author.

- **Conflicts of Interest/ Competing Interests:** Based on my understanding, this article has no conflicts of interest.
- **Funding Support:** This article has not been funded by any organizations or agencies. This independence ensures that the research is conducted with objectivity and without any external influence.
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AUTHOR'S PROFILE

Nishant Sahdev is a distinguished researcher and student of Dr Chinmoy Bhattacharya as a Research Fellow at Austin Paints & Chemicals Pvt. Ltd. With extensive national and international experience at prestigious institutions, Nishant's academic journey spans Delhi Technological University, New Delhi, India, and the University of Debrecen, Hungary. His work, based on quantum gravity, cosmology, and dark matter, contributes to the development of a unified quantum gravity theory and an innovative space quantisation model. Nishant has published extensively in leading scientific journals and has further honed his expertise in advanced mathematics during research training at King's College London, England. Dedicated to expanding the frontiers of scientific knowledge, Nishant's current work focuses on pioneering theories and equations that challenge conventional understanding. Beyond his academic pursuits, he is also a passionate romance writer and a columnist for national newspapers, seamlessly blending science with creative expression.

Chinmoy Bhattacharya earned his PhD in Polymer Physics in 1988 and completed post-doctoral research on liquid crystal polymers at Laval University, Canada. Returning to India in 1991, he joined ICI India Ltd. and later founded his own paint company. He is a former chairman of the Indian Paint Association and a leading figure in India's paint industry. Bhattacharya's research spans quantum gravity, cosmology, and dark matter, culminating in a unified quantum gravity theory and a novel space quantization model. He has numerous publications in prestigious journals, including his work on a new initiator for free radical polymerization, published in Polymer Chemistry (Royal Society of Chemistry, DOI: 10.1039/COPY00180E). As a guest faculty member at the University of Calcutta, he teaches Colour Physics, Polymer Physics, and Rheology of Coatings to postgraduate students, continuing to inspire the scientific community.