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The Universal Structure in the Moebius Band

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Abstract

A geometric model previously developed to analyze the quantum structure of Hardy's paradox and explore the generic structure of universal states is applied to the Moebius band. The Moebius band's conformity to the model strengthens its hypothesis. The claim made is that universal states cannot be represented as singular structures without reference to a partition of entangled parts that do not share property with each other. In other words, universal states categorically incorporate a systemic feature of inconsistency within their frameworks. In logic and mathematics, this is the prohibition to forming theoretical principles that are singularly fundamental as absolute truths. The Moebius band contains a dualism of two categorically separate formats. It has, firstly, two discrete and observable sides and secondly, a unitary path, in which the sides are entangled and indistinguishable. Quantum structures display a similar attribute of duality. However, unlike quantum structure, the Moebius band displays the full duality of its structure at the classical level. The geometric model demonstrates the common structural basis shared in the Moebius band and quantum structure.

Keywords

Moebius Band, Paradox, Hardy's Paradox, Self-Organization, Quantum Entanglement, Bell's Inequality, Russell's Paradox, Universal Structure

1. Introduction

The paper by Richard Evan Schwartz, "Optimal Paper Moebius Band", proves that the smooth Moebius band must have an aspect ratio greater than ($\sqrt{3}$) and converges up to the isometry of the triangular Moebius band which has the unfolded rectangular dimensions ($\sqrt{3}\times 1$) (Schwartz, 2023: p. 1).

The geometric model previously developed to analyze the quantum structure of Hardy's paradox analyzes the structural basis of the Moebius band to demonstrate and define the fundamental framework contained in all universal states.

Universal states, by definition, necessarily take reference to a boundary within which all the structural elements of the state are included. The state then represents an infinity for a given property. The conundrum found for logic, mathematics, and physics is how to represent the boundary in a consistent theoretical framework of operational relationships that embrace infinity.

At the heart of the problem, and as has emerged in the study of a diverse collection of examples, as a minimum, universal states have either an interior structure that is observationally hidden, as in the quantum framework, or a boundary found to be incomplete for inclusion of its totality, as in the classical framework. The two formats have a complementary form of inconsistency to each other.

The two companion papers to this document, "The Limit to Rationalism in the Immaculately Nonordered Universe" (Gill, 2023a), and "The Mechanism of Paradox in the Structures of Logic, Mathematics, and Physics" (Gill, 2023b), examine the above properties of universal (unitary) states, called *parent* states, and the *sibling* dualism of internal parts they contain. The Cartesian plane of the unit circle is an apt and simple example of the two formats that apply.

In the first format, the parent is the collection of siblings that share a given property. For the unit circle on the Cartesian plane, the parent's component siblings are the x and y axes. They share a common identity under rotation to the parent structure of the unit circle.

In the second format, the parent is the collection of siblings that are *not* members of a common basis for logical conclusion on their relationship but still have membership in the parent state. Using the above example, the unit circle is transformed downward to the dimensionally lower basis of quantum structure, which is the complex plane (Wikipedia, 2023a). Its defining orthogonal directions are the component (x, iy) axes, where i is the identity $\sqrt{-1}$, and i is imaginary in classical formalism. The iy-axis cannot be claimed to be real, and in the classical framework, the x-axis, of the unit circle, has lost its sibling partner at 90 degrees.

The result is that the complex framework of the unit circle becomes an entangled superposition of one- and two-dimensional frameworks. On the one hand, it is observationally classical and Cartesian, with two orthogonal siblings. On the other hand, the sibling iy-axis does not classically exist. There are multiple empirical examples of entangled parent/sibling relationships in quantum structure:

1) The waveform of a photon projecting across a half-silvered mirror has a quantum probability expressed on two quantum-entangled paths, at 90 degrees to each other, $|B\rangle + i|C\rangle$ (Penrose 1994: pp. 261-262). If disturbed by classical detection, the state collapses to a classical framework in which the entangled paths become real and have a 50:50 classical probability for the detection of the photon.

2) The qubit of the quantum computer, as parent, entangles the siblings of classical computing, 0 and 1, by applying the quantum version of the *logical-not*

property (Deutsch, 1999: p. 6).

3) In the entanglement found for the correlated particles in the quantum structure of Bell's inequality, particles display both quantum entanglement and discrete classical locations in separate dimensional frameworks (Gill, 2023b; Herbert, 1985: pp. 218-227).

The example of the parent/sibling relationship for the complex unit circle is reminiscent of the structure found in the Russell set, which is defined as the set of all sets that are not members of themselves (Wikipedia, 2023b; Gill, 2023b: p. 163). In the analogy to the complex unit circle, its circumference is the parent set of all sets. The orthogonal directions are its members, and they are not members of each other for a common property.

By extension, in the higher dimensional framework of the classical unit circle, the x and y axes are also not members of each other. They become distinctly and observationally separate siblings to their parent, and the dictum of the Russell set applies in a new format. The dimensional transformation to the classical level camouflages the paradoxical relationship found in the quantum structure in a framework that supports observation.

The Russell set questions if the parent set should be included as a member of itself. In the analogy to the unit circle, can the circumference have the logical-not property defined by its siblings, to itself? The question is circular and introduces the fundamental problem of how to understand the boundary structure of universal states.

The Moebius band uniquely demonstrates, in a fully classical framework, the two perspectives of inconsistency found in the above structures. On the one hand, the Moebius band is a universal parent state with a single, continuous path of two entangled sides as its boundary condition. From the perspective of the boundary's continuous path, the sides have lost their discrete identities. On the other hand, the parent has two discrete sibling sides that form a second inconsistent framework to the parent's universality. The crucial distinction in the Moebius band is that its two partitioned and inconsistent frameworks are both observable in an exclusively classical format.

2. The Geometric Model

This section presents the detailed structure of the geometric model developed in the companion papers, (Gill, 2023a; Gill, 2023b). Then, in section 3, the model is applied to illustrate the common mathematical basis found in the Moebius band. The example of the Moebius band further supports the contention that the inconsistency found in its entangled structure points to a fundamental principle for universal frameworks.

The model is based on a thought experiment using the general concepts of sequenced emergent self-organization and stationary action principles (Wikipedia, 2023d; Wikipedia, 2023f; Wikipedia, 2023c; Gill, 2023a: pp. 590-591). From an initial null state, segments develop across dimensional boundaries, and each segment is an infinity bound within its upper and lower limits. We claim that the geometry describes the root structure in which a universal state develops complexity.

Because the circumference of the geometry encloses segments that each form infinities, it is a self-contained infinity of infinities. Classical states are always open within a larger framework, and instead, the circumference forms an infinitely closed space that cannot, theoretically, be considered a classical location. Neither can its interior be considered observable for its totality.

The structure of the geometric model illustrated in **Figure 1** and **Figure 2** has no special significance for the claim that its two-dimensional framework contains dimensional infinities. The justification developed in the companion papers, and further discussed in the following sections, is that the segments to the right triangle counter-intuitively entangle linear values as unitary object identities. The segments of the triangle are each assigned the object identity (1) despite having different linear values.

The validity of the geometry's conversion to a nonclassical format is borne out, in sections 2.1 and 2.2, by comparing the two methods of calculating the values generated for the cosine squared identities of the right triangle. The same results are obtained for both methods:

1) The standard format applies in which the sides have linear values.

2) The entangled format applies, in which the segments to the sides have

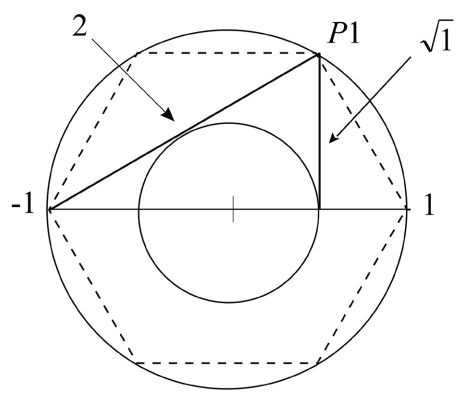

Figure 1. Cosine squared identity for the 60-degree angle.

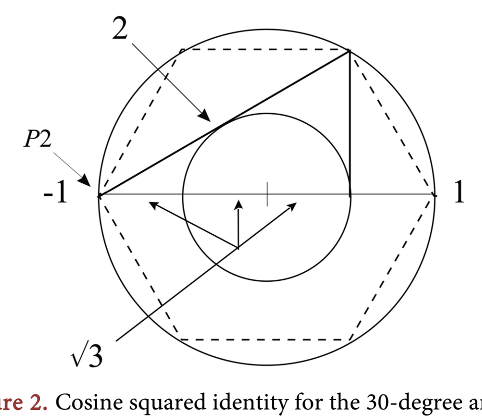

Figure 2. Cosine squared identity for the 30-degree angle.

nonclassical and lower-dimensional object identities.

The entanglement of linear and object formats creates the same effect of the inconsistent relationship identified above for the Moebius band and the other examples. There are two frameworks of sibling structures. The first is quantum-like, with entangled linear/object identities, and the second is classical with linear values for the sides of the geometry. The two frameworks are entangled in the single structure of the geometric model and display a lower dimensional format, native to quantum structure, in the higher dimensional platform of classical space. The superposition of the two levels of dimension in a single framework can be compared to the entanglement of two waveforms in holographic imaging creating a three-dimensional effect on a two-dimensional surface (Wikipedia, 2023e; Gill, 2023b: p. 158).

The geometric figure has an inner and outer circumference, with a superposition of the right triangle within it. The sides to the right triangle cross dimensional boundaries that are established by the inner and outer circumferences. The companion paper, "The Mechanism of Paradox in the Structures of Logic, Mathematics, and Physics" successfully applies the geometric model to the wavefunction rotation, in Bell's inequality (Gill, 2023b: pp. 156-158). The calculation of the twin-state polarization attribute "… is an elementary exercise in quantum theory" (Herbert, 1985: p. 220). The same framework predicts the experimental outcome in Hardy's paradox (Gill, 2023b: pp. 156-158). The pure states for both experiments are found on the right triangle. By analogy, the two pure states of the Moebius band are its sides.

The Hexagonal Calculator calculates the linear values for the adjacent sides to the right triangle on the Cartesian plane (Szyk & Díez, 2023). The diameter of the geometry for the outer circumference is assigned the value 4, and the portion that applies in the geometry is 3. The linear measurements of the 30-60-90 right triangle are:

3) for Cos (30) 3, for Cos (60) 1.732, for the hypotenuse 3.464.

2.1. Calculation in Standard Mathematical Formalism

For the linear values (1.732, 3, 3.464):

$$P1 \text{ - } \ \mathrm{Cos}^2(60) = (1.732/3.464)^2 = 0.25 \tag{1}$$

$$P2 \text{ - } \ \mathrm{Cos}^2(30) = (3/3.464)^2 = 0.75 \tag{2}$$

2.2. Calculation Using Entangled Identities

By entangling linear and object identities, the geometric structure compacts two separate dimensional frameworks. The classical two-dimensional space of the Cartesian plane is transformed downward into a one-dimensional structure, and the square root function is applied to each segment. The hypotenuse consists of two segments, beginning and ending on the same dimensional level, and the square root cancels.

$$P1 \text{ - } \operatorname{Cos}^2(60) = \left(\sqrt{1}/2\right)^2 = 0.25 \quad (3)$$

$$P2 \text{ - } \operatorname{Cos}^2(30) = \left(\sqrt{3}/2\right)^2 = 0.75 \quad (4)$$

The geometry counterintuitively (paradoxically) opens dimensional boundaries in an inconsistent framework to formal mathematical representation. The agreement of the two formats for calculating the cosine squared identity is a strong validation of the rationale in the geometric model.

3. Application of the Moebius Band to the Right Triangle

In this section, the geometric model is applied to the mathematical structure of the Moebius band. The dimensions of the unfolded rectangle of the Moebius band ($\sqrt{3} \times 1$) are predicted by the values assigned to the sides of the right triangle of the geometric model. The agreement is validation for the model's application and demonstrates the common framework of entanglement in the geometry and the Moebius band.

With Object Identities Applied in a Nonclassical Format:

The adjacent side to 30 degrees = $\sqrt{3}$

The adjacent side to 60 degrees: = $\sqrt{1}$ (absolute value = 1)

The value (2) for the hypotenuse, represents both the singular continuous path and the two separate sides of the Moebius band in a single structural format found in tracing the continuous path of the band.

With Linear Values Applied in a Classical Format

The adjacent side to 30 degrees = 3.0 (not relevant to the aspect of the Moebius band);

The adjacent side to 60 degrees: = 1.732 (or $\sqrt{3}$, correct for Moebius band aspect);

The Hypotenuse = 3.464 (not relevant).

4. Conclusion

In the above analysis, we demonstrate the common framework of entanglement shared among the geometric model, the Moebius band, and quantum structure.

The format of entanglement depends on the dimensional level in which it resides. From the classical perspective, entanglement in quantum structure is observed as openly paradoxical because the dimensional framework does not support the level of complexity that allows siblings independent identities. The transformation to the higher dimensional level of classical structure allows sibling elements to have normalized, complementary relationships and the openly paradoxical framework of quantum structure is camouflaged.

The evidence explored in this, and the two companion papers indicates that entanglement is the systemic and root mechanism of relationships at all dimensional levels for universal structures. In the most general sense, universal structures are infinities that, by definition, should contain all the elements of the property they define. However, theoretical, and empirical evidence abounds indicating that, in the simplest framework, universal structures systemically contain an internal partition separating inconsistently conjoined frameworks. As a minimum, two sibling structures arise that form the actual limit of consistency for observation and conclusion.

The difficulty in conceptualizing the framework of universal structure is that whatever form observation and conclusion take, a second inconsistent framework of conclusion is hidden by the mechanism of paradox.

From purely formal theory to everyday observations and conclusions, the structure of rationalism hides the root framework of inconsistency that has as its basis the development of complexity across dimensional boundaries. The paradoxes found in diverse theoretical and empirical examples are discounted because the default rule of rationalism is that counter-rational structure is ruled invalid. Truth is proven false if an argument has inconsistency. Nevertheless, mathematics provides a key understanding of how paradox is a valid mechanism in universal structures.

Dimensional structure is placed on a consistent basis for mathematical operations using the power function. Dimensions can then be grouped and interpreted as having a real relationship between them. However, this hides the root framework in the generation of complex structure, that each dimensional level incorporates an infinity.

Following the above dictum, the boundary of a universal structure also takes its reference in two paradoxical frameworks, that it is contained, and that it is not contained to itself. This is the theoretical conundrum arising in Russell's paradox. Such entanglement, in a dynamic state, would generate tension, as a force, between the two paradoxical frameworks. Finally, the force itself would display sibling frameworks of attraction and repulsion.

One of Richard Feynman's last thoughts, as he lay dying on his hospital bed, was, "I don't have to know an answer. I don't feel frightened by not knowing things, by being lost in a mysterious universe without any purpose, which is the way it really is, as far as I can tell. It doesn't frighten me" (Gleick, 1993: p. 438). Feynman's insights are legendary, and his last statement hints at the role of paradox in all universal structures (Gill, 2023a: p. 587).

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendix—Definitions

For clarity, the following definitions are indicated.

Classical: Classical mechanics refers to the period of mathematical understanding in physics before the discovery of the basis of quantum phenomena. Classical mechanics is the domain of Newton's laws of motion and Einstein's General and Special Relativity theories. Classical structure describes the basis of our observable universe.

Immaculate Nonorder: Immaculate nonorder is distinguished from disorder which is the random mixing of the elements of an ordered state such that the framework of the original structure is lost. Immaculate nonorder does not come from an antecedent higher-ordered structure. Instead, it is the basis of building order by the cyclical subsummation of complexity from its origin which is a null state. The term immaculate nonorder is adopted from the novel *Dimensional Boundaries* (Gill, 2023c).

Null State: A null state is without internal form and does not have a location within a larger structure.

Quantum: The fundamental mathematical component of quantum theory is the square root of minus one. The term imaginary is used because, in classical mathematics, the antecedents $(+1)^2$ and $(-1)^2$ both produce the product (+1). The reverse operation taking the square root is only in the form ($\sqrt{+1}$) and not ($\sqrt{-1}$) which is found in quantum structure and is paradoxical to the format of classical mathematics.

Sub-classical: Sub-classical is a new term applied in the geometric model. Sub-classical structure is multi-dimensional but cannot be mathematically represented by the power function. This is because each segment is a self-contained infinity, and therefore, dimensions cannot be grouped in a consistent mathematical framework. In the geometric model, each unique sub-classical component is subsumed as the complexity of the structure builds across its dimensional boundaries to the circumference that wraps them into a universal state.

Universal State: A universal state is one in which its boundary contains all the structural components it defines. There are two fundamental formats. In the first format, the component parts have a logical-not structure. Observation of their normalized membership in the parent state is prohibited. In the second format, internal components are observationally distinct and normalized. The difficulty in conceptualizing the framework of universal structure is that all frameworks of observation have a circular complexity both within and to the outside by the mechanism of paradox. As a minimum one-half of the framework is necessarily left out in any view taken on the composition of a universal state.