Deterministic Structures in bi-gravitational Fields: A Unified Model Bridging Black Hole Singularities and Quantum Topology

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October 1, 2024

Contents

Abstract

This paper presents a deterministic model that unifies gravitational, strong, weak, and electromagnetic interactions by examining the intersection of gravitational fields. Drawing a connection to bi-gravity theories, where two metric tensors describe gravitational behavior, the model highlights how expanding and contracting fields couple and influence curvature. These intersecting fields, characterized by complementary topological transformations, form a shared nucleus of subfields and reinterpret singularities as abrupt curvature discontinuities, linking phenomena across quantum and cosmic scales. The model offers insights into energy and density transfer and information preservation. It explores connections to dark matter, reflection positivity, the mass gap problem, and Hodge cycles, providing a pathway to understand the breakdown of General Relativity in both atomic and black hole structures.

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1 Introduction

In 2020, Roger Penrose was awarded the Nobel Prize in Physics for his work demonstrating the existence of black hole singularities—points of extreme curvature where density and gravity become infinite—within the framework of Einstein's General Relativity.

Although it remains a theoretical model, Penrose mathematically demonstrated that the gravitational collapse of massive stars leads to a process of extreme compression, culminating in the formation of a curvature singularity where density and the gravitational field reach infinity, resulting in the creation of a black hole. Other researchers, such as Kip Thorne, have modeled black hole formation by studying binary black hole mergers and the resulting gravitational waves.

Mathematically, singularities are characterized as points where a curve abruptly changes direction or sign, forming a sharp cusp where a tangent cannot be defined. Such a singular point is described as a point-like region of undefined or infinite curvature.

Within the framework of General Relativity, which models gravity as a consequence of spacetime curvature, such a curvature singularity represents a point where gravitational forces become infinitely strong. This leads to a breakdown of the laws of General Relativity, highlighting the need for a more comprehensive theory to fully describe the behavior of spacetime in the presence of curvature singularities, which are considered extreme conditions.

The static universe model, prevalent at the beginning of the 20th century, was a foundational assumption in Einstein's original General Relativity theory. To maintain a static gravitational field, Einstein introduced a cosmological constant — an outward-pushing force — to compensate for the inward gravitational pull caused by spacetime curvature.

However, in 1922, Alexander Friedmann developed solutions to Einstein's General Relativity equations that demonstrated that the universe, as a curved spacetime manifold, could be dynamically changing — either expanding or contracting — instead of being static. Friedmann's solutions showed that, depending on the universe's density and the cosmological constant, different evolutionary scenarios involving contraction and expansion were possible, laying the groundwork for modern cyclic cosmology.

2 Singularities as Abrupt Changes in Curvature

In this paper, we propose a novel model in which black holes emerge from the intersection of two merging gravitational fields whose curvature periodically varies in or out of phase. This intersection forms a nucleus composed of two vertical and two transverse gravitational subfields, which are characterized as black holes with an inner singularity point where gravitational forces remain finite.

Additionally, the model posits that similar singularities exist in the curvature of subatomic field particles, being integrated into the nucleus proposed by a deterministic dual atomic model formed by two intersecting gravitational fields varying in or out of phase.

Under this framework, black holes and subatomic particles share identical topological structures, wherein curvature singularities involve abrupt changes in sign or direction. These singularities contrast with the gradually changing, smooth curvature predicted by General Relativity, possibly resulting in the failure of Einstein's equations.

Conceptually, our model shares a link with Gerard 't Hooft's work, particularly in exploring connections between black holes and subatomic particles through a deterministic framework, although it differs in both approach and results.

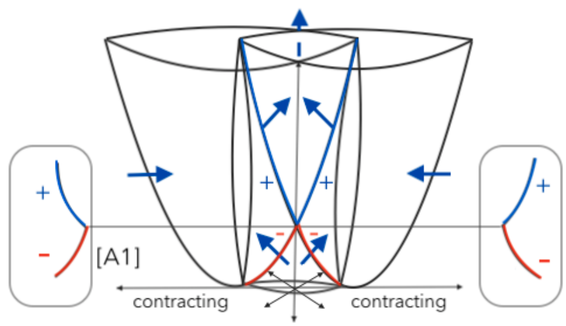

Figure 1: *Singularities in the symmetric system when both intersecting fields contract.*

The intersecting gravitational fields produce two vertical and two transverse subfields. The vertical subfields resemble inverted cones of light meeting at their apex, while the transverse subfields resemble mirrored regions connected at a cusp singularity. This apex marks the intersection of the gravitational fields, creating regions of positive, negative, or mixed curvature.

In string theory, curvature singularities emerge as Calabi-Yau conifold cusps, with various mechanisms proposed to resolve the resulting infinities by introducing extended fundamental objects and extra dimensions to smooth spacetime curvature, aiming to unify quantum mechanics and General Relativity.

We relate the transverse subfields and their singularities to topological features such as conifold singularities and Calabi-Yau transverse regions, akin to those in string theory, though our approach to compactifying additional dimensions is distinct. This framework maintains finite gravitational forces at singularity points, offering a unified view of spacetime geometry.

Our model conceptualizes the transverse subfields, their singularities, and elliptic orbits as curved, "trapped" folds within a dual system, providing a relativistic interpretation of their hyperdimensionality. Additional spatial coordinates are necessary to describe the transverse subfields because their Y-axis would be considered from the perspective of their host gravitational fields as a diagonal, introducing dilation or contraction in the resultant measures of space and time. Additionally, a second time dimension is needed to describe the differences in phase between the nuclear subfields and their respective hosts, or the different phases between the mirror subfields when antisymmetry is introduced.

On the other hand, the intersecting fields model may be thought of as related to bigravity theories.

3 Bigravity Theory and Its Relation to the Intersecting Fields Model

Bigravity theory primarily emerged as a cosmological theory that modifies general relativity by introducing two metric tensors corresponding to two interacting gravitational fields. These gravitational fields interact to form a coupled system consisting of two different gravitational wave modes: one corresponding to a massless graviton and the other to a massive graviton.

While the coupling of the two metrics is mathematically defined, the underlying physical mechanism that would provide an explanation for this coupling remains unclear and is not explicitly physically described.

The intersecting fields model suggests a possible physical mechanism coupling the gravitational fields by considering the dynamics and types of the interacting curvatures: a positive convex curvature associated with an expanding field (which may be related to the massless graviton), and a negative concave curvature associated with a contracting field (which may be related to the massive graviton).

The expanding field generates an outward pulling effect with its outer convex side, similar to that caused by a cosmological constant, with long-range influence, while the contracting field produces a localized pushing effect with it inner concave side.

When these two fields vary out of phase — for example, a left field contracting while a right field expands — a central manifold of interaction emerges in the coupled system. In these regions, the left-hand curvature of a right expanding field and the right-hand curvature of a left contracting field become intertwined, forming a shared structure composed of four subfields, each one with double curvature coupled by a singularity point.

Each subfield exhibits double curvature, which can be seen as a single curvature with two different sectors or components: one component corresponding to the curvature of the expanding field and the other to the curvature of the contracting field. The double curvature within these subfields can be either doubly positive, doubly negative, or a combination of half-positive and half-negative curvatures (depending on the phases of variation of he intersecting fields), coupled or united at a singularity point where the intersecting gravitational fields meet.

A bigravity theory modeled in this way would potentially provide a description of the singularity points inside black holes as abrupt changes in curvature generated by the coupling of the two types of interacting curvatures. However, the current mathematical framework of bigravity theory does not associate the interacting fields with positive or negative curvatures that expand of contract. It does not predict a manifold of subfields shared by the coupled system, and it does not propose that curvatures are coupled through a singularity point. Additionally, bigravity theory does not offer a framework for understanding quantum gravitational effects or interactions at the atomic or subatomic scale.

The intersecting fields model is proposed as a deterministic, non-probabilistic "bigravitational" atom whose nucleus is formed by the coupled interaction of two gravitational fields. It suggests that the inward-pushing force from the negative curvature (of a contracting field) and the outward-pulling force from the positive curvature (of an expanding field) interact to form different subfield-particles: a doubly compressed subfield-particle for the strong interaction, a doubly decompressed subfield-particle for the weak interaction, and a half-compressed, half-decompressed subfield-particle for the electromagnetic interaction.

4 Supersymmetric Dual Atomic Nucleus

The subfields will act as fermionic or bosonic particles, being topologically transformed into each other through time without the need of additional superpartners in the following way:

With opposite phases, the upper vertical subfield will move right or left toward the side of the host field that contracts. Moving leftwards, that subfield will act as an electron. The pushing force generated by the outer positive side of its left curvature when moving left is interpreted as an electric charge. On the right side of the system, that vertical subfield will exist as a virtual particle; that is, it will not currently exist but will later appear as a positron subfield moving rightwards when the left field expands and the right contracts.

The pendular displacements of this subfield allow us to describe it as a Majorana antiparticle, a particle that is its own antiparticle at different times.

The inner curvature of this vertical subfield is formed by two negative curvatures united by a cusp point; it also can be considered as a single negative curvature that abruptly changes direction at its central singularity point.

Simplifying its curvature in a 2D model, we can say that acting as a positron, when the right field expands and the left one expands, the subfield's right side curvature is formed by the negative curvature inside the right-handed half part of the left expanding field, and the subfield's left curvature is formed by the negative side of the curvature inside the left half part of the right contracting field.

At that same stage, when the right field contracts and the left one expands, the right transverse subfield receives a double pushing force that contracts it: one caused by the positive outer side of the right-handed half part of the left expanding field, and another caused by the inner negative curvature of the left half part of the right contracting field. At that moment, the left transverse subfield does not exhibit symmetry because it will be experiencing a double decompression: Its upper positive curvature will move rightwards because it is formed by the outer side of

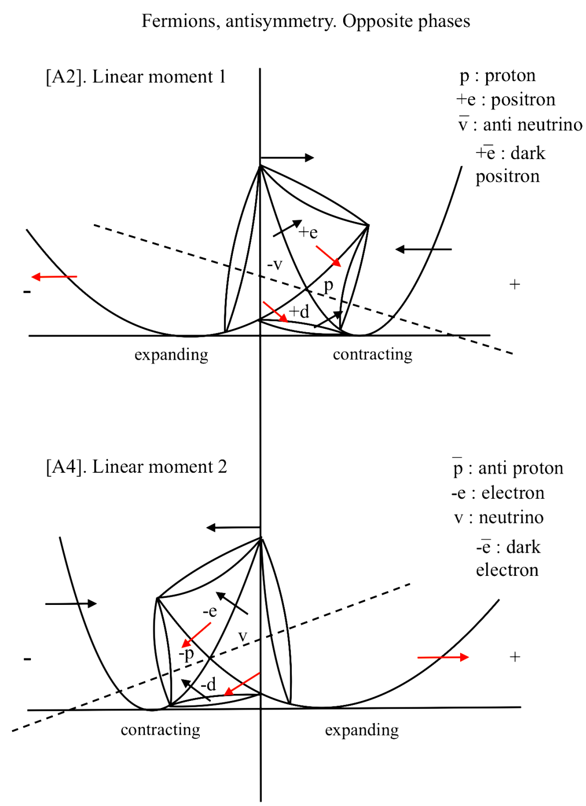

Figure 2: *Atomic model: Antisymmetric system.*

the half part of the right contracting field; and its bottom negative curvature will also move right because it is formed by the negative side of the right half part of the left expansive field.

The subfield that contracts increases its inner kinetic orbital energy and its mass density, creating a stronger bond that unites the system. The subfield that expands decreases its inner kinetic energy and its mass density, representing a weaker bond in the interactions that allow the nucleus and the whole system to remain united.

When the left field contracts and the right one expands, the left transverse subfield will contract, reaching mirror symmetry with the previous stage of the right transverse contracting subfield, which now will be expanding.

The left expanding transverse subfield at moment 1 will be the mirror antiparticle of the right expanding transverse subfield at moment 2; and the left contracting transverse subfield at moment 2 will be the antiparticle of the right contracting subfield at moment 1. These would be Dirac antiparticles.

These topological transformations represent an oscillatory flux of transfer density and energy between the left and right sides of the system.

In this antisymmetric system, the singularity point will move left or right of the center of the system, toward the side of the fields that contract.

In the context of this dual atomic model, the right transverse contracting subfield is predicted to be a contracting proton that decays into a neutrino when expanding; the right expanding transverse subfield is proposed to be an antineutrino that becomes an antiproton when contracting. Neutrons are characterized in this model as the neutral stage where the negative and positive sides of the system annihilate their charges because the vertical subfields pass through the vertical axis that determines the center of the system, and the transverse subfields exhibit the same shape and density during the short moment when the left and right fields have the same curvature while contracting and expanding (or expanding and contracting).

Antisymmetry is introduced in the system because of a delay in the phase of one of the intersecting fields. This implies the necessity of an additional time di-

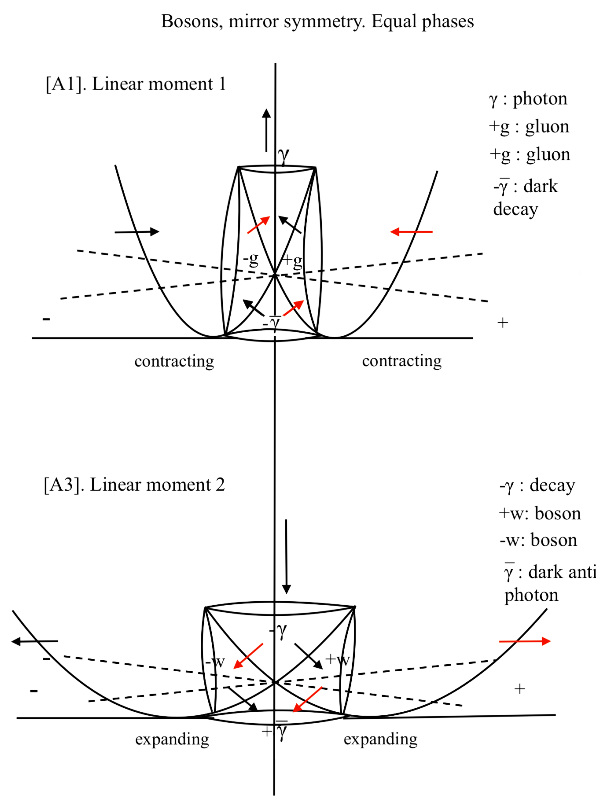

Figure 3: *Symmetric system: subatomic particles.*

mension represented by a coordinate that moves—in a type of Wick rotation—from the imaginary coordinate Y to a purely imaginary coordinate represented by a diagonal axis.

As the vertical subfield cannot simultaneously be at the left and right sides, and the transverse subfields cannot be simultaneously expanding or simultaneously contracting, they can be considered governed by an exclusion principle. Considering Pauli's principle in the context of mirror symmetry or antisymmetric field-particles, we could state that the four subfields in this antisymmetric system would be fermions.

When the phases of the intersecting fields synchronize, the upper central subfield will move upwards while contracting, receiving a double inward force caused by the negative side of the left half part of the right field's curvature, and by the negative side of the right half part of the left field's curvature. The singularity point will move upwards through the central Y axis. The double force of compression would cause an upward pushing force that can be interpreted as Hawking radiation in the context of cosmological black holes, a pulsation that emits a photon in an atomic realm.

When a moment later both intersecting fields expand, the vertical subfield will expand moving downwards, losing its inner density and slowing its inner kinetic orbital energy. This decay that occurs in the concave side of the system does not imply a loss of information because an equivalent inverted force will emerge at the convex side of the system, where an inverted cone of light with a double positive curvature connected by the singularity point receives the compression caused by the positive side of the right half part of the left expanding field, and by the positive side of the left half part of the right expanding field. This inverted pulsation would cause an antiphoton. Photon and antiphoton would follow the Exclusion principle.

However, in the symmetric system, the transverse subfields have chiral symmetry; they simultaneously contract or expand, being interchangeable under rotation. As the left and right transverse subfields simultaneously contract or simultaneously expand, their states of being contracting or expanding would not be ruled by the Pauli Exclusion Principle, being characterized as bosons.

Individually considered, each intersecting field has a smooth curvature with no singularity; if they were separately considered black holes, they would fit with Kerr's statements about the non-mandatory existence of singularities in black holes.

However, considered as a system, it can be said that although singularity points exist inside the "trapped" transverse subfields and in the vertical subfields, a singularity point does exist on the outer side of the black hole systems, below Penrose's event horizon, representing a counterexample to Penrose's censorship conjecture.

The inner singularity of the subfield placed at the convex side of the system will be seen naked by an observer at a distance looking at the convex side of the black hole system. Its inner kinetic energy and material density will be considered dark by an observer placed in the concave side of the system.

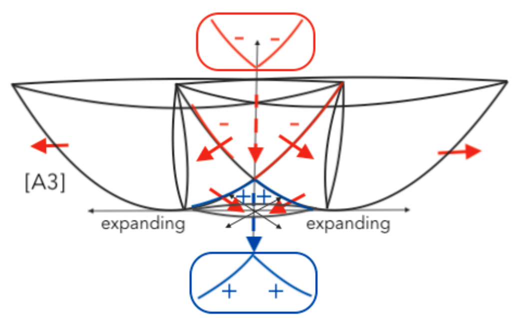

Figure 4: *Singularities in the symmetric system when both intersecting fields expand.*

Initially, it can be thought that the dynamics of the system can be described by two separate functions: a complex differential function that describes the evolution of the symmetric system, and a complex conjugate differential function which describes the evolution of the antisymmetric system. Even if they synchronize and desynchronize periodically, those smooth and continuous transformations would respond to the traditional continuity of classical wave mechanics. Then, where does the quantum behaviour originate from?

By representing the pushing forces caused by the inner or outer curvatures of the expanding or contracting fields with eigenvectors of value 1 or -1, and representing those eigenvectors as the elements of a set of 2x2 complex rotational matrices, the evolution of the vectors indicates an interpolation between the symmetric complex and the antisymmetric complex conjugate moments of a rotational system:

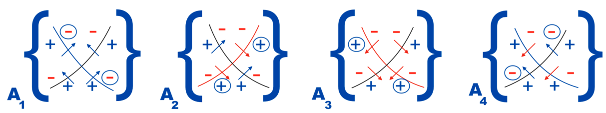

Figure 5: *Rotational system: eigenvectors evolution interpolates the symmetric and the antisymmetric systems.*

A first symmetric stage where both intersecting fields contract. A second antisymmetric stage where the right field contracts and the left expands. A third symmetric stage where both intersecting fields expand. A fourth antisymmetric stage where the left intersecting field contracts and the right expands. The nuclear transformations in curvature through these stages imply a total of 4x4=16 singularities, which relates this composite model with a Kummer-type surface and thus with algebraic geometry.

Along with the abrupt changes in the smoothness of the curvature of the nuclear subfields, the discontinuity derived from that unexpected interpolation may be interpreted as a quantum jump in the continuous development of a classical wave function.

5 Discussion and Outlook: Innovations and Open Possibilities

While the intersecting fields model presented in this paper lacks a rigorous algebraic formalism, a mathematical background has been added to the model in a previous paper Bueno [2023a] and Bueno [2023b], characterizing in a conceptual way the curvature singularities with Gorenstein theory, offering insights into the mass gap problem and reflection positivity. It also describing the interpolation between the symmetric and antisymmetric transformations of the nuclear subfields as Hodge cycles related to Tomita-Takesaki theory.

The model offers a comprehensive and integrative framework that draws connections between previously separate theories across both cosmology and quantum physics, aiming to provide a coherent set of conceptual tools and predictions that may inspire further research and the development of a more formal mathematical structure.

The model's innovative contributions and open possibilities include:

- **A Unified Geometric Framework for General Relativity and Quantum Mechanics:** The model proposes a unified geometric framework that aims to bridge general relativity and quantum mechanics. By conceptualizing a deterministic atomic structure, it unifies all known fundamental interactions, aligning with the work of t'Hootf. This framework provides a comprehensive, non-probabilistic perspective on the atomic structure, offering an integrated view of gravitational, electromagnetic, strong, and weak forces within a singular topological model.

- **Counterexample to the Cosmic Censorship Conjecture:** The framework suggests a possible counterexample to Penrose's Cosmic Censorship Conjecture by proposing the existence of naked singularities visible from certain perspectives. Moreover, it posits that these singularities are linked to regions of space that appear "dark" to some observers, potentially offering connections to the phenomena of dark matter and dark energy. The model also predicts upward and downward, or leftward and rightward, displacements in the singularity point with respect to the center of the system.

- **Singularities in Subatomic Particles:** Extending the concept of singularities to the quantum realm, the model hypothesizes the existence of curvature singularities within subatomic particles. This perspective aims to provide a unified topological description of spacetime across both cosmological and quantum scales.

- **A Physical Mechanism for Bigravity Theories:** By proposing an interaction mechanism for two metric tensors—each representing distinct gravitational curvatures—the model provides a conceptual foundation for bigravity theories. It extends these concepts to the atomic scale, thereby offering a non-standard "quantum bigravity" model that integrates massive and massless gravitons through intersecting gravitational field singularities.

- **Proton Decay Mechanism via Model Dynamics:** The dynamics of the model provide a mechanism for proton decay, suggesting that interactions between symmetric and antisymmetric curvatures facilitate this process. The decay is conceived through topological changes in the field structure, offering a new perspective on how proton instability can arise from underlying gravitational interactions.

- **Periodic Transfer of Density and Energy Between Symmetric and Antisymmetric Sides:** The model proposes periodic transfers of density and energy between the symmetric and antisymmetric sides of the system. These transfers, while preserving the total Hamiltonian, offer a way to integrate concepts from "handshaking" theories, where events and interactions are mediated through time-symmetric processes. This periodic exchange provides a novel way to describe the balance of forces and conservation laws within the system.

- **Topological Nature of Singularities and Curvature Discontinuities:** The model reinterprets singularities in black holes and subatomic particles as topological features characterized by abrupt curvature discontinuities, unlike the gradual spacetime curvatures predicted by General Relativity.

- **Duality in Field Dynamics and Holographic Interpretation:** The intersecting gravitational fields produce vertical and transverse subfields, resembling mirrored regions connected by cusp singularities. This structure suggests a possible holographic nature to the system, where the dynamics of the entire space may be encoded within lower-dimensional manifolds, akin to ideas in the holographic principle.

- **Geometric Interpretation of Charge and Force through Curvature:** The model provides a deterministic interpretation of charge and force as outcomes of the curvature in gravitational fields. Specifically, electric charge is viewed as a "pushing" force resulting from the curvature of expanding or contracting fields offering a unified geometric approach that links gravity with electromagnetic interactions.

- **Supersymmetry without Superpartners:** The model introduces a novel perspective on supersymmetry, conceptualizing it as a topological transformation within a rotational dual intersecting fields system. Unlike conventional supersymmetric theories that rely on additional superpartners, this framework describes how subfields transform between fermions and bosons, achieving supersymmetry through topological oscillations influenced by the system's rotational dynamics.

- **Connection to Quantum Chromodynamics (QCD):** The model connects to QCD by representing the pushing and pulling forces within the system as vectors in a vector space. These vectors, interpreted as quarks, offer a novel geometric perspective on the color force and the strong interaction, framing quarks as fundamental carriers of force within the model's topological structure.

- **Integration of Calabi-Yau Structures and Conifold Singularities:** The model establishes a connection between the transverse subfields of the dual gravitational system and Calabi-Yau structures, such as elliptic fibrations and conifold singularities encountered in string theory. Notably, the framework retains the complex extradimensional structure inherent to these topological features, without reducing or compactifying the spatial dimensions.

- **Dynamic Phase Synchronization and Asymmetry in Gravitational Interactions:** By accounting for phase differences between intersecting gravitational fields, the model provides a mechanism for dynamic symmetry-breaking and synchronization. The interplay between synchronized and desynchronized phases offers insights into the origin of asymmetry in gravitational systems and its potential cosmological implications.

- **Additional Time Dimension and Phase Differences:** A purely imaginary additional time dimension is introduced to account for phase differences within the gravitational system. This dimension enables a description of antisymmetry in the phases of nuclear antisymmetric subfields or between the symmetric subfields and intersecting fields.

- **Insights into the Mass Gap, Reflection Positivity, and Hodge Cycles:** By employing Gorenstein theory to characterize curvature singularities, the model offers potential explanations for the mass gap problem and reflection positivity. Additionally, it suggests interpolations between the smooth continuous transformations of symmetric and antisymmetric moments within the system, resulting in unexpected discontinuities in complex or conjugate wave functions. These interpolations and related transformations are interpreted as Hodge cycles, which manifest in the periodic transformations of a Kummer-type surface, thereby providing a connection to complex geometry and algebraic structures.

- **Quantum Jumps as Curvature Discontinuities:** The model interprets quantum jumps as discontinuities in curvature interpolation between symmetric and antisymmetric states. This provides a topological framework for quantum transitions, suggesting that what appear as probabilistic quantum events may be understood as deterministic transformations in the curvature of intersecting gravitational fields.

Keywords: black holes, singularities, Cosmic Censorship Conjecture, intersecting gravitational fields, bi-gravity, bi metric tensors, dual gravitational fields, information paradox, mirror symmetry, strong and weak interactions, electromagnetic interactions, supersymmetry, naked singularities, quantum field theory, General relativity, Gorenstein singularities, Hodge cycles, Kummer surfaces, T-duality, reflection positivity, SYZ conjecture, mass gap problem.

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