

The Three Spheres Theory

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Abstract

Quantum mechanics successfully describes matter from elementary particles through atoms and larger quantum systems, yet fundamental questions remain concerning the physical structure underlying different levels of matter, the nature of additional spatial dimensions proposed by theories such as string theory, and the physical relationship maintained between spatially separated entangled systems.

This paper introduces the **Three Spheres Theory**, a speculative framework in which the nine spatial dimensions of superstring theory are represented as three real, mutually orthogonal three-dimensional physical spaces: the **Bottom, Middle and Top Spheres**. Fundamental strings occupy the Bottom Sphere, stable subatomic particles manifest in the Middle Sphere, and atoms and larger structures manifest in the Top Sphere.

The theory introduces Dimensional Orientation, D_o , as a property determining dimensional manifestation, while a string's Vibrational State, V , contains both a species-defining component, V_s , and a manifestation-relevant Rotational Vibrational Component, R_v . Changes in R_v are proposed to generate Dimensional Rotation, D_r , which changes D_o while preserving V_s . Stable Middle-sphere particle manifestation occurs when the resulting Dimensional Orientation reaches the orthogonal orientation of 90° . Stable bound systems of fully oriented Middle-sphere particles can subsequently acquire an emergent Collective Dimensional Orientation, D_{oc} , permitting manifestation as atoms in the Top Sphere.

The framework also proposes that locality is sphere-dependent. Systems widely separated in the Top Sphere may retain a joint quantum relationship in the underlying Middle and/or Bottom Spheres, providing a possible physical interpretation of entanglement while requiring consistency with Bell correlations and the no-signalling principle. The framework further allows speculative interpretations of mass, dark matter, WIMPs and gravity in terms of Middle- and Bottom-sphere structure.

A principal testable consequence is reversible dimensional manifestation. If a controllable change in the Rotational Vibrational Component R_v can generate Dimensional Rotation, an inverse vibrational change applied to a trapped elementary particle should, in principle, remove its stable Middle-sphere manifestation while preserving the species-defining vibrational structure V_s , with a subsequent forward change restoring the same particle state. A controlled single-electron experiment is proposed as a conceptual test of this prediction.

The Three Spheres Theory does not replace the established mathematical predictions of quantum mechanics. A provisional dimensional potential and Lagrangian are introduced to model stable Bottom and Middle orientations and to derive a critical Rotation threshold and hysteresis. These are provisional dynamics rather than established laws. The framework's viability depends upon a

fundamental derivation of such dynamics, compatibility with established experimental results, and the identification of physical interactions capable of testing its distinctive predictions.

1. Introduction

1.1 The Problem

Quantum mechanics is extraordinarily successful at predicting the behaviour of matter at atomic and subatomic scales. It describes phenomena such as superposition, interference and entanglement with remarkable accuracy. Yet the physical world experienced at ordinary scales appears very different. Objects have apparently definite positions, behave approximately according to classical physics, and do not normally display observable quantum superpositions.

There is no known fundamental size at which quantum mechanics ceases to apply. Atoms, molecules and increasingly large systems can exhibit quantum behaviour, while decoherence provides an important explanation for why quantum interference becomes extremely difficult to observe in macroscopic systems. Nevertheless, this leaves open a deeper question: what physical structure underlies the different levels at which strings, subatomic particles, atoms and macroscopic objects might exist?

Entanglement raises a related problem. Two quantum systems that have interacted can remain described by a joint quantum state even after becoming widely separated. Bell experiments demonstrate correlations that cannot be explained by local hidden-variable theories, while quantum mechanics nevertheless prevents entanglement from being used for controllable faster-than-light communication. The mathematical predictions are extremely successful, but they do not require a conventional mechanical explanation of what physically connects the entangled systems.

The central question considered in this paper is therefore whether apparently different levels of physical reality could be manifestations of a deeper dimensional structure.

In particular:

Could strings, subatomic particles and ordinary atomic matter occupy different but related three-dimensional physical spaces within a larger nine-dimensional spatial structure, with emergence between these levels determined by dimensional orientation?

If so, apparently separate questions involving physical scale, particle emergence, entanglement and the transition from microscopic to macroscopic structure might be different consequences of the same underlying geometry.

1.2 Motivation

Modern physics already contains several ideas suggesting that the three spatial dimensions directly experienced by humans need not constitute the complete structure of physical reality.

Superstring theory, for example, is normally formulated in a spacetime containing nine spatial dimensions and one dimension of time. Conventional approaches explain the absence of six observable spatial dimensions through compactification, often using a six-dimensional Calabi–Yau

geometry. Quantum mechanics similarly employs structures that cannot be represented simply in ordinary three-dimensional space.

These theories have produced powerful mathematical frameworks, but important questions remain open. String theory has not been experimentally confirmed, the physical nature of additional dimensions remains unknown, the underlying physical interpretation of entanglement remains debated, and no experimentally established boundary separates the quantum and classical worlds.

The present work approaches these questions from the standpoint of Scientific Realism: the assumption that a physical reality exists independently of observation and may contain structures that are not directly accessible to human senses or present experimental instruments.

This motivates considering whether the additional spatial dimensions required by string theory might have a different physical organisation from conventional compactification. Existing higher-dimensional models already allow different possibilities. Brane-world theories, for example, explore the possibility that ordinary matter may be largely confined to a lower-dimensional domain while gravity can extend into additional dimensions.

The Three Spheres Theory explores a different possibility. Rather than treating the six additional spatial dimensions as a single compact six-dimensional geometry, or treating ordinary space as a brane embedded within a higher-dimensional bulk, it proposes that the nine spatial dimensions form three real, mutually orthogonal three-dimensional physical spaces. These spaces are associated with successive levels of physical organisation: strings, subatomic particles, and atoms and larger structures.

Such a structure could potentially provide a common physical framework for several otherwise separate ideas: strings underlying elementary particles, subatomic particles underlying atoms, atoms forming ordinary matter, and entangled systems retaining relationships that are not determined solely by their separation in observable three-dimensional space.

The motivation is therefore not to replace the successful predictions of quantum mechanics or string theory, but to investigate whether a different physical interpretation of dimensional structure can connect these phenomena.

1.3 Proposal

The Three Spheres Theory proposes that the nine spatial dimensions of ten-dimensional superstring theory form three real, mutually orthogonal three-dimensional physical spaces: the Bottom Sphere, Middle Sphere and Top Sphere.

The Bottom Sphere consists of the first three spatial dimensions and contains fundamental strings.

The Middle Sphere consists of the next three spatial dimensions. Stable subatomic particles manifest in the Middle Sphere from underlying Bottom-sphere string states.

The Top Sphere consists of the final three spatial dimensions and corresponds to the ordinary three-dimensional physical world. Atoms manifest in the Top Sphere from stable bound systems of Middle-sphere subatomic particles, and molecules and larger structures are subsequently constructed from these atoms.

The connection between the Bottom and Middle Spheres is proposed to depend upon Dimensional Orientation, D_o , and the vibrational structure of the underlying string. The Vibrational State V is taken to contain a species-defining component V_s and a Rotational Vibrational Component R_v . A suitable change in R_v can generate Dimensional Rotation, D_r , changing D_o while leaving V_s unchanged. Particle identity is therefore associated principally with V_s , while the vibrational component R_v influences whether the required dimensional orientation for manifestation is reached.

A string state becomes capable of stable Middle-sphere manifestation when a suitable change in its Rotational Vibrational Component produces sufficient Dimensional Rotation for D_o to reach the required orthogonal orientation of 90° .

Top-sphere emergence follows a related but collective process. When all the required subatomic constituents of a stable bound system have achieved complete Middle-sphere orientation, their binding can produce a new Collective Dimensional Orientation, D_{oc} . This emergent orientation permits the complete bound system to manifest in the Top Sphere as an atom.

The theory therefore proposes a hierarchy:

Bottom Sphere: strings $\rightarrow$ Middle Sphere: subatomic particles $\rightarrow$ Top Sphere: atoms and larger structures.

The same dimensional structure also provides a possible interpretation of entanglement. Two systems that are widely separated in the Top Sphere need not have the same degree of separation in the underlying Middle or Bottom Spheres. Their joint quantum relationship may therefore persist at a lower dimensional level without requiring a signal to travel between their Top-sphere manifestations.

1.4 Scope

The Three Spheres Theory is a speculative physical framework. It does not propose to replace quantum mechanics, relativity, the Standard Model or the experimentally successful predictions derived from them. Any complete version of the theory would have to reproduce those predictions wherever they have been experimentally established.

The theory instead attempts to provide a possible underlying physical structure connecting dimensionality, emergence, physical scale and entanglement.

Several additional implications are explored. Mass is proposed as a property associated with Middle-sphere particle manifestation. Matter that remains principally within the Middle Sphere provides a possible interpretation of dark matter. Weakly Interacting Massive Particles (WIMPs), if they exist, could represent Middle-sphere particles possessing extremely weak coupling to Top-sphere matter. Gravity may potentially involve interactions extending through the Middle and/or Bottom Spheres.

These ideas are consequences or extensions of the proposed framework rather than established results.

The present theory does not yet specify the physical mechanism that makes three real three-dimensional spaces mutually orthogonal, derive the particular vibrational feature represented by R_v from fundamental string dynamics, determine how physical interactions change R_v , derive the observed masses or charges of elementary particles, derive Collective Dimensional Orientation from a fundamental interaction, or provide a complete mathematical description of gravity.

It must also reproduce the experimentally observed correlations of entangled systems, including Bell-test results, while preserving the no-signalling principle.

The purpose of the present paper is therefore narrower: to define the Three Spheres hypothesis clearly, establish its initial mathematical structure, identify its principal physical consequences, and determine what distinctive experimental predictions would be required for it to develop into a testable physical theory.

2. Related Work and Physical Background

Modern physics describes nature across an enormous range of scales, from macroscopic objects to atoms, nuclei and elementary particles. Quantum mechanics provides the fundamental framework for describing matter and radiation at these scales, while classical behaviour emerges for large systems under appropriate conditions. Several concepts are particularly relevant to the framework developed in this paper: quantum mechanics, entanglement, orthogonality, emergence, scale, dimensionality, string theory and brane-world physics.

2.1 Quantum Mechanics

Quantum mechanics describes physical systems in terms of quantum states rather than the definite positions and trajectories of classical mechanics. A quantum state may be represented by a wavefunction or, more generally, by a state vector in Hilbert space.

$$|\psi(x, t)|^2$$

For a wavefunction $\psi(x, t)$, the quantity $|\psi(x, t)|^2$ gives the probability density associated with a position measurement.

One of the defining characteristics of quantum mechanics is superposition. If two states $|A\rangle$ and $|B\rangle$ are possible states of a system, quantum mechanics permits states of the form

$$|\psi\rangle = \alpha|A\rangle + \beta|B\rangle$$

where α and β are probability amplitudes. Quantum mechanics is not restricted to elementary particles. Protons, neutrons, atoms and molecules are quantum systems, and quantum behaviour has been demonstrated experimentally in increasingly large systems. There is no established physical scale at which quantum mechanics is known to cease to apply.

Classical mechanics nevertheless provides an extremely accurate description of ordinary macroscopic objects. Rather than representing a fundamental boundary between quantum and classical physics, classical behaviour can in many circumstances be understood as an effective description arising when quantum interference becomes inaccessible.

2.2 Calabi–Yau Geometry and Compact Dimensions

Modern superstring theory is formulated in ten-dimensional spacetime: nine spatial dimensions and one dimension of time. Three spatial dimensions are extended and directly observable. In conventional compactification approaches, six additional spatial dimensions are taken to be compactified into an extremely small internal geometry, often modelled using a Calabi–Yau manifold

A Calabi–Yau manifold should not be visualised as six tiny curled tubes inside ordinary space. Instead, it is a compact six-dimensional geometry associated with every location in the observable three-dimensional universe. The curled illustrations commonly used in textbooks are projections of a higher-dimensional geometry rather than literal shapes embedded in x , y and z .

Every physical location may therefore be represented schematically as $(x, y, z ; w_1, w_2, w_3, w_4, w_5, w_6)$, where the w -coordinates describe position within the compact geometry. The Calabi–Yau coordinates supplement ordinary space rather than replacing it.

Orthogonality in this framework is defined mathematically by the metric of the higher-dimensional space. A displacement in a compact direction satisfies $dx = dy = dz = 0$ while $dw \neq 0$, making the compact directions genuinely independent of the three extended dimensions even though they are not directly observable.

This distinction motivates one of the central questions of the present work: if the compact dimensions are physically real rather than merely mathematical, could quantum states possess a measurable property describing their orientation between the extended and compact sectors of spacetime?

2.3 Brane-World Physics

Brane-world models provide another approach to the possible physical role of additional spatial dimensions. Rather than requiring all additional dimensions to be compactified at extremely small scales, these models propose that the observable universe may occupy a lower-dimensional structure, known as a **brane**, embedded within a higher-dimensional space called the **bulk**.

The term *brane* is derived from *membrane*. More generally, a brane can have different numbers of spatial dimensions. In a brane-world model intended to describe our universe, ordinary matter and the interactions of the Standard Model may be largely confined to a three-dimensional spatial brane, while some physical effects can extend into the higher-dimensional bulk.

Gravity is particularly important in these models. Some brane-world theories propose that gravity can propagate through dimensions that ordinary matter cannot directly access. This provides one possible explanation for why gravity appears much weaker than the other fundamental interactions: part of its behaviour may involve additional spatial dimensions.

One important example is the **Arkani-Hamed–Dimopoulos–Dvali (ADD) model**, which proposes additional spatial dimensions that can be substantially larger than the Planck length. Standard Model particles are confined to a brane, while gravity can propagate through the higher-dimensional bulk.

Another important example is the **Randall–Sundrum model**, in which the observable universe is represented by a brane within a higher-dimensional geometry. The geometry of the additional dimension can modify the apparent strength and behaviour of gravity within the observable universe.

Brane-world models therefore illustrate an important theoretical possibility relevant to theories involving additional dimensions: different physical phenomena need not have equal access to every spatial dimension. Matter may be largely restricted to one dimensional domain while another interaction, particularly gravity, can extend into a larger dimensional structure.

No experimental evidence has established that the observable universe is a brane or that gravity propagates through additional spatial dimensions. Brane-world models remain theoretical proposals and are subject to experimental constraints.

2.4 Entanglement

When two quantum systems interact, their combined state may become entangled. An entangled system cannot in general be represented as two independent states:

$$|\Psi_{AB}\rangle \neq |\psi_A\rangle|\psi_B\rangle$$

Instead, the two systems must be described by a joint quantum state. Measurements performed on entangled systems can display correlations that cannot be reproduced by local hidden-variable theories. Bell's theorem provided a means of distinguishing such correlations experimentally, and subsequent Bell tests have repeatedly confirmed the predictions of quantum mechanics.

Entanglement is not restricted to a particular type or size of particle. Photons, electrons, atoms and larger systems can be entangled. Nor is there a known maximum separation beyond which entanglement ceases to exist. Entanglement does not, however, permit controllable information to be transmitted instantaneously between separated systems. The correlations revealed by measurements are consistent with the no-signaling principle.

The persistence of correlations between spatially separated systems remains one of the most striking features of quantum mechanics and raises an important conceptual question: what constitutes the physical relationship between two entangled objects? Quantum mechanics predicts the correlations with extraordinary accuracy but does not require a classical mechanical connection between the objects.

2.5 Orthogonality

Orthogonality is fundamental to the mathematical structure of quantum mechanics.

$$\langle A|B\rangle = 0$$

Two quantum states $|A\rangle$ and $|B\rangle$ are orthogonal when their inner product is zero. Orthogonality occurs throughout mathematics and physics. In ordinary Euclidean geometry, two vectors are orthogonal when they meet at an angle of 90° . Each then has zero component in the direction of the other.

In linear algebra, non-zero orthogonal vectors are linearly independent, although linearly independent vectors need not be orthogonal. Functions may similarly be orthogonal when their inner product over a specified interval is zero. In signal processing, orthogonality allows signals to be separated without cross-contribution under the relevant inner product.

In quantum mechanics, orthogonal states represent mutually exclusive measurement alternatives and can, in principle, be perfectly distinguished. For a single qubit there is an important geometric distinction. Pure qubit states can be represented as points on the Bloch sphere. Two orthogonal quantum states occupy antipodal positions on that sphere. Their Bloch vectors are therefore separated by 180° , despite the corresponding state vectors being orthogonal in Hilbert space.

Orthogonality consequently provides a mathematical means of representing distinction without requiring spatial separation.

2.6 Emergence

A property is described as emergent when it appears at one level of description as a consequence of interactions or organisation at a more fundamental level. Temperature provides a familiar example. An individual molecule does not possess temperature in the thermodynamic sense. Temperature becomes meaningful as a collective property of large numbers of particles.

Similar ideas occur throughout physics. The properties of solids emerge from interactions among atoms and electrons; fluid behaviour emerges from molecular interactions; and many collective quantum phenomena arise from the behaviour of large numbers of quantum constituents.

The relationship between quantum and classical behaviour can also be considered in this context. A major mechanism is decoherence. A quantum system cannot normally be isolated completely from its environment. Interaction with photons, surrounding particles and other environmental degrees of freedom causes the system to become entangled with that environment. Interference between components of the system's quantum state then becomes extremely difficult to observe locally.

Consequently, macroscopic objects behave approximately classically even though their constituent particles continue to obey quantum mechanics. This raises a broader possibility relevant to fundamental physics: some properties that appear fundamental at one scale may themselves emerge from relationships operating at another.

2.7 Physical Scale

Nature spans an extraordinary hierarchy of physical dimensions.

Level	Approximate scale	Examples
Macroscopic	10^0 m	humans and everyday objects
Molecular	10^{-9} – 10^{-7} m	molecules and molecular structures
Atomic	10^{-10} m	atoms
Nuclear	10^{-15} m	atomic nuclei, protons and neutrons
Subatomic	10^{-15} m and below	elementary-particle phenomena
Planck	10^{-35} m	hypothetical quantum-gravity regime

These values represent characteristic scales rather than strict boundaries. Atoms are approximately 10^{-10} m across, while their nuclei have dimensions of order 10^{-15} m. Thus, the characteristic diameter of an atom is approximately 100,000 times that of its nucleus.

Protons and neutrons themselves possess internal structure and are composed of quarks and gluons. Electrons and quarks, by contrast, are treated as elementary particles in the Standard Model and have no experimentally established internal structure or physical radius.

The enormous difference between atomic and nuclear dimensions illustrates that the familiar concept of matter as continuously filled space is inappropriate at microscopic scales. At still smaller scales, even the concept of particles as miniature solid objects becomes inadequate.

Importantly, these changes of scale do not correspond to known boundaries of quantum mechanics. An atom is a quantum system, but so is a molecule composed of many atoms. In principle, the quantum description extends to macroscopic systems. What changes with increasing scale is primarily the complexity of the system and the strength of its interaction with the environment.

2.8 Dimensionality

The physical world is ordinarily described in terms of three spatial dimensions, length, width and height, together with time, producing the four-dimensional spacetime of relativity.

Mathematics and theoretical physics, however, are not restricted to three spatial dimensions. The word dimension can also have different meanings depending upon what is being described. In particular, it is important to distinguish dimensions of physical space from dimensions used to represent the possible states of a physical system.

Higher-dimensional theories have played an important role in attempts to unify the fundamental forces of nature. The early Kaluza–Klein approach, for example, introduced an additional spatial dimension in an attempt to bring gravity and electromagnetism within a common geometrical framework.

Modern string theories also require additional dimensions for mathematical consistency. Superstring theories are generally formulated in ten-dimensional spacetime, nine spatial dimensions and one time dimension, while M-theory is formulated in eleven dimensions, conventionally interpreted as ten spatial dimensions and one time dimension.

The fact that everyday experience reveals only three extended spatial dimensions requires the additional spatial dimensions in these theories to be hidden or otherwise inaccessible at ordinary scales. One approach is compactification, in which additional spatial dimensions are curled into extremely small geometrical structures. In conventional Calabi–Yau compactification, for example, six additional spatial dimensions form a compact internal space associated with the three extended spatial dimensions. In a simplified product-space description, the extended and compact sectors can be treated as orthogonal under the higher-dimensional metric. Another approach is provided by brane-world models, in which observable matter may be confined to a lower-dimensional domain embedded within a higher-dimensional space, while some interactions may extend into the additional dimensions.

Physical spatial dimensions must be distinguished from the dimensions of a mathematical state space. Quantum mechanics represents the possible states of a physical system in a Hilbert space. The dimensions of Hilbert space correspond to independent quantum-state possibilities and do not imply an equivalent number of physical spatial directions.

For example, a single qubit has a two-dimensional complex Hilbert space with basis states $|0\rangle$ and $|1\rangle$. Its general state can be written as:

$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle,$$

$$|\alpha|^2 + |\beta|^2 = 1.$$

The physically distinct pure states of this qubit can be represented geometrically on a Bloch sphere. The Bloch sphere is therefore a visual map of possible qubit states rather than an additional three-dimensional physical space. A rotation on the Bloch sphere represents a change in quantum state and should not be confused with rotation through physical spatial dimensions.

The number of Hilbert-space dimensions depends upon the quantum system. Two qubits have a four-dimensional Hilbert space, while N qubits have a Hilbert space of dimension 2^N . Other quantum systems may require an infinite-dimensional Hilbert space. This potentially enormous dimensionality describes the range of possible quantum states rather than the dimensionality of physical spacetime.

The Hamiltonian provides a further distinction. It is not another type of space or dimension. The Hamiltonian is an operator acting upon states in Hilbert space and represents the energy and dynamics of the system. Through the Schrödinger equation,

$$i\hbar d|\psi\rangle/dt = \hat{H}|\psi\rangle,$$

it determines how a quantum state evolves through Hilbert space with time. Hilbert space can therefore be regarded as the space of possible quantum states, while the Hamiltonian provides the dynamical rule governing their evolution.

Dimensionality consequently occurs in several distinct senses: the three dimensions of observable physical space; the four dimensions of relativistic spacetime; possible additional physical spatial dimensions proposed by higher-dimensional theories; and the mathematical dimensions required to represent the possible states of quantum systems. These meanings should not be conflated.

Whether the familiar three-dimensional character of observable space is itself fundamental, or forms part of a deeper higher-dimensional physical structure, remains an open question in fundamental physics.

2.9 Spinors and Internal Quantum State

Quantum theory provides examples in which the state of a physical system cannot be represented adequately by an ordinary vector in three-dimensional physical space. Fermions, including electrons and quarks, are described by spinorial states. A spinor is a mathematical object whose transformation properties under rotation differ fundamentally from those of an ordinary spatial vector. In particular, a spin $-1/2$ state acquires a sign change under a 360° rotation and returns to its original spinor only after a 720° rotation. The sign change does not by itself represent a different observable state, although relative phase differences can have observable consequences.

Spinors therefore provide an established example of an internal quantum state possessing rotational properties that cannot be interpreted simply as the physical orientation of an object in ordinary three-dimensional space. The mathematical space in which a spinor is represented should consequently be distinguished from physical three-dimensional space.

More generally, quantum states may contain several components and may transform under rotations and other symmetry operations in ways that have no direct classical analogue. Such internal state

structures are fundamental to the quantum description of elementary particles and provide an important example of how rotational behaviour can occur within a mathematical state space without corresponding to the ordinary spatial rotation of a physical object.

2.10 The Quantum–Classical Question

The preceding sections illustrate that nature can be described at several different levels of physical organisation. String theory proposes fundamental structures below the level of elementary particles; the Standard Model describes elementary and composite subatomic particles; atoms and molecules form increasingly complex systems; and macroscopic objects are constructed from these underlying constituents.

Quantum mechanics is not confined to the smallest of these levels. Elementary particles, atoms and molecules all obey quantum mechanics, and quantum behaviour can persist in larger systems under suitable conditions. There is no experimentally established physical scale at which quantum mechanics ceases to operate.

The apparently classical behaviour of macroscopic objects is therefore not evidence for a simple boundary between a quantum microscopic world and a classical macroscopic world. Decoherence provides an important explanation for the suppression of observable quantum interference as systems interact increasingly with their environments.

Other questions remain open at a more fundamental level. The physical nature and organisation of any additional spatial dimensions have not been established experimentally. Compactification and brane-world models demonstrate mathematically different ways in which additional dimensions might be related to the observable universe. Quantum entanglement also demonstrates that spatially separated systems can retain correlations that cannot be explained by local hidden-variable theories.

These observations leave open the possibility that apparently different levels of physical organisation may reflect a deeper underlying dimensional structure.

The framework developed in the following section explores this possibility by proposing that strings, subatomic particles and atoms are associated with different but related three-dimensional physical domains within a larger nine-dimensional spatial structure. It asks whether dimensional orientation and emergence, rather than a simple boundary of physical size, could provide a physical relationship between these successive levels.

3. Fundamental Principles

This section forms the speculative core of Three Spheres Theory. The preceding sections describe established or broadly accepted physics; the principles below are hypotheses introduced by the present framework.

3.1 Foundational Postulate — Layered Physical Reality

The theory assumes nine spatial dimensions arranged as three mutually orthogonal three-dimensional physical spaces: the Bottom, Middle and Top Spheres. “Sphere” denotes a real three-dimensional physical domain rather than a conventional sphere embedded inside another sphere. The special orthogonality relation between the three domains is a postulate of the theory.

The Three Spheres proposal is motivated in part by the distinction between known and hypothetical dimensional structures. Three-dimensional physical space is directly established by observation, whereas the existence and physical form of six additional spatial dimensions have not been experimentally established. If nine spatial dimensions are required, one possible interpretation is therefore not a familiar three-dimensional space supplemented by a fundamentally different six-dimensional physical structure, but three three-dimensional physical domains having the same dimensionality while occupying mutually orthogonal sectors of the larger nine-dimensional space. This does not provide evidence that such additional three-dimensional domains exist, but it offers a conceptually simpler physical interpretation in which the additional dimensions are organised using a type of spatial structure already known to exist.

The Bottom Sphere contains fundamental strings. The Middle Sphere is the domain in which subatomic particles manifest. The Top Sphere begins at the atomic scale and contains atoms, molecules and all larger ordinary three-dimensional objects.

Every Top-sphere location is associated with the Middle Sphere, and every Middle-sphere location is associated with the Bottom Sphere. Spatial separation in one sphere therefore need not correspond to the same separation in another.

3.2 Principle 1 — Dimensional Orientation (D_o)

D_o originates as the Dimensional Orientation of the underlying string state. After Middle-sphere manifestation, $D_o = 90^\circ$ remains a property of the resulting particle's underlying dimensional state. D_o does not describe the geometrical direction in which a string or particle points. It determines where the state manifests dimensionally.

A state may remain physically associated with a location while having a different Dimensional Orientation and manifestation. Physical position X and Dimensional Orientation D_o are therefore distinct properties.

3.3 Principle 2 — Vibrational State (V)

A string possesses a Vibrational State, V . In the present theory V is not treated as a single immutable label, but as containing at least two physically distinct aspects. A species-defining component, V_s , determines which elementary-particle state the string is capable of manifesting as and the intrinsic properties associated with that species. A second feature, the Rotational Vibrational Component, R_v , represents the part of the vibration capable of coupling to Dimensional Orientation. R_v may depend on

properties such as phase relationship, polarization, angular momentum or another coherent rotational feature of the vibration; its fundamental form is not yet specified. Schematically: $V = (V_s, R_v)$.

The mathematical form of R_v is left open. In particular, it need not correspond to an ordinary geometrical rotation of the string within the Bottom Sphere. One possibility is that R_v forms part of a multi-component internal state with spinor-like transformation properties. In such a description, changes in the internal vibrational state could alter its relationship to the orthogonal Bottom and Middle dimensional sectors without requiring an ordinary spatial rotation. This possibility is not assumed by the present model but provides one possible direction for a more fundamental formulation of Dimensional Rotication, D_r .

The Rotational Vibrational Component R_v is a property of the string's Vibrational State that generates or biases D_r . Dimensional Orientation D_o is the resulting geometrical orientation of the string state between the Bottom and Middle Spheres. R_v and D_o are therefore distinct: R_v provides the vibrational influence that drives or biases the change, while D_o describes the resulting dimensional state.

Particle identity is therefore associated with V_s , while a change in R_v can influence dimensional manifestation by generating Dimensional Rotication. The complete string state may still be written schematically as $S(D_o, V)$, with V understood to include both V_s and R_v .

3.4 Principle 3 — Dimensional Rotication (D_r)

Dimensional Rotication, D_r , is proposed to arise from a change in the Rotational Vibrational Component R_v of the Bottom-sphere string. D_r is not an ordinary spatial rotation of the string within the Bottom Sphere. Rather, it represents a transformation of the string's dimensional state. If the manifestation-relevant vibrational component ultimately possesses a spinor-like or other multi-component structure, D_r could correspond to a transformation within that internal state space whose physical consequence is a change in D_o . The 0° to 90° angular representation used below should therefore be understood as a simplified coordinate for D_o and not necessarily as the angle of an ordinary spatial rotation.

Instead, it is the dimensional response produced when the vibrational structure acquires, loses or reverses the component capable of coupling to the orientation between the orthogonal Bottom and Middle-sphere domains. During this process the species-defining component V_s remains unchanged, so the identity of the particle state that can manifest is preserved.

In the provisional dynamics developed in Section 4, R_v produces a signed Rotication bias on the potential governing D_o . A positive effective R_v favours evolution toward the Middle orientation, while an oppositely directed change can favour return toward the Bottom orientation. The strength and duration of the vibrational change therefore determine how D_o evolves.

D_o may be represented by an angular coordinate θ on a scale from 0° to 90° . At 0° the state is fully Bottom-oriented. Intermediate orientations between 0° and 90° represent transitional dimensional orientations rather than stable partial particles. At 90° the state is fully Middle-oriented and can manifest as the corresponding stable subatomic particle. The mathematical framework developed in

Section 4 proposes an energy landscape in which 0° and 90° are stable orientations and 45° is the zero-field energy barrier between them.

The relative orientation of the state with respect to the Bottom and Middle spheres is represented by two normalized quantities, W_B and W_M , termed the Bottom and Middle Dimensional Weights:

$$W_B = \cos^2\theta$$

$$W_M = \sin^2\theta$$

$$W_B + W_M = 1$$

The two quantities therefore provide a normalized measure of the relative dimensional orientation of the state.

$$\text{At } \theta = 0^\circ, W_B = 1, W_M = 0$$

$$\text{At } \theta = 45^\circ, W_B = W_M = 1/2$$

$$\text{At } \theta = 90^\circ, W_B = 0, W_M = 1$$

The 0° values correspond to a fully Bottom-oriented state. At 45° the Bottom and Middle Dimensional Weights are equal. This orientation corresponds to the zero-field energy barrier between the two stable states rather than to a stable particle divided between the two spheres. The 90° values correspond to a fully Middle-oriented state capable of manifesting as the stable subatomic particle determined by V_s .

W_B and W_M are Dimensional Weights and should not be interpreted as probabilities that the particle exists in either sphere, nor as fractions of a particle occupying the two spheres. They describe the relative dimensional orientation of a single state with respect to the two orthogonal dimensional domains. During D_r , these weights change continuously as D_o changes.

The distinction between the three principal quantities may therefore be summarized as:

$V_s \rightarrow$ particle identity and associated intrinsic properties

$D_o \rightarrow$ dimensional manifestation

$D_r \rightarrow$ change in D_o produced by a change in R_v while preserving V_s

D_r therefore changes the Dimensional Weights associated with a state through a manifestation-relevant change in vibration, without changing the species-defining vibrational structure V_s .

In summary, a change in R_v biases the potential energy governing D_o . A sufficiently strong positive vibrational bias reduces and ultimately removes the energy barrier maintaining the Bottom orientation, allowing D_o to evolve from 0° to the stable Middle orientation at 90°.

3.5 Principle 4 — Bottom-to-Middle Emergence

A stable Middle-sphere particle requires complete dimensional orientation at $D_o = 90^\circ$. Intermediate orientations represent an emergence transition rather than a stable partial particle. The string does not move conventionally from the Bottom Sphere into the Middle Sphere; its Dimensional Orientation changes, altering its dimensional manifestation.

For an electron-producing string, the species-defining vibrational component V_s remains in the electron-producing form while R_v changes. If the resulting Dimensional Rotation drives D_o to 90° , the corresponding stable electron manifests in the Middle Sphere. Middle-sphere manifestation is therefore not caused by vibration frequency or amplitude alone, but by whatever manifestation-relevant change in the string's vibration is represented by R_v .

3.6 Principle 5 — Collective Dimensional Orientation (D_{oc})

When subatomic particles form a stable bound system capable of becoming an atom, the theory proposes that the combined system can acquire a new Collective Dimensional Orientation, D_{oc} .

The formation of D_{oc} requires every constituent dimensional state required for the bound system to have reached $D_o = 90^\circ$. This prerequisite can be represented by:

$$\min(D_{o1}, D_{o2}, \dots, D_{on}) = 90^\circ$$

which is satisfied if and only if:

$$D_{o1} = D_{o2} = \dots = D_{on} = 90^\circ.$$

If even one required constituent has $D_o < 90^\circ$, the prerequisite for producing D_{oc} is not satisfied.

When all required constituent particles have $D_o = 90^\circ$ and form the required stable bound state, their collective state produces D_{oc} as a new orthogonal dimensional orientation. D_{oc} is an emergent property of the complete bound system and is not possessed independently by any constituent particle.

D_{oc} is not produced by a further D_r . Instead, it emerges from stable binding of completely Middle-oriented constituent particles and permits the complete bound system to manifest in the Top Sphere as an atom.

The emergence of D_{oc} does not alter the individual $D_o = 90^\circ$ states of the constituent particles. It is an additional collective property of the bound system.

3.7 Principle 6 — Hierarchical Emergence

The theory therefore proposes a strict hierarchy of emergence:

Bottom Sphere: string states → Middle Sphere: stable subatomic particles → Top Sphere: atoms and larger structures

Complete lower-level emergence is a prerequisite for stable higher-level emergence. Individual subatomic constituents retain $D_o = 90^\circ$ and remain the underlying Middle-sphere structure of the Top-sphere atom.

3.8 Principle 7 — Reversibility

Because the species-defining vibrational component V_s remains unchanged, an inverse change in R_v could in principle generate D_r^{-1} , rotate D_o away from 90° and remove a particle's stable Middle-sphere manifestation without changing its underlying particle identity.

Restoring the required R_v condition could generate forward D_r in the same underlying string state, return D_o to 90° and cause the same particle state to re-emerge in the Middle Sphere.

3.9 Principle 8 — Entanglement and Sphere-Dependent Locality

In conventional quantum mechanics, entangled systems are described by a joint quantum state. The Three Spheres Theory proposes that locality is sphere-dependent: systems widely separated in the Top Sphere need not be independent in the underlying Middle and Bottom Spheres.

Entangled systems may retain a joint lower-sphere quantum state, allowing Bell correlations to persist regardless of Top-sphere separation without requiring a signal to propagate between their Top-sphere manifestations.

The lower-sphere relationship cannot be used for controllable communication between separated Top-sphere manifestations and must reproduce both observed Bell correlations and the no-signaling predictions of quantum mechanics.

3.10 Principle 9 — Cross-Sphere Interaction

A Top-sphere manifestation is not independent of its underlying Middle-sphere constituents. When Middle-sphere particles form a system possessing Collective Dimensional Orientation, D_{oc} , and manifest in the Top Sphere, the constituent particles retain their underlying Middle-sphere states. The Top- and Middle-sphere descriptions therefore represent different dimensional aspects of the same physical system rather than separate copies of it.

Consequently, a physical operation applied to a Top-sphere system can modify the quantum states of its underlying Middle-sphere constituents. Such an operation does not require a signal to travel from the Top Sphere to the Middle Sphere. Instead, the Top-sphere manifestation and its Middle-sphere constituents remain parts of the same cross-sphere physical state. An interaction with the manifestation is therefore also an interaction with the underlying system from which that manifestation emerges.

This principle does not imply that every Top-sphere interaction produces a significant change in the Middle-sphere quantum state. The effect depends upon the nature of the interaction and the quantum states involved. Ordinary operations that alter the state of a particle, such as changes to its spin, momentum, energy or other quantum properties, correspond to changes in the state of the underlying Middle-sphere particle.

Entanglement provides a particularly important case. If a Top-sphere operation produces an entangling interaction between two particles, the corresponding Middle-sphere states cease to be completely describable as independent quantum states. Before the interaction they may be represented schematically as:

$$|\psi_A\rangle \otimes |\psi_B\rangle$$

Following the entangling interaction, they are represented by a joint Middle-sphere state:

$$|\psi_{AB}\rangle \neq |\psi_A\rangle |\psi_B\rangle$$

Subsequent separation of the particles' Top-sphere manifestations does not necessarily separate this joint Middle-sphere state. The particles may therefore become widely separated in the Top Sphere while remaining components of the same underlying Middle-sphere quantum relationship.

Measurement of either Top-sphere manifestation acts upon its corresponding component of the joint Middle-sphere state. Because the entangled particles remain components of the same joint quantum state in the Middle Sphere, the theory does not require a signal to travel from one separated particle to the other at the time of measurement. Their observed correlations arise from this persistent joint state rather than from communication between the particles.

The joint Middle-sphere state must preserve the no-signalling principle. Although measurements of the two Top-sphere manifestations can reveal correlations belonging to their shared Middle-sphere state, neither observer can control the outcome of an individual measurement or use a local operation to alter the locally observable probabilities of the other particle. The Three Spheres Theory therefore interprets entanglement as a persistent joint Middle-sphere quantum relationship rather than as faster-than-light communication between separated Top-sphere particles.

3.11 Comparison with Calabi–Yau Compactification

The orthogonal dimensional structure proposed by the Three Spheres Theory has a useful geometrical comparison with conventional Calabi–Yau compactification. In a simplified product-space description of compactification, the three extended spatial dimensions and the six-dimensional compact space can be treated as orthogonal dimensional sectors under the higher-dimensional metric. A displacement entirely within the compact sector can therefore occur without displacement in the three extended spatial dimensions.

The Three Spheres Theory adopts a related concept of dimensional orthogonality but proposes a different organisation of the nine spatial dimensions. Rather than separating them into a three-dimensional extended sector and a six-dimensional compact sector, the theory postulates three mutually orthogonal three-dimensional physical domains:

Conventional compactification: $9 = 3 \text{ extended} + 6 \text{ compact}$

Three Spheres Theory: $9 = 3 \text{ Bottom} + 3 \text{ Middle} + 3 \text{ Top}$

The mathematical concept of orthogonality between dimensional sectors is therefore not, by itself, unique to the Three Spheres Theory. The distinctive proposal is the division of the nine spatial dimensions into three mutually orthogonal three-dimensional domains and the assignment of different levels of physical manifestation to them.

The comparison is geometrical rather than an assertion that the two models describe the same physical structure. In conventional compactification, the six additional dimensions form a compact, generally curved Calabi–Yau manifold. The Three Spheres Theory instead hypothesises that the nine spatial dimensions can be organised into Bottom, Middle, and Top-sphere domains, each with a distinct physical role.

The theory further introduces Dimensional Orientation, D_o , to describe orientation between the Bottom and Middle domains, and Collective Dimensional Orientation, D_{oc} , to describe the emergence of a bound Middle-sphere system into the Top Sphere. These physical interpretations are hypotheses of the Three Spheres Theory and are not features of conventional Calabi–Yau compactification.

4. Mathematical Framework

4.1 Notation and Symbols

The principal mathematical symbols used in the Three Spheres Theory are defined below.

Symbol	Meaning
A	Intrinsic dimensional barrier energy. Sets the energy scale of the barrier separating stable Bottom and Middle orientations.
D_o	Dimensional Orientation. Determines the dimensional manifestation of a string or particle state.
D_{oc}	Collective Dimensional Orientation. An emergent orientation produced by a stable bound system of fully Middle-oriented particles, permitting Top-sphere manifestation.
D_r	Dimensional Rotication. The change in Dimensional Orientation generated by a manifestation-relevant change in the string's Rotational Vibrational Component R_v while preserving the species-defining component V_s .
g_v	Vibrational-orientation coupling constant. Determines the strength with which R_v biases Dimensional Orientation, with $\lambda = g_v R_v$.
I_D	Dimensional inertia. An effective parameter governing the dynamical response of D_o to the dimensional potential.
L_D	Dimensional Lagrangian. Describes the proposed dynamics of Dimensional Orientation.
S	Fundamental string. The underlying Bottom-sphere entity whose state is characterised by its Dimensional Orientation D_o , Vibrational State V , and physical location X .
S_B	Bottom Sphere three-dimensional spatial subspace.
S_M	Middle Sphere three-dimensional spatial subspace.
S_T	Top Sphere three-dimensional spatial subspace.
T	Kinetic energy. In the Dimensional Orientation model, $T = \frac{1}{2} I_D \dot{\theta}^2$ represents the kinetic contribution associated with the rate of change of Dimensional Orientation.
U	Dimensional potential energy. The proposed potential governing the stability and evolution of D_o .
V	Vibrational State. In the revised model $V = (V_s, R_v)$, containing a species-defining component V_s and a manifestation-relevant Rotational Vibrational Component R_v .
R_v	Rotational Vibrational Component. A signed manifestation-relevant feature of V that can bias Dimensional Orientation and generate Dimensional Rotication. It may arise from phase, polarization, angular momentum or another coherent rotational feature; its fundamental form is not yet specified.
WB	Bottom Dimensional Weight. In the simplified model, $W_B = \cos^2 \theta$.

W_M	Middle Dimensional Weight. In the simplified model, $W_M = \sin^2\theta$.
X	Bottom-sphere position. The physical location of a string within the Bottom Sphere, independent of its Dimensional Orientation.
$\Delta U_{B \rightarrow M}$ $\Delta U_{M \rightarrow B}$	Δ (delta) means “change” or “difference.” $\Delta U_{B \rightarrow M}$ represents the difference in potential energy between the Bottom minimum and the top of the barrier that must be crossed to move toward the Middle orientation. $\Delta U_{M \rightarrow B}$ represents the difference in potential energy between the Middle minimum and the top of the barrier that must be crossed to move toward the Bottom orientation.
θ	Theta: Dimensional Orientation angle. The angular representation of D_o , such that $\theta \equiv D_o$. For the simplified Bottom-to-Middle model, $0^\circ \leq \theta \leq 90^\circ$.
θ^*	Denotes a stationary (equilibrium) Dimensional Orientation.
$\dot{\theta}$	Rate of change of Dimensional Orientation with time.
$\ddot{\theta}$	Dimensional angular acceleration: the rate at which θ changes with time.
λ	Lambda: Rotication bias parameter. In the revised model $\lambda = g_v R_v$.
V_s	Species-defining vibrational component. The part of V that determines the elementary-particle species and associated intrinsic properties.
∂	Partial derivative symbol. Used when differentiating a function with respect to one variable while treating its other variables as fixed.
$\oplus$	Direct sum. Used in $\mathbb{R}^9 = S_B \oplus S_M \oplus S_T$ to represent the decomposition of nine-dimensional space into three independent three-dimensional spatial subspaces.
$\perp$	Orthogonal to. Indicates the proposed mutual orthogonality of the Bottom, Middle and Top spatial subspaces.

Unless otherwise stated, D_o and θ refer to the same dimensional-orientation quantity. D_o denotes the physical property proposed by the theory, while θ is used when that property is represented mathematically as an angle.

4.2 Dimensional State

A fundamental string is represented schematically by $S(D_o, V, X)$, where D_o is its Dimensional Orientation, V is its Vibrational State, and X represents its physical location within the Bottom Sphere. In the revised model $V = (V_s, R_v)$: V_s is the species-defining vibrational component and R_v is the manifestation-relevant Rotational Vibrational Component. Dimensional Rotication changes D_o through changes in R_v without requiring the string to move from its location X or change V_s .

4.3 Nine-Dimensional Structure

A simple mathematical representation treats nine-dimensional space as three mutually orthogonal three-dimensional spatial subspaces: the Bottom Sphere, Middle Sphere and Top Sphere.

Complete spatial structure:

$$\mathbb{R}^9 = S_B \oplus S_M \oplus S_T$$

where:

S_B = Bottom Sphere spatial subspace

S_M = Middle Sphere spatial subspace

S_T = Top Sphere spatial subspace

Each sphere contains three spatial dimensions:

$$\dim(S_B) = \dim(S_M) = \dim(S_T) = 3$$

The three spatial subspaces are mutually orthogonal:

$$S_B \perp S_M$$

$$S_M \perp S_T$$

$$S_B \perp S_T$$

The notation S_B , S_M and S_T is used for the spatial subspaces to distinguish them clearly from $\mathbf{V}$, which elsewhere in the theory represents the Vibrational State of a string.

4.4 Dimensional Weight

For the simplified Bottom-to-Middle orientation, Dimensional Orientation, D_o , is represented by an angular coordinate θ , such that:

$$\theta \equiv D_o, 0^\circ \leq \theta \leq 90^\circ.$$

Bottom and Middle are treated as two orthogonal dimensional directions. The Dimensional Orientation of a string can therefore be represented by the a simplified two-component representation of Dimensional Orientation.

$$D_o = \begin{pmatrix} \cos \theta \\ \sin \theta \end{pmatrix}$$

The first component represents the string's orientation towards the Bottom Sphere and the second its orientation towards the Middle Sphere. Because:

$$\cos^2 \theta + \sin^2 \theta = 1,$$

the orientation vector is normalized. The corresponding Bottom and Middle Dimensional Weights are defined as:

$$W_B = \cos^2 \theta$$

$$W_M = \sin^2 \theta$$

Consequently:

$$W_B + W_M = 1.$$

At $\theta = 0^\circ$, the string is completely Bottom-oriented, with $W_B = 1$ and $W_M = 0$. At $\theta = 45^\circ$, the Bottom and Middle Dimensional Weights are equal, with $W_B = W_M = 0.5$. At $\theta = 90^\circ$, the string is completely Middle-oriented, with $W_B = 0$ and $W_M = 1$.

Intermediate values of θ describe transitional Dimensional Orientations between Bottom and Middle. They do not represent fractionally existing stable particles. In the proposed model, stable Middle-sphere manifestation occurs when the required Middle orientation is reached.

4.5 Potential Energy of Dimensional Orientation

To make 0° and 90° dynamically distinguished rather than merely stipulated, the theory introduces a provisional potential-energy model for D_o :

$$U(\theta, \lambda) = A \sin^2(2\theta) - \lambda \sin^2\theta$$

where $A > 0$ sets the intrinsic energy barrier between Bottom and Middle orientations and λ represents the bias produced by D_r . With $\lambda = 0$, $U(0^\circ) = U(90^\circ) = 0$ while $U(45^\circ) = A$. Thus 0° and 90° are stable minima separated by an unstable barrier at 45° . The string can remain at either 0° or 90° without something continuously forcing it to stay there.

The value of U at a particular D_o represents the potential energy associated with that orientation. Differences in U therefore represent energy that can be released or must be supplied as D_o changes. In the unbiased case, $\theta = 0^\circ$ and $\theta = 90^\circ$ are low-energy stable orientations, while moving towards $\theta = 45^\circ$ requires climbing the dimensional potential-energy barrier.

In the proposed potential, the sign convention is chosen such that positive λ lowers the potential energy of the Middle-oriented state relative to the Bottom-oriented state, while negative λ favours the Bottom orientation. Dimensional Rotication is therefore modelled not as an ordinary spatial turning of the string, but as the dimensional response to a change in the manifestation-relevant part of its vibration.

Increasing the manifestation-relevant vibrational bias changes the potential energy governing D_o . When the bias becomes sufficiently strong, the Bottom-oriented state becomes unstable and D_o evolves through intermediate orientations towards the stable Middle-oriented state.

4.6 Vibrational Coupling and Equation of Motion

Let R_v denote the signed Rotational Vibrational Component of the string and let g_v be the effective coupling between this vibrational component and Dimensional Orientation. The Rotication bias is represented by:

$$\lambda = g_v R_v$$

so that:

$$U(\theta, R_v) = A \sin^2(2\theta) - g_v R_v \sin^2\theta.$$

To give D_o a dynamical evolution, introduce an effective dimensional inertia, I_D , and the provisional Lagrangian:

$$L_D = \frac{1}{2} I_D \dot{\theta}^2 - U(\theta, R_v)$$

Thus L_D has the standard Lagrangian form $L = T - U$: the kinetic contribution associated with changing Dimensional Orientation minus the potential energy associated with its current orientation.

The first term, $\frac{1}{2} I_D \dot{\theta}^2$, represents the kinetic contribution associated with a change in Dimensional Orientation. It is chosen as the simplest quadratic kinetic term for an angular coordinate, analogous to the rotational kinetic-energy expression $T = \frac{1}{2} I \omega^2$ in classical mechanics. Here, $\dot{\theta} = d\theta/dt$ represents the rate at which Dimensional Orientation changes, while I_D is an effective inertia parameter representing resistance to that change. This form is introduced as a modelling assumption rather than being derived from established string theory.

The Euler–Lagrange equation then gives:

$$I_D \ddot{\theta} = -2A \sin(4\theta) + g_v R_v \sin(2\theta).$$

In simple terms, this equation describes how Dimensional Orientation changes with time: the acceleration of θ is determined by the combined effect of its underlying potential-energy landscape and the vibrational bias R_v . The first term, $-2A \sin(4\theta)$, represents the influence of the intrinsic energy landscape, while the second term, $g_v R_v \sin(2\theta)$, represents the bias produced by the manifestation-relevant vibrational component. The dimensional inertia I_D determines how strongly θ accelerates in response to these influences.

This equation forms part of the provisional dynamical model for D_o . It does not yet derive R_v from fundamental string dynamics or identify which microscopic feature of vibration supplies it. Its purpose is to show how a change in vibration could bias and dynamically change D_o while preserving the species-defining component V_s .

4.7 Energy Conservation during Rotication

During Dimensional Rotication, energy is exchanged between the string's vibrational degrees of freedom and the Dimensional Orientation degree of freedom. This energy may appear as changes in dimensional potential energy and as kinetic-like energy associated with changing orientation. A complete theory must account for the corresponding change in vibrational energy and preserve total energy.

The vibrational degrees of freedom that produce R_v should therefore be regarded as part of the complete energy system rather than as an external influence that changes D_o without an associated energy exchange. In a closed system, the total energy must remain conserved.

A complete theory must specify the physical mechanism by which this energy is transferred and conserved as the state evolves and settles into a stable dimensional orientation.

4.8 Critical Rotication and Hysteresis

The stationary orientations satisfy:

$$\partial U / \partial \theta = \sin(2\theta)[4A \cos(2\theta) - \lambda] = 0.$$

The intermediate barrier therefore obeys:

$$\cos(2\theta^*) = \lambda/(4A).$$

where θ^* is the stationary (equilibrium) value of θ . The superscript $*$ is a label indicating the particular value of θ at which the potential is stationary; it is not multiplication.

For $|\lambda| < 4A$, Bottom and Middle orientations remain separated by an energy barrier. At $\lambda = +4A$ the Bottom minimum loses stability; for stronger positive bias the state is driven toward $D_o = 90^\circ$. At $\lambda = -4A$ the Middle minimum loses stability and inverse Rotication drives the state toward $D_o = 0^\circ$.

The corresponding critical condition is:

$$|g_v R_v| = 4A.$$

For a transition from Bottom toward Middle, the barrier height is:

$$\Delta U_{B \rightarrow M} = A(1 - \lambda/(4A))^2.$$

Where $\Delta U_{B \rightarrow M}$ is the potential-energy barrier that must be overcome for Dimensional Orientation to move from the Bottom state toward the Middle state.

For the reverse transition:

$$\Delta U_{M \rightarrow B} = A(1 + \lambda/(4A))^2.$$

The model therefore predicts threshold behaviour and hysteresis. After a sufficiently strong positive change in R_v has driven a state to 90° , R_v may return toward its neutral value while 90° remains a stable minimum. A sufficiently strong oppositely directed vibrational change is required to destabilize that state and return it toward Bottom orientation.

A finite barrier also raises a stability requirement. Known particles do not spontaneously disappear, so any completed theory must make ordinary fluctuations of R_v , thermal activation and quantum tunnelling between dimensional minima negligibly small under normal conditions. This constrains the allowed values of A , ID , g_v and the dynamics of R_v .

4.9 Collective Emergence

Top-sphere atomic manifestation requires all necessary Middle-sphere constituents to have $D_o = 90^\circ$ and to form the required stable bound state. Their binding then produces the emergent collective orientation D_{oc} that permits Top-sphere manifestation.

4.10 Scale and Emergence

The Bottom, Middle and Top Spheres correspond respectively to the string/fundamental, subatomic, and atomic-and-larger levels. These are proposed physical domains, not boundaries at which quantum mechanics stops operating. Classical behaviour at larger Top-sphere scales is still expected to arise largely through decoherence.

4.11 Entanglement

Top-sphere distance is not assumed to be sufficient to specify the physical separation relevant to entanglement. A complete model must derive, rather than merely assume, the observed quantum correlations and must preserve no-signaling.

5. Predictions and Experimental Tests

5.1 Prediction — Reversible Emergence

If Dimensional Rotication is generated by a change in the Rotational Vibrational Component R_v , the potential-energy model predicts threshold behaviour. A stable dimensional orientation should persist while the effective vibrational bias remains below the critical magnitude $|g_v R_v| = 4A$. A sufficiently strong inverse vibrational change should destabilize $D_o = 90^\circ$ and remove stable Middle-sphere manifestation; an oppositely directed change exceeding the corresponding threshold should restore the state.

5.2 Proposed Single-Electron Test of Dimensional Rotication

A direct experimental test of Dimensional Rotication could use a single electron confined in a cryogenic Penning trap. Such a system provides long-duration confinement together with precise monitoring of the electron's trapped motion and quantum state. The purpose of the experiment would not be to search indiscriminately across all possible electron manipulations. It would be to test a specific candidate interaction that had first been identified as capable of coupling to the proposed Rotational Vibrational Component, R_v .

A stable reference state would first be established for the trapped electron. Its continued presence would be monitored through the electrical signals associated with its trapped motion and, where appropriate, through measurements of its cyclotron and spin states. These measurements would provide independent confirmation that the electron remained confined.

Within the Three Spheres Theory, a normally manifested electron corresponds to an underlying string state whose species-defining component V_s remains in the electron-producing form while its Dimensional Orientation is $D_o = 90^\circ$. The identified candidate interaction would then be varied gradually while the electron continued to be monitored. The interaction would be required to alter the manifestation-relevant component R_v without changing V_s or merely ejecting, absorbing or otherwise conventionally destroying the trapped electron.

For the provisional dimensional potential developed in Section 4, the Middle-oriented state loses stability when the inverse Rotication bias reaches

$$g_v R_v = -4A.$$

At this threshold, the model predicts that D_o should evolve away from 90° toward the Bottom orientation. If stable Middle-sphere manifestation requires $D_o = 90^\circ$, the observable electron should then cease to manifest as a stable Middle-sphere particle while the underlying species-defining state V_s remains unchanged.

An apparent disappearance would not by itself constitute evidence for Dimensional Rotication. Conventional explanations would first have to be excluded, including escape from the trap, collision with residual gas, interaction with trap material, changes in trapping conditions, ordinary spin or cyclotron transitions, electronic or detector failure, and other established mechanisms capable of producing loss of the electron signal.

The candidate interaction would then be reversed. The provisional model predicts restoration of the Middle-oriented state when the opposite critical bias is reached:

$$g_V R_V = +4A.$$

The distinctive prediction is therefore not simply disappearance, but reproducible disappearance and reappearance at different directional thresholds. The corresponding hysteresis interval in the provisional model is

$$\Delta(g_V R_V) = 8A.$$

Repeated switching at reproducible thresholds would provide a substantially stronger test than an isolated loss event. An even stronger result would be evidence that the re-manifested electron retained the same elementary properties and, to the extent experimentally accessible, continuity with the state prepared before disappearance.

No existing Penning-trap result is taken here as evidence for Dimensional Rotication. The role of the Penning trap is to provide an established means of isolating and monitoring a single electron with exceptional precision. The unresolved requirement is the prior identification of a physical interaction capable of addressing R_V . The systematic search for such an interaction is considered in the following section.

5.3 Systematic Search for the Manipulation Mechanism

The physical interaction capable of changing R_V has not yet been identified. Many properties that might plausibly be associated with such a coupling, including electron spin, cyclotron motion and responses to electric, magnetic and electromagnetic fields, have already been investigated extensively without any reported reversible loss of the electron. This places an important constraint on the theory: R_V cannot simply be identified with one familiar electron property whose manipulation is already well established. It remains possible, however, that a particular interaction, resonance or combination of controllable conditions could couple to a manifestation-relevant degree of freedom not independently isolated in existing experiments.

An initial stage of the programme would therefore be to construct a systematic inventory of existing single-electron experiments. The inventory would record which physical variables have been manipulated, over what ranges, and particularly which variables have been manipulated simultaneously. This exercise would be useful independently of the Three Spheres Theory because it would provide a consolidated map of experimentally explored parameter space and identify combinations that remain comparatively unexplored.

The principal experimental variables considered in such an inventory might initially include:

Experimental variable	Example control	Purpose in the search
Magnetic field B	Strength and direction	Test magnetic and spin-dependent responses
Electric field E	Strength and direction	Test electric coupling and changes in trapped motion

Excitation frequency ω	RF/microwave frequency sweep	Search for resonant responses
Excitation amplitude	Field or pulse strength	Search for threshold-dependent effects
Relative phase ϕ	Phase of coherent excitation	Test sensitivity to quantum phase relationships
Spin state	Prepared spin orientation or superposition	Test possible coupling to spinorial structure
Cyclotron state	Controlled excitation level	Test dependence on electron motional state
Field orientation	Relative directions of applied fields	Search for orientation-dependent effects
Pulse duration	Interaction time	Test dependence on duration of perturbation
Combined controls	Selected simultaneous manipulations	Search for effects requiring a specific relationship between variables

The number of possible experimental conditions increases rapidly when several variables are combined. Six independent variables sampled at only five values each would produce

$$5^6 = 15,625$$

possible combinations, while eight variables sampled at five values each would produce

$$5^8 = 390,625.$$

Repeated measurements and control runs would increase these numbers further. A literal exhaustive physical search of every possible combination would therefore be neither practical nor necessary.

The search should instead proceed hierarchically. Existing experimental results would first be used to identify regions of parameter space that have already been investigated sufficiently. Individual variables and low-order combinations could then be considered, followed by broader coarse-resolution searches involving selected combinations. Any reproducible anomalous region could subsequently be investigated at progressively finer resolution.

Computational modelling could assist this process by screening large numbers of candidate relationships between laboratory controls and R_V before physical testing. Such modelling would not itself provide evidence for Dimensional Rotication, because the physical form of R_V and its coupling to known interactions have not yet been derived. Its value would be to test the internal consequences of candidate mechanisms, reject mechanisms that predict effects under conditions already explored experimentally without anomalous electron behaviour, and identify comparatively unexplored conditions for targeted laboratory tests.

The purpose of the systematic search is therefore not to assume that one of the established electron properties is R_v , but to identify a specific interaction or combination of interactions that could plausibly address the proposed manifestation-relevant component. A candidate mechanism that survives comparison with existing experimental evidence and computational screening could then be tested using the single-electron experiment described in Section 5.2.

5.4 Computational Screening of Candidate Manipulations

Computational modelling could substantially reduce the experimental parameter space. Candidate relationships between experimentally controllable variables and the Rotational Vibrational Component R_v could be incorporated into the provisional Dimensional Rotication dynamics and evaluated over large numbers of parameter combinations. Candidate mechanisms predicting dimensional transitions under conditions already explored experimentally without anomalous electron behaviour could thereby be rejected before further laboratory testing.

Such simulation would not itself provide evidence for Dimensional Rotication. Because the physical form of R_v and its coupling to known interactions have not yet been derived, any simulated relationship between laboratory controls and R_v would initially constitute a hypothesis. The principal value of computational screening would therefore be to test the internal consequences of candidate mechanisms, compare their predictions with existing experimental constraints, and identify comparatively unexplored conditions under which distinctive experimental predictions might arise.

The resulting programme would therefore proceed from existing experimental evidence to computational screening and finally to targeted physical testing:

existing experiments → candidate R_v mechanisms → computational screening → elimination of incompatible mechanisms → targeted single-electron experiment.

5.5 Conservation Requirements

The experiment cannot be interpreted successfully unless the theory provides conservation laws for the complete nine-dimensional system. Electric charge and the electron's rest-energy equivalent cannot simply be destroyed. In the revised provisional dynamics, energy associated with Dimensional Orientation must be exchanged with the vibrational degrees of freedom that generate R_v rather than created or lost. Schematically, a complete model would require $E_{\text{total}} = E_v + \frac{1}{2}I\dot{\theta}^2 + A \sin^2(2\theta) - g_v R_v \sin^2\theta$, together with $dE_{\text{total}}/dt = 0$ for a closed system. A future theory must also explain how quantities that manifest as charge and mass in the Middle Sphere are represented or conserved in the underlying Bottom-sphere state.

6. Discussion

6.1 Relationship to Quantum Mechanics

The proposal is intended as an underlying physical interpretation rather than a replacement for the successful mathematical predictions of quantum mechanics. Any completed theory must recover ordinary quantum probabilities, interference, tunnelling, uncertainty and measurement statistics in regimes already tested.

6.2 Relationship to String Theory, Compactification and Brane-World Models

The framework borrows from string theory the ideas that fundamental entities may be one-dimensional strings, that different string vibrational states may correspond to different particle states, and that physical spacetime may contain additional spatial dimensions beyond the three directly experienced.

The Three Spheres Theory differs from conventional Calabi–Yau compactification by proposing that the six additional spatial dimensions form two real, mutually orthogonal three-dimensional physical domains, the Bottom and Middle Spheres, rather than a compact six-dimensional internal geometry.

There is also a conceptual relationship with brane-world physics. Brane-world models demonstrate that higher-dimensional theories can allow different physical phenomena to have different relationships with additional dimensions. In some models, Standard Model matter is confined to a brane while gravity can propagate through a higher-dimensional bulk.

The Three Spheres Theory adopts neither the brane nor bulk structure. Instead, strings, subatomic particles and atoms are associated respectively with the Bottom, Middle and Top Spheres. Matter is connected across these domains through Dimensional Orientation and emergence rather than confinement to a brane.

Nevertheless, the possibility that gravity may operate partly through the Middle and/or Bottom Spheres has a conceptual similarity to brane-world proposals in which gravity has access to dimensions that ordinary matter does not. This similarity provides a useful conceptual precedent for considering dimension-dependent interactions, but does not constitute evidence for the Three Spheres mechanism.

There is also a mathematical similarity between the orthogonality assumed in the Three Spheres Theory and the separation of dimensional sectors used in some higher-dimensional models. In simplified descriptions of string compactification, the extended spatial dimensions and compact internal dimensions may be treated as orthogonal under the higher-dimensional metric. The Three Spheres Theory adopts the general idea of independent dimensional sectors but differs by proposing three real, mutually orthogonal three-dimensional physical domains. Brane-world models provide a related, though different, precedent in which physical fields can have different access to dimensions; they do not in general require the same three-way orthogonal structure proposed here.

6.3 Relationship to Wave Numbers

The term Dimensional Rotication is adapted from the Wave Numbers operation of Rotication. In the present theory, D_r is interpreted as the dimensional change in D_o produced by a manifestation-

relevant change in the string's vibration. The species-defining component V_s is preserved, while the Rotational Vibrational Component R_v biases the potential governing D_o . The resulting angular evolution depends on the magnitude and duration of that vibrational change rather than being imposed as an instantaneous ordinary spatial rotation.

6.4 Quantum Tunnelling

Quantum tunnelling occurs when a quantum particle crosses an energy barrier that it could not overcome according to classical physics. Within the Three Spheres Theory, this may admit a dimensional interpretation.

An electron manifested within a Top-sphere system retains its underlying Middle-sphere quantum state, and spatial relationships in the Top Sphere need not correspond directly to those in the Middle Sphere. A potential barrier encountered in the Top Sphere may therefore not constitute an equivalent spatial barrier for the underlying Middle-sphere state. Tunnelling could consequently be interpreted as an evolution of that underlying quantum state that allows the electron subsequently to manifest at a Top-sphere location beyond the classically forbidden region, without requiring the electron to traverse the intervening Top-sphere path in the classical sense. This interpretation does not require Dimensional Rotation, D_r , because D_r is presently reserved for changes in Dimensional Orientation, D_o , between Bottom and Middle-sphere states. Any complete version of this interpretation would nevertheless have to reproduce the experimentally established quantum-mechanical tunnelling probabilities and conservation laws.

6.5 Superposition and Interference

Quantum superposition should be distinguished from Dimensional Orientation, D_o . In the Three Spheres Theory, D_o determines the dimensional manifestation of a state, whereas quantum superposition describes the possible quantum states of a system within the relevant sphere. A particle that is fully Middle-oriented, with $D_o = 90^\circ$, may therefore remain in a quantum superposition of position, momentum, spin or other quantum states. The Dimensional Weights W_B and W_M should not be interpreted as probabilities that a particle exists in either sphere, nor should an intermediate Dimensional Orientation be interpreted as an ordinary quantum superposition of Bottom- and Middle-sphere particles.

This distinction may also provide a possible interpretation of quantum interference. In the double-slit experiment, for example, the electron can be regarded as a single Middle-sphere quantum system whose state evolves in a superposition of alternative paths. The electron does not need to be interpreted as physically dividing into two particles. The alternative paths form part of the quantum state in the Middle Sphere, and their amplitudes can interfere according to ordinary quantum mechanics. The resulting interference pattern is subsequently manifested through interactions with the Top-sphere experimental apparatus. The Three Spheres Theory therefore does not replace the conventional quantum-mechanical description of interference, but proposes a dimensional framework within which the underlying quantum state and its Top-sphere manifestation may be distinguished.

6.6 Quantum Measurement

Quantum measurement presents a further question for the Three Spheres Theory because a measurement made using a Top-sphere apparatus ultimately interacts with an underlying Middle-sphere quantum state. The theory proposes that Top-sphere objects retain their underlying Middle-sphere constituents, so a measuring instrument and the quantum system being measured are not fundamentally isolated at the Middle-sphere level. A measurement observed in the Top Sphere may therefore be regarded as the Top-sphere manifestation of an interaction involving their underlying Middle-sphere states.

The theory does not presently propose a new mechanism for wavefunction collapse or attempt to resolve the wider quantum measurement problem. It must instead reproduce the experimentally established probabilities predicted by quantum mechanics, including the Born rule and the correlations observed in entangled systems. The distinction between Middle-sphere quantum states and their Top-sphere manifestations may provide a framework for investigating measurement, but it does not by itself explain why an individual measurement produces one definite outcome. Developing such a mechanism would require additional mathematical and experimental justification beyond the present theory.

6.7 The Uncertainty Principle

The Heisenberg Uncertainty Principle places a fundamental limit on the precision with which certain pairs of quantum properties, most notably position and momentum, can simultaneously be specified. In conventional quantum mechanics this is not simply a limitation of measurement equipment, but follows from the mathematical structure of the quantum state itself. The Three Spheres Theory should preserve this principle rather than attempt to replace it.

$$\Delta x \Delta p \geq \hbar/2$$

where Δx and Δp represent the uncertainties in position and momentum. Any Three Spheres description of a Middle-sphere particle must reproduce this relation.

Within the theory, uncertainty may be regarded as a property of the underlying Middle-sphere quantum state. A particle can possess a definite Dimensional Orientation, for example $D_0 = 90^\circ$, while its position and momentum remain subject to the normal quantum uncertainty relation. Dimensional Orientation therefore does not provide additional information that would allow the uncertainty principle to be circumvented. In particular, the existence of an underlying Bottom-sphere string position, X , should not automatically be interpreted as providing a simultaneously measurable precise position for the corresponding Middle-sphere particle.

This distinction is important because the theory proposes different levels of physical description. The Bottom-sphere state may contain properties that contribute to the emergence of a Middle-sphere particle without those properties being equivalent to the observable position and momentum of that particle. The Three Spheres Theory must therefore reproduce the established uncertainty relations for Middle-sphere quantum systems and must not permit information from the Bottom Sphere to be used to predict simultaneously incompatible Middle-sphere observables with greater precision than quantum mechanics allows.

6.8 Quantum Spin

Quantum spin is an intrinsic property of elementary particles and should be distinguished from both ordinary spatial rotation and Dimensional Orientation. An electron, for example, has spin 1/2, but this does not mean that the electron is literally a small object rotating about an axis. In the Three Spheres Theory, spin should therefore not be identified with D_o or with Dimensional Rotication, D_r .

A natural interpretation within the theory is that spin belongs to the quantum state of the fully manifested Middle-sphere particle. The species-defining vibrational component V_s determines the particle species and therefore the intrinsic properties associated with that species, including its characteristic spin, while R_v influences Dimensional Rotication and D_o determines whether the corresponding particle state can manifest in the Middle Sphere. Once $D_o = 90^\circ$ is reached and an electron manifests, the electron possesses the spin properties required by conventional quantum mechanics. A measurement of spin in a Top-sphere experiment would consequently probe a property of the underlying Middle-sphere electron state rather than the electron's Dimensional Orientation.

This separation gives the theory three conceptually different properties:

$V_s \rightarrow$ particle species and associated intrinsic properties

$R_v \rightarrow$ manifestation-relevant vibrational component that can generate D_r

$D_o \rightarrow$ dimensional manifestation

quantum state $\rightarrow$ particular spin state and other quantum observables

Dimensional Rotication changes D_o through a change in R_v while preserving V_s , and there is presently no reason to assume that it changes the particle's spin state. Any future extension proposing a relationship between R_v , Dimensional Rotication and quantum spin would require an additional physical mechanism and would have to reproduce established spin statistics, including the spin correlations measured in Bell experiments.

6.9 Mass

The Three Spheres Theory proposes that mass emerges as a property of Middle-sphere manifestation. When a Bottom-sphere string retains the species-defining vibration V_s of a particular particle and a suitable change in R_v drives D_o to the orientation required for stable manifestation, the resulting Middle-sphere particle acquires the characteristic mass associated with that species.

V_s determines particle identity and associated intrinsic properties, while completed $D_o = 90^\circ$ permits that particle state to manifest with those properties, including mass. R_v is proposed to influence the transition into or out of that manifested state rather than to determine the numerical value of the particle's mass. The precise mechanism by which the underlying string state gives rise to the particular mass of each particle is not yet specified.

6.10 Dark Matter and Gravity — Open Possibilities

Dark matter is proposed to consist of Middle-sphere particles or bound systems that do not acquire the Collective Dimensional Orientation, D_{oc} , required for stable Top-sphere manifestation. If the required constituent orientations or stable bound configuration cannot be achieved, no stable Top-sphere atom emerges.

Gravity may operate wholly or partly through the Middle and/or Bottom Spheres. Because ordinary Top-sphere matter retains its underlying Middle-sphere structure, matter that does not manifest in the Top Sphere could potentially influence ordinary matter gravitationally.

The possibility that gravity operates across dimensional domains has a conceptual precedent in brane-world physics, where gravity may propagate through a higher-dimensional bulk while ordinary matter remains largely confined to a brane. The Three Spheres proposal differs in its geometry and mechanism, but similarly allows gravitational interaction to have access to dimensional structure that ordinary Top-sphere matter does not directly manifest.

6.11 WIMPs

Weakly Interacting Massive Particles (WIMPs) are hypothetical particles that have been proposed as possible constituents of dark matter. No WIMP has yet been experimentally confirmed.

A WIMP remains fundamentally a Middle-sphere particle and does not acquire the Collective Dimensional Orientation, D_{oc} , required for Top-sphere manifestation. It may nevertheless possess a very weak coupling to Top-sphere matter, permitting rare interactions without itself manifesting in the Top Sphere.

The strength of this interaction would not necessarily be determined simply by the mass or physical size of the WIMP. Instead, the theory proposes that it could depend upon the dimensional relationship between the WIMP's Middle-sphere state and the Top Sphere.

This provides a possible Three Spheres interpretation of weakly interacting dark matter: the particle is difficult to detect because it does not manifest in the Top Sphere, but its dimensional state permits a small probability of interaction with Top-sphere matter.

Gravity could provide a separate and much more persistent connection. If gravity operates partly through the Middle Sphere, WIMPs and other Middle-sphere dark matter could exert gravitational effects on ordinary matter even though their direct Top-sphere interactions are extremely weak.

6.12 Limitations

The Three Spheres construction, its special orthogonality, Dimensional Orientation, vibration-driven Dimensional Rotation and Collective Dimensional Orientation are hypotheses. No experimental evidence presently establishes these structures. The potential $U(\theta, \lambda) = A \sin^2(2\theta) - \lambda \sin^2\theta$ and the associated Lagrangian are provisional models rather than derived fundamental laws. They provide a mathematical reason for treating 0° and 90° as stable orientations and predict a critical Rotation threshold. The theory also does not yet determine whether the manifestation-relevant vibrational structure R_v should be represented by a scalar, vector, spinor, or more general quantum state, nor derive its transformation properties from an underlying symmetry. The theory does not yet derive R_v from string dynamics, identify which vibrational feature it represents, determine how laboratory

interactions can change it, determine A , g_v or ID , derive particle masses or charges, specify a complete Hamiltonian, reproduce Bell correlations mathematically, derive D_{oc} from binding dynamics, or demonstrate all conservation laws across emergence.

7. Summary

The theory proposes a nine-spatial-dimensional physical structure consisting of three mutually orthogonal three-dimensional domains. Fundamental strings occupy the Bottom Sphere, subatomic particles manifest in the Middle Sphere, and atoms and all larger ordinary three-dimensional structures manifest in the Top Sphere.

Each string has a Vibrational State V , now represented as containing a species-defining component V_s and a manifestation-relevant Rotational Vibrational Component R_v . V_s determines which particle species the string can manifest as, while a suitable change in R_v generates Dimensional Rotation and biases Dimensional Orientation D_o . For Bottom-to-Middle orientation the Dimensional Weights remain $W_B = \cos^2 D_o$ and $W_M = \sin^2 D_o$. The provisional potential $U = A \sin^2(2D_o) - g_v R_v \sin^2 D_o$ makes 0° and 90° stable orientations separated by an energy barrier. Stable Middle-sphere manifestation occurs when the vibration-driven Rotation brings D_o to 90° .

When all required constituents of a stable Middle-sphere bound system have $D_o = 90^\circ$, their collective binding can produce a new orthogonal Collective Dimensional Orientation D_{oc} , permitting the complete system to manifest as a Top-sphere atom.

The theory further proposes sphere-dependent locality as a possible physical interpretation of entanglement, while requiring compatibility with Bell-test correlations and no-signaling. Mass, dark matter and gravity are retained as open implications requiring further development.

The central experimental prediction is reversibility with threshold behaviour: if R_v can be physically and controllably altered, the dynamics predicts loss of stability when $|g_v R_v|$ reaches $4A$, followed by switching of Dimensional Orientation. A controlled inverse vibrational change should in principle remove an elementary particle's stable Middle-sphere manifestation while preserving V_s , and a subsequent opposite change should restore it, with hysteresis between the two switching directions.

The framework remains speculative and will require a fundamental derivation of the proposed potential, a precise definition of the vibrational quantity R_v , a complete mathematical dynamics and an experimentally identifiable interaction capable of changing R_v without conventionally destroying the particle state.