

# Resolving Spin and Entanglement with Testable Local Hidden Variables

## The Liquid Gravity Atomic Model and a Proposed Stern–Gerlach Experiment Challenging Standard Probabilistic Predictions

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### Abstract

We present the Liquid Gravity Atomic (LGA) framework: an alternative, locally causal model in which electron spin and related quantum phenomena emerge from structured nuclear dynamics rather than being intrinsic properties of electrons. In LGA, nucleons form linked multichain arrangements whose internal figure-8 standing-wave motions generate oscillating fields that propagate along proton–neutron chains. The terminal neutron in each chain transmits a driven, oscillatory field into the orbital region; electrons tethered to these orbitals inherit a two-turn ( $720^\circ$ ) rotational signature and the observed up/down spin behavior. Superposition appears as an alternating spin pattern set by the neutron pulse position (West/East hemispheres), and entanglement is maintained by phase-locked pulse pairs carrying coordinated local variables rather than invoking nonlocal influences.

We apply the framework to spin measurement using a three-stage Stern–Gerlach apparatus. LGA predicts that adjusting the distance between the second and third stages to match particle wavelength and velocity can confine the pulse into the upper or lower beam, enabling deterministic control of spin outcomes. This contrasts with standard quantum mechanics, which predicts irreducible 50/50 statistics independent of such geometric tuning. LGA also characterizes measurement probabilities in terms of a magnetic-angle dependence ( $0^\circ \rightarrow$  no flip;  $90^\circ \rightarrow$  50/50 flip/no-flip) arising from torque on the pulse.

The paper outlines the physical mechanisms, symbol conventions for diagrams, and experimental signatures that distinguish LGA from quantum expectations, and proposes concrete Stern–Gerlach tests to validate or falsify the model.

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## 1. Introduction

The concept of spin occupies a foundational yet paradoxical role in quantum mechanics. Unlike classical angular momentum, spin is treated as an intrinsic property of elementary particles, [2] lacking a clear mechanical origin. This abstraction has contributed to longstanding interpretational difficulties, including the measurement problem and apparent violations of classical causality.

Despite the predictive success of quantum formalism, the absence of a physically intuitive mechanism for spin remains a motivation for alternative approaches. The present work investigates whether electron spin may arise as an emergent phenomenon rooted in atomic and nuclear structure, rather than being a fundamental quantum postulate.

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## 2. Experimental and Historical Context

### 2.1 Stern–Gerlach Experiment

The Stern–Gerlach experiment [3] yielded a significant and unexpected result from an investigation initially designed for different purposes. It demonstrated that neutral silver atoms, when passed through a non-uniform magnetic field, separate into two discrete spatial trajectories. This outcome revealed quantized angular momentum states, which were later interpreted as the spin orientations of electrons: spin-up and spin-down.

It is important to note that the electron is considered to be in a superposition of all possible spin states until a measurement is made, at which point the quantum state collapses into a definite spin orientation. Additionally, it is noteworthy that free electrons cannot be measured using this technique; only valence electrons in atoms, such as silver, can be tested in this manner. The Stern–Gerlach experiment laid the groundwork for critical concepts in quantum physics, including particle collapse, probability, and superposition.

### 2.2 The EPR paper

The discovery of the double-slit experiment sparked a debate about the workings of the quantum realm, focusing on concepts such as wave-particle duality, wave function collapse, and entanglement. The discussion featured prominent figures like Niels Bohr, who argued that the quantum world is fundamentally unknowable and that we must accept its inherent strangeness, given the remarkable accuracy of quantum probabilities. In contrast, Albert Einstein maintained that the quantum realm should ultimately adhere to classical principles.

Together with Boris Podolsky and Nathan Rosen, Einstein co-authored a paper in 1935 known as the EPR paper, which contended that quantum probability undermines the causal nature of reality. They argued that "spooky action at a distance"—the instantaneous connection between entangled particles—cannot be real, suggesting that quantum theory is incomplete. They posited that there must be hidden variables that govern the synchronized behavior of entangled particles, regardless of the distance separating them.

### **2.3 John Bell's theorem**

In 1964, physicist John Bell developed a method for testing local hidden variable theories [4] against the probabilistic, non-local predictions of quantum mechanics [5]. He designed an experiment based on the Stern-Gerlach setup, where two entangled electrons measure their spins at different angles. Bell's findings demonstrated a measurable difference between the outcomes predicted by hidden variable theories and those predicted by quantum mechanics. Although his theorem was largely overlooked at the time, its significance has come to light in recent years, leading to several Nobel Prizes awarded for tests of Bell's theorem.

### **2.4 Many Interpretations of Quantum Mechanics**

The challenge of quantum mechanics lies in its ability to provide a highly precise mathematical framework for calculating quantum probabilities, yet it offers no concrete explanation for how these results manifest physically. This situation often appears to contravene classical principles of locality and causality. Consequently, numerous interpretations have been proposed to elucidate the underlying nature of this perplexing quantum realm.

#### **Many-Worlds Interpretation:**

This interpretation posits that rather than collapsing into a single state upon measurement, all possible states of a quantum system coexist, resulting in a branching of reality with each collapse event.

#### **Superdeterminism:**

This interpretation suggests that all particles are predetermined from the beginning of time, implying that entangled particles possess prior knowledge of their respective outcomes, and thus display local pre-knowledge.

### **Time-Travel Interpretation:**

This interpretation proposes that particles can communicate with their past selves, allowing them to remain correlated into the future.

Despite these interpretations, none provide testable or falsifiable methods to validate their claims, leaving the scientific community in a state of ongoing debate regarding the true nature of phenomena in the quantum world.

## **2.5 What Can We Learn from History?**

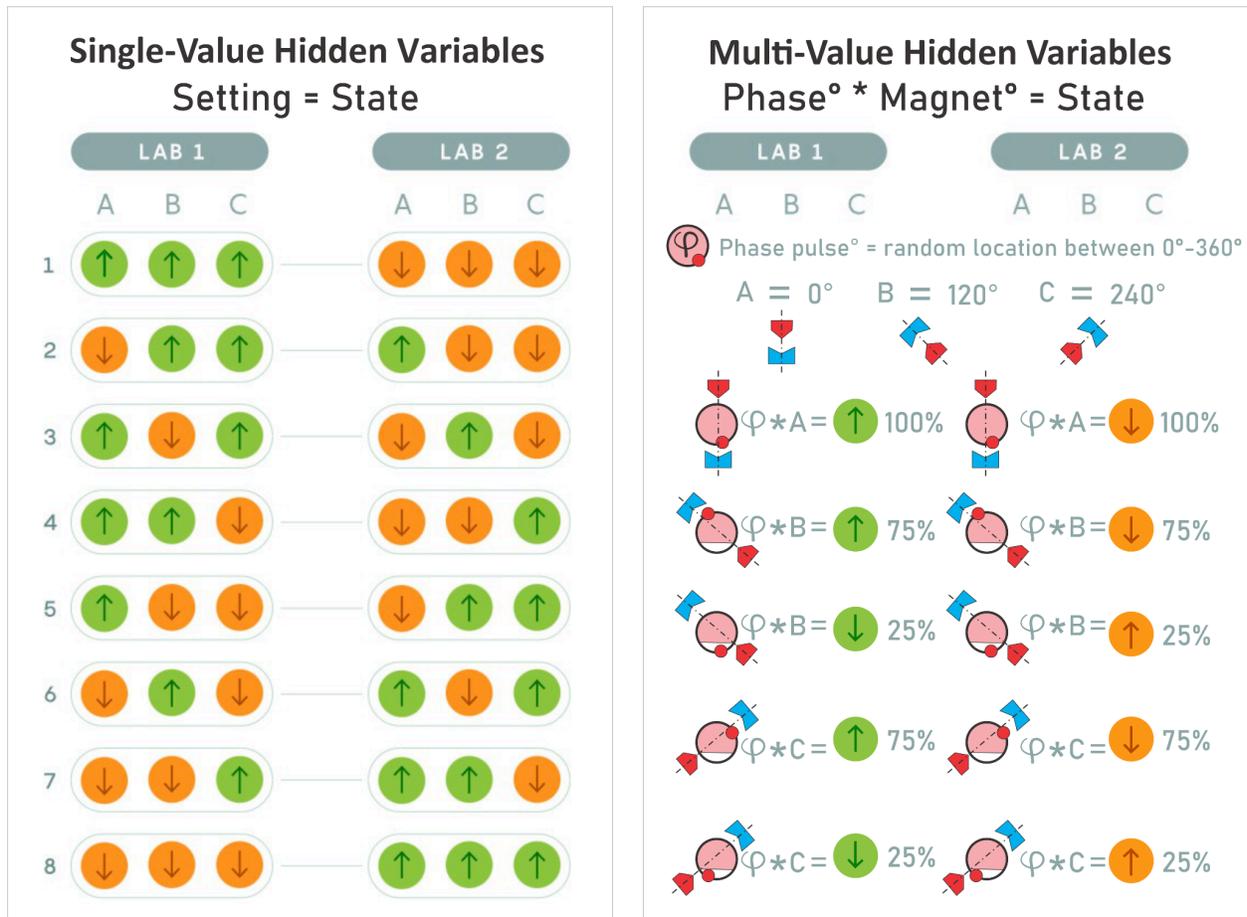
The narrative of quantum physics has shifted away from seeking explanations based on real-world, local causality, leaning instead toward ideas that resemble science fiction or mythological magic. Throughout the history of quantum physics, significant details have often been overlooked, and new assumptions have taken center stage. Claims such as Bell's theorem disproving Einstein, the notion that rethinking quantum mechanics leads to clarity, and the assertion that locality and causality cannot coexist contribute to a frenzy of unconventional interpretations that dominate scientific discourse today.

I contend that Einstein was correct in asserting the incompleteness of quantum theory and that a locally causal, hidden-variable explanation remains worth examining. Critics argue that Bell's theorem rules out local hidden variables, but it rules out only certain classes of models — specifically those that assign a single predetermined outcome to each measurement setting (which I will call single-valued hidden variables).

Quantum probability outcomes suggest that each hidden variable must accommodate two possible results for a given measurement angle, with associated probabilities; these form a class of multi-valued hidden variables. Producing multiple outcomes locally requires at least two parameters — for example, the orientation of a magnetic field and a local phase parameter of a wave. Combining these locally defined parameters can yield probabilistic outcome statistics consistent with quantum predictions.

**Figure 1:**

*A schematic that compares single-value hidden variables with multi-value hidden variables.*



### 3. Hypothesis

This paper proposes that electron spin is not an intrinsic quantum property but an emergent classical behavior produced by nuclear dynamics. We hypothesize that quantum phenomena are ultimately classical and that their apparent mystery can be resolved by restoring local causality. A clearer picture of atomic structure can help answer three central questions in quantum mechanics: What is spin? What causes wavefunction collapse? Are there nonlocal “spooky” actions at a distance, or do local hidden variables exist?

The core idea is that the mechanical structure and dynamics of the atomic nucleus drive the behavior observed in electrons. Important structural and dynamical details of the nucleus have been neglected in mainstream accounts; incorporating these pieces yields a coherent, causal account that explains spin, collapse, and entanglement without invoking nonlocality.

## 4. The Liquid Gravity Atomic (LGA) Framework

This section outlines the Liquid Gravity Atomic (LGA) framework, which offers an alternative account of electron spin as an emergent property of nuclear structure rather than an intrinsic attribute of the electron.

### Context and motivation

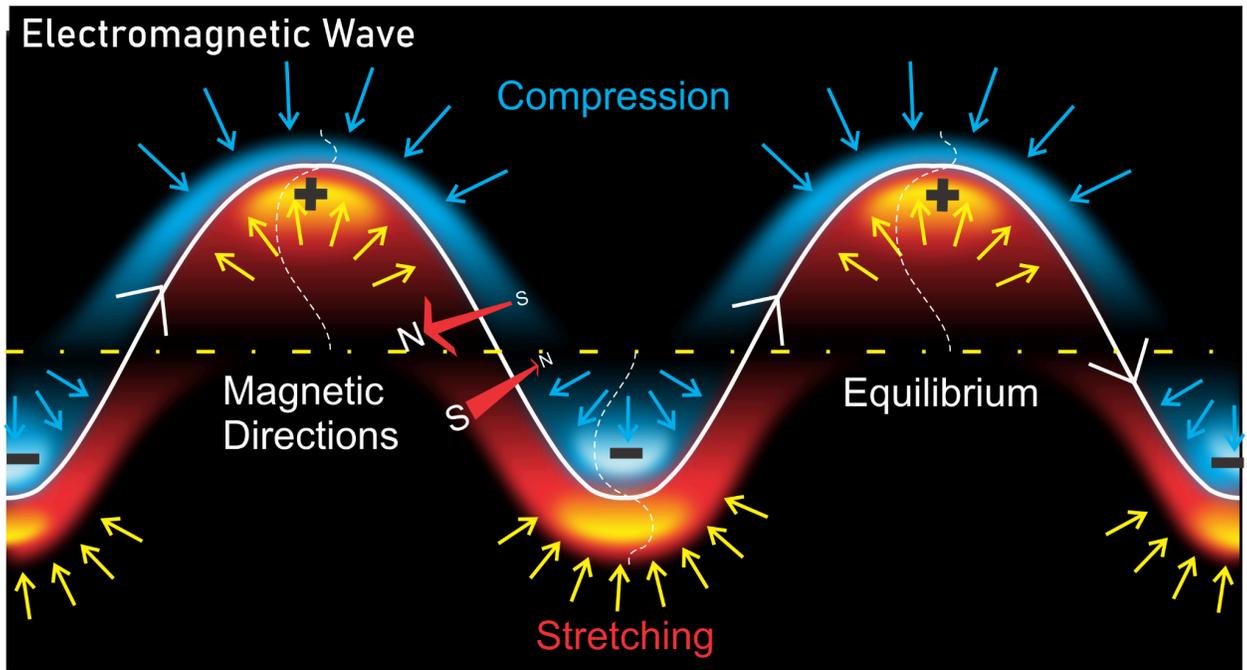
Mainstream physics treats half-integer spin as an intrinsic quantum property of electrons; this description explains experimental results but does not provide a classical causal mechanism for how spin arises or how measurement collapses an outcome. The LGA framework instead traces spin back to the nucleus and the dynamical fields it generates.

### Core ideas

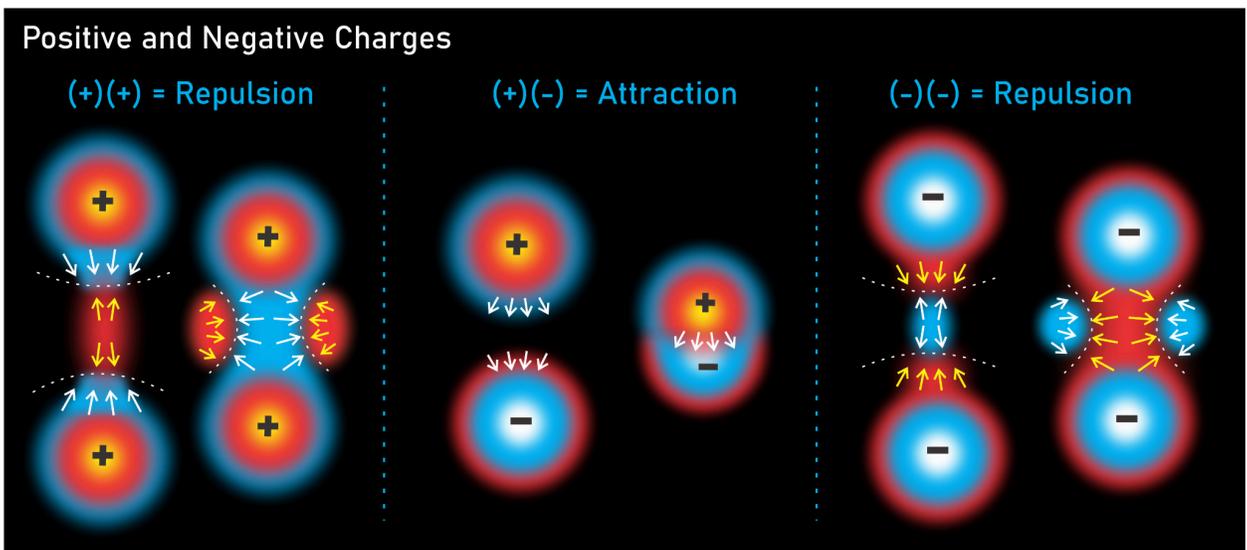
Fundamental medium: LGA proposes that all particles, fields, and forces emerge from a single, ubiquitous medium with both fluid and elastic properties. Interactions are carried by positive and negative pressure gradients in this medium, enabling charges, waves, standing waves, and gravity to operate across macroscopic and quantum scales. This unified framework is intended to explain the mechanical structure of subatomic particles and the origin of their effective (non-fundamental) forces.

- Emergent particles: In LGA, subatomic particles arise from patterns of energy propagation within the fundamental medium.
- Electromagnetic waves: Electromagnetic waves exploit the medium's elasticity; the medium's restoring resistance provides the periodic exchange between stretching and

compression that sustains wave propagation.

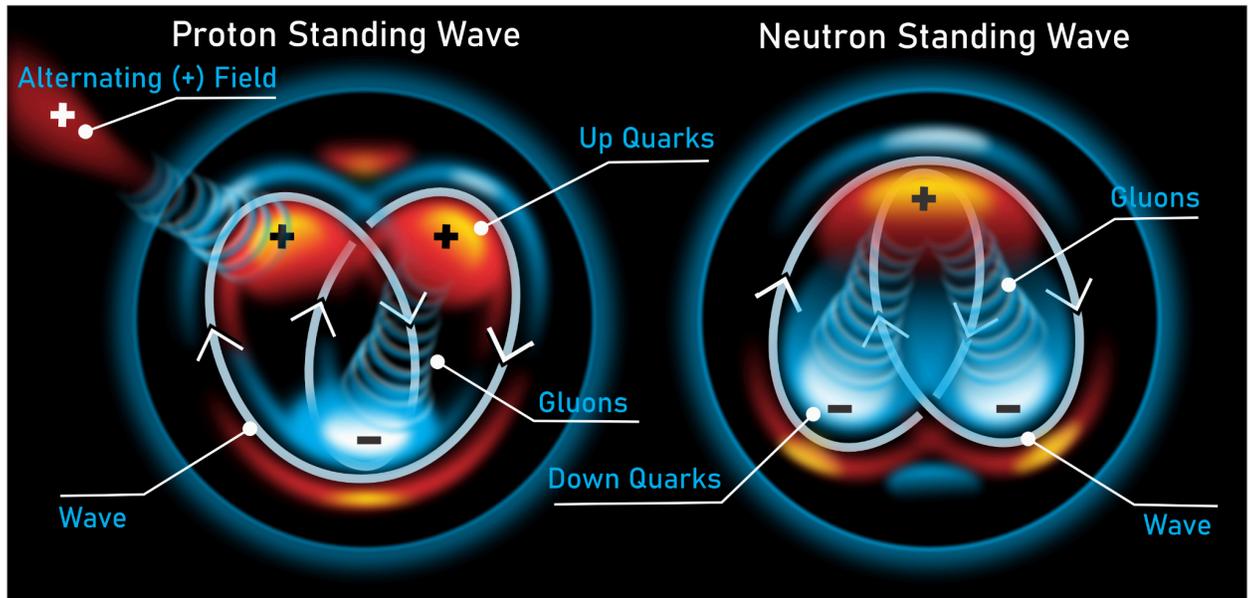


- Charges and electrostatic interaction: Charges manifest as localized stretches or compressions of the medium. Limited stretching or compression between like regions produces repulsion, while complementary deformations produce attraction, giving rise to electrostatic behavior.



- Nucleons and strong interactions: Nucleons are modeled as high-energy pulses confined within a condensed superfluid region of the medium. They adopt figure-eight ( $\infty$ ) standing-wave patterns that produce alternating positive and negative eddies and drive vortex-tube structures. These complementary vortex interactions produce the binding

behavior identified experimentally as quarks and gluons and explain nucleon-level (hydrodynamic-like) behavior in a single-medium picture.



- Spin Emergence from the nucleus: LGA proposes that electron spin emerges from structured motions within the nucleus, transmitted outward to the orbitals that bind electrons. Electrons themselves do not carry intrinsic spin in this picture; rather, they inherit rotational characteristics from nuclear dynamics.

- Nuclear structure: Whereas the Liquid Drop Model (LDM) describes the nucleus as a relatively loose, dynamic collection of nucleons, LGA posits a highly structured arrangement in which nucleons form linked multichain configurations. These chained structures mediate the transmission of fields from protons into the orbital region.

- Role of neutrons: In LGA, neutrons play an active role in distributing the positive field of the atomic shells. While neutrons are electrically neutral, they receive and relay positive field effects along proton–neutron chains; the terminal neutron in each chain couples that field into the orbital region.

- Shared nucleon dynamics: Both protons and neutrons are modeled as having internal standing-wave motion following a figure-8 path that alternates through regions of effective positive and negative phase within their roughly spherical structure. These motions occur within a dense superfluid medium that supports strong, vortex-like hydraulic forces—interpreted here as the effective strong nuclear interaction—which organize and transmit the field along the nucleon chains.

- Transmission to orbitals: The dynamic rotation and oscillation of the terminal neutron's field impose a driven motion on the orbital fields. Electrons, being tethered to these orbitals, acquire the observed  $720^\circ$  (two-turn) rotational signature attributed to electron spin through this coupling.

### **Summary of the mechanism**

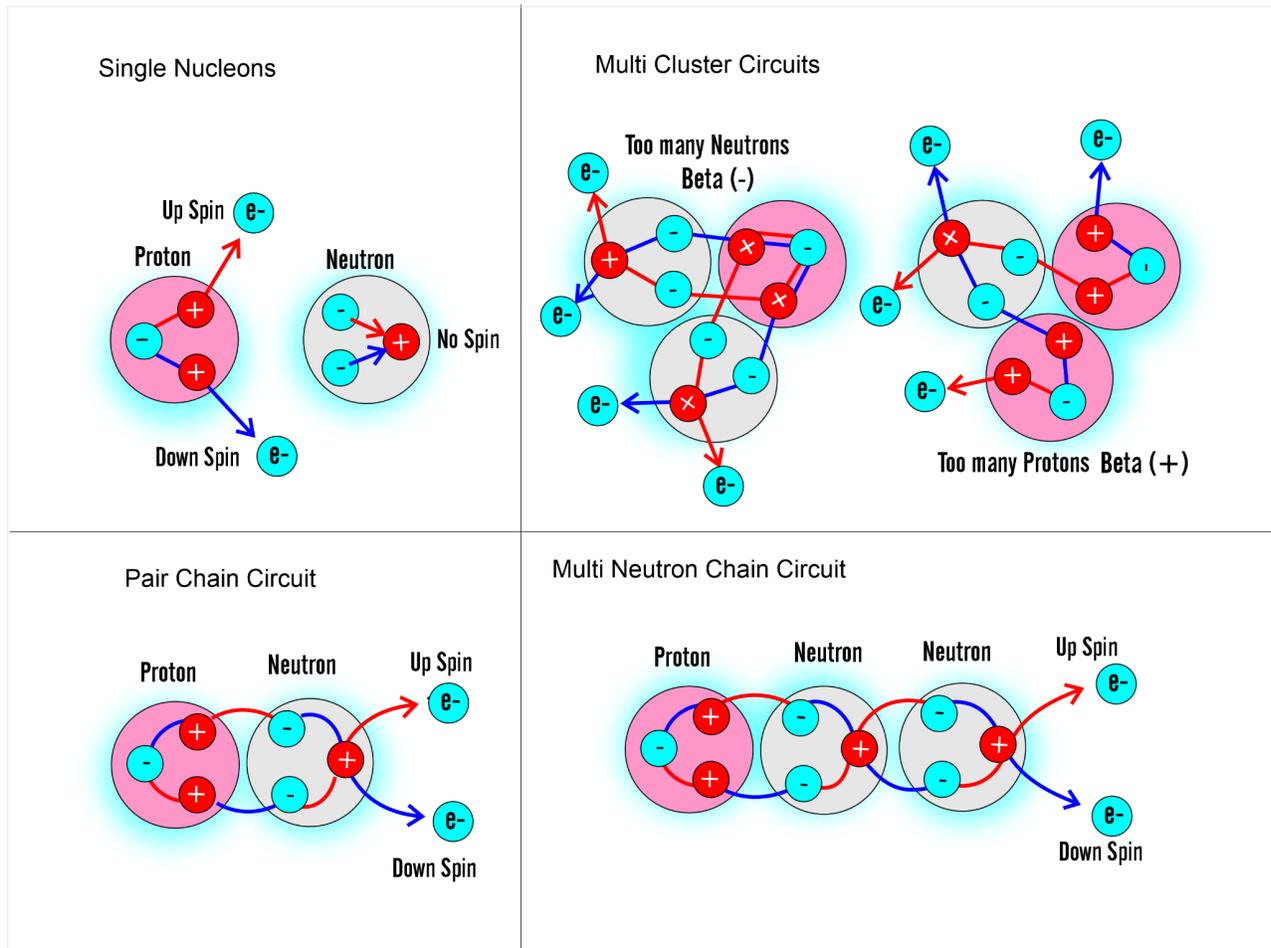
- Protons initiate a circulating positive field.
- Neutrons propagate and structure that field via coupled wave motion through nucleon chains.
- The terminal neutron in each chain transmits an oscillating field into the orbital region.
- Electrons inherit the resulting rotational properties from the orbital field, producing the effective spin behavior (including the characteristic  $720^\circ$  property) observed in experiments.

### **Notes:**

This section presents the LGA framework as a conceptual model for how spin might emerge from nuclear dynamics. Detailed mathematical formulation and our suggested experimental tests would be required to evaluate its predictions against established quantum-mechanical descriptions.

**Figure 2:**

*Schematic of proton–neutron chain coupling and transmission of orbital field.*



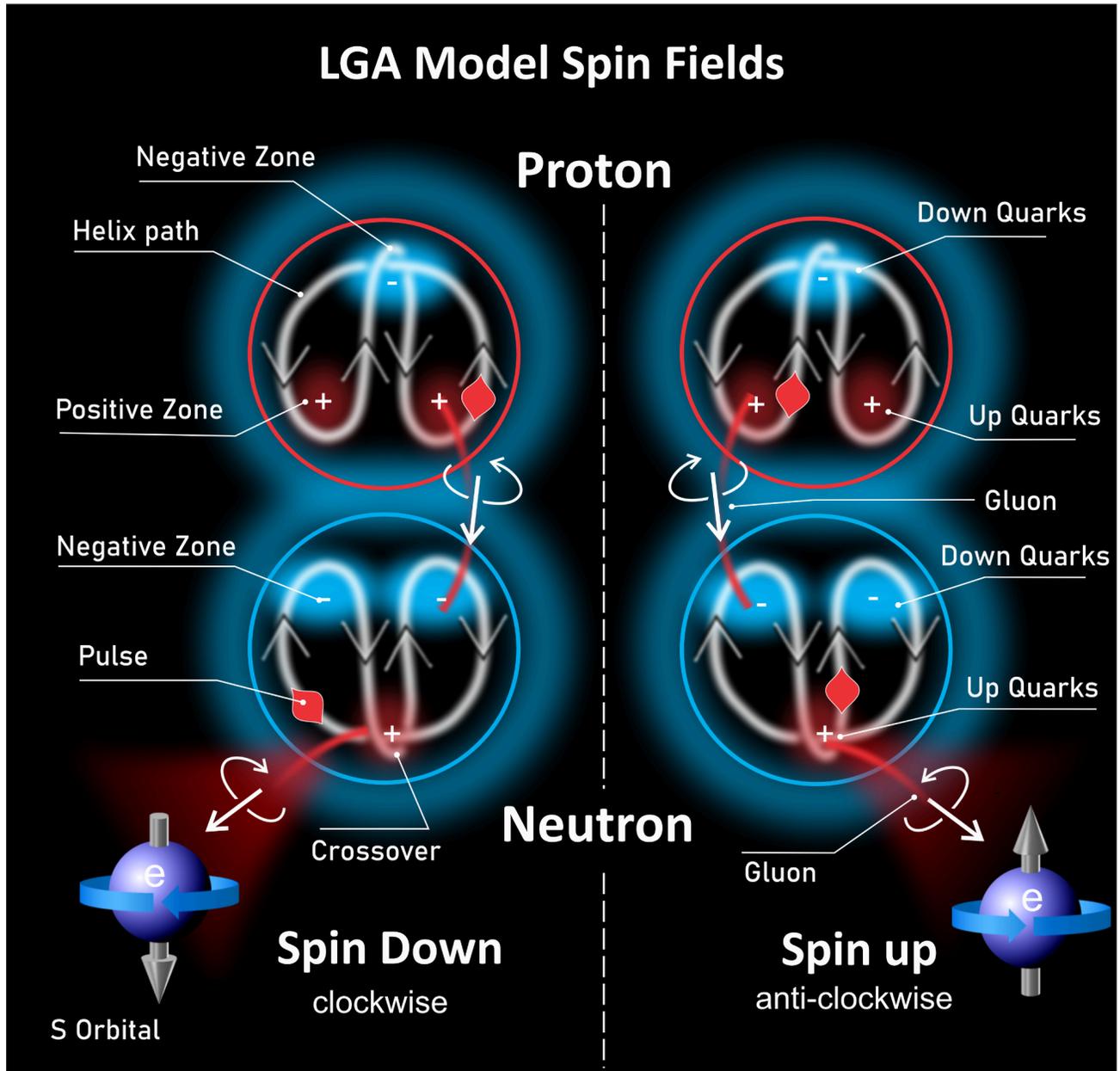
## 5. Nucleon Dynamics and Orbital Formation

### 5.1 Balanced Helix Path State (Superposition)

In the absence of external magnetic influence, the neutron propagates a pulse along a closed, double-loop figure-eight trajectory. This energy pulse completes a  $720^\circ$  dual-wave cycle, passing through two negative zones and one positive zone twice per cycle. The resulting alternating positive field radiates outward to form the sss-orbital. The valence electron is confined within this alternating field and follows the same  $360^\circ$  rotational motion on each side, oscillating between opposing sides of the orbital. In this balanced state, no fixed spin orientation exists.

**Figure 3:**

*Helix pulse trajectory showing negative zones, positive zone, and crossover point.*

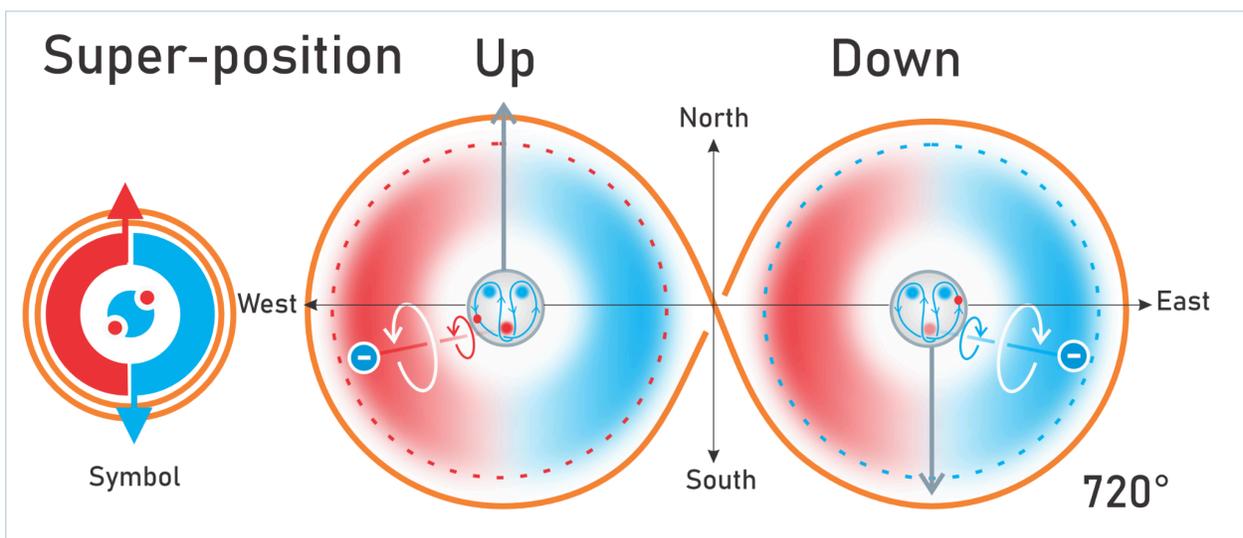


For clarity in the diagrams that follow, we introduce a set of symbols to represent an atom's possible states.

“Superposition” [7] is the quantum-mechanical term for a system existing in a continuum of possible states simultaneously. In the LGA model, this is represented more simply as an alternating spin pattern induced by the neutron's wave path: the spin orientation flips each time the neutron trajectory crosses over along its figure-8 route. The accessible states are determined by the neutron pulse's position in the West or East orbital, and the electron's motion is guided by the dynamic field emitted by the neutron, causing the electron to follow the prescribed spin path. We have represented the  $720^\circ$  path as an orange line with the symbol showing double lines indicating the double rotation. The up and down arrows show the respective spin states, and the blue nucleus with the red dot symbolises the pulse position

**Figure 4** — Simplified atom (single nucleon shown)

A schematic showing a single nucleon's figure-8 trajectory and the separated West and East hemispheres. The orange double-lined curve traces the nucleon's  $720^\circ$  (two-turn) path. The blue sphere represents the nucleus; the red dot marks the nucleon pulse position. Up and down arrows indicate the local spin orientations produced as the trajectory crosses between hemispheres. Other nucleons are omitted for clarity.



## 6. Magnetic-Field-Induced Eigenstate

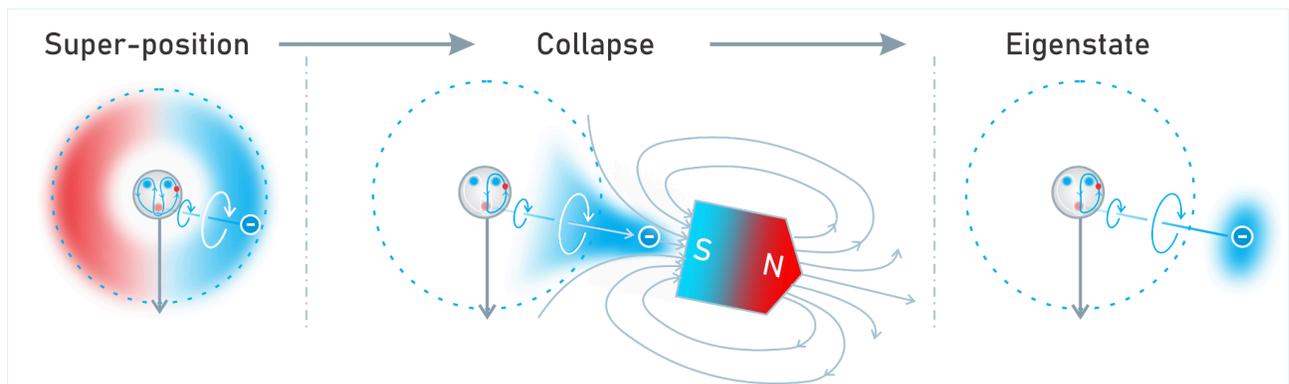
### 6.1 Wave collapse into an Eigenstate

The collapse of the wavefunction—commonly called the measurement problem—refers to the unresolved question of what physically causes a quantum state to reduce to a single eigenstate. Here, we identify a sequence of steps and conditions that, in this model, produce the collapse of an atom's electron state.

1. Driven spin. In this framework, the electron's spin is not taken as an isolated intrinsic property but as a response to the neutron's propagation of the positive field; the electron's motion tracks that field.
2. Field competition. When the atom enters a strong external magnetic field, the electron becomes subject to both the local positive field and the external magnetic field. The competing fields deform the electron's trajectory, concentrating (collimating) the electron's spatial distribution.
3. Geometric consolidation and dynamical change. This spatial consolidation increases the effective centrifugal influence on the neutron pulse and drives a dynamical transition of the pulse trajectory from a balanced helical/figure-eight path into a locked single-loop rotation.
4. Stabilization. Although the external magnetic perturbation is transient, the new geometric configuration produces increased centrifugal stability that maintains the single-loop rotation. The result is a persistent, well-defined rotational (spin) orientation — i.e., a collapsed eigenstate — that can survive after the atom leaves the magnetic region.

**Figure 5:**

*Transition from superposition to collapse to a persistent eigenstate of spin down*



## 7. Measurement without Observer Dependence

In the Stern–Gerlach experiment, atomic beam splitting arises from deterministic interaction between the atomic magnetic structure and the external field. The magnetic field constrains the system into a single rotational state, which remains stable upon subsequent measurements using identically aligned detectors.

In this model, measurement outcomes are determined by physical interaction rather than observer-induced wavefunction collapse.[9]

## 8. Spin State Reversal

Reorientation of the external magnetic field can unlock the single-loop state depending on the progression of the neutron pulse. Torque increases as the pulse approaches the crossover point of the original figure-eight trajectory.

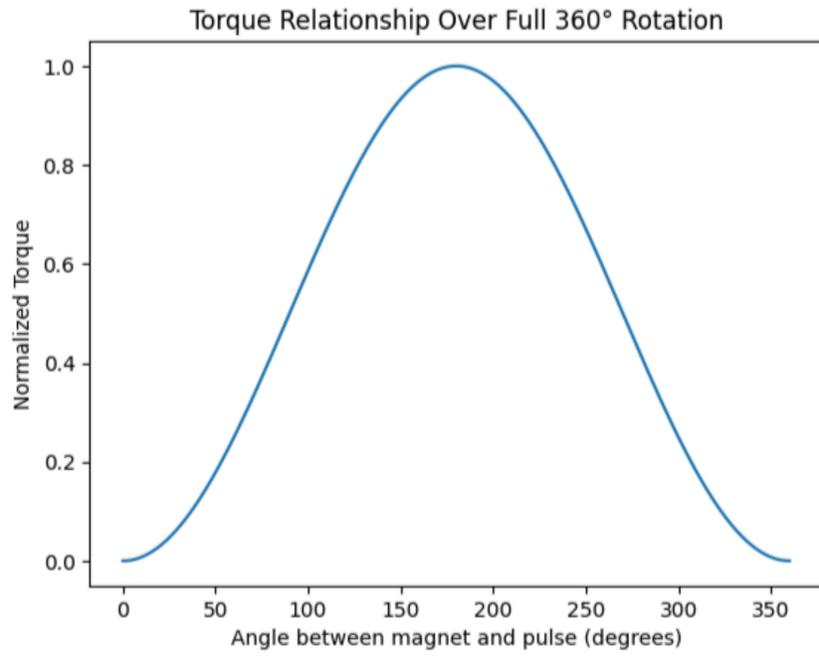
- Torque is minimal at the apex of negative zones
- Torque is maximal at the crossover point

Spin reversal occurs when magnetic torque exceeds pulse-generated torque.

## 9. Torque–Angle Relationship

The torque acting on the neutron pulse as a function of angular separation between the magnetic field and pulse orientation is modeled as:

**Figure 6:** *Showing the relationship between the external magnetic torque and the nucleon pulse torque. These results map the same path as Quantum probability.*

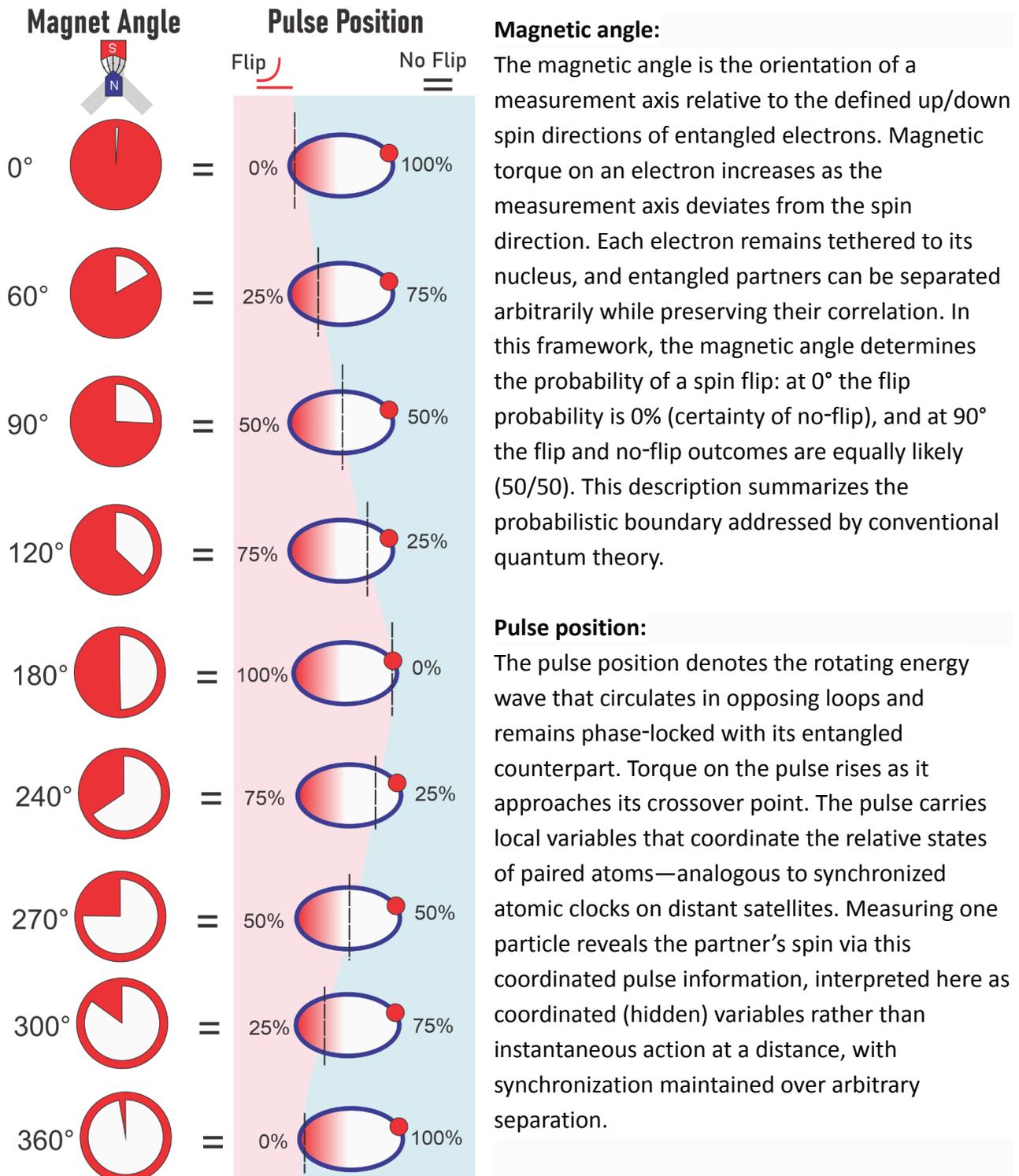


$$\tau(\theta) = \tau_{\max} \sin^2\left(\frac{\theta}{2}\right)$$

$$\frac{1 - \cos \theta}{2} = \sin^2\left(\frac{\theta}{2}\right)$$

## 9.1 How to calculate the flip threshold

**Figure 7:** Illustrating the relationship between the external magnetic angle and the pulse's flip threshold position.



### Spin Flip Threshold:

Spin-flip zones are defined by the ratios of competing torques between the external magnetic field and the cross-over loop. These thresholds match the percentage values of quantum probability calculations. The critical factor is the pulse's location relative to the flip threshold. If the pulse lies within the flip zone, the electron spin will invert to its opposite state. Conversely, if the pulse is within the "No-Flip" zone, it will maintain its current 'Spin up' or 'Spin down' orientation. While the other entangled particle may experience a different magnetic angle, it will retain its pulse position and act in a synchronized manner with its entangled partner.

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## 10.0 Bell's theorem test.

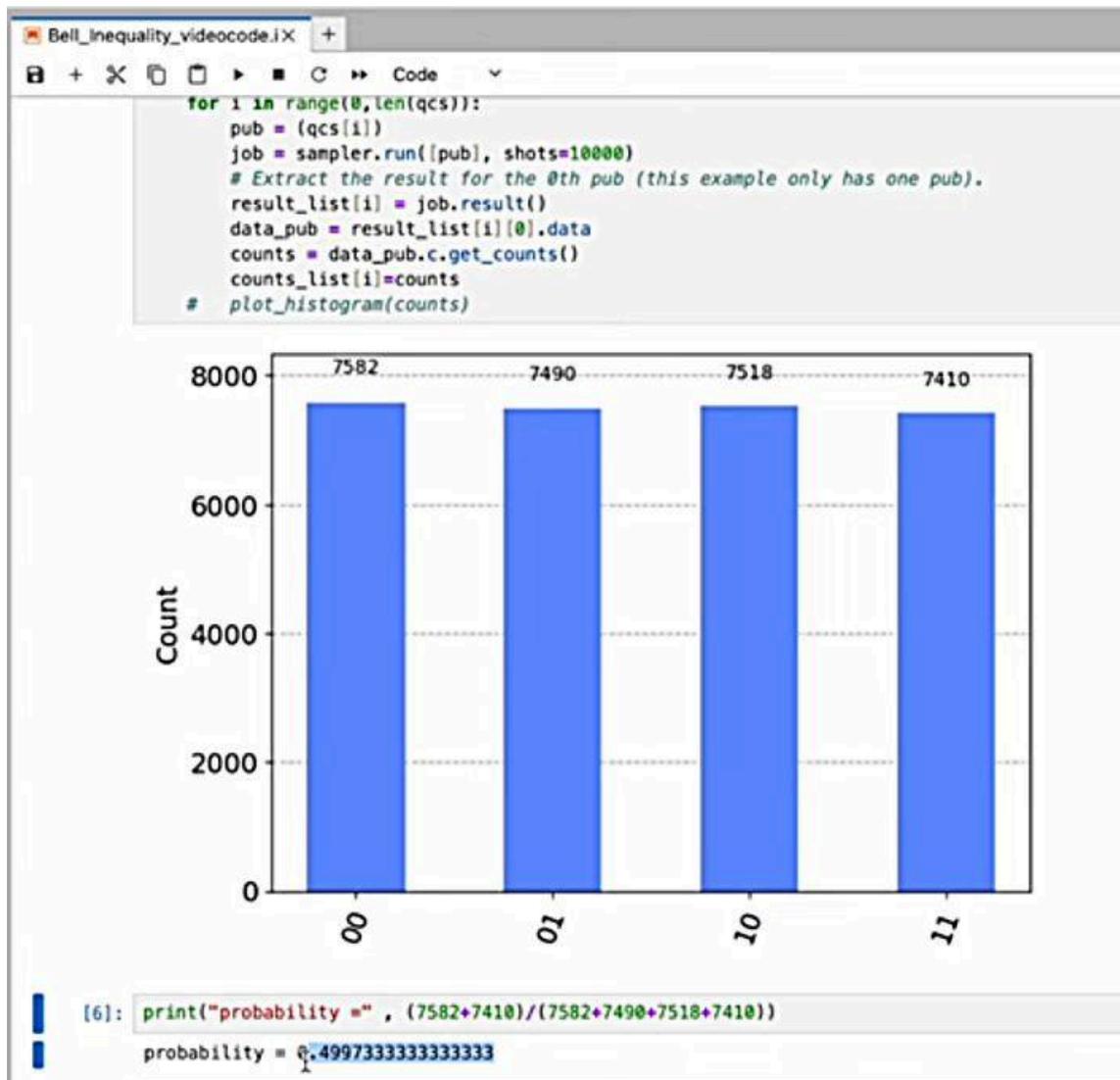
Testing Bell's theorem requires a comparison of theoretical predictions with empirical results. To date, the primary contenders in this realm have been predictions derived from quantum probability and the hidden variable theories proposed by Einstein and his collaborators.

Classical hidden variable theories suggest a statistical likelihood of differing outcomes ranging from 55.6% to 100%. In contrast, quantum probability calculates that differing results will occur 50% of the time. Empirical testing involving a limited number of iterations often fails to yield conclusive results, as probability accuracy increases with the quantity of tests conducted.

With a high number of test iterations, these two frameworks have consistently shown that quantum probability predictions align more closely with experimental outcomes, particularly those approaching the 50% threshold.

**Figure 8** presents an example from IBM's Qiskit, which employs qubits to measure real-world probabilities using a quantum computer, yielding a result of 0.4997333333333333, closely approximating the expected quantum probability.

**Figure 8:** Showing a screen grab of the QisKit application running over 7000 entangled measurement tests to determine the probability results.

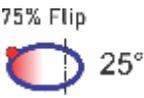


The accuracy of probability testing increases with the number of trials conducted, and advancements in quantum testing recently earned the Nobel Prize in 2022 for enhancing the outcomes of entangled state measurements.[12] Utilizing supercomputers to generate millions of test events significantly improves the statistical reliability of these outcomes.[13]

## 10.1 Testing the LGA method with Bell's theorem.

The test sheet illustrated in Figure 9 encompasses all components necessary to evaluate the Liquid Gravity Atomic (LGA) method. While the test adheres to the established framework, it

may also incorporate various random iterations. A key feature of this test is the "Pulse," which can assume any random orientation while remaining synchronized with its entangled pair, as

denoted by the red dot on the loop diagram. 

In practical terms, the pulse generates a diminishing torque gradient from the crossover point to the opposite apex, resulting in a point of no torque force. This gradient is visually represented by the red color gradient on the loop diagram.

The flip threshold is determined by the angle of the magnets relative to the known spin direction of the electron. This reflects the torque exerted by the external magnetic apparatus based on its orientation. If the randomly selected pulse point lies within the flip zone, it will trigger a reorientation of the spin direction, resulting in a discernible outcome.

The flip action is denoted by specific symbols , while the no-flip action is indicated by .

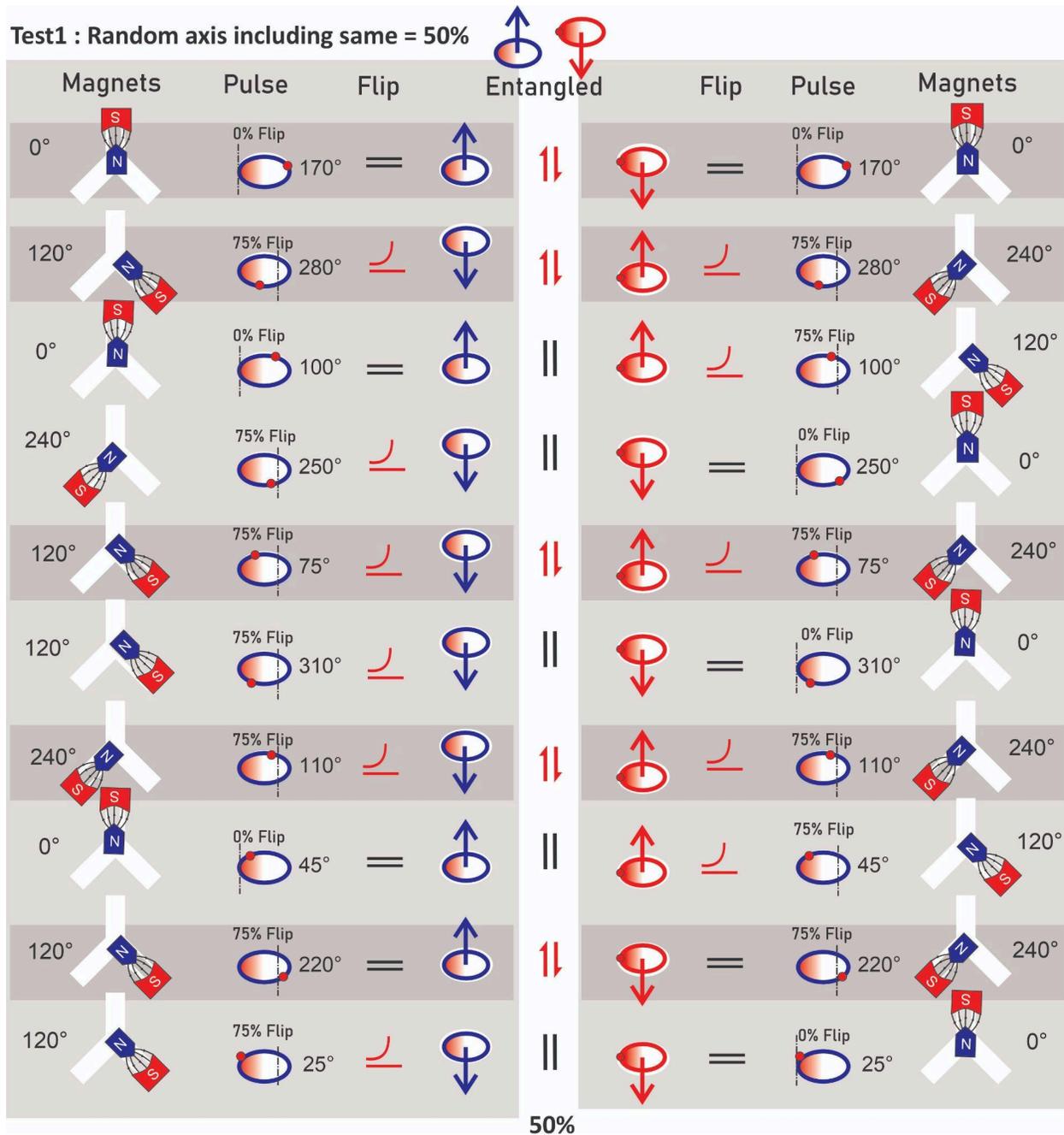
Arrow icons  illustrate the final results, showing the spin outcomes as either "up" or "down." Each of the two separate entangled particles is represented with their respective data settings for comparative analysis.

The magnetic apparatus can be randomly oriented along any of the three axes ( $0^\circ$ ,  $120^\circ$ ,  $240^\circ$ ) for each entangled particle. The pulse point is randomly selected for each test while ensuring synchronization between the entangled particles.

The Bell's test calculation is based on the frequency of differing results compared to the instances where the outcomes across each entangled pair remain consistent. This statistical evaluation provides insights into the validity of the LGA method within the context of Bell's theorem.

The test sheet presents only 10 trials, collectively resulting in a perfect score of 50%. However, this test should be conducted thousands of times with randomized data to enhance its probabilistic accuracy and validate its predictions through comparison with empirical testing.

**Figure 9:** Illustrating the 10 theoretical tests of two entangled electrons using the LGA model, using 3 random axis, including axis in the same direction.



The test displays four columns, each representing different attributes for the entangled electrons:

- **A:** The angle of the magnet relative to the known spin axis of the entangled electrons.
- **B:** The random position of the pulse and the threshold for whether it flips or remains unchanged.

- **C:** The Flip Action taken as a result of the pulse's position relative to the flip zone.
- **D:** The final state of the electron following the applied flip action.

The middle column presents the statistical results of entangled pairs, indicating whether their properties are identical or distinct. These statistics enable us to calculate the outcomes of Bell's Theorem test, revealing the percentage of agreement in spin orientation among the entangled particles. Comparative results from various models are as follows:

- Traditional hidden variable tests yield 55%,
- Quantum Probabilistic tests show 50%,
- The Liquid Gravity Atomic (LGA) model synchronised variable tests also yield 50%.

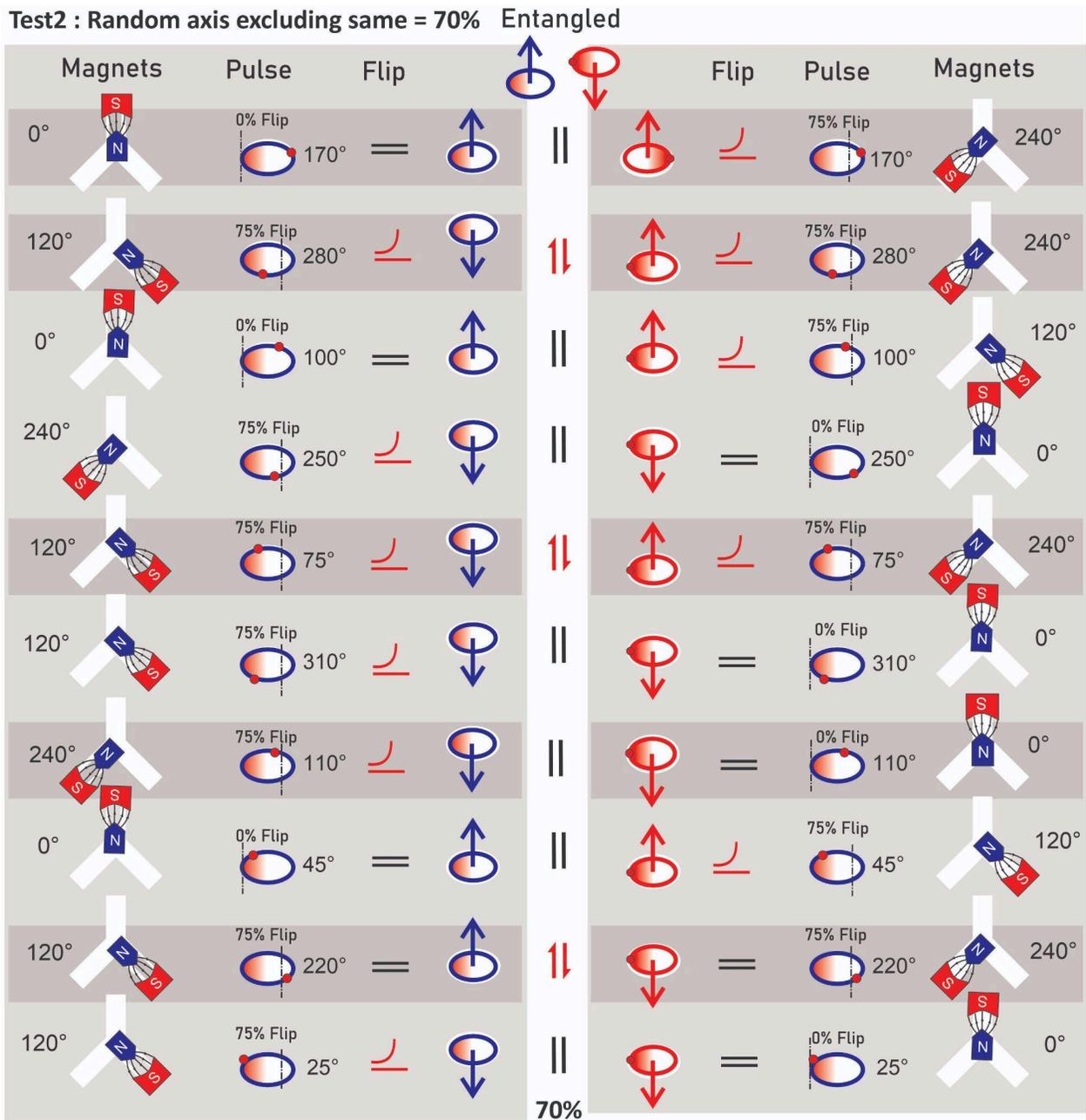
Subsequent tests focused on comparing results across different solutions by excluding scenarios where the particles exhibited the same orientation in their testing angles. This analysis further facilitates the application of Bell's Theorem, highlighting the percentage of agreement in spin orientation among entangled particles.

These tests predict the following outcomes:

- Traditional hidden variable tests result in 66%,
- Quantum Probabilistic tests yield 75%,
- and the LGA model synchronised variable tests achieve 70% (with the potential to reach 75% over a larger sample).

While increased test numbers generally provide greater accuracy, in this preliminary test of 10 results, the LGA model notably surpasses the upper limit established by the traditional hidden variables test.

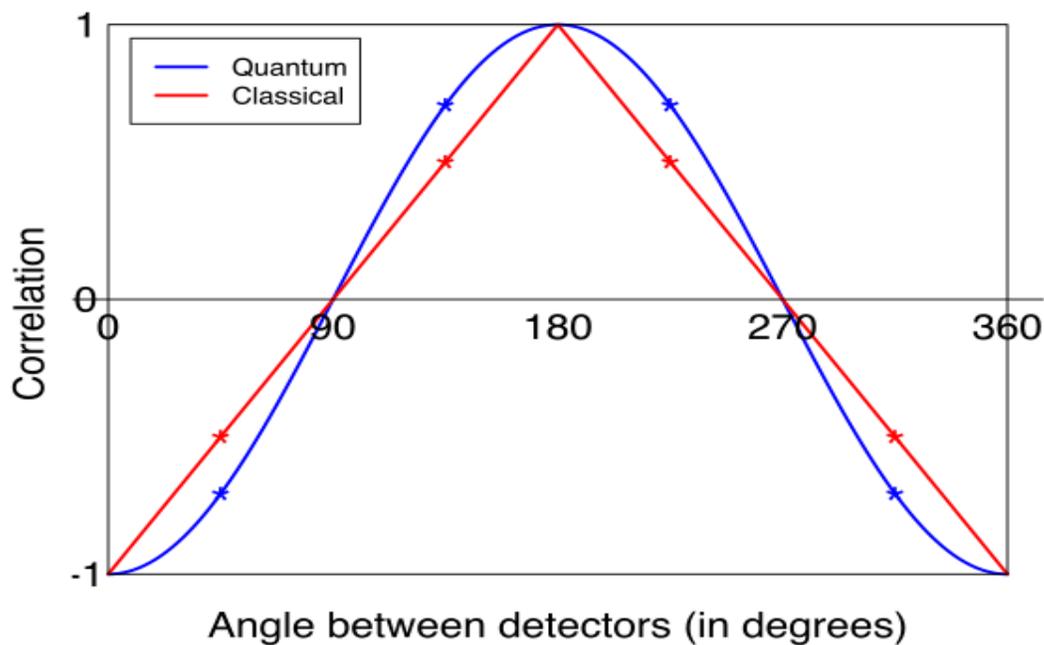
**Figure 10:** Illustrating the 10 theoretical tests of two entangled electrons using the LGA model, using 3 random axis, excluding axis in the same direction.



## 10.2 Statistical Consistency with Bell-Type Tests

When evaluated under Bell-style statistical constraints, the LGA spin mechanism reproduces probability distributions consistent with experimental observations. The model, therefore, satisfies empirical limits while attributing observed randomness to internal phase progression rather than intrinsic indeterminacy.

**Figure 11:** Showing the relationship between the QM probabilistic results and Classical hidden variable results (excluding LGA synchronised hidden variables)



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## 11. Discussion

This framework supplants traditional intrinsic spin postulates with a mechanically grounded, field-mediated mechanism. Spin quantization is shown to arise from stable rotational path locking, while the resulting probabilistic outcomes are influenced by sensitivity to internal phase conditions at the moment of interaction.

The comparisons of entangled states reveal that synchronized hidden variables can yield results commensurate with those predicted by quantum probability. Furthermore, this approach supports the validity of Einstein's EPR paradox, suggesting that such hidden variables provide a

plausible explanation for entanglement phenomena while preserving the deterministic nature of the underlying physical processes.

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## 12. Conclusion

A nuclear-origin, torque-mediated mechanism for electron spin has been presented within the Liquid Gravity Atomic framework. The model offers a deterministic, observer-independent reinterpretation of the Stern–Gerlach experiment and provides a classical foundation compatible with observed quantum statistics. Further experimental investigation is required to distinguish this model from standard quantum interpretations.

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## 13. Testable Predictions Distinguishing the LGA Spin Model from Standard Quantum Mechanics and other hidden variable models

A defining requirement of any alternative physical model is the ability to generate experimentally testable predictions that differ from established theory. The Liquid Gravity Atomic (LGA) spin mechanism makes predictions that, if observed, would distinguish it from conventional quantum-mechanical interpretations.

### 13.1 Using the Stern–Gerlach Apparatus to Control Spin Measurement Outcomes

#### Objective:

Demonstrate that spin measurement outcomes can be influenced by the Stern–Gerlach apparatus by reducing the spatial spread of the atomic pulse. This is achieved by separating spin-up and spin-down atoms with a three-stage sequence of inhomogeneous magnetic fields. Control is applied at the final stage: the distance between the stage-2 splitter and the stage-3 splitter is adjusted to match the atoms' de Broglie wavelength and particle velocity. By tuning this distance, the pulse can be confined to the upper or lower beam at the stage-3 splitter, producing a predictable spin-up or spin-down outcome.

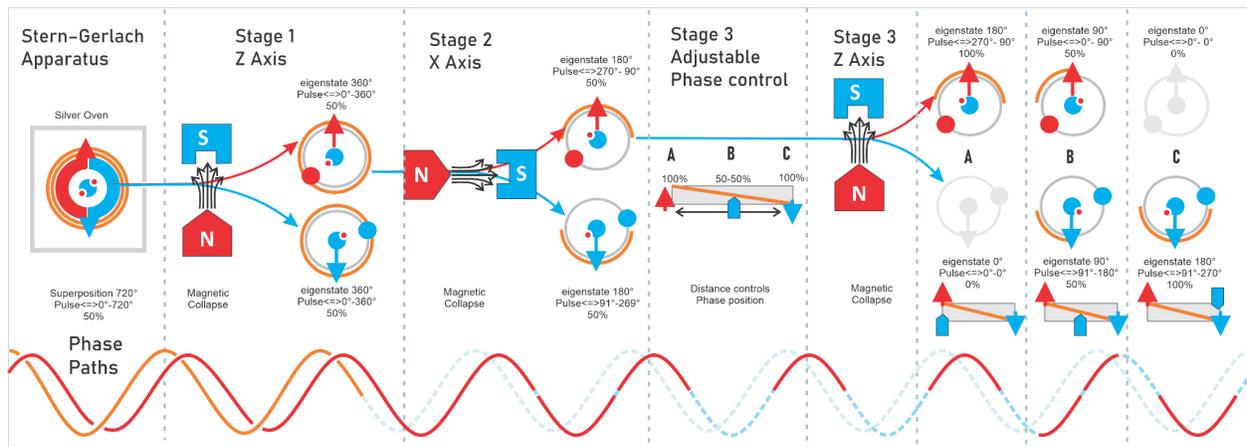
### LGA Prediction:

LGA predicts that the spin outcome can be controlled by setting the distance of the third-stage apparatus.

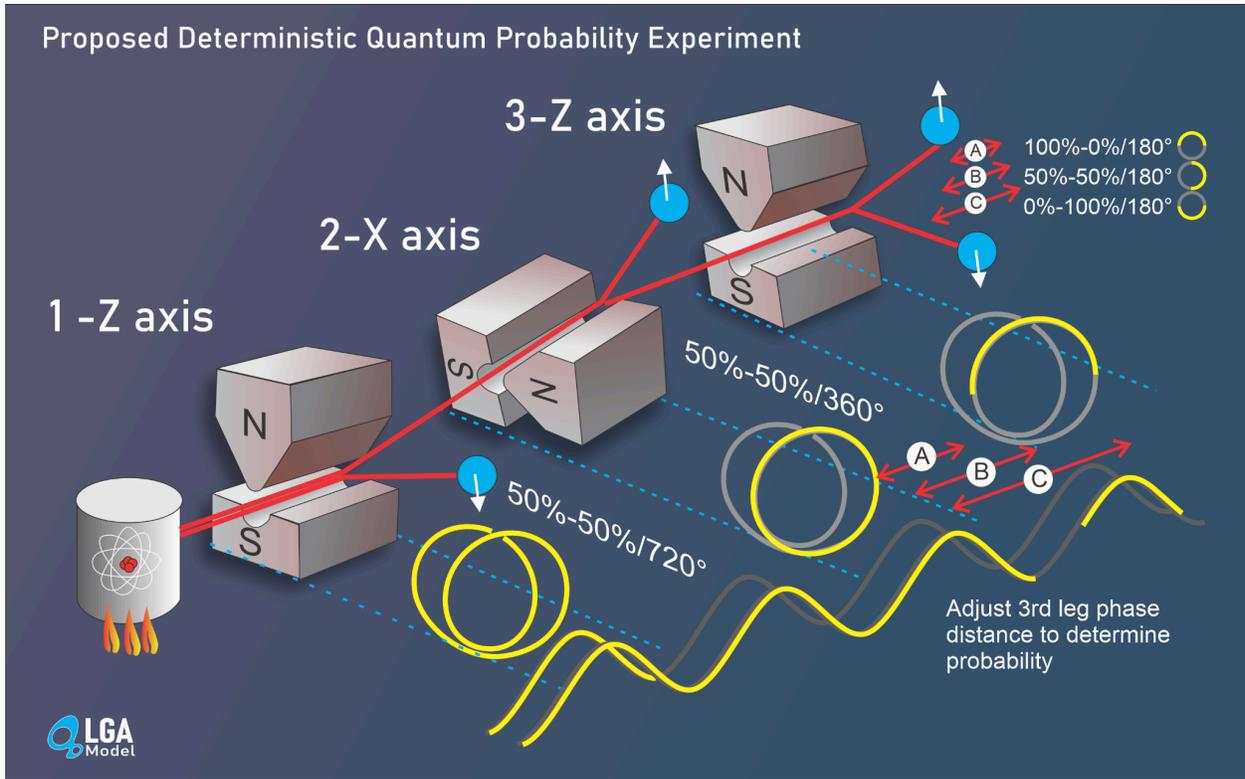
### QM Expectation:

Quantum mechanics predicts a 50% probability for each spin outcome, independent of the distance settings.

**Figure 12:** Showing the full test Stern-Gerlach apparatus configured with three stages and a distance controller between the second and third stages.



**Figure 13:** Schematic image of the proposed 3-stage Stern-Gerlach experiment with adjustable phase settings to control spin measurement probabilities.



**Figure 14:** Showing the first three stages of the Stern-Gerlach apparatus, going from Stage 0: Silver atom oven. Stage 1: with an inhomogeneous magnetic field, at 0 degrees on the x-axis. Stage 2: with an inhomogeneous magnetic field, at 90 degrees on the y-axis

Stage 0 — Source

Silver atoms are emitted from the oven in an excited, coherent state. Each atom’s unpaired outer-shell electron exhibits the spinor property (a 720° rotation returns the quantum state to itself). As atoms travel through the apparatus, the electron’s state evolves relative to the local pulse trajectory of the S-orbital field.

Stage 1 — First splitter (0°)

Atoms pass through the first inhomogeneous magnetic field oriented at 0° about the vertical (x) axis. The interaction causes the electron state to project onto one of the detector-associated

eigenstates (east or west), determined by the neutron pulse being in the eastern or western hemisphere at the moment of collapse. By symmetry, this stage yields an approximately 50:50 distribution between the two outcomes in line with probabilistic calculations. After this projection, the atom's effective rotation signature is reduced from the full  $720^\circ$  spinor behavior to a single  $360^\circ$  rotation characteristic of the selected branch.

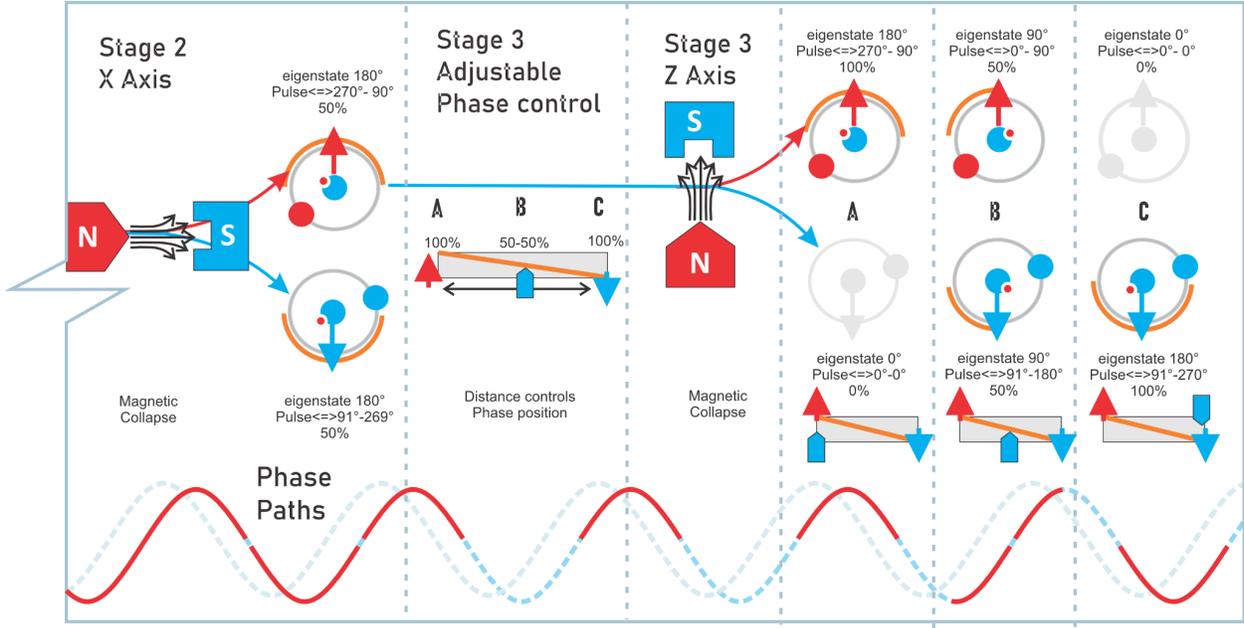
### Stage 2 — Second splitter ( $90^\circ$ )

The atoms identified as “up” from Stage 1 are routed into the second stage. At this point the pulse phase of each atom remains undetermined and may occupy any phase across  $0^\circ$ – $360^\circ$ . The second inhomogeneous magnetic field is oriented at  $90^\circ$  (relative to Stage 1) and separates atoms according to pulse position in the north or south hemisphere, reorienting them into the corresponding up/down states. Under symmetric source conditions, roughly half populate the northern hemisphere and half the southern, in line with probabilistic calculations.

### Stage 3 — Final splitter ( $0^\circ$ with tunable spacing)

The atoms selected as “up” from Stage 2 enter the third stage. Their pulse phases are still distributed over a  $180^\circ$  band determined by the prior selection. The third inhomogeneous field is again oriented at  $0^\circ$ , providing a  $90^\circ$  relative rotation from Stage 2. Crucially, the spatial separation between Stage 2 and Stage 3 can be adjusted to tune the phase evolution of the pulse (via the particle wavelength and velocity). By matching the interstage distance to the pulse period, the pulse band can be made to arrive predominantly in the upper or lower beam at Stage 3, allowing deterministic biasing of the final up/down outcomes.

**Figure 15:** Showing the third stage of the Stern-Gerlach apparatus at 0 degrees to the Z-axis, with three distance settings A,B,C that correspond to specific measurement outcomes.



**Conclusion:**

The proposed 3-stage Stern-Gerlach experiment is experimentally feasible and offers a clear, testable means to distinguish the Liquid Gravity Atomic (LGA) prediction from standard quantum statistics. If adjusting interstage spacing reproducibly biases final up/down outcomes as described, it would indicate the presence of coordinated local variables influencing spin measurements; if not, it would falsify the LGA mechanism. Either result would be significant: a positive result would prompt re-examination of probabilistic assumptions and inspire new approaches to control in quantum technologies, while a null result would constrain or rule out this class of local-variable models.

## 13.2 Investigating Spin Transition Probabilities in Tethered vs. Free Electrons using Stern-Gerlach Apparatus

### Objective:

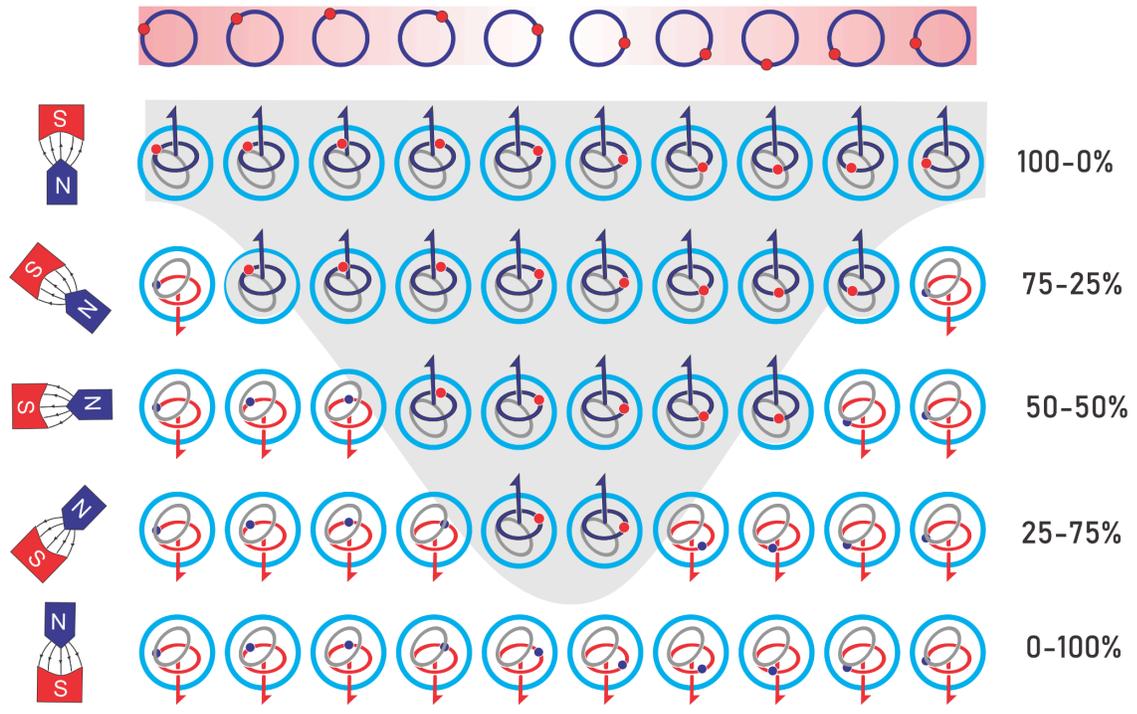
To investigate the spin transition probabilities of tethered electrons compared to free electrons, assessing how these probabilities are influenced by torque exchange with an external magnetic field. Previous attempts to conduct this experiment faced challenges due to the Lorentz force acting on charged particles in electromagnetic fields. However, advancements in modern techniques may allow for the cancellation of these effects, enabling a clearer analysis of the differences in spin behavior between tethered and free electrons.

### LGA Prediction:

Identify the distinctive effects of torque from a pulse on tethered electrons, predicting that they exhibit probabilistic results due to the torque exchange, while free electrons solely respond to the external magnetic field without flipping spins, resulting in classical behavior.

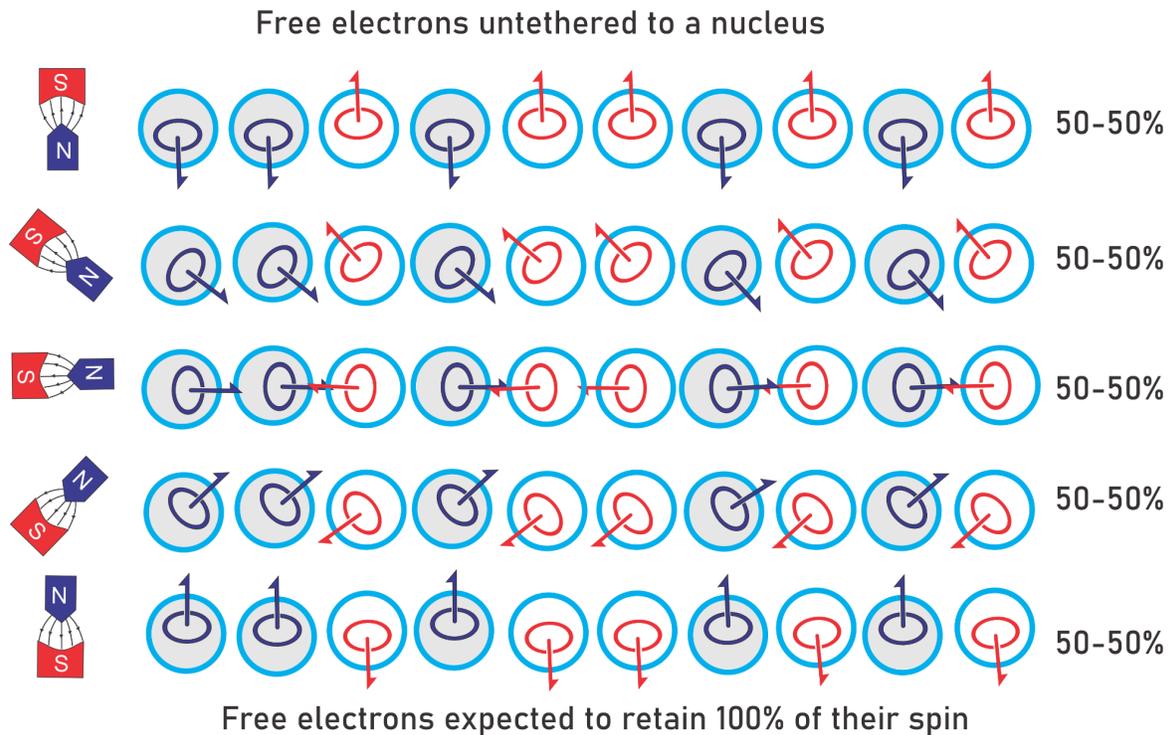
**Figure 16:** *Showing the expected LGA results of tethered electrons using Stern-Gerlach Apparatus.*

Electrons tethered to a nucleus



Electrons expected to flip their spin 50%

**Figure 17:** Showing the expected LGA results of free electrons using the Stern-Gerlach Apparatus.



### QM Expectation:

Both tethered and free electrons are predicted to yield uniform probabilistic results when subjected to the Stern-Gerlach apparatus, resulting in no observable difference in outcomes.

### Experimental Design:

#### 1. Preparation of Electron Sources:

- Utilize a controlled setup to generate and distinguish between tethered electrons (possibly the silver(AG47) atom with a tethered valence electron ) and free electrons (from a thermionic emission source).

#### 2. Stern-Gerlach Apparatus Configuration:

- Design a multi-stage Stern-Gerlach apparatus that allows for the sequential measurement of spin states with adjustable magnetic field orientations.
- When considering the design of a path for each stage of the Stern-Gerlach apparatus, it's crucial to take into account the potential effects of various forces. The Lorentz force, which acts on charged particles moving through electromagnetic fields, may be negligible for neutral atoms such as silver, which are typically used in these experiments. However, ensuring that the apparatus

design allows for precise control and measurement requires an understanding of all relevant forces and interactions, including possible electromagnetic influences, to achieve accurate and reliable results.

### 3. **Magnetic Field Rotation Protocol:**

- Implement a system to slowly and systematically rotate the magnetic field between measurement stages. This can be achieved using precision magnetic coils controlled by a programmable interface to maintain consistent torque application.

### 4. **Spin State Measurement:**

- Utilize detectors at each stage of the apparatus to measure the resultant spin states, collecting data on transition probabilities for both tethered and free electrons.

### 5. **Data Analysis:**

- Analyze the data for any variations in the transition probabilities between tethered and free electrons. Look for evidence of non-probabilistic behavior; deviations from expected QM predictions could indicate hidden variables or other phenomena.

### 6. **Repetitions & Statistical Validation:**

- Conduct multiple trials for statistical significance, ensuring that variations are not due to experimental error. Use appropriate statistical methods to validate the findings.

### **Potential Outcomes:**

- **Probabilistic Results:** Both tethered and free electrons behave as expected per QM, indicating no fundamental differences in spin behavior.
- **Non-Probabilistic Results:** Observation of differing behavior between tethered and free electrons could suggest the existence of underlying mechanistic systems that warrant a reevaluation of current QM models.

### **Conclusion:**

This study seeks to reconcile theoretical predictions with observable phenomena in quantum mechanics. By thoroughly analyzing spin transition probabilities, we can gain valuable insights into the fundamental principles governing quantum behavior across various electron states.

The observation of any effect that transcends established quantum corrections could challenge the prevailing notion that spin is an intrinsic, observer-independent quantum property. Such

findings would not only advance our understanding of spin dynamics but also underscore the potential existence of deeper underlying mechanisms governing quantum systems.

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Figures6: Generated by OpenAI GPT 4o

Figure 8: Qiskit video. <https://youtu.be/pS69IqCMdy8?si=ECivYWE86CqJ5Azh>

Figure 11: Bell's Theorem. *Brilliant.org*. Retrieved 19:53, December 18, 2025, from <https://brilliant.org/wiki/bells-theorem/>

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