Resolving Quantum Spin Through Synchronized Hidden Variables:

Discovering the Quantum local variables that solve Bell's theorem with the Liquid Gravity Atomic Framework

Michael Hodges [1]

Independent Researcher

Abstract

Electron spin is conventionally treated as an intrinsic quantum property without a classical analogue, leading to interpretational challenges such as wavefunction collapse and observer dependence. This work proposes an alternative physical interpretation in which spin emerges from internal nuclear dynamics and is transmitted to the electron through the atomic orbital field. Within the Liquid Gravity Atomic (LGA) framework, nucleons are modeled as structured, looping waves whose motion generates alternating orbital fields. Interaction with an external magnetic field induces a torque-mediated transition between alternating and locked rotational states, producing the observed spin quantization in Stern–Gerlach experiments. This model offers a deterministic, observer-independent mechanism that reproduces key experimental outcomes while remaining consistent with probabilistic statistics.

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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] demonstrated that neutral silver atoms passing through a non-uniform magnetic field separate into two discrete spatial trajectories. This result revealed quantized angular momentum states, later interpreted as electron spin-up and spin-down orientations. In the absence of the magnetic field, no such splitting occurs, indicating that the phenomenon is field-induced rather than observational.

2.2 Bell-Type Constraints

Debate over the interpretation of spin led to competing frameworks, including local hidden-variable models [4] and probabilistic quantum interpretations [5]. Bell's Theorem [6] provided a method for experimentally distinguishing between these views, with results favoring quantum statistical predictions. However, Bell's results do not preclude deterministic internal mechanisms that reproduce the same statistics through contextual interactions.

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3. Hypothesis

This paper proposes that electron spin is not an intrinsic quantum property but an emergent classical behavior arising from nuclear dynamics. Specifically, spin originates in nucleon motion within the atomic nucleus and is transmitted to the electron via the orbital field. External magnetic fields act as torque-inducing agents that stabilize one of two dynamically available rotational states.

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4. The Liquid Gravity Atomic (LGA) Framework

The Liquid Gravity Atomic model treats nucleons as structured wave entities confined within a gravitationally condensed medium. Except for hydrogen-1, atomic nuclei are composed of coupled proton–neutron chains.

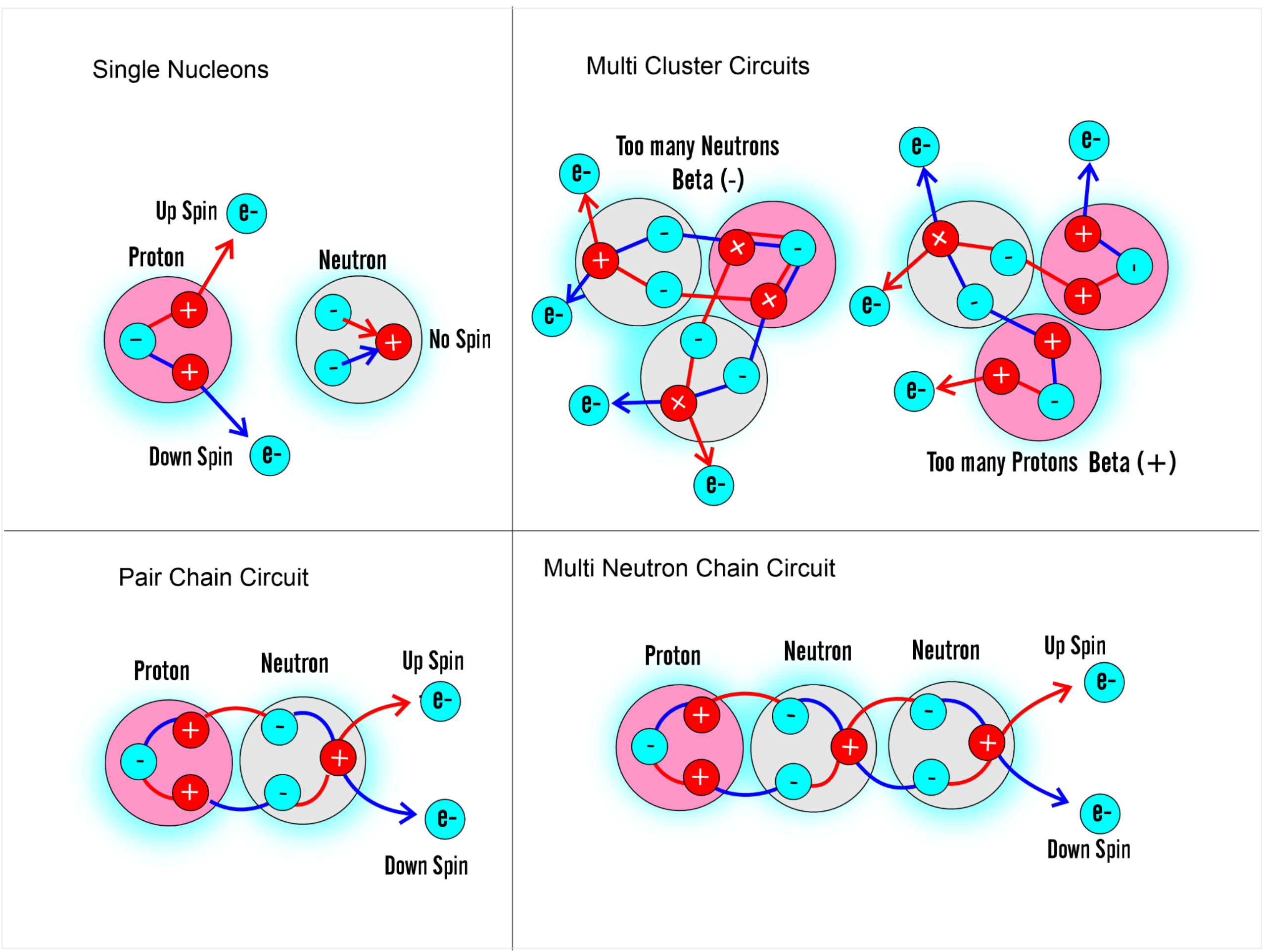
In this framework:

- Protons initiate a circulating positive charge
- Neutrons propagate this charge through structured wave motion
- The terminal neutron in a chain transmits the field into the orbital region

This process establishes the spatial and rotational structure of the atomic orbital field

Figure 1:

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



5. Nucleon Dynamics and Orbital Formation

5.1 Balanced Helix Path State

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° 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° rotational motion on each side, oscillating between opposing sides of the orbital. In this balanced state, no fixed spin orientation exists.

According to quantum mechanics (QM), this alternating state is identified as a superposition, where it is thought that the spin exists in multiple locations simultaneously [7]. This concept also contributes to the 'many worlds theory', where all possible states exist simultaneously [8]. The Liquid Gravity Atomic (LGA) model, however, simply identifies this as a left-right oscillating state, manifesting as relativistic light-speed oscillations.

Figure 2:

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

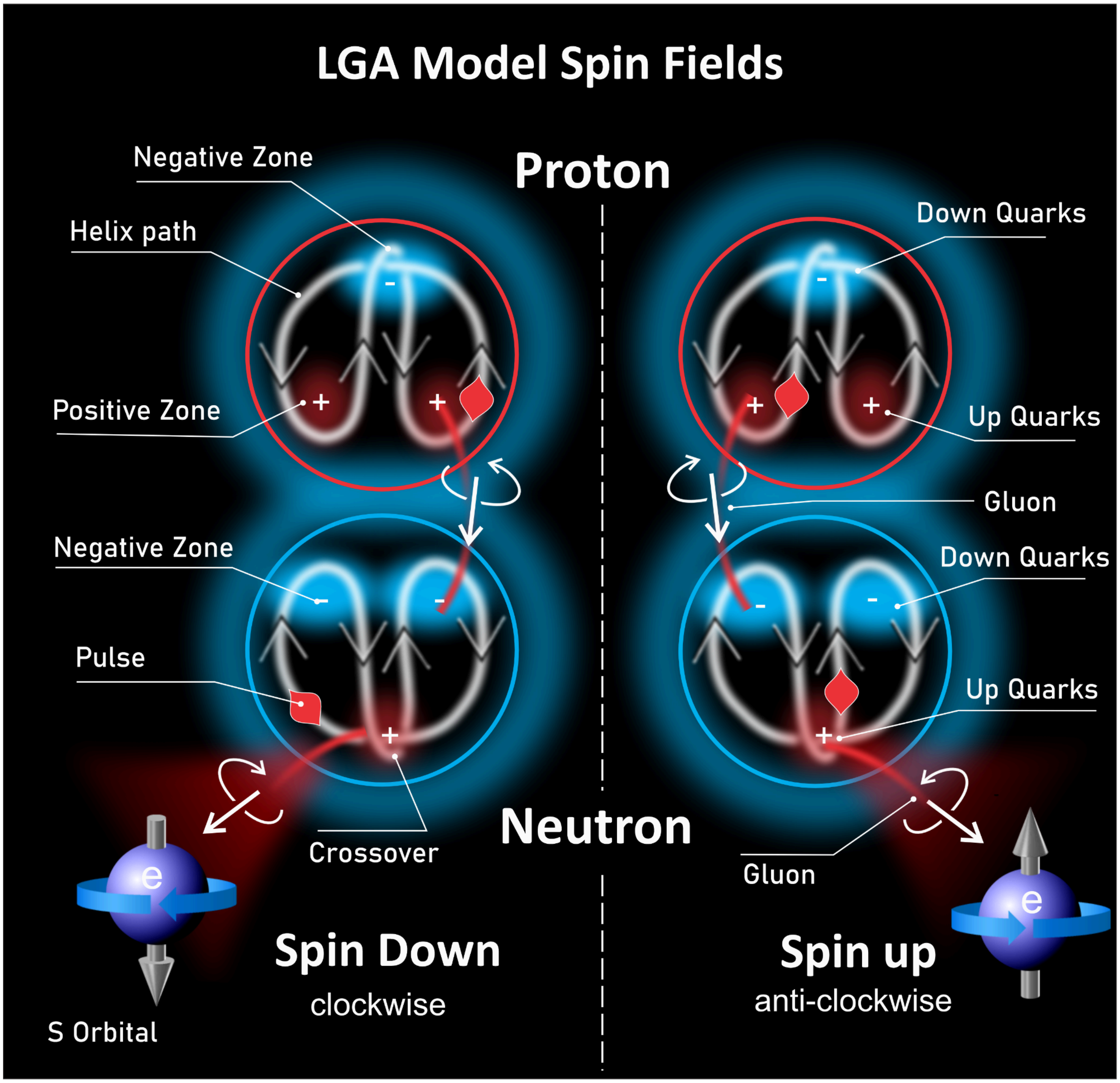
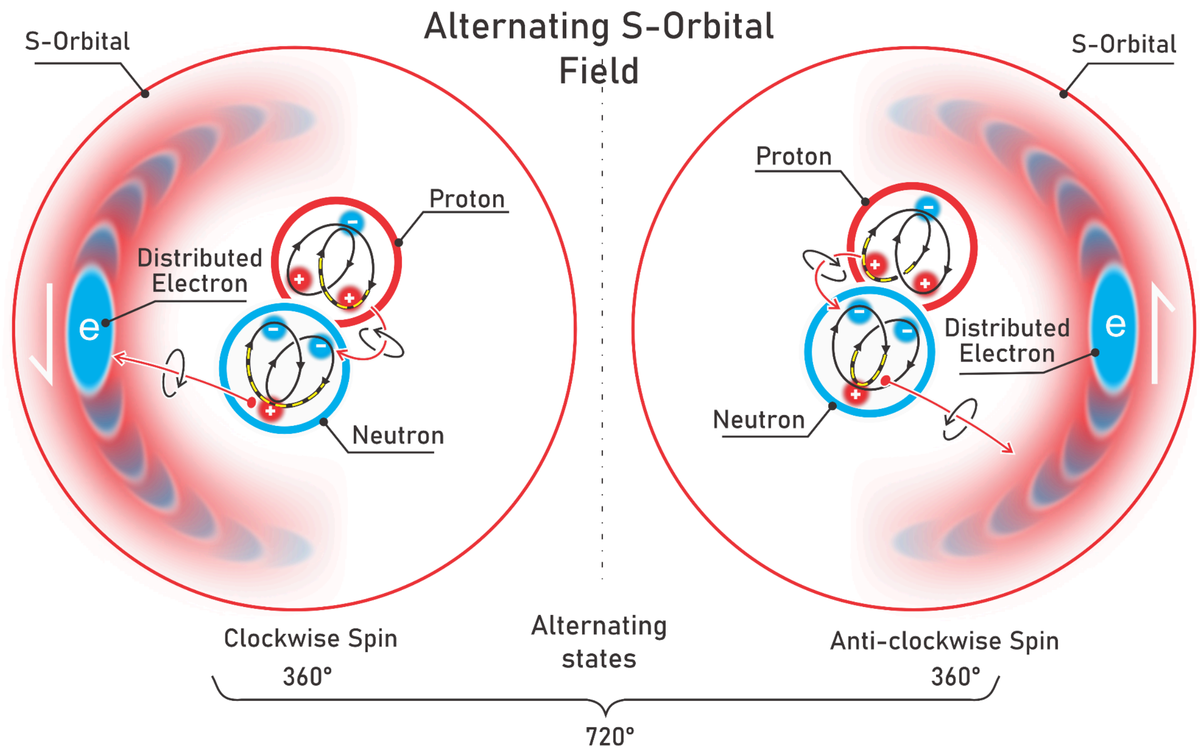


Figure 3:

Formation of the sss-orbital from alternating nuclear field discharge.



6. Magnetic-Field-Induced Path Locking

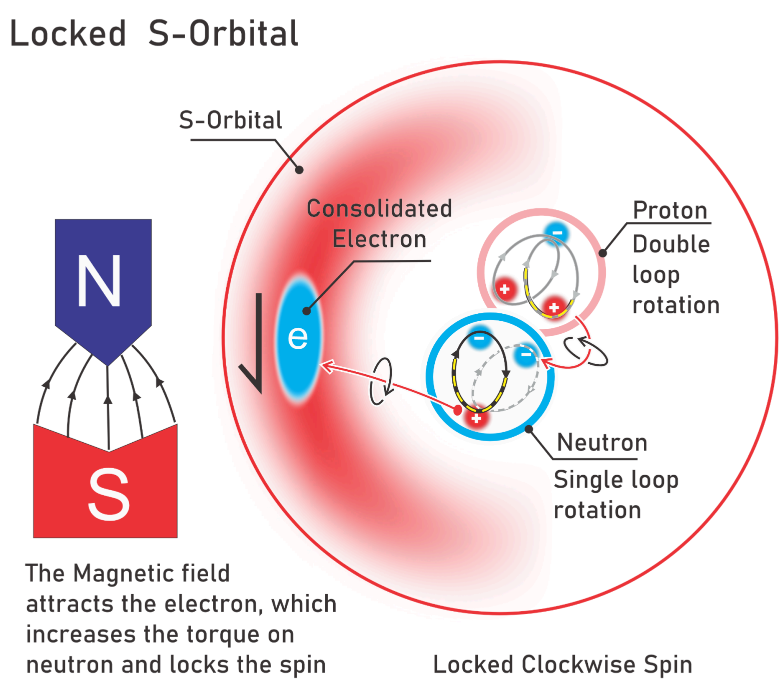
6.1 Unbalanced Loop Path State

When the atom encounters a strong external magnetic field, the electron transitions into a more localized configuration. This geometric consolidation increases the effective centrifugal force acting on the neutron pulse, driving a transition from the balanced helix path into a locked single-loop rotation.

The transition occurs when magnetic torque equals the centrifugal torque associated with the localized electron. Once established, this locked rotational state can persist beyond the magnetic field region, resulting in a stable, single spin orientation.

Figure 4:

Transition from balanced figure-eight path to locked single-loop rotation.



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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]

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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.

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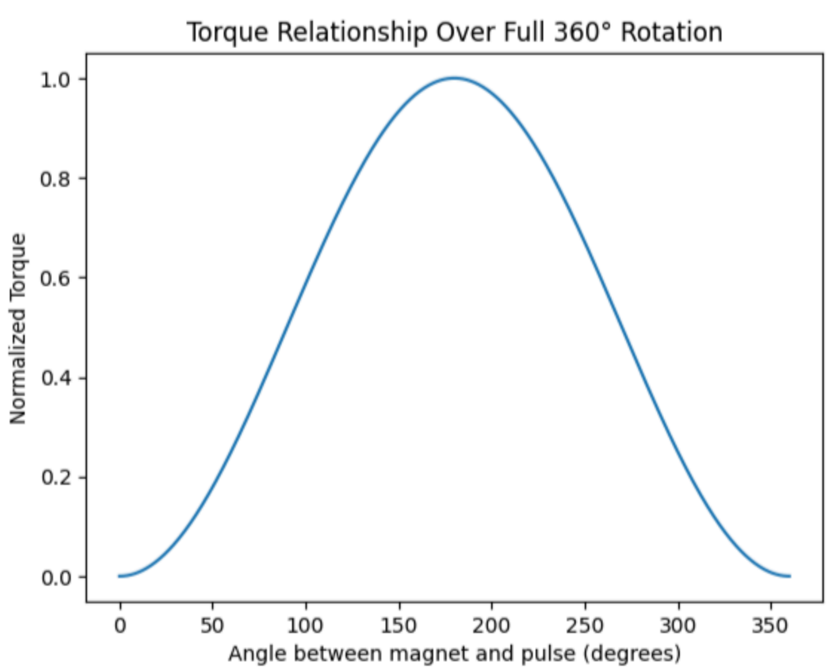
9. Torque–Angle Relationship

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

Figure 5: *Showing the relationship between the external magnetic torque and the nucleon pulse torque. These results map the same path as Quantum probability.*

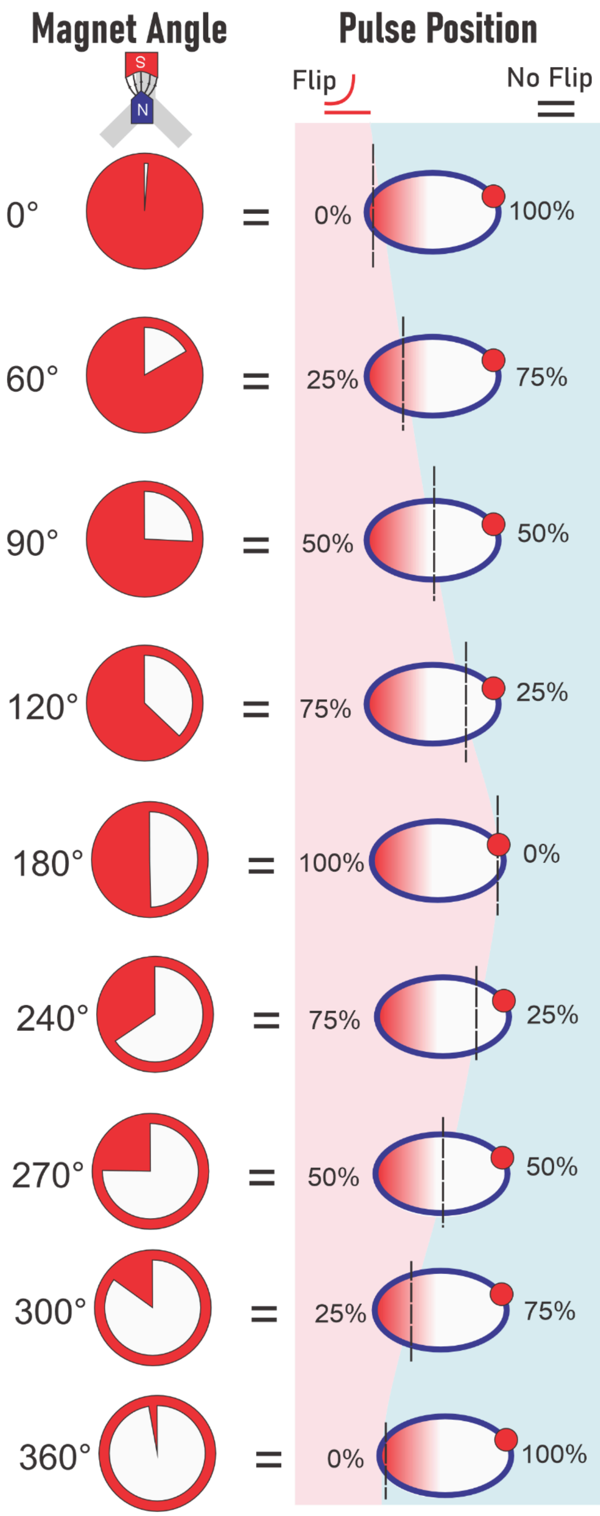


$$\tau(\theta) = \tau_{\max} \sin^2\left(\frac{\theta}{2}\right)$$

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

9.1 How to calculate the flip threshold

Figure 6: *Illustrating the relationship between the external magnetic angle and the pulse's flip threshold position.*



Magnetic Angle:
The magnetic angle refers to the orientation relative to the defined up and down spin positions of entangled electrons. The magnetic torque increases as the angle deviates from the spin direction. Each electron is tethered to its respective nucleus, and their atoms can be separated over any distance while maintaining their entangled state. Probability calculations indicate that the magnetic angle presents a certain percentage probability affecting a Spin-Flip. At a 0° rotation, the likelihood of a "Flip" is 0%, ensuring a 100% probability of maintaining a "No-Flip" state. Conversely, at a 90° rotation, there is an equal 50-50% probability of a "Flip" or "No-Flip" state. This characterizes the present understanding boundaries of Quantum theory concerning probability.

Pulse Position:
The pulse position refers to the rotating energy wave circulating in opposing loops, remaining synchronized with its entangled counterpart. As the pulse approaches its crossover point, its torque strength increases. This pulse carries essential local variables that coordinate the relative positions of each atom, similar to how two distant satellites maintain relativity through atomic clocks. Consequently, by measuring one particle, we can determine the spin of its partner via its paired atomic clock. This process hinges on coordinated hidden variables rather than spooky actions at a distance, maintaining synchronization over any distance.

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.

10.0 Bell's theorem test.

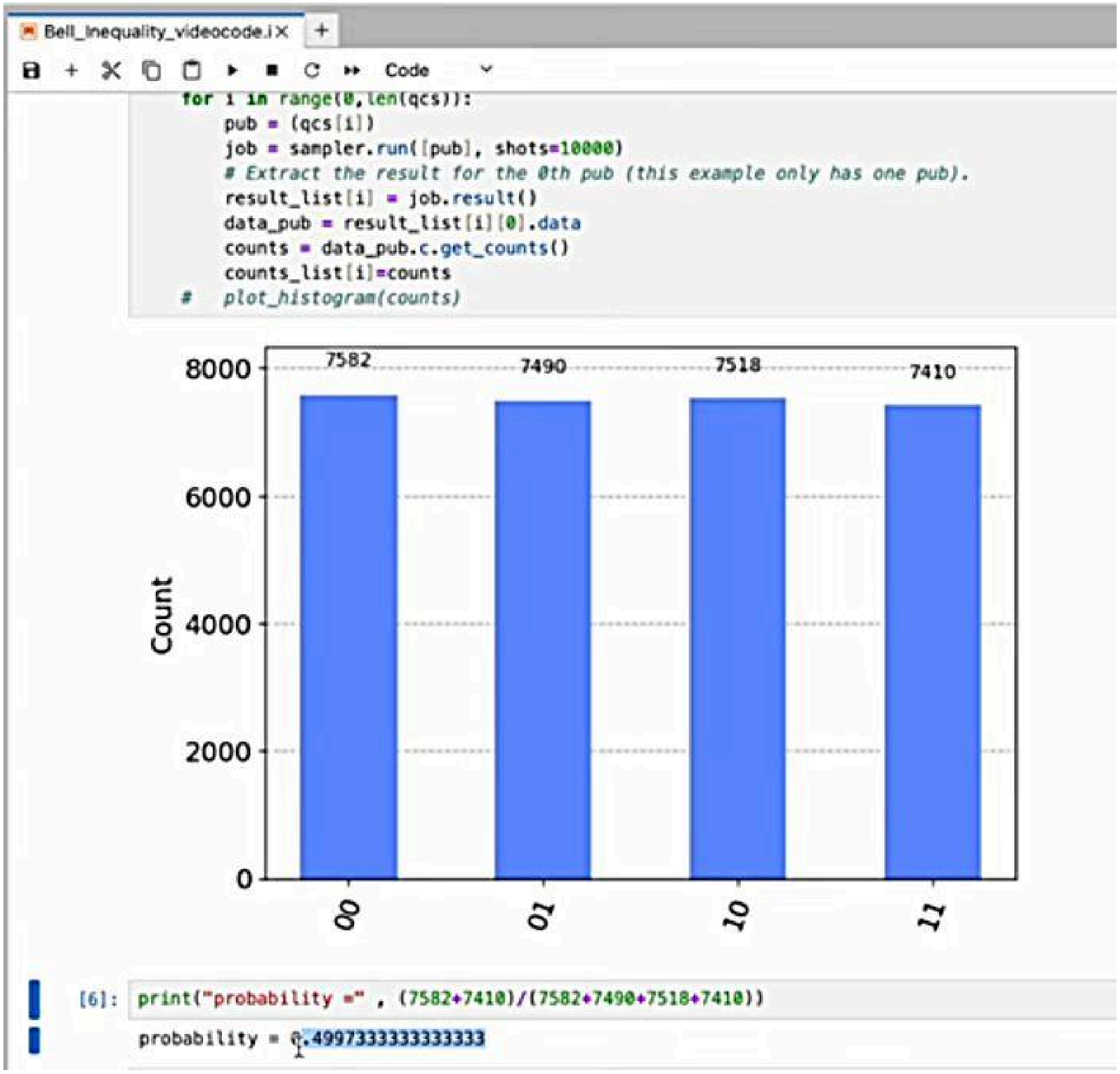
Testing Bell's theorem requires a comparison of theoretical predictions with empirical results. To date, the primary contenders in this realm have been predictions derived from quantum probability and the hidden variable theories proposed by Einstein and his collaborators.

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.

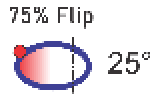
Figure 7 presents an example from IBM's Qiskit, which employs qubits to measure real-world probabilities using a quantum computer, yielding a result of 0.4997333333333333, closely approximating the expected quantum probability.

Figure 7: *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 7 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 ═.

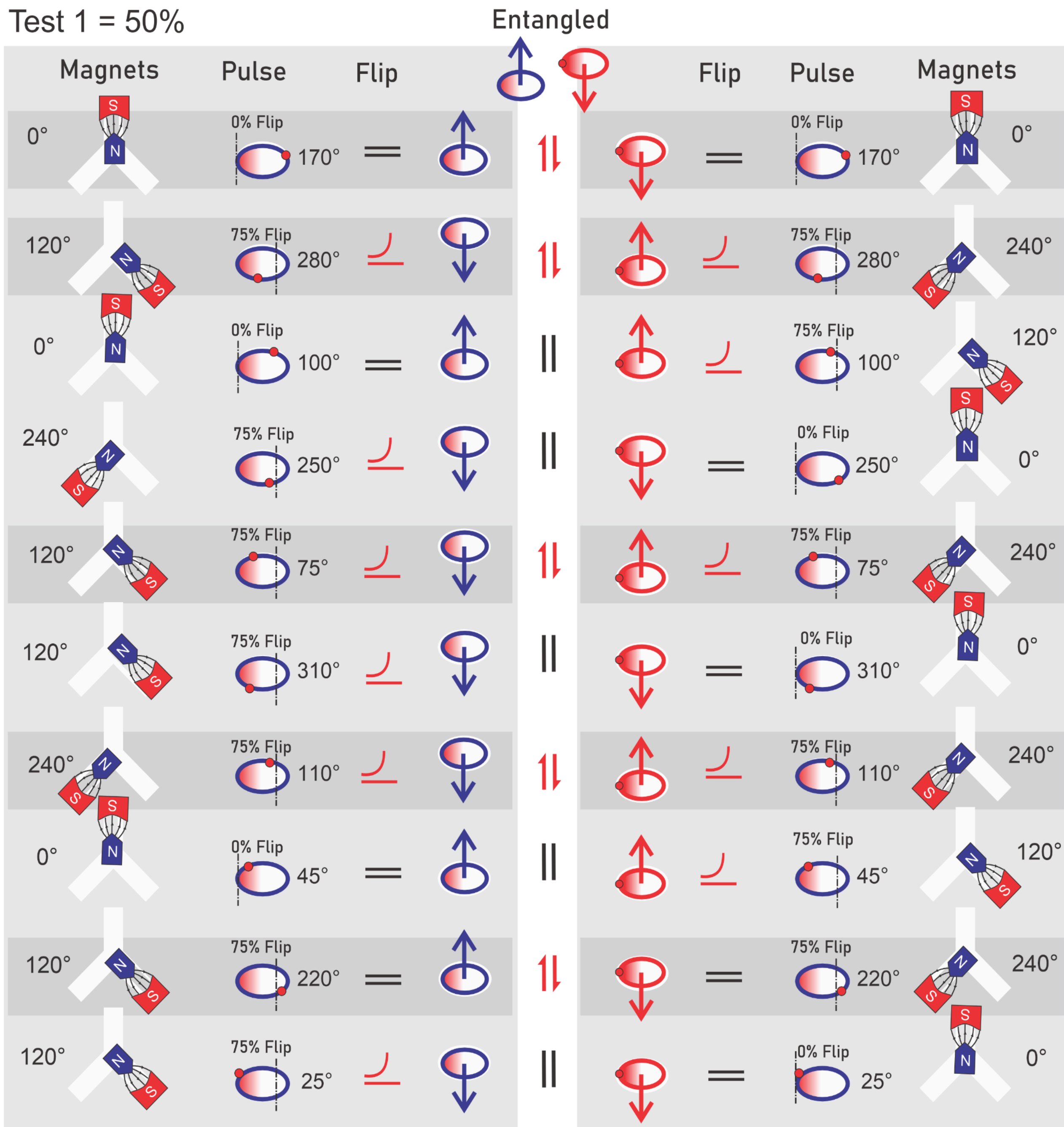
Arrow icons  illustrate the final results, showing the spin outcomes as either "up" or "down." Each of the two separate entangled particles is represented with their respective data settings for comparative analysis.

The magnetic apparatus can be randomly oriented along any of the three axes (0°, 120°, 240°) 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 8: *Illustrating the 10 theoretical tests of two entangled electrons using the LGA model*



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.

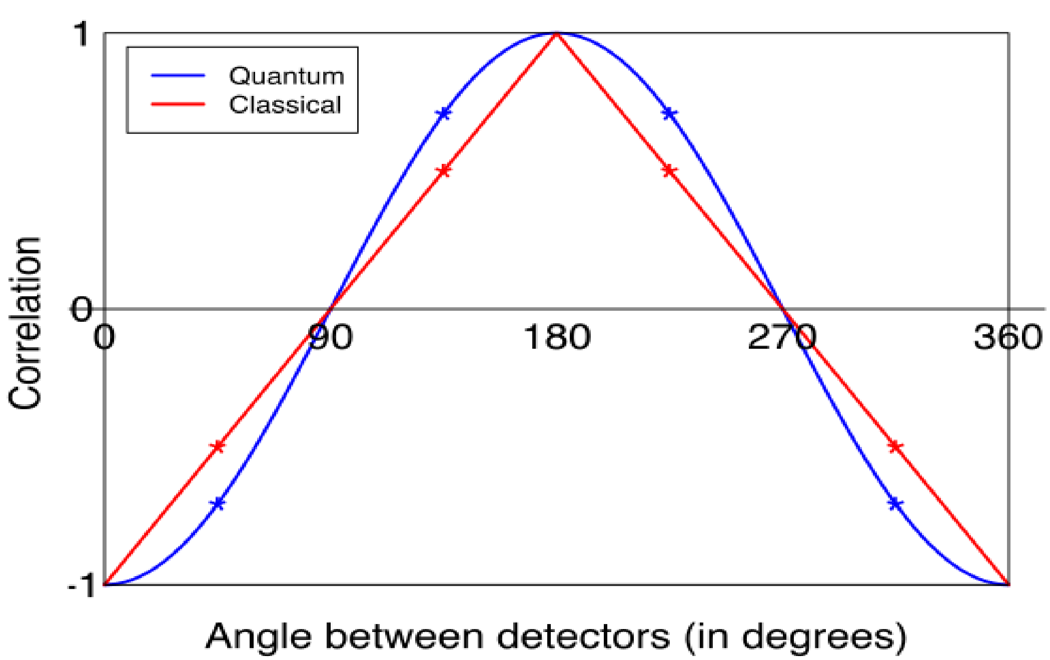
- **C:** The Flip Action taken as a result of the pulse's position relative to the flip zone.
- **D:** The final state of the electron following the applied flip action.

The middle column reports the statistical results of entangled pairs, indicating whether they are the same or different from one another. These statistics allow us to compute the results of Bell's Theorem test.

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 9: *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 Calculating Spin Probabilities using the LGA method at large scales

Objective:
The goal is to scale up the LGA method and assess whether large-scale random data testing yields consistent results. Empirical testing at this scale typically results in outcomes that are less than the mathematically perfect 50%. A computer simulation of the LGA method should similarly produce results that deviate from the ideal 50%. This represents a key distinction between the LGA method and quantum probability, which can only yield a mathematically exact 50% result (0.6666~ * 0.75 = 0.5).

LGA Prediction:
Slightly less than 50%

QM Expectation:
Exactly 50%

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

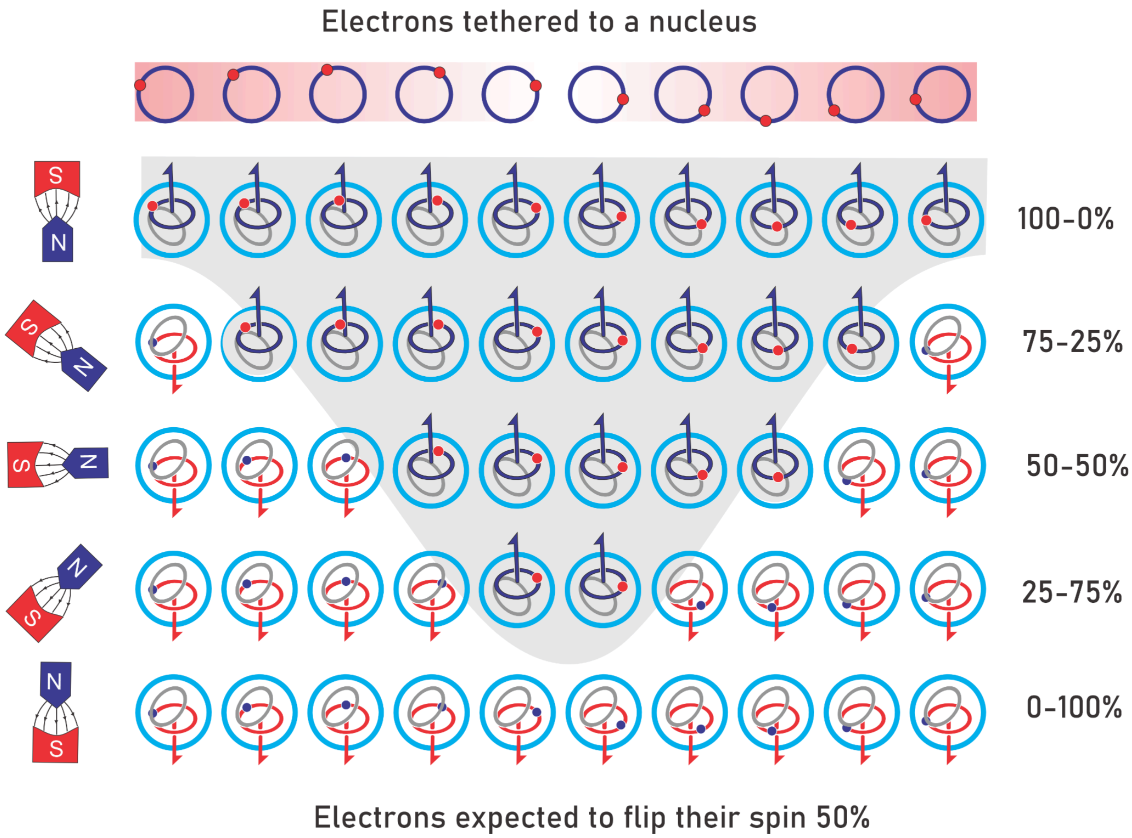
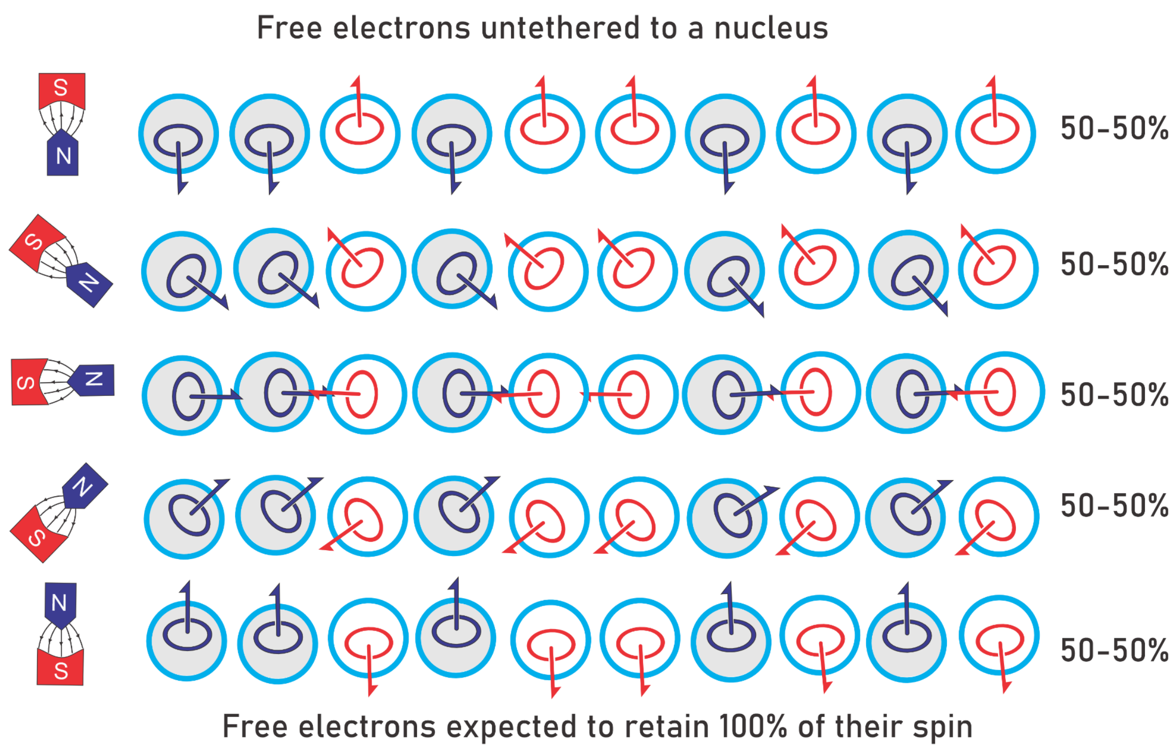

Electrons tethered to a nucleus
S
N
100-0%
75-25%
50-50%
25-75%
0-100%
Electrons expected to flip their spin 50%

Figure 11: *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.

References

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Figure reference:

Figures 1-4, 6, 8, 10-11: Michael Hodges, Liquid Gravity Atomic Model https://liquidgravity.nz/LGAM/ -10-12-2025

Figures5: Generated by OpenAI GPT 4o

Figure 7: Qiskit video. https://youtu.be/pS69lqCMdy8?si=ECIvYWE86CqJ5Azh

Figure 9: Bell's Theorem. *Brilliant.org*. Retrieved 19:53, December 18, 2025, from https://brilliant.org/wiki/bells-theorem/