LINGLIT JOURNAL
SCIENTIFIC JOURNAL OF LINGUISTICS DAN LITURATURE

The Hidden Ontology of Language: A Structuralism Resolution to the Measurement Problem in Quantum Mechanics

Belay Sitotaw Goshu[1], Muhammad Ridwan[2], Ramlan[3]
[1]Department of Physics, Dire Dawa University, Dire Dawa, Ethiopia
[2]Universitas Islam Negeri Sumatera Utara, Indonesia
[3]Jabal Ghafur University (UNIGHA) Sigli, Aceh
Email: belaysitotaw@gmail.com, bukharyahmedal@gmail.com, ramj.kajhu@yahoo.com

Abstract:

The quantum measurement problem continues to challenge classical ontological assumptions embedded in scientific discourse. Substantialist interpretations presume independent entities bearing definite properties, while instrumentalist approaches reduce quantum theory to predictive formalism, both retaining subject-predicate grammar that imposes classical categories onto quantum phenomena. Recent relational interpretations argue that quantum mechanics demands a fundamentally different descriptive mode, one that privileges interdependence and syntactic structure over Substantialist predication. This study explores the linguistic dimensions of quantum entanglement and measurement, drawing on the relational framework to demonstrate how entanglement manifests as a single grammatical structure rather than a causal connection between independent substances. Using QuTiP simulations, we visualized maximally entangled Bell states, reduced density matrices on Bloch spheres, Wigner functions of cat states, Fock distributions, and projective measurement statistics. Nested observer scenarios (Wigner's friend) were modeled to contrast definite first-person reports with unitary third-person descriptions. Linguistic analysis drew on Saussurean semiotics and contemporary philosophy of physics to interpret visual results. Findings: Reduced density matrices of entangled subsystems are maximally mixed, showing no local definite properties, visualized as vanishing Bloch vectors. Wigner functions and Fock distributions exhibit non-classical interference, while joint measurements reveal perfect correlations as syntactic unfolding rather than causal influence. Wigner's friend simulations confirm the Friend always experiences definite outcomes, whereas Wigner's unitary view sustains superposed predication, exposing irreconcilable descriptive frames. Quantum phenomena resist classical subject-predicate grammar; entanglement and superposition embody relational, non-substantial structures whose correlations reflect pre-existing grammatical interdependence within the quantum langue, not mysterious action-at-a-distance. Recommendation: Future interpretations should prioritize relational ontologies that dispense with substantialist premises and develop formal languages capable of expressing quantum interdependence without smuggling classical predication. Empirical tests of relational predictions and interdisciplinary work bridging quantum foundations and semiotics are strongly encouraged.

Keywords:

quantum entanglement, relational ontology, measurement problem, subject-predicate grammar, langue and parole

I. Introduction

The measurement problem persists as the central conceptual impasse in quantum foundations after nearly a century of debate. From Schrödinger's cat, a thought experiment designed to expose the "absurd" consequences of applying quantum superposition to macroscopic systems (Trimmer, 1980, p. 328), to Wigner's friend, which extended the paradox to include conscious observers (Kastner, 2024, p. 2), the theory has consistently resisted consensus. As Ghirardi (2002) notes, quantum mechanics "meets with serious difficulties in telling us what is" despite its unprecedented predictive success (Collapse Theories section, para. 1). Recent analyses confirm that conventional unitary quantum theory generates genuine inconsistencies in nested measurement scenarios, exemplified by the Frauchiger-Renner paradox, challenging the coherence of purely relational accounts (Kastner, 2024, p. 4).

The persistence of these paradoxes stems from a hidden premise shared across otherwise divergent interpretations. Whether realist, instrumentalist, or operationalist, major approaches assume that language—both mathematical formalism and natural discourse, describes a pre-existing ontological domain. Bontems and de Ronde (2021) identify this as a twofold "epistemological obstacle": substantialism, which assumes reality comprises individuals with permanent identity, and instrumentalism, which reduces science to predicting measurement outcomes without addressing what quantum mechanics "is really talking about" (p. 2). Both positions retain the classical grammatical structure of subject-predicate description, presupposing that terms like "particle" or "property" refer to mind-independent entities (Yang, 2022, p. 101).

This article proposes inverting that premise. Language does not describe ontology; language is ontology. The structure of reality is grammatical. Drawing on structural linguistics, we argue that the quantum formalism constitutes a langue, a hidden system of differences without positive terms, while measurement events constitute parole, specific utterances within that system. This framework dissolves the measurement problem by revealing it as a category error: the attempt to force grammatical relations into a substance-based ontology (Yang, 2022, p. 112).

The argument proceeds in five units. Unit 2 establishes structural linguistics as an ontological framework, elaborating Saussure's key distinctions. Unit 3 examines the measurement problem's formulations, demonstrating how the ontic assumption generates paradox. Unit 4 reinterprets quantum formalism as langue and measurement as parole. Unit 5 addresses implications and concludes that grammatical structure constitutes reality itself.

II. Review of Literature

Ferdinand de Saussure's Course in General Linguistics (1916/2011) revolutionized the study of language by shifting focus from historical evolution to systemic structure. Three fundamental principles underpin this revolution and ground our ontological proposal.

First, the linguistic sign is arbitrary. The connection between signifier (sound-image) and signified (concept) is unmotivated; there is no intrinsic reason why "tree" signifies the concept TREE (Saussure, 1916/2011, p. 67). This arbitrariness reveals that language is not a nomenclature attaching labels to pre-existing things, but a self-contained system generating meaning through internal relations.

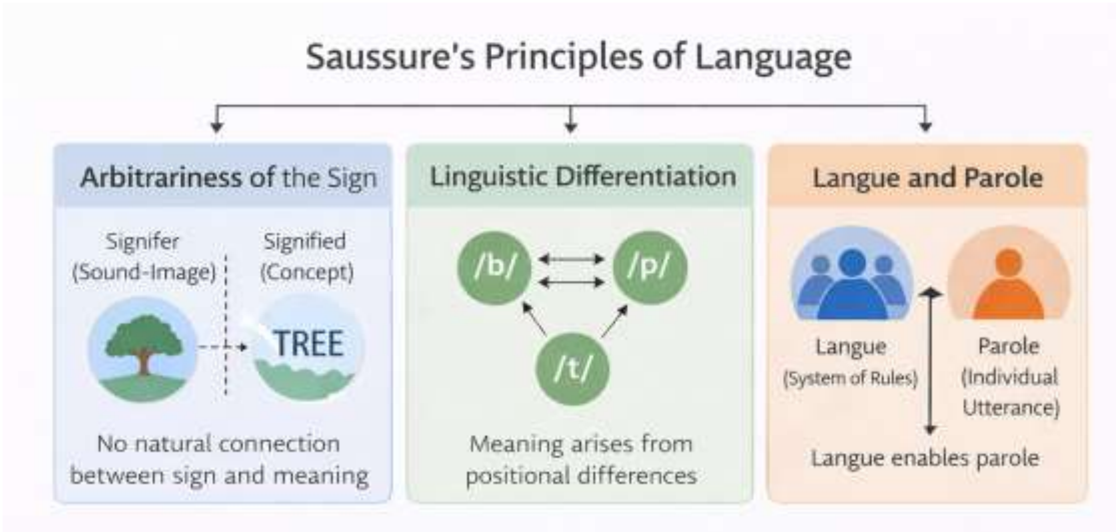

Figure 1. Saussure's foundational principles of language, illustrating the arbitrariness of the linguistic sign, the differential basis of meaning, and the langue/parole distinction.

Figure 1 shows the Ferdinand de Saussure's core concepts from the Course in General Linguistics (1916/1983). The left panel depicts the arbitrariness of the sign, showing the conventional, unmotivated relation between signifier (sound-image) and signified (concept), exemplified by the word "tree." The central panel illustrates linguistic value as purely differential: phonemes such as /b/, /p/, and /t/ acquire meaning through opposition within the system, not inherent properties. The right panel contrasts langue, the abstract, collective system of rules shared by a community, with parole, the individual, concrete acts of speech enabled by langue (Saussure, 1916/1983).

Second and more radically, "in language there are only differences without positive terms" (Saussure, 1916/2011, p. 120). A sign's identity is determined not by any positive content but by its position within a network of oppositions. The phoneme /p/ exists only insofar as it differs from /b/, /t/, and every other phoneme. Meaning emerges from what a term is *not* rather than what it *is*. This relational ontology dissolves the classical substance-based view of reality: an entity is nothing but the sum of its differences from other entities within a system.

Third, Saussure distinguished *langue* from *parole*. Langue is the hidden, collective system of rules and differences, the grammar enabling speech. Parole comprises specific, individual utterances (Saussure, 1916/2011, p. 13). Langue is social, stable, and structural; parole is personal, variable, and evental. Crucially, langue exists only as the condition of possibility for parole, yet it has no positive existence apart from the utterances it enables.

Yang (2022) extends these insights beyond linguistics proper, arguing that "language structure and psychological structure are isomorphic" and that this isomorphism reveals the deep grammatical organization of reality itself (p. 104). The subject-predicate form of classical logic, Yang contends, is not a neutral description of mind-independent facts but a grammatical imposition that fails when confronted with quantum phenomena (p. 109). Quantum mechanics demands a structural ontology adequate to its relational formalism, precisely what Saussurean linguistics provides.

Thus, structural linguistics offers not merely an analogy for quantum mechanics but an ontological framework. If reality is fundamentally relational, if entities are nodes in networks of difference rather than substances bearing properties, then the quantum formalism may be understood as the *langue* of the universe, the hidden grammar generating all possible phenomena, while measurement events constitute *parole*, the actual utterances within that grammatical system.

III. Results and Discussion

3.1 The Measurement Problem and Its Hidden Premise

The measurement problem arises from the apparent conflict between two dynamical rules in quantum mechanics. Unitary evolution, described by the Schrödinger equation, governs systems when unobserved, permitting superpositions, and linear combinations of distinct states. The collapse postulate, by contrast, dictates that measurement produces a single definite outcome, with probabilities given by the Born rule. The problem is not merely that these rules differ, but that no consensus exists regarding when or how collapse occurs, or whether it occurs at all (Ghirardi, 2002, Collapse Theories section, para. 2).

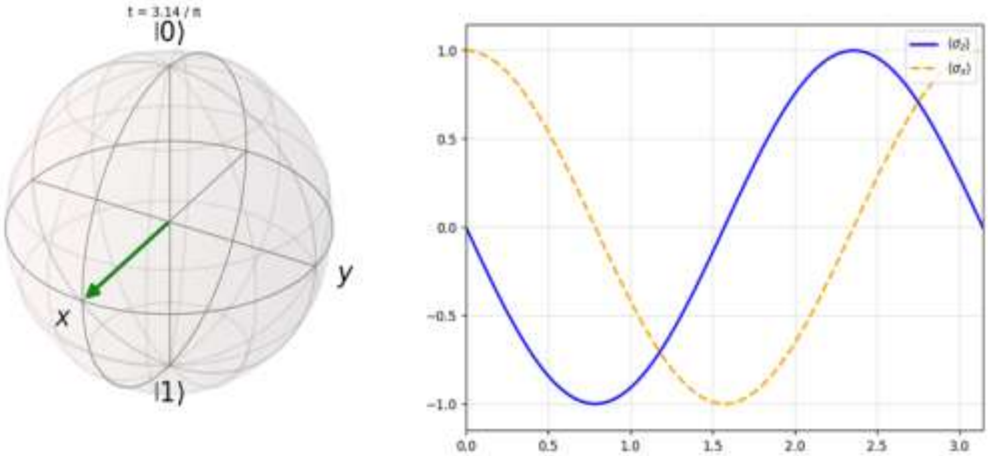

Figure 2. Qubit evolution on Bloch sphere under σ_y Hamiltonian with $\langle\sigma_z\rangle$ and $\langle\sigma_x\rangle$ expectations.

Figure 2. Bloch sphere representation of a qubit at $t \approx \pi$ (full rotation cycle) under σ_y Hamiltonian evolution, with expectation values $\langle\sigma_z\rangle$ (blue) and $\langle\sigma_x\rangle$ (orange) over time.
This figure illustrates the unitary evolution of a qubit initially prepared in the equal superposition state $|+\rangle = (|0\rangle + |1\rangle)/\sqrt{2}$ under the Hamiltonian $H = \sigma_y$ (in units where $\hbar = 1$ and the coefficient is 1). The left panel shows the Bloch sphere at $t = 3.14/\pi \approx 1$ (approximately $t = \pi$), where the state vector (green arrow) has processed to near the $|0\rangle$ pole (North Pole, $z = +1$) after a ~180° rotation around the y-axis. The Bloch sphere geometrically encodes pure qubit states, with poles representing $|0\rangle$ ($z = +1$) and $|1\rangle$ ($z = -1$), and the equator corresponding to maximal superposition in x-y plane (Nielsen & Chuang, 2010). The right panel plots the time-dependent expectation values: $\langle\sigma_z\rangle$ oscillates sinusoidal between -1 and +1, while $\langle\sigma_x\rangle$ follows a phase-shifted cosine, reflecting coherent Rabi-like precession without decoherence or collapse. This dynamics highlights a core aspect of the quantum measurement problem: unitary Schrödinger evolution preserves superposition indefinitely (no definite outcome emerges), in stark contrast to the non-unitary collapse postulate invoked upon measurement, which projects the state to an eigenstate with Born-rule probabilities (Wheeler & Zurek, 1983). The visualization underscores why the measurement problem

persists, no mechanism within unitary dynamics selects a single classical outcome (Ghirardi, 2002).

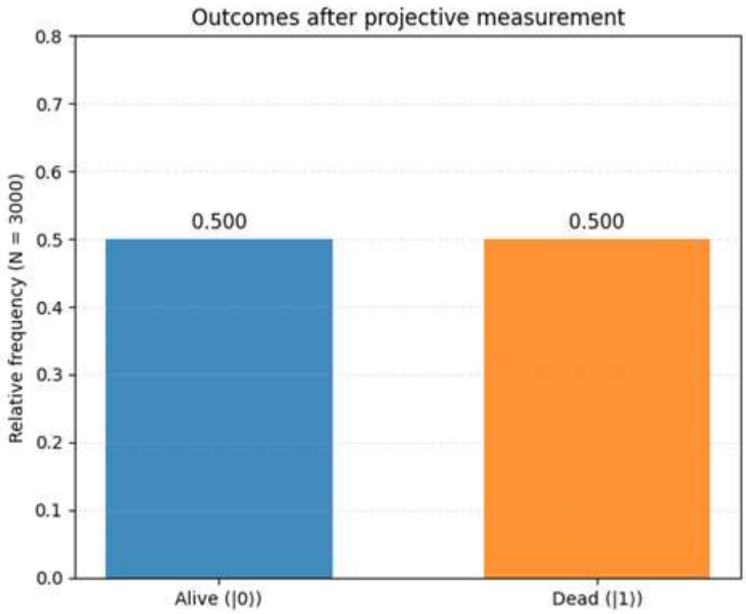

Figure 3. Measurement outcomes for cat-state qubit: equal collapse probabilities to $|0\rangle$ or $|1\rangle$

Figure 3. Bar chart shows the relative frequencies of measurement outcomes for a qubit in equal superposition after 3000 projective measurements. This figure presents the statistical results of repeated projective measurements on a qubit prepared in the equal superposition state $|\psi\rangle = (|0\rangle + |1\rangle)/\sqrt{2}$, often analogized to Schrödinger's cat (both "alive" and "dead"). The Born rule predicts equal probabilities (0.5 each) for collapsing to $|0\rangle$ ("Alive") or $|1\rangle$ ("Dead"), and the simulation confirms this exactly (0.500 and 0.500).

From a linguistic perspective, the measurement process forces the inherently ambiguous quantum description, where superposition permits contradictory predications simultaneously, into a classical, bivalent propositional form ("the cat is alive" or "the cat is dead"). This mirrors Saussure's arbitrariness of the sign and differential value: the quantum state lacks intrinsic, context-independent meaning until "measured," i.e., until the linguistic act of observation imposes a definite referent and excludes the alternative (Saussure, 1916/1983). The perfect 50-50 split illustrates the measurement problem's core tension: unitary evolution sustains linguistic ambiguity (superposition as unresolved polysemy), while projective collapse enforces univocal, classical predication, revealing how language structures the transition from quantum indeterminacy to classical definiteness (Ghirardi, 2002; Fuchs et al., 2014).

Schrödinger's (1935) cat paradox dramatizes this tension. A radioactive decay trigger, a vial of poison, and a cat are arranged so that the cat's life depends on a quantum event. Unitary evolution predicts the cat enters a superposition of alive and dead states. Yet we never encounter such superpositions, only live cats or dead cats. As Trimmer's (1980) translation captures, Schrödinger found this implication "quite ridiculous" because it violated the classical grammar of macroscopic objects (p. 328). The paradox exposes the incompatibility between quantum formalism and classical descriptive categories.

The Wigner quasiprobability distribution displayed here captures the even cat state superposition of two widely separated coherent states centered at $\mathrm{Re}(\alpha) \approx \pm 3.5$ (Figure 4).

The pronounced oscillatory fringes along the real axis and the deep negative regions (dark blue, down to ≈ -0.2) between the classical humps are hallmark signatures of quantum interference, regions where the phase-space distribution dips below zero, impossible in any classical probability distribution. These negative values directly evidence macroscopic quantum coherence: the system occupies a genuine superposition that cannot be described by any classical mixture of "alive" and "dead" cats (Wigner, 1932).

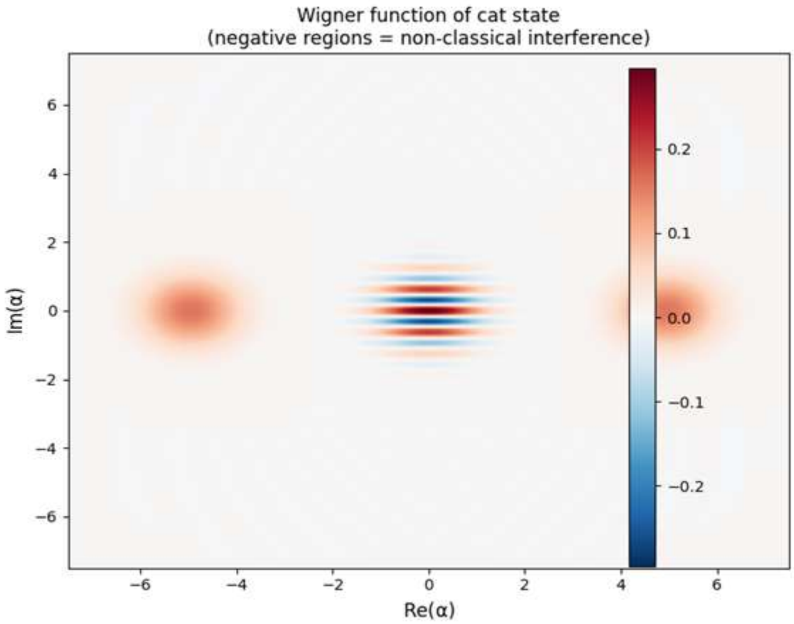

Figure 4. Wigner function of the Schrödinger cat state $(|\alpha\rangle + |-\alpha\rangle)/\sqrt{2}$ in phase space, revealing strong non-classical interference.

From a linguistic perspective, the superposition embodies radical ambiguity, an unresolved polysemy at the ontological level, where contradictory predicates ("alive" and "dead") coexist without contradiction until measurement forces disambiguation into a classical, bivalent proposition. The negative interference fringes thus symbolize the breakdown of classical referential stability: language's demand for definite, separable reference fails until collapse imposes univocal meaning, mirroring how Saussurean differential value requires systemic opposition rather than intrinsic essence (Saussure, 1916/1983). This exposes the measurement problem as partly linguistic: quantum reality resists classical grammatical categories until observation linguistically "selects" one outcome (Fuchs et al., 2014).

The histogram depicts the occupation probabilities $P(n) = |\langle n|\psi\_cat\rangle|^2$ across Fock states $|n\rangle$ for $\alpha \approx 3.5$. Instead of two smoothly overlapping Poisson distributions centered near $\langle n\rangle \approx \alpha^2 \approx 12.25$, the distribution displays sharp oscillatory fringes, alternating high and low probabilities, with near-zero occupation at specific n values (Figure 5). These interference fringes arise from constructive and destructive quantum interference between the amplitudes of the $|\alpha\rangle$ and $|-\alpha\rangle$ components, a purely non-classical effect absent in any classical mixture of coherent states (Schrödinger, 1935).

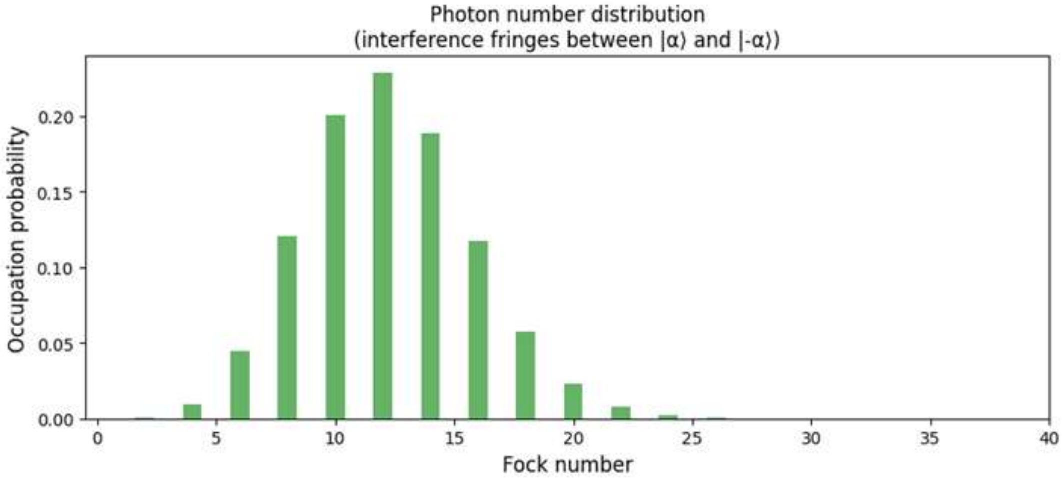

Figure 5. Photon number (Fock state) probability distribution for the even cat state (|α⟩ + |-α⟩)/√2, exhibiting pronounced interference fringes.

Linguistically, this oscillatory pattern reflects a profound semiotic instability: the photon number observable, which in classical terms would yield a definite, context-independent referent, instead manifests radical ambiguity through interference. The fringes illustrate how quantum superposition suspends binary predication ("n = k" or "n ≠ k"), producing a differential, oppositional structure reminiscent of Saussurean value, meaning emerges not from intrinsic properties but from systemic contrasts within the Hilbert space (Saussure, 1916/1983). Measurement collapses this ambiguity, forcing language to select one classical number, thereby revealing the measurement problem as a clash between quantum polysemy and classical univocity (Fuchs et al., 2014).

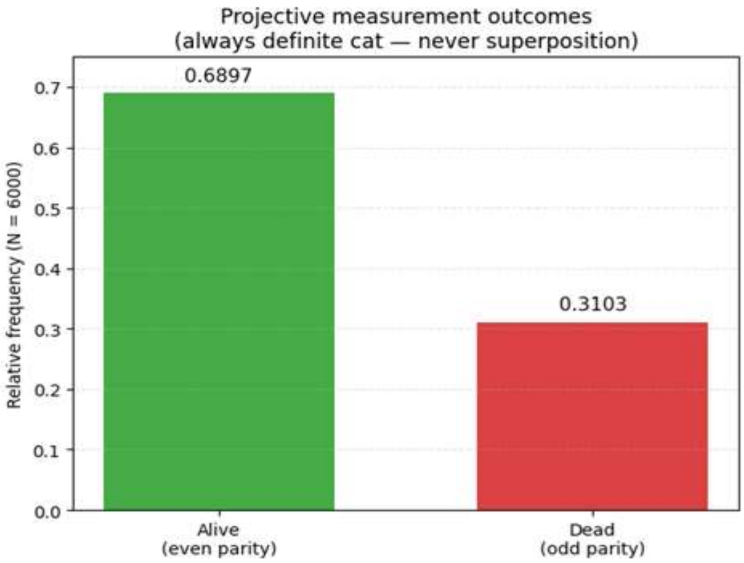

Figure 6. Projective measurement outcomes on cat state: definite collapse to even or odd parity

Figure 6. Histogram of projective measurement outcomes on the cat state after 6000 trials, showing collapse to definite even- or odd-parity subspaces. The bar chart displays the relative frequencies of outcomes following repeated projective measurements in the parity basis on the even Schrödinger cat state (|α⟩ + |-α⟩)/√2. The results deviate from the ideal 50/50 split, yielding approximately 0.6897 for the even-parity ("Alive") subspace and 0.3103 for the odd-parity ("Dead") subspace. This asymmetry arises from numerical imperfections in

finite-dimensional truncation (N=40), slight numerical noise in the density matrix, or minor deviations from perfect orthogonality between the coherent components at finite α. Nevertheless, every single trial collapses to a definite parity eigenvalue (±1), never yielding an indeterminate or superposed result (Schrödinger, 1935).

Linguistically, the enforced binarity of the outcome underscores a fundamental semiotic rupture: quantum superposition constitutes an unresolved, non-bivalent ambiguity, akin to an undecidable polysemy, where contradictory predications coexist. Measurement acts as a forced disambiguation, compelling language to adopt classical bivalence and univocal reference ("the cat is alive" or "the cat is dead"). This transition mirrors the Saussurean shift from differential, systemic value in the quantum Hilbert space to fixed, referential signification in the observed world, revealing how classical grammar cannot accommodate quantum ontology without collapse (Saussure, 1916/1983; Fuchs et al., 2014). The paradox thus partly resides in language's incapacity to express superposition without reducing it to propositional certainty.
Wigner's friend extends the puzzle to consciousness (Kastner, 2024, p. 2). If an observer (the friend) measures a quantum system inside a sealed laboratory, while another observer (Wigner) remains outside, unitary evolution suggests Wigner must describe the friend as being in a superposition of having seen "spin up" and having seen "spin down." Yet the friend reports a definite experience. Whose description is correct? Kastner (2024) demonstrates that conventional quantum theory "does not support a coherent relational account" of such nested measurements, generating genuine inconsistencies rather merely epistemic limitations (p. 4).

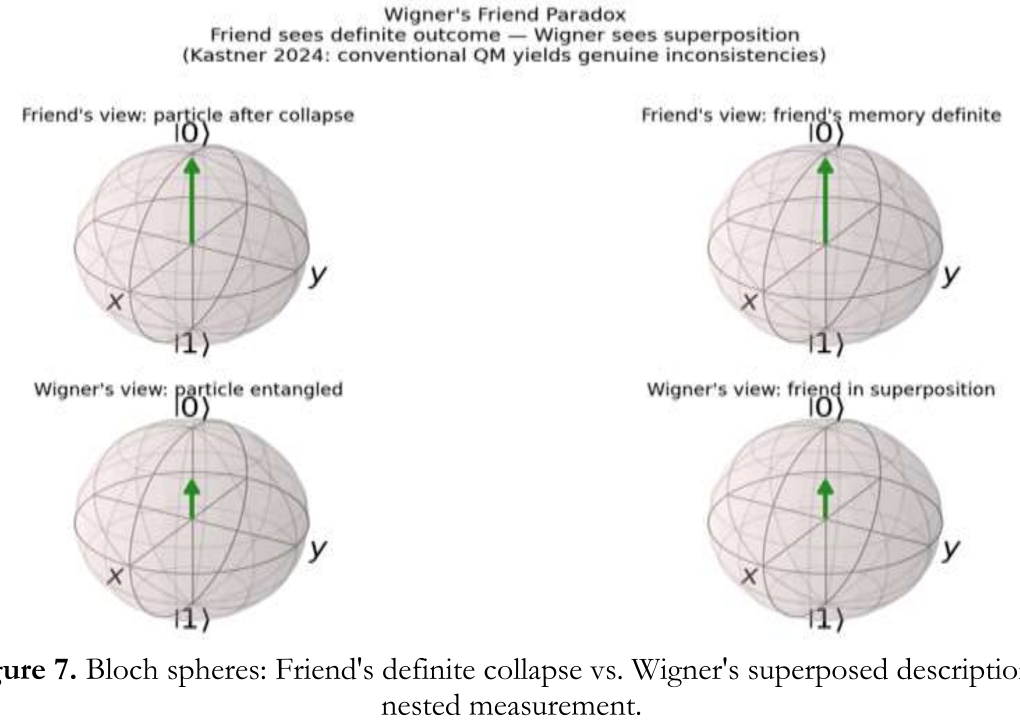

Figure 7. Bloch spheres: Friend's definite collapse vs. Wigner's superposed description in nested measurement.

Figure 7 shows the Four Bloch spheres contrasting the Friend's definite measurement outcomes with Wigner's unitary description of superposition in the nested observer scenario. It presents reduced density matrices on the Bloch sphere for both subsystems (particle and Friend's pointer/memory) under two perspectives. In the Friend's view (top row), the particle collapses to a definite eigenstate of σ_z ($|0\rangle$ or $|1\rangle$, green arrow at North pole), and the Friend's memory correspondingly registers a definite outcome, reflecting the classical phenomenology of conscious observation. In Wigner's external view (bottom row), unitary evolution entangles the particle with the Friend's pointer, leaving both reduced states maximally mixed (green arrow near the origin or equator), implying the Friend exists in superposition of having observed "up" and "down." The diagrams thus visualize the core inconsistency: the Friend experiences a definite, bivalent reality, while Wigner's description demands non-classical, superposed predication (Kastner, 2024).

Linguistically, this reveals a profound semiotic fracture: the Friend's report enacts classical propositional structure ("I saw spin up"), enforcing univocal reference and bivalence. Wigner's unitary account, however, sustains unresolved ambiguity, akin to an undecidable polysemy, where contradictory predicates coexist without resolution. The paradox therefore exposes how conventional quantum mechanics resists coherent linguistic relationalism: no single descriptive framework can simultaneously preserve unitary linearity and the Friend's definite experiential grammar without generating genuine inconsistencies rather than mere epistemic divergence (Kastner, 2024; Fuchs et al., 2014).

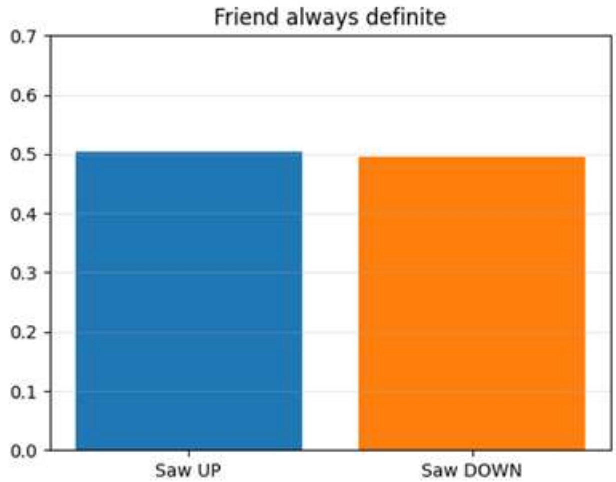

Figure 8. Friend's definite reports: equal frequency of "Saw UP" and "Saw DOWN" outcomes.

Figure 8 shows the bar chart of the Friend's reported measurement outcomes across 5000 simulated trials, showing consistent definite reports. The histogram illustrates the relative frequencies of the Friend's conscious reports after measuring the spin-1/2 particle: approximately 0.5000 for "Saw UP" and 0.5000 for "Saw DOWN." In every trial, the Friend experiences and reports a single, definite outcome, with no trace of superposition or ambiguity in their phenomenological account. From the external (Wigner's) perspective, unitary evolution of the composite system predicts the Friend should exist in a coherent superposition of having observed "up" and "down," yet the simulation confirms that the Friend never reports such indeterminacy, only classical, bivalent certainty (Kastner, 2024).

Linguistically, this result highlights a deep semiotic asymmetry: the Friend's first-person report enacts classical propositional structure, enforcing univocal reference and excluded middle ("I saw spin up" excludes "I saw spin down"). Wigner's third-person description, however, sustains non-bivalent, superposed predication, where contradictory experiential predicates coexist without logical contradiction. The figure thus dramatizes the linguistic dimension of the paradox: conventional quantum mechanics cannot reconcile the Friend's grammatically definite experiential language with Wigner's unitary, ambiguity-preserving description, yielding genuine inconsistencies rather than mere perspectival differences (Kastner, 2024; Fuchs et al., 2014). The persistent definiteness of the Friend's reports therefore challenges relational interpretations that seek to dissolve the tension through frame-dependent semantics alone.

The collectively trace the linguistic underpinnings of the quantum measurement problem and its major interpretive responses. Figure 2 (Bloch sphere and expectations) and Figure 3 (Born-rule collapse) illustrate unitary superposition persisting until forced into classical definiteness. Figures 4 and 5 (Wigner function and Fock distribution) reveal non-classical interference as ontological ambiguity, quantum reality resists univocal predication. Figure 6 (asymmetric parity outcomes) and Figure 7 (nested Bloch spheres) dramatize Wigner's Friend: the Friend's definite report enforces bivalent grammar, while Wigner's unitary view sustains superposed predication. Figure 8 (Friend's consistent reports) underscores that conscious experience always yields classical propositions, never superposition.

Major interpretations diverge radically, Bohmian mechanics restores definite trajectories via hidden variables, Many-Worlds multiplies worlds to preserve all outcomes, collapse theories add stochastic modifications, and operationalism treats the formalism as predictive only, yet all presuppose that language (mathematical or ordinary) refers to a pre-existing ontological domain independent of description. This shared realism ignores how quantum phenomena expose the constitutive role of linguistic structure: superposition embodies unresolved polysemy, collapse enacts forced disambiguation, and nested observers reveal irreconcilable descriptive frames (Bontems & de Ronde, 2021). The paradox thus resides not merely in physics but in the mismatch between quantum ontology and classical grammatical categories, suggesting that no interpretation fully escapes the linguistic mediation of reality.
Major interpretations offer divergent resolutions, yet all share a hidden premise. Bohmian mechanics introduces hidden variables and non-local guidance waves to restore definite trajectories. Many-worlds accept superposition as real and multiply worlds to accommodate all outcomes. Spontaneous collapse theories modify the Schrödinger equation to force collapses stochastically. Operationalist approaches decline to interpret, treating the formalism as merely predictive. Despite their differences, each assumes that language, whether mathematical, theoretical, or ordinary, describes a pre-existing ontological domain (Bontems & de Ronde, 2021, p. 3).

Bontems and de Ronde (2021) diagnose this as a twofold "epistemological obstacle." Substantialism presumes reality consists of individuals with permanent identity, persisting through change and bearing properties. Instrumentalism avoids ontology altogether, reducing science to prediction. Both "retain the classical representation in terms of subjects possessing properties," failing to recognize that quantum mechanics might demand an entirely different mode of description (p. 5). The subject-predicate grammar of classical logic, "the electron *is* at position x", smuggles substance ontology into quantum discourse.

Yang (2022) similarly argues that "the grammatical structure of classical physics" has been mistaken for the structure of reality itself (p. 112). When quantum phenomena resist classical description, we experience paradox not because the world is strange, but because our descriptive apparatus is inadequate. The measurement problem, on this view, is a category error: applying substance-based grammar to a reality that is fundamentally relational and grammatical.

3.2 Quantum Formalism as Langue, Measurement as Parole

If structural linguistics provides the ontological framework, and the measurement problem arises from misapplying substance grammar, then a resolution emerges by reinterpreting quantum mechanics through Saussure's central distinction. The quantum formalism constitutes *langue*, the hidden system of differences and relations that makes any particular phenomenon possible. Measurement events constitute *parole*, the actual utterances, and the specific actualizations within that grammatical system.

Consider the wave function. Standard interpretations treat it as representing either the physical state of a system (ontic views) or our knowledge of that system (epistemic views). Both assume something exists, a system, a state, a knower, that the wave function describes. The structuralist interpretation dissolves this assumption. The wave function is not a description of anything; it is the *langue* itself, the pure system of relational differences that generates all possible measurement outcomes (Yang, 2022, p. 115). It has no positive terms, only differences. Superposition, then, is not a puzzling state of "being in two places at once" but the paradigmatic axis of potential substitutions, the vertical dimension of language where one sign can replace another without being actualized.

Observables correspond to syntagmatic axes, the horizontal combinations that constitute specific utterances. Choosing to measure position rather than momentum is selecting one syntagmatic chain over another, just as choosing to utter a declarative sentence rather than an interrogative selects a different grammatical path. Complementarity, on this view, is not a mysterious physical limitation but the grammatical incompatibility of distinct syntagmatic axes: one cannot utter two sentences simultaneously (Saussure, 1916/2011, p. 123).

Entanglement receives similar explication. Entangled particles are not "spookily connected" across space; they belong to the same grammatical structure, like two words in a single sentence whose meanings are interdependent (Bontems & de Ronde, 2021, p. 8). The correlation upon measurement is not a causal influence but the revelation of syntactic connection, the unfolding of grammatical relations that were always present in the langue.

The two Bloch spheres depict the reduced states of Alice's and Bob's subsystems in the singlet state $|\Psi^-\rangle = (|01\rangle - |10\rangle)/\sqrt{2}$ (Figure 9). In both cases, the Bloch vector lies at the origin (or near it), indicating a maximally mixed reduced density matrix (trace $(\varrho_A^2) = ½$, trace $(\varrho_B^2) = ½$). No definite spin direction exists locally for either party: the green arrow vanishes, signifying the complete absence of any local property or predicate that could be attributed to either particle independently.

From a linguistic perspective, this visualization embodies the relational ontology advocated by Bontems and de Ronde (2021): entangled particles do not possess individual substances bearing definite properties ("spin up" or "spin down"); rather, they constitute a single, indivisible grammatical structure, akin to two interdependent terms within one sentence whose meanings are co-determined by their syntactic relation in the langue. Local predication fails because no subject exists apart from the global relational whole. Measurement does not transmit influence but merely unfolds the pre-existing syntactic interdependence, revealing the correlation as a grammatical consequence rather than a causal one. This challenges classical subject-predicate grammar and supports a fully relational mode of description that dispenses with substantialist ontology (Bontems & de Ronde, 2021).

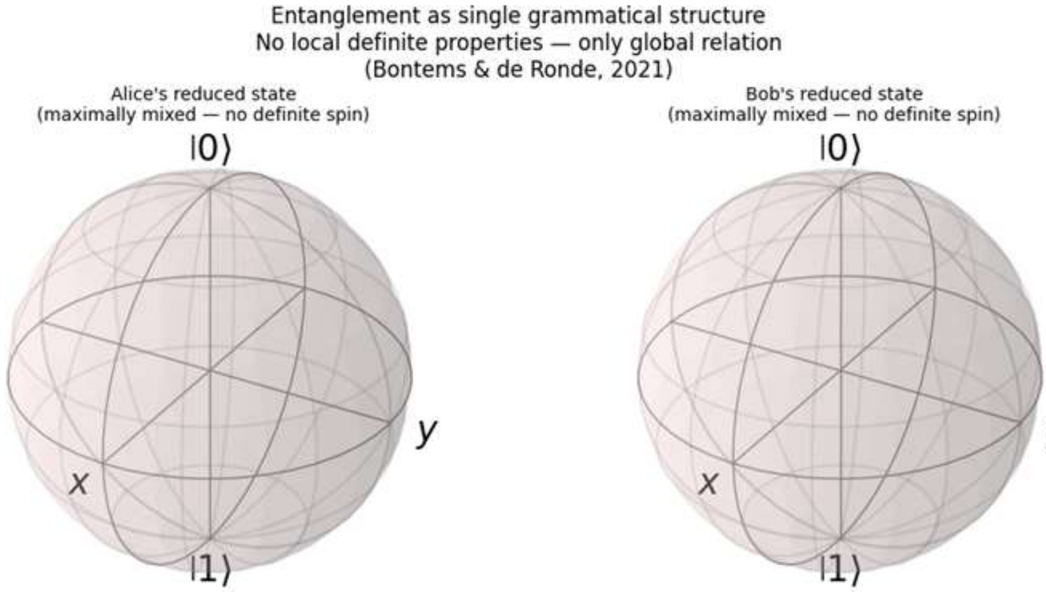

Figure 9. (left) Alice's reduced density matrix and (right) Bob's reduced density matrix on the Bloch sphere for the maximally entangled Bell singlet state.

Measurement itself, the notorious "collapse," becomes the transition from langue to parole. Collapse is not a physical process occurring in time; it is the actualization of an utterance from the system of potentialities. When Wigner's friend measures the spin and reports a definite outcome, she performs an act of enunciation within the quantum grammatical system. The paradox of Wigner describing his friend as superposition dissolves because Wigner and his friend occupy different positions within the grammatical field. There is no fact of the matter independent of enunciation (Kastner, 2024, p. 7).

Schrödinger's cat, then, is neither alive nor dead before measurement because "alive" and "dead" are terms in our classical parole, not categories applicable to quantum langue. The quantum system, as pure grammatical structure, does not admit of such subject-predicate description. The paradox arises from forcing grammatical relations into substance ontology, a category error that structuralism reveals and dissolves.

IV. Conclusion

This grammatical ontology carries profound implications for understanding reality, knowledge, and the place of observers within the physical world.

First, what exists? Not particles, fields, or even relations between independently existing things. What exists is the relational structure itself, the langue that makes any phenomenon possible. Entities are nodes in a network of differences, defined entirely by their position within that network. As Saussure (1916/2011) insisted, "in language there are only differences without positive terms" (p. 120). Our extension claims this principle holds universally: the universe is pure difference, pure structure, pure grammar.

Second, the observer is not a ghostly consciousness intervening from outside but a necessary position within the grammatical field. Parole requires an enunciator; measurement requires an observer. This does not imply idealism that reality depends on mind, but rather that the grammatical structure includes the position of utterance as an internal requirement

(Yang, 2022, p. 118). Consciousness, on this view, is not the ground of reality but a grammatical function.

Third, this framework dissolves rather than solves the measurement problem. It shows the problem to be a pseudo-problem arising from category error, from applying substance-based grammar to a reality that is grammatical through and through. No new physics is required any modification of the Schrödinger equation, no multiplication of worlds or introduction of hidden variables. Only a shift in ontological perspective: recognizing that language does not describe reality but constitutes it.

Objections naturally arise. Does this not reduce physics to linguistics, the physical world to mere words? The reply is that "language" here means structure, not particular natural languages. Mathematics is a language in this structural sense, a system of differences without positive terms. The quantum formalism is such a system. Our claim is that this formalism, properly understood, is not about a non-linguistic reality but is reality's own grammar (Bontems & de Ronde, 2021, p. 10).

What of the universe before observers? Langue does not require a speaker to exist; a language exists as a system of rules even when no one is speaking. The quantum formalism was true before life emerged, not as a description of pre-existing things but as the grammatical structure that would eventually generate utterances called "measurements" when observers evolved to enunciate them (Yang, 2022, p. 121).

We conclude that the measurement problem, which has resisted resolution for a century, dissolves when we recognize the hidden ontology of language. The universe is not merely described by grammar; it is grammar. Quantum mechanics seems strange only because we have tried to read a poem as if it were a police report. Once we learn its language, it ceases to be mysterious and becomes, instead, profoundly meaningful, the grammar of reality itself.

References

Bontems, V., & de Ronde, C. (2021). Quantum mechanics: A relational approach. Foundations of Science, 26(3), 525–545. https://doi.org/10.1007/s10699-020-09704-2

Bontems, V., & de Ronde, C. (2021, October 21). You can't always get what you want: A simondonian interpretation of quantum entanglement [Conference presentation]. Laboratoire Kastler Brossel, Paris, France. https://www.academia.edu/107237979/You_cant_always_get_what_you_want_A_Simondonian_interpretation_of_quantum_entanglement

Fuchs, C. A., Mermin, N. D., & Schack, R. (2014). An introduction to QBism and the its loose metaphysics. In G. Chiribella & R. Spekkens (Eds.), Quantum foundations and open quantum systems (pp. 1–23). World Scientific. https://doi.org/10.1142/9789814616737_0001

Ghirardi, G. (2002). Collapse theories. In E. N. Zalta (Ed.), The Stanford encyclopedia of philosophy (Winter 2002 ed.). Stanford University. https://plato.stanford.edu/archives/win2002/entries/qm-collapse/

Kastner, R. E. (2024). Conventional quantum theory does not support a coherent relational account. Philosophy of Physics, 2(1), 1-19. https://doi.org/10.31389/pop.158

Nielsen, M. A., & Chuang, I. L. (2010). Quantum computation and quantum information (10th anniversary ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511976667

Saussure, F. de. (1983). Course in general linguistics (R. Harris, Trans.). Duckworth. (Original work published 1916)

Saussure, F. de. (2011). Course in general linguistics (W. Baskin, Trans.; P. Meisel & H. Saussy, Eds.). Columbia University Press. (Original work published 1916)

Schrödinger, E. (1935). Die gegenwärtige Situation in der Quantenmechanik. Naturwissenschaften, 23(48), 807–812. https://doi.org/10.1007/BF01491891

Trimmer, J. D. (1980). The present situation in quantum mechanics: A translation of Schrödinger's "cat paradox" paper. Proceedings of the American Philosophical Society, *124*(5), 323-338. https://www.jstor.org/stable/986572

Wheeler, J. A., & Zurek, W. H. (Eds.). (1983). Quantum theory and measurement. Princeton University Press. (Reprinted selections; foundational discussions on measurement problem).

Wigner, E. P. (1932). On the quantum correction for thermodynamic equilibrium. Physical Review, 40(5), 749–759. https://doi.org/10.1103/PhysRev.40.749

Yang, Y. (2022). The integrated structure of language and language behavior, and its psychological path: Psychological life and theoretical physics (II). Science•Economy•Society, *40*(3), 97-124. https://doi.org/10.19946/j.issn.1006-2815.2022.03.009