Operational Framework CMR

From Quantum Interpretation to the Engineering of Functional Reality

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Abstract

This work presents the CMR Framework (Relational Materialization Field), an operational approach to investigate the role of measurement method, physical medium, and observer integration in the emergence of observed physical reality. We start from the premise that quantum mechanics provides an extremely accurate description of reality as accessed through measurement, without necessarily constituting a complete ontological account of reality "in itself".

Through a sequence of reproducible operational tests, including controlled simulations and a non-simulational experiment using real physical noise, we demonstrate that the stability commonly associated with the classical world emerges primarily from temporal persistence (memory) at the observer level, while the physical medium may remain statistically unchanged. The CMR framework reorganizes classical quantum paradoxes, such as those associated with Bell and Wigner, by treating objectivity as an emergent regime of high environmental coherence rather than as a fundamental axiom of nature.

This work does not propose a new physical theory nor reinterpret quantum formalism. Instead, it delineates the operational conditions under which stable reality emerges, remains functional, and becomes sufficient for science and technology.

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1. Origin of the Investigation

This investigation did not arise from questioning the validity of quantum mechanics, but from a methodological concern:

What if quantum experiments reveal, with extreme precision, not reality "in itself", but a reality materialized by the measurement method, the sampled system, and the chosen physical medium?

This concern echoes historical questions raised by Einstein regarding observer-independent reality. However, rather than seeking a strong underlying ontology, this work adopts a strictly operational posture: to investigate what is required for reality to function, not what reality is in absolute terms.

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2. Historical Context and the Interpretation Problem

Throughout the twentieth century, quantum mechanics produced extraordinary mathematical and experimental successes, accompanied by deep conceptual debates involving figures such as:

- **Niels Bohr**, emphasizing the primacy of experimental context;
- **John Bell**, demonstrating the impossibility of local realism;
- **Eugene Wigner**, exposing paradoxes involving multiple observers.

These debates reveal a persistent tension between operational success and ontological interpretation. Quantum mechanics functions impeccably, yet remains ambiguous regarding the ontological status of observed states.

The CMR framework emerges precisely in this gap: not to reinterpret equations, but to organize operationally what experiments actually demonstrate.

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3. Definition of the CMR Framework

The Relational Materialization Field (CMR) is neither a new physical field nor an alternative dynamical theory. It is an operational framework grounded on three principles:

1. The physical medium sustains correlations, not pre-existing local truths;
2. Observation materializes facts locally, without requiring global consistency;
3. The stability of reality emerges from temporal persistence (memory), not from intrinsic ontological solidity.

In this context, “reality” is defined as a stable functional experience, sufficient for science and technology, without requiring a globally shared ontology.

Operational Definition of Memory

In this work, “memory” refers to any mechanism of temporal integration that allows an observer to reduce local fluctuations through statistical persistence. This definition is strictly operational and does not imply cognitive, psychological, or conscious processes.

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4. Methodological Approach

Rather than debating abstract interpretations, we adopt an experimental-operational approach based on:

- controlled simulations implemented in Python;
- explicit falsification criteria;
- repeated tests across multiple observational regimes;
- a direct attack on the “simulation artifact” objection through experiments using real physical noise.

All tests were designed to answer a single guiding question:

Is the stability of the world rooted in the physical medium, or in the way observers integrate observations over time?

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5. Main Operational Results

5.1 The Fallacy of Global Objectivity

We demonstrate that two independent observers can materialize mutually incompatible facts within the same physical context without any system failure. The observed divergence, of the order of 50% and persistent under wide variation of observational parameters, indicates that global objectivity is not a functional requirement of reality.

5.2 Memory as a Source of Stability

By introducing temporal memory (integration windows), we observe a dramatic reduction in perceived instability, while the physical medium remains statistically unchanged. Classical stability thus emerges as an observer-dependent effect rather than as a property of the medium itself.

5.3 Operational Reinterpretation of Bell-Type Results

Bell-type simulations show that violations of Bell inequalities do not require ontological non-locality. Instead, they indicate the absence of pre-existing local values, with the medium sustaining correlations without imposing deterministic local truths.

5.4 Consensus Does Not Create Truth

Saturation tests with up to 10,000 observers show that consensus does not eliminate divergence, but merely renders it invisible at the aggregate level. Consensus is statistical, not ontological.

5.5 Multiple Observers and the Wigner Regime

Operational implementations of asynchronous observers demonstrate that no shared collapse occurs. Each observer maintains a locally stable reality, even when incompatible with others.

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6. Non-Simulational Test Using Physical Noise

To directly address the objection that CMR effects might be simulation artifacts, we conducted an experiment using real network RTT jitter as physical noise.

Empirical Results:

- Physical medium standard deviation: ≈ 11.34 ms (unchanged);
- Perceived instability without memory: 74 events;
- Perceived instability with memory: 12 events.

Conclusion:
The physical medium did not become more stable. Stability emerged exclusively at the observer level, confirming that the central effect of the CMR framework extends beyond simulation.

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7. Relation to the Physics Tradition

- **Einstein** sought an underlying objective reality.
  → CMR shows such objectivity is not required for functionality.
- **Bohr** emphasized experimental primacy.
  → CMR agrees and adds that experiments delimit what can emerge.
- **Bell** demonstrated the limits of local realism.
  → CMR shows that abandoning global truth removes the paradox.
- **Wigner** exposed observer-related paradoxes.
  → CMR shows these vanish when facts are accepted as local.

This work does not oppose historical perspectives, but extends them operationally.

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8. What the CMR Framework Does Not Claim

This work does not claim that:

- quantum mechanics is incorrect;
- established experimental results are invalid;
- a definitive ontology is proposed;
- reality is illusory or arbitrary.

On the contrary, the CMR framework explains why physics functions so effectively without requiring access to reality "in itself".

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9. Scope and Limits

The CMR framework applies to regimes where the physical medium does not impose absolute objective coherence. Ultra-stable regimes (e.g., atomic clocks, high-coherence interferometry) represent classical limits rather than contradictions. When the medium enforces strict causal commonality, divergence collapses and objectivity emerges.

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10. General Conclusion

The CMR framework demonstrates that reality, even when not ontologically objective, is functional, consistent, and sufficient for science, technology, and everyday life. Quantum mechanics remains correct within its methodological scope; CMR merely delineates what that scope allows us to access.

We do not resolve quantum strangeness.
We remove the requirement that made it paradoxical.

This marks a transition from interpretation to the engineering of lived reality.

Methods & Reproducibility Note

All experiments were conducted using explicitly defined operational parameters and automated orchestration to ensure reproducibility. Divergence metrics, observer memory windows, and medium coherence regimes were systematically varied. Non-simulational tests employed real physical noise sources.

Reproducibility was prioritized over formalism, and all methodological assumptions ere made explicit.