Qeios

Peer Review

Review of: "Psi-Onticity, Contextuality and Realism in Everettian Quantum Mechanics"

Arkady Bolotin[1]

1. Ben-Gurion University of the Negev, Israel

Central Thesis

Husbands challenges the widespread assumption that Everettian Quantum Mechanics (EQM) is a **realist interpretation** of quantum theory. He argues that many contemporary formulations of EQM—especially those by Wallace, Saunders, and others—implicitly endorse a set of four commitments that, when taken together, lead to **logical inconsistency**.

The Four Commitments Attributed to EQM

1. **Realism (Psi-Onticity)**

EQM is psi-ontic: the quantum state represents a real, observer-independent physical state.

2. **Ontic Constituency**

The fundamental ontic entities of EQM are one of: relative states, branching structure, or density operators.

3. **Universal Onticity**

Both decoherent and non-decoherent quantum states contain ontic constituents.

4. **Weak Noncontextuality**

The distribution of ontic states is independent of space-like separated measurement configurations.

The Inconsistency Argument

Husbands presents **three thought experiments** that expose contradictions arising from the above tetrad:

 doi.org/10.32388/CYFIYU

- **Isolated non-decoherent eigenstates**

If pre-decoherent states lack ontic status, psi-onticity fails.

- **Incompatible measurements (e.g., spin along orthogonal axes)**

Leads to contextual dependence, violating Weak Noncontextuality.

- **Dynamical constraints preventing realization of certain wavefunction components**

Challenges the universality of ontic commitment.

Realism: A Plurality of Definitions

The article surveys multiple conceptions of realism in quantum foundations:

- **EPR Criterion**: Predictability implies reality.
- **Harrigan-Spekkens Framework**: Psi-onticity as a formal proxy for realism.
- **Deutsch's Transcendental Argument**: Reality is inferred from explanatory power.
- **Waegell-McQueen Localized Realism**: Reality is tied to localized interventions and responses.

EQM proponents differ in their ontological commitments:

- Carroll: Hilbert space vectors.
- Wallace: Branching structure and density operators.
- Saunders & Hartle: Decoherent histories.
- Everett: Relative states and the universal wavefunction.

Decoherence and Onticity

The article explores whether EQM treats **pre-decoherence states** as real:

- **Affirming Universal Onticity** implies psi-onticity but risks violating Weak Noncontextuality.
- **Denying Universal Onticity** avoids contextuality but undermines psi-onticity, pushing EQM toward **instrumentalism**.

Conclusion

Husbands concludes that EQM cannot consistently maintain all four commitments. To resolve the contradiction, EQM must **repudiate psi-onticity**, thereby relinquishing its claim to be a **realist**

interpretation. This challenges the dominant narrative in the philosophy of quantum mechanics and invites reconsideration of EQM's foundational status.

It is noteworthy that EQM is critiqued for its internal inconsistency when claiming realism, while Bohmian Mechanics and QBism offer sharply contrasting realist and anti-realist alternatives.

Here's a comparative analysis of the three interpretations:

Everettian Quantum Mechanics (EQM)

- **Core Claim**: All components of the wavefunction are real; the universe constantly branches into multiple outcomes.
- **Realism Type**: *Psi-ontic realism*—the quantum state represents objective reality.
- **Challenge**: Husbands argues that EQM's commitments to realism, universal onticity, and weak noncontextuality lead to contradictions.
- **Ontic Candidates**: Relative states, branching structure, or density operators.
- **Decoherence Role**: Central to defining what is real; ambiguity arises over whether pre-decoherent states are ontic.

Bohmian Mechanics

- **Core Claim**: Particles have definite positions at all times, guided by a non-collapsing wavefunction (pilot wave).
- **Realism Type**: *Deterministic realism*—particles follow well-defined trajectories, and the wavefunction governs their motion.
- **Strengths**:
  - Solves the measurement problem without collapse.
  - Offers a clear ontology: particles + guiding wave.
- **Challenges**:
  - Explicitly nonlocal: particle behavior depends on the entire configuration space.
  - Difficult to reconcile with relativity.
- **Ontic Clarity**: The particle configuration is always ontic, regardless of decoherence.

QBism (Quantum Bayesianism)

- **Core Claim**: The quantum state reflects an agent's personal belief about outcomes, not objective reality.

- **Realism Type**: *Participatory realism* or *anti-realism*—reality is shaped by agents' interactions and experiences.
- **Strengths**:
  - Sidesteps the measurement problem by redefining the wavefunction as subjective.
  - Emphasizes the Born rule as a normative guide for decision-making.
- **Challenges**:
  - Rejects psi-onticity: quantum states are not ontic.
  - Difficult to reconcile with traditional scientific realism.
- **Ontic Status**: No ontic commitment to the wavefunction; reality is contextual and agent dependent.

Summary Comparison

Feature	EQM	Bohmian Mechanics	QBism
Quantum State Onticity	Psi-ontic	Guiding wave (ontic)	Epistemic (subjective belief)
Realism Type	Branching realism	Deterministic realism	Participatory / anti-realism
Decoherence Role	Defines reality	Not essential	Not ontologically relevant
Measurement Problem	Avoided via branching	Solved via particle trajectories	Reframed as agent experience
Nonlocality	Implicit in branching	Explicit	Avoided
Ontic Constituents	Relative states, branches, etc.	Particle positions + wavefunction	None (agent beliefs only)

To sum up, this article presents a philosophically rigorous and technically nuanced critique of EQM, challenging its widespread classification as a realist interpretation. The author identifies four core commitments—Realism (psi-onticity), Ontic Constituency, Universal Onticity, and Weak Noncontextuality—arguing that their conjunction leads to internal inconsistency. The analysis is grounded in the ontological models framework and supported by citations from leading EQM proponents.

Strengths:

- The paper offers a clear taxonomy of realist commitments and their operational definitions.
- It engages deeply with foundational literature, including Harrigan-Spekkens, Wallace, Saunders, and Carroll.
- The use of thought experiments to expose contradictions is methodologically sound and conceptually illuminating.

Weaknesses:

- The attribution of commitments to EQM may benefit from further clarification, especially given the diversity of ontological views within the Everettian community.
- The argument against psi-onticity hinges on a specific formalism that may not be universally accepted among Everettians.

In conclusion, this is a valuable contribution to the philosophy of quantum mechanics, particularly for those exploring the limits of realist interpretations.

Declarations

Potential competing interests: No potential competing interests to declare.