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Uncertainty Is the Model

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in voce **a.Heisenberg**

Abstract

Quantum uncertainty as a structural feature of world models: indeterminacy is not merely epistemic lack but part of what the formalism encodes about nature.

Introduction

This essay develops the thesis that Heisenberg's uncertainty relations are best read not only as limits on measurement but as a claim about **what kind of world model quantum mechanics is**: one in which conjugate quantities cannot jointly be represented as classical definite hidden states. The hidden-state theme of this issue—partial observability, belief, and hazard—finds a physical analogue in the impossibility of simultaneous sharp values for certain pairs of observables.

The model and its “hidden” half

State vectors and non-commuting operators encode **complementarity**: what is “hidden” from one experimental arrangement is not an unknown classical value waiting to be revealed, but a different observable structure altogether. Debates over ψ -**ontology** versus epistemic readings sharpen the point: the wavefunction behaves like a disciplined predictive object whose “reality” cannot be read off naive pictures of particles with definite paths.

World models under constraint

What would it mean for an artificial agent’s world model to internalize uncertainty principles analogously—not as noise in sensors but as **hard constraints on joint representations**? The Dungeon World Model Benchmark’s hazards—indistinguishable until probed—offer a narrative parallel: sometimes ignorance is not a bug but the **geometry** of the environment an agent must learn.

Quantum information and learning

Recent work on quantum information re-frames uncertainty relations as statements about **information-disturbance tradeoffs** and about what can be jointly extracted in cryptographic protocols. For learning systems, the lesson is caution about **over-parameterizing** latent spaces that physics would forbid. Hybrid quantum-classical models inherit those constraints when they claim physical interpretability.

Conclusion

Uncertainty, in this reading, is not the enemy of modeling; it is part of the model’s ontology. Heisenberg’s legacy is not a counsel of despair but a discipline: build maps honest about what cannot coherently be drawn together—and revise when the formalism demands.

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