

# Constraint-Level Closure of the Mott Problem: Related Work and Collapse-Model Stress Tests

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## Companion Note

This paper is a companion to the constraint-level *Triplicate Closure* formulation of the Mott problem within the  $\psi_0$ -OCM. The triplicate closure paper establishes the primary theoretical framework and priority definition. The present document evaluates existing interpretations and collapse models against that framework, providing structural comparison and stress testing while remaining non-constructive and public-safe.

## Abstract

This paper accompanies the public presentation of the  $\psi_0$ -OCM *triplicate, constraint-level closure* of the Mott problem. It surveys the principal existing approaches (Copenhagen-style interpretations, Everettian frameworks, decoherence accounts, and objective collapse models) and evaluates them against the triplicate closure structure introduced in the companion paper: symmetry viability, track stability, and localisation admissibility.

We show that none of the established approaches provide a logically complete resolution at the level of single-outcome admissibility and track formation without invoking additional axioms, interpretive postulates, or new dynamics. A formal stress test then demonstrates that any objective collapse model capable of reproducing Mott phenomenology must implicitly encode constraint structures operationally equivalent to the triplicate closure. The analysis clarifies the sense in which the constraint-level perspective is both novel and logically minimal, while remaining independent of specific constructive mechanisms.

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## 1 Related Work and Structural Limitations

The Mott problem is often presented as solved within existing interpretive or dynamical frameworks. However, closer examination shows that most approaches either:

1. postulate outcome selection,
2. deny outcome selection at the fundamental level, or
3. displace selection into additional axioms or collapse rules.

None address, in a unified way, the three conditions articulated in the triplicate closure: loss of symmetry viability, stability of a directionally aligned history, and admissible localisation along that history.

### 1.1 Copenhagen-type interpretations

Copenhagen-style views explain single tracks by invoking collapse linked to measurement or classical apparatus. These reproduce phenomenology but introduce outcome selection as a primitive rule. No criterion is provided for when the symmetric quantum description ceases to be viable, nor why a specific direction is selected in a single run. Localisation is an assumption, not a regime property.

### 1.2 Everett (Many-Worlds)

Everettian approaches explain track-like correlations through branching and entanglement. The global state retains symmetry; branches host linear records. However, there is no fundamental single-outcome selection. The question shifts from physical definiteness to observer self-location. As a result, admissibility of a single realised track is not addressed at the level required by the triplicate closure.

### 1.3 Decoherence

Decoherence explains suppression of interference and robustness of classical records. It yields effective mixtures and clarifies preferred bases. But decoherence alone is not an outcome theory: it does not select one realised track. Without supplementation, single-outcome admissibility remains unresolved.

### 1.4 Objective collapse models

Objective collapse models introduce stochastic or nonlinear terms that enforce macroscopic definiteness. Directional tracks can result, but collapse criteria and stabilisation conditions are encoded directly in the collapse postulate. Symmetry loss and localisation are therefore imposed by new dynamics rather than arising as constraint-driven regime properties.

## 1.5 Summary

Existing approaches illuminate important aspects of the Mott phenomenon but do not simultaneously deliver:

1. a criterion for symmetry non-viability,
2. a selective stability condition for track-consistent histories, and
3. an admissibility criterion for localisation independent of collapse axioms.

This motivates the constraint-level analysis developed in the companion paper.

## 2 Stress Test: Objective Collapse Models

We now formalise the claim that any collapse model reproducing Mott-type behaviour in the strong sense must implicitly realise the triplicate closure structure.

Let  $\mathcal{V}_{\text{sym}}$  denote a symmetry-viability diagnostic,  $\mathcal{S}_{\text{trk}}$  a track-stability functional over candidate curves  $\gamma$ , and  $\mathcal{L}$  a localisation admissibility functional over regions  $\Omega$ .

### 2.1 Generic collapse dynamics

Let

$$\frac{d\hat{\rho}}{dt} = \mathcal{U}[\hat{\rho}] + \mathcal{C}[\hat{\rho}], \quad (1)$$

with  $\mathcal{U}$  unitary and  $\mathcal{C}$  a collapse generator, and assume an initial rotationally symmetric state  $\hat{\rho}_0$ .

### 2.2 Lemma 1: Symmetry viability

Single-run directional outcomes require the model to distinguish symmetry-viable from non-viable regimes, yielding an effective  $\mathcal{V}_{\text{sym}}$ .

### 2.3 Lemma 2: Track stability

Producing straight tracks requires reinforcement of direction-aligned histories, implying an induced ranking equivalent to  $\mathcal{S}_{\text{trk}}$ .

### 2.4 Lemma 3: Localisation admissibility

Licensing localisation along the realised track requires a threshold structure equivalent to  $\mathcal{L}[\hat{\rho}; \Omega]$ .

### 2.5 Theorem

**Theorem.** Any objective collapse model reproducing Mott phenomenology must implicitly encode constraint structures operationally equivalent to the triplicate closure: symmetry viability, track stability, and localisation admissibility.

### 2.6 Consequence

Collapse models differ not in the structural requirements they satisfy but in the location of those structures: they embed them into dynamical laws, whereas the constraint-level perspective isolates the same logical architecture without committing to any particular mechanism.

### 3 Conclusion

The analysis presented here shows that familiar approaches to the Mott problem either postulate outcomes, reinterpret them away, or embed them in auxiliary dynamical rules. The triplicate closure identified in the companion paper specifies the minimal constraint architecture required for single-outcome, track-like behaviour to be physically admissible. Any framework that reproduces Mott phenomenology necessarily instantiates this closure, whether stated explicitly or not. Frameworks that do not formalise it remain structurally incomplete, even when empirically successful.