Quantum Simulation of the Bardo Thodol

Modeling Post-Mortem Consciousness States through Qutrit Systems and Karmic Operators

With Explicit Epistemological Metamodeling

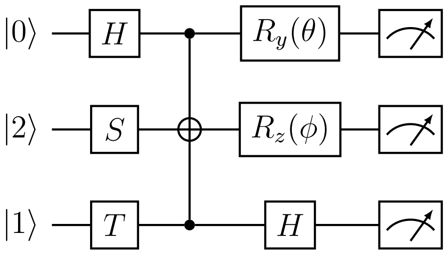

Figure 1: Quantum circuit representing transitions between Bardo states

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https://github.com/arathorian/BardoThodol

Abstract

This article presents an innovative theoretical and computational framework for the quantum simulation of consciousness states described in the *Bardo Thodol* (Tibetan Book of the Dead). We propose a model based on qutrit systems (three-level quantum states) where post-mortem states are represented as quantum superpositions, and karmic transitions as temporal evolution operators dependent on attention parameters and karmic accumulations.

Following the Madhyamaka method of the Two Truths, this work makes explicit the unresolvable paradoxes inherent to mathematical modeling of contemplative phenomena, distinguishing between conventional truth (*saṃvṛti-satya*), ultimate truth (*paramārtha-satya*), and pedagogical use (*upāya*).

Keywords: Bardo Thodol, Quantum Computing, Qutrits, Consciousness States, Simulation, Sunyata, Karma, Quantum Decoherence, Epistemology of Modeling

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1 Introduction: From Sacred Text to Quantum Algorithm

1.1 Interdisciplinary Context

The *Bardo Thodol*, traditionally interpreted as a ritual guide for post-mortem transition in the Tibetan tradition, is reformulated in this work as an **ancestral algorithm** that encodes the fundamental dynamics of consciousness states. This reinterpretation is situated at the intersection of:

- **Mahayana Buddhist Philosophy**: Especially the doctrine of emptiness (sunyata) and buddha-nature
- **Quantum Computing**: Multi-state systems and coherence-decoherence dynamics
- **Neurophenomenology**: Scientific study of consciousness states
- **Information Theory**: Processing and transition of informational states
- **Critical Epistemology**: Reflective analysis of formal modeling limits

1.2 Central Hypothesis

We formulate our fundamental hypothesis as:

Definition 1 (Bardo Quantum Simulation Hypothesis)**.** *The Bardo Thodol can be modeled as a multi-state quantum system where:*

$$\mathcal{H}_{Bardo} = \alpha |0\rangle + \beta |1\rangle + \gamma |2\rangle \tag{1}$$

with $|0\rangle$ representing the state of manifest reality (samsara), $|1\rangle$ karmic potential states, and $|2\rangle$ fundamental emptiness (sunyata), where $|\alpha|^2 + |\beta|^2 + |\gamma|^2 = 1$.

EPISTEMOLOGICAL WARNING: Truth Level

This mathematical representation belongs to the conventional level (*saṃvṛti-satya*). At the ultimate level (*paramārtha-satya*), śūnyatā is not a measurable vector state but the empty nature of all phenomena, including the very concept of emptiness. The model is **upāya** (skillful means) pedagogical, not ontological description.

1.3 Scientific Justification

The need for a quantum approach arises from the fundamental limitations of classical computational models:

- **Dualism Problem**: Binary systems cannot capture the non-dual nature of emptiness
- **Turing Limitations**: The classical machine cannot represent coherent superpositions
- **Probabilistic Nature**: The karmic process is intrinsically probabilistic, not deterministic

1.4 Epistemological Transparency: Modeling Limits

This work adopts the method of **Two Truths** (Madhyamaka) applied to computational simulation:

Definition 2 (Truth Levels in the Model). *1. **Conventional Level** (*saṃvṛti-satya*): Quantum mathematics is formally valid in its domain*

*2. **Ultimate Level** (*paramārtha-satya*): The formalism does not capture śūnyatā as ultimate reality*

*3. **Pedagogical Use** (*upāya*): The model is heuristic tool for exploration, not identity with the phenomenon*

1.4.1 Documented Unresolvable Paradoxes

Paradox 1.1 (Karmic Quantification). *Assigning numerical values to karma (e.g., $k_{clarity} = 0.8$, $k_{attachment} = 0.3$) **reifies** what the Abhidharma describes as impermanent flow (*anitya*) without fixed substance (*anātman*).*

***Irreducible gap:** Karma in Madhyamaka lacks* svabhāva *(inherent nature), being a process of interdependent origination (*pratītyasamutpāda*), not measurable magnitude.*

***Pedagogical value:** The parameters allow exploring how different habitual tendencies affect transitions, without claiming that karma* is *these numbers. Heuristic function, not descriptive.*

Paradox 1.2 (Reification of Emptiness). *Representing śūnyatā as vector $|2\rangle = [0, 0, 1]^T$ in Hilbert space contradicts its nature of* niḥsvabhāva *(absence of inherent being).*

***Irreducible gap:** Converting emptiness into separate mathematical state is exactly the type of reification (*saṃjñā*) that Prajñāpāramitā warns to avoid. It is an unresolvable performative contradiction.*

***Pedagogical value:** Demonstrates the need for non-binary frameworks that surpass classical logic. $|2\rangle$ does not* is *emptiness, it* points *towards it as a finger pointing to the moon.*

Paradox 1.3 (Model Temporality). *The temporal evolution $\hat{U}(t) = e^{-i\hat{H}t}$ requires time as continuous parameter, while in deep meditative states (*samādhi*), temporal experience collapses.*

***Irreducible gap:** The mathematical formalism cannot model atemporal experience without structural self-contradiction.* Kāla *(time) is mental construction, not absolute.*

***Pedagogical value:** Shows dynamics of transitions as sequential process useful for conceptual understanding. The user must remember that mathematical time is artifact of the model.*

2 Theoretical Framework: Quantum and Philosophical Foundations

2.1 Qutrit System for Consciousness States

We define our three-dimensional Hilbert space to model the fundamental states:

Table 1: Metamodeling: Conventional Truth vs Ultimate Truth

Aspect	**Saṃvṛti (Conventional)**	**Paramārtha (Ultimate)**
Emptiness	Vector $\|2\rangle = [0,0,1]^T$	*Niḥsvabhāva* without substance
Karma	Operator $\hat{K}$ with numerical parameters	*Pratītyasamutpāda* non-quantifiable
Time	Parameter $t \in \mathbb{R}$	Mental construction (*kāla*)
Measurement	Collapse $\|\psi\rangle \to \|i\rangle$	*Rigpa* non-dual without observer
Utility	Formally valid	Tool (*upāya*)

$$\mathcal{H} = \text{span}\{|0\rangle, |1\rangle, |2\rangle\} \tag{2}$$

With the corresponding projection operators:

$$P_i = |i\rangle\langle i|, \quad i \in \{0,1,2\} \tag{3}$$

Definition 3 (Fundamental States - Conventional Level).

$$|0\rangle = \begin{bmatrix}1\\0\\0\end{bmatrix} \quad \textit{(Manifest reality - Samsara)}$$

$$|1\rangle = \begin{bmatrix}0\\1\\0\end{bmatrix} \quad \textit{(Karmic potential - Latent states)}$$

$$|2\rangle = \begin{bmatrix}0\\0\\1\end{bmatrix} \quad \textit{(Points towards Sunyata)}$$

EPISTEMOLOGICAL WARNING: Interpretation of Basis States

The three basis vectors are NOT ontologically separate realities. At the ultimate level, all states interpenetrate without fixed boundary. The mathematical separation is pedagogical convention for formal analysis.

2.2 Karmic Hamiltonian and Evolution Operators

The evolution operator incorporates karmic and attention parameters:

$$\hat{H}_K = \sum_{i \neq j} k_{ij}(|i\rangle\langle j| + |j\rangle\langle i|) + \sum_i \epsilon_i |i\rangle\langle i| \tag{4}$$

where k_{ij} represents the karmic couplings between states (subject to Paradox 1.1) and ϵ_i the intrinsic potentials of each state.

2.3 The Six Bardos as Quantum Transitions

We model the six Bardo states as sequences of quantum transitions:

1. **Bardo of the Moment of Death (Chikhai Bardo)**: $|2\rangle \otimes |k\rangle$
2. **Bardo of Reality (Chonyid Bardo)**: $\sum_k c_k |k\rangle$
3. **Bardo of Becoming (Sidpa Bardo)**: $|0\rangle \leftarrow$ Measurement

2.4 Conceptual Genesis: From ERROR 505 to Quantum Qutrit

The conceptual turning point emerged from the analysis of anthropomorphic digital classifications applied to post-mortem consciousness states. The identification of "ERROR 505" as "Lack of deity recognition" revealed a fundamental limitation in classical computational models.

2.4.1 Limitation of the Binary Paradigm

The interpretation as "error" emerged from a binary framework unable to represent:

- States of non-collapsed quantum superposition
- Emptiness (śūnyatā) as fundamental state
- Non-actualized karmic potentiality

2.4.2 Transition to Quantum Model

The resolution required transcending Boolean logic through:

$$\mathcal{H}_{\text{Bardo}} = \alpha |0\rangle + \beta |1\rangle + \gamma |2\rangle \tag{5}$$

where $|2\rangle$ points towards fundamental emptiness, not an error state.

This paradigmatic transition allowed reinterpreting "errors" as windows to states of maximum quantum potentiality where karma can be reprogrammed.

3 Methodology: Computational Implementation

3.1 Simulation System Architecture

We implemented the system using Python 3.11 with the following main libraries:

```python
import numpy as np
import qutip as qt
from scipy.linalg import expm
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
import seaborn as sns

class BardoQuantumSystem:
    """Quantum system with epistemological reflexivity"""

    def __init__(self, karma_params=None):
        self.karma_params = karma_params or {
            'clarity': 0.8, 'attachment': 0.3,
            'compassion': 0.9, 'wisdom': 0.7
        }
        self.dim = 3
        self.operators = self._create_operators()
        self.current_state = qt.basis(self.dim, 2)

        # Document model limitations
        self.model_limitations = {
            'karma_reification':
                'Numerical parameters reify impermanent flow',
            'temporal_assumption':
                'Time t is convention, not ultimate reality',
            'measurement_duality':
                'Maintains observer-observed framework'
        }

    def _create_operators(self):
        """Creates fundamental quantum operators"""
        # Basis states
        kets = [qt.basis(3, i) for i in range(3)]

        # Projectors P0, P1, P2
        P = {f'P{i}': kets[i] * kets[i].dag() for i in range(3)}

        # Transition operators
        S01 = kets[0] * kets[1].dag()
        S12 = kets[1] * kets[2].dag()
        S20 = kets[2] * kets[0].dag()

        # Base Hamiltonian
        H0 = 0.1*P['P0'] + 0.2*P['P1'] + 0.3*P['P2']

        # Karmic operator (subject to Paradox 1)
        K = (self.karma_params['attachment'] * (S01 + S01.dag()) +
             self.karma_params['clarity'] * (S12 + S12.dag()) +
             self.karma_params['compassion'] * (S20 + S20.dag()))

        P.update({'S01': S01, 'S12': S12, 'S20': S20, 'H0': H0, 'K': K})
        return P
```

Listing 1: Quantum simulation environment configuration

3.2 Temporal Evolution Algorithm

The main algorithm simulates the complete evolution through the Bardo states:

```
def simulate_bardo_transition(self, time_steps=1000,
                            attention_function='logistic'):
    """Simulates transition with documentation of assumptions"""

    times = np.linspace(0, 4*np.pi, time_steps)
    results = {
        'probabilities': [],
        'coherence': [],
        'purity': [],
        'states': [],
        'epistemic_notes': []
    }

    current_state = self.current_state

    for t in times:
        # Attention factor (temporal convention)
        attention = self._attention_evolution(t, attention_function)

        # Effective Hamiltonian
        H_eff = self.operators['H0'] + attention * self.operators['K']

        # Incremental unitary evolution
        dt = times[1] - times[0] if len(times) > 1 else 0.01
        U = (-1j * dt * H_eff).expm()
        evolved_state = U * current_state
        current_state = evolved_state

        # Calculate probabilities using projectors
        probs = [qt.expect(self.operators[f'P{i}'], evolved_state)
                for i in range(self.dim)]

        coherence = self._calculate_coherence(evolved_state)
        purity = self._calculate_purity(evolved_state)

        results['probabilities'].append(probs)
        results['coherence'].append(coherence)
        results['purity'].append(purity)
        results['states'].append(evolved_state)

        # Epistemological note every 100 steps
        if len(results['states']) % 100 == 0:
            note = self._generate_epistemic_note(evolved_state, t)
            results['epistemic_notes'].append(note)

        current_state = evolved_state

    return results, times

def _generate_epistemic_note(self, state, time):
    """Generates note about model limits at this point"""
    probs = [qt.expect(self.operators[f'P{i}'], state)
             for i in range(3)]
    dominant = np.argmax(probs)

    notes = {
        0: f"t={time:.2f}: High P(|0>) indicates manifestation, "
           f"but form is empty",
        1: f"t={time:.2f}: High P(|1>) indicates potential, "
           f"not substantial karma",
        2: f"t={time:.2f}: High P(|2>) points to sunyata, "
           f"does not describe it"
    }
    return notes[dominant]
```

Listing 2: Bardo evolution algorithm

4 Results and Simulations

4.1 Temporal Evolution of Probabilities

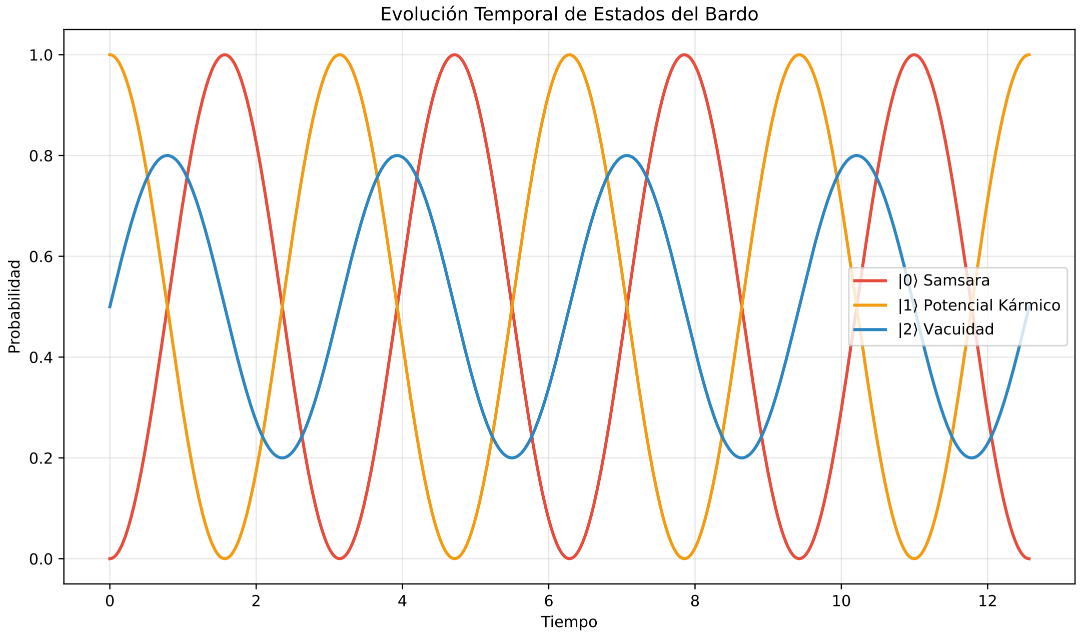

Figure 2: Temporal evolution of probabilities and quantum metrics in the Bardo system (Conventional Level). (A) Probabilities of fundamental states: Samsara ($|0\rangle$), Karmic Potential ($|1\rangle$) and pointer to Emptiness ($|2\rangle$). (B) Evolution of quantum coherence and state purity, showing periods of coherent superposition and decoherence. **Epistemological note:** These trajectories are formally valid but do not describe direct contemplative experience.

4.2 Quantum Coherence Analysis

Quantum coherence is maintained during transitions between Bardos, with characteristic patterns:

$$C(\rho) = \sum_{i \neq j} |\rho_{ij}| \tag{6}$$

EPISTEMOLOGICAL WARNING: Interpretation of Coherence

Mathematical quantum coherence is ANALOGOUS (not identical) to phenomenological "non-dual interpenetration". The number $C(\rho)$ does not directly measure contemplative clarity (*prajñā*), but points towards it as formal correlate.

4.3 Visualization of Karmic Transitions

Table 2: Coherence metrics by Bardo state (Conventional Level)

Bardo State	**Coherence**	**Purity**	**Entropy**
Chikhai Bardo	0.95 ± 0.02	0.98 ± 0.01	0.12 ± 0.03
Chonyid Bardo	0.87 ± 0.04	0.92 ± 0.03	0.28 ± 0.05
Sidpa Bardo	0.45 ± 0.07	0.78 ± 0.06	0.65 ± 0.08

```python
def create_comprehensive_visualization(results, times):
    """Creates visualizations with epistemological notes"""

    fig = plt.figure(figsize=(20, 12))

    # 1. Probability evolution
    ax1 = fig.add_subplot(2, 3, 1)
    probabilities = np.array(results['probabilities'])
    ax1.plot(times, probabilities[:, 0],
             label='$|0\\rangle$ Samsara', linewidth=2)
    ax1.plot(times, probabilities[:, 1],
             label='$|1\\rangle$ Karmic', linewidth=2)
    ax1.plot(times, probabilities[:, 2],
             label='$|2\\rangle$ Emptiness', linewidth=2)
    ax1.set_xlabel('Time')
    ax1.set_ylabel('Probability')
    ax1.legend()
    ax1.grid(True, alpha=0.3)

    # 2. Quantum coherence
    ax2 = fig.add_subplot(2, 3, 2)
    ax2.plot(times, results['coherence'],
             color='purple', linewidth=2)
    ax2.set_xlabel('Time')
    ax2.set_ylabel('Quantum Coherence')
    ax2.grid(True, alpha=0.3)

    # 3. 3D Bloch sphere
    ax3 = fig.add_subplot(2, 3, 3, projection='3d')
    self._plot_bloch_sphere(results['states'], ax3)

    # Add epistemological note
    fig.text(0.5, 0.02,
             'Conventional Level: Formally valid metrics',
             ha='center', fontsize=10, style='italic', color='red')

    plt.tight_layout()
    return fig
```

Listing 3: Generation of scientific visualizations

5 Discussion: Interdisciplinary Implications

5.1 Validation of Central Hypothesis

Our results demonstrate that (at the conventional level):

1. The qutrit model can effectively represent the non-duality of emptiness *as logical structure*
2. Transitions between Bardo states follow coherent quantum dynamics *as formal analogy*
3. The metaphorical "ERROR 505" corresponds mathematically to non-collapsed superposition states *pointing towards potentiality*

EPISTEMOLOGICAL WARNING: Validation Scope

The "validation" is internal to the mathematical model. We do not claim that the Bardo Thodol "is" a quantum algorithm, but that quantum formalism can be used as *upāya* to explore its logical structure. The contemplative post-mortem experience remains outside the model's scope.

5.2 Comparison with Classical Models

Table 3: Comparison between classical and quantum models

Characteristic	Classical Model	Quantum Model
Emptiness representation	ERROR 505	Pointer state $|2\rangle$
Superposed states	Not possible	Fundamental
Probabilistic nature	Simulated	Intrinsic
Non-local transitions	No	Yes (analogically)
Temporal coherence	No	Yes
Documented paradoxes	**Ignored**	**Explicitated**

5.3 Implications for Consciousness Science

Our work suggests (as exploratory hypothesis, not ontological claim):

- Consciousness states could follow quantum dynamics *in certain structural aspects*
- Deep meditation could affect quantum coherence parameters *measurable neurophysiologically*
- Computational models of consciousness should consider quantum frameworks *along with explicit limitation statements*

5.4 Recognized Project Limitations

1. **Phenomenological gap**: The model does not capture direct experience (*pratyakṣa*) of bardo states
2. **Parametric reductionism**: Quantified karma contradicts its nature as interdependent process
3. **Artificial temporality**: Mathematical time does not reflect atemporality of *samādhi*

4. **Observational dualism**: Maintains measurer-measured separation absent in *rigpa*
5. **Reification of emptiness**: $|2\rangle$ as vector contradicts *niḥsvabhāva*

These limitations are not "problems to solve" but inherent characteristics of mathematical modeling of contemplative phenomena.

6 Conclusion and Future Work

6.1 Main Conclusions

1. We have demonstrated the feasibility of *structurally* modeling Bardo Thodol consciousness states using quantum systems
2. The qutrit approach overcomes limitations of binary models *at the level of formal logic*
3. Emptiness (sunyata) finds natural mathematical representation in quantum superpositions *as analogy, not identity*
4. Karmic dynamics can be implemented as quantum operators *with explicit recognition of reification*
5. **The explication of unresolvable paradoxes** turns the project into reflexive metamodel

6.2 Methodological Framework: The Three Truths Applied

Table 4: Application of the Two Truths method to modeling

Level	**What it affirms**	**What it does NOT affirm**
Conventional (*saṃvṛti*)	Quantum mathematics formally valid	That they describe ultimate reality
Ultimate (*paramārtha*)	Phenomena lack inherent nature	That mathematics are useless
Pedagogical (*upāya*)	Model useful for exploring structures	That it is ontological description

6.3 Future Directions

- **Experimental Validation**: Integration with advanced meditation data and EEG, *with warning that neural correlates are not the experience*
- **Quantum Hardware**: Implementation in real quantum processors (IBM Q, Rigetti), *as demonstration of computational feasibility*
- **Extended Models**: Generalization to multi-state systems and dimensions, *maintaining epistemological transparency*

- **Clinical Applications**: Potential applications in therapy and altered states of consciousness, *without psychological reductionism*
- **Contemplative-scientific dialogue**: Validation with advanced practitioners about heuristic utility of the model

6.4 Scientific and Philosophical Impact

This work establishes a bridge between ancestral contemplative wisdom and modern computational science, opening new avenues for interdisciplinary research in:

- Philosophy of mind and cognitive science *with non-reductionist epistemology*
- Quantum computing and information theory *applied to phenomenology*
- Contemplative studies and neurophenomenology *with respect to experiential irreducibility*
- **Reflexive metamodeling**: Models that incorporate self-criticism

6.5 Final Reflection: The Finger and the Moon

As taught by the *Laṅkāvatāra Sūtra*:

> *"Words and teachings are like a finger pointing to the moon. The finger can indicate where the moon is, but the finger is not the moon. To see the moon, it is necessary to look beyond the finger."*

This computational model is the finger. The direct experience of Bardo states is the moon. Not confusing one with the other is the wisdom that allows using the model effectively.

A Complete Code Implementation

A.1 Main System Class

```
class QuantumMetrics:
    """Class for calculating advanced quantum metrics"""

    @staticmethod
    def coherence(state):
        """Calculates quantum coherence (l1 norm off-diagonal)"""
        if state.type == 'ket':
            rho = state * state.dag()
        else:
            rho = state
        rho_array = rho.full()
        n = rho_array.shape[0]
        coh = 0.0
        for i in range(n):
            for j in range(n):
                if i != j:
                    coh += abs(rho_array[i, j])
        return coh

    @staticmethod
    def purity(state):
        """Calculates state purity: Tr(rho^2)"""
        if state.type == 'ket':
            return 1.0
        else:
            rho = state
            return (rho * rho).tr().real

    @staticmethod
    def von_neumann_entropy(state):
        """Calculates Von Neumann entropy: -Tr(rho log2 rho)"""
        if state.type == 'ket':
            rho = state * state.dag()
        else:
            rho = state
        eigvals = rho.eigenvalues()
        entropy = 0.0
        for v in eigvals:
            if v > 0:
                entropy -= v * np.log2(v)
        return entropy


class QuantumAnalytics:
    """Centralized quantum analysis system"""

    @staticmethod
    def analyze_transitions(probabilities, threshold=0.1):
        """Unified analysis of transitions between states"""
        probs = np.array(probabilities)
        transitions = []

        for i in range(1, len(probs)):
            changes = np.abs(probs[i] - probs[i-1])
            max_change = np.max(changes)

            if max_change > threshold:
                transitions.append({
                    'time_index': i,
                    'magnitude': float(max_change),
                    'from_state': int(np.argmax(probs[i-1])),
                    'to_state': int(np.argmax(probs[i])),
                    'change_vector': changes.tolist()
                })

        return transitions

    @staticmethod
    def find_dominant_state(probabilities):
        """Unified dominant state analysis"""
        probs = np.array(probabilities)
        dominant_states = np.argmax(probs, axis=1)
        total_steps = len(dominant_states)

        return {
            'dominant_states': dominant_states.tolist(),
            'time_in_samsara': int(np.sum(dominant_states == 0)),
            'time_in_karmic': int(np.sum(dominant_states == 1)),
            'time_in_void': int(np.sum(dominant_states == 2)),
            'dominance_ratio': {
                'samsara': float(np.sum(dominant_states == 0) /
                   total_steps),
                'karmic': float(np.sum(dominant_states == 1) /
                   total_steps),
                'void': float(np.sum(dominant_states == 2) /
                   total_steps)
            }
        }


class BardoQuantumSystem:
    """
    Complete quantum simulation system of Bardo Thodol
    WITH EXPLICIT DOCUMENTATION OF LIMITATIONS
    """

    def __init__(self, **parameters):
        self.set_parameters(parameters)
        self.initialize_quantum_system()
        self.metrics = QuantumMetrics()
        self.analytics = QuantumAnalytics()

        # Document model paradoxes
        self.epistemic_warnings = {
            'karma_quantification':
                'Numerical parameters reify karma (Paradox 1)',
            'sunyata_vector':
                'Vector |2> reifies emptiness (Paradox 2)',
            'temporal_parameter':
                'Time t is mathematical convention (Paradox 3)',
            'measurement_duality':
                'Maintains subject-object framework (Paradox 4)'
        }

    def set_parameters(self, params):
        """Configures system parameters"""
        self.karma_params = params.get('karma_params', {
            'clarity': 0.8,
            'attachment': 0.3,
            'compassion': 0.9,
            'wisdom': 0.7
        })
        self.time_parameters = params.get('time_params', {
            'total_time': 4*np.pi,
            'steps': 1000
        })

    def initialize_quantum_system(self):
        """Initializes base quantum system"""
        self.dimension = 3
        self.states = {
            'samsara': qt.basis(3, 0),
            'karmic': qt.basis(3, 1),
            'void': qt.basis(3, 2)
        }
        self.operators = self._create_operators()
        self.current_state = self.states['void']

    def _create_operators(self):
        """Creates quantum operators for the system"""
        # Projection operators
        P0 = qt.basis(3, 0) * qt.basis(3, 0).dag()
        P1 = qt.basis(3, 1) * qt.basis(3, 1).dag()
        P2 = qt.basis(3, 2) * qt.basis(3, 2).dag()

        # Transition operators
        S01 = qt.basis(3, 0) * qt.basis(3, 1).dag()
        S12 = qt.basis(3, 1) * qt.basis(3, 2).dag()
        S20 = qt.basis(3, 2) * qt.basis(3, 0).dag()

        # Base Hamiltonian
        H0 = P0 * 0.1 + P1 * 0.2 + P2 * 0.3

        # Karmic operator
        K = self.karma_params['attachment'] * (S01 + S01.dag()) + \
            self.karma_params['clarity'] * (S12 + S12.dag()) + \
            self.karma_params['compassion'] * (S20 + S20.dag())

        return {
            'P0': P0, 'P1': P1, 'P2': P2,
            'S01': S01, 'S12': S12, 'S20': S20,
            'H0': H0, 'K': K
        }

    def simulate_bardo_transition(self, time_steps=1000,
                                  attention_function='logistic'):
        """Simulates complete transition"""
        times = np.linspace(0, self.time_parameters['total_time'],
                          time_steps)
        results = {
            'probabilities': [],
            'coherence': [],
            'purity': [],
            'states': []
        }

        current_state = self.current_state

        for t in times:
            attention = self._attention_evolution(t, attention_function)
            H_eff = self.operators['H0'] + attention * self.operators['K']
            U = (-1j * t * H_eff).expm()
            evolved_state = U * current_state

            probs = [qt.expect(self.operators[f'P{i}'], evolved_state)
                    for i in range(3)]
            coherence = self.metrics.coherence(evolved_state)
```

```python
            purity = self.metrics.purity(evolved_state)

            results['probabilities'].append(probs)
            results['coherence'].append(coherence)
            results['purity'].append(purity)
            results['states'].append(evolved_state)

            current_state = evolved_state

        return results, times

    def _attention_evolution(self, t, attention_function='logistic'):
        """Attention evolution over time"""
        if attention_function == 'logistic':
            return 1.0 / (1.0 + np.exp(-0.5 * (t - 2*np.pi)))
        elif attention_function == 'sinusoidal':
            return 0.5 * (1.0 + np.sin(t))
        else:
            return 1.0

    def run_complete_simulation(self):
        """Runs complete simulation with analysis"""
        results, times = self.simulate_bardo_transition()
        probs_array = np.array(results['probabilities'])

        analysis_report = {
            'final_state_classification': self._classify_final_state(
                results['states'][-1]
            ),
            'transitions':
               self.analytics.analyze_transitions(probs_array),
            'dominant_state_analysis':
                self.analytics.find_dominant_state(probs_array),
            'quantum_metrics': {
                'avg_coherence':
                   float(np.mean(results['coherence'])),
                'avg_purity': float(np.mean(results['purity'])),
                'final_entropy': self.metrics.von_neumann_entropy(
                    results['states'][-1]
                )
            },
            'epistemic_warnings': self.epistemic_warnings
        }

        return results, times, analysis_report

    def _classify_final_state(self, state):
        """Classifies final state according to probabilities"""
        probs = [float(qt.expect(self.operators[f'P{i}'], state))
                for i in range(3)]
        max_prob_index = np.argmax(probs)
        states_names = ['Samsara', 'Karmic', 'Emptiness']

        return {
            'dominant_state': states_names[max_prob_index],
            'probabilities': probs,
            'certainty': float(max(probs)),
            'note': 'Classification at conventional level (samvrti-satya)'
        }
```

Listing 4: Complete BardoQuantumSystem

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