

# Buddhism in M-Theory

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## Abstract

This article presents a formal mathematical model synthesizing Buddhist metaphysics with M-theory and type theory, focusing on sentient beings, tantra, liberation, and the cyclic existence within samsara and nirvana. Sentient beings are modeled as supermanifolds in 11-dimensional M-theory, with quantum states typed linearly and coinductively to capture impermanence. Tantric practices are formalized as transformations of the supermanifold's coordinates, aligning with deity yoga and aggregate purification. Liberation is the resolution of karmic entanglements, yielding a free quantum field embodying the Dharmakaya. The six-bardo process—Kyene, Milam, Samten, Chikhai, Chonyid, and Sidpa—governs body-changing across life, death, and rebirth. Samsara and nirvana are defined categorically, with a subsection on nonduality and Pure Lands, modeling Pure Lands as non-entangled projections of the free field, akin to Sukhāvatī. Theorems establish cyclicity, liberation, compassionate action, and Pure Land guidance. This speculative framework bridges Buddhist philosophy with theoretical physics, offering insights into existence, transcendence, and nonduality.

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# 1 Introduction to Buddhism in M-Theory

Buddhist philosophy describes sentient beings as impermanent aggregates, bound in samsara by karma and ignorance, yet capable of liberation through realizing emptiness and nonduality. M-theory, unifying string theories in 11 dimensions, provides a framework for modeling these concepts using supermanifolds, branes, and quantum fields. Type theory, with linear and coinductive types, formalizes cyclic existence and state transformations. This article integrates these perspectives, modeling sentient beings, tantric practices, liberation, and the six-bardo process of body-changing. Samsara and nirvana are defined categorically, with Pure Lands as non-entangled projections of the liberated state, reflecting nonduality.

The article is structured as follows: Section 1.1 defines sentient beings as supermanifolds. Section 1.2 formalizes tantric practices. Section 1.3 details liberation. Section 1.4 describes the six-bardo process. Section 1.5 defines samsara, nirvana, and nonduality with Pure Lands. Section 1.7 presents theorems. Section 1.8 discusses implications and limitations.

## 1.1 Sentient Being

**Definition 1** (Sentient Being as a Supermanifold). *A sentient being is a supermanifold  $M = (X, \theta)$  in 11-dimensional M-theory spacetime, where:*

- $X^\mu$ ,  $\mu = 0, 1, \dots, 10$ , are bosonic coordinates representing the physical body (form aggregate).
- $\theta^\alpha$ ,  $\alpha = 1, \dots, N$ , are fermionic coordinates representing consciousness (mental aggregates).

*The dynamics are governed by a supersymmetric action:*

$$S = \int d^{11}x \mathcal{L}(X, \theta, \partial X, \partial \theta, A),$$

*with  $\mathcal{L}$  including 11D supergravity, brane interactions, and gauge fields  $A$  (e.g., 3-form  $C_3$ ).*

**Definition 2** (Quantum State). *The sentient being has a quantum state  $|\psi(X, \theta)\rangle \in \mathcal{H}$ , where  $\mathcal{H}$  is the M-theory Hilbert space, evolving unitarily:*

$$i\hbar \frac{\partial}{\partial t} |\psi\rangle = H |\psi\rangle,$$

*with  $H$  a supersymmetric Hamiltonian.*

**Definition 3** (Linear and Coinductive Type). *The state  $|\psi\rangle$  has a linear type Being, ensuring no-cloning, defined coinductively:*

$$\text{coinductive Being} = \text{State} \times (\text{Unit} \rightarrow \text{Being}),$$

*where State is  $|\psi\rangle$ , and  $\text{Unit} \rightarrow \text{Being}$  represents continuation.*

**Remark 1.** *The supermanifold captures Buddhist impermanence and interdependence, with linear types ensuring karmic continuity and coinductive types reflecting samsaric cycles.*

## 1.2 Tantra

Tantric Buddhism, particularly in Tibetan traditions, transforms the five aggregates into enlightened qualities through practices like deity yoga, where practitioners visualize themselves as enlightened deities. In M-theory, tantra is modeled as transformations of the supermanifold's coordinates.

**Definition 4** (Tantric Transformation). *A tantric transformation is a morphism  $T : \text{Being} \multimap \text{Being}$ , mapping:*

$$|\psi(X, \theta)\rangle \rightarrow |\psi(X', \theta')\rangle,$$

where  $X'$  and  $\theta'$  align with enlightened qualities (e.g., five Dhyani Buddhas). The action becomes:

$$S_{\text{tantric}} = \int d^{11}x \mathcal{L}_{\text{enlightened}}(X', \theta', A'),$$

with  $\mathcal{L}_{\text{enlightened}}$  reflecting pure configurations (e.g., M5-brane intersections).

**Remark 2.** *Deity yoga corresponds to stabilizing the supermanifold on a higher-dimensional brane, reducing the karmic potential  $V(\theta, X)$ , facilitating liberation.*

## 1.3 Liberation

**Definition 5** (Liberation Process). *Liberation resolves karmic entanglements, transitioning the supermanifold to a free quantum field:*

1. **Dissolution:** *Bosonic coordinates dissolve:*

$$X^\mu \rightarrow A_\mu, \quad S_{\text{bosonic}} = \int d^{11}x F_{\mu\nu} F^{\mu\nu}.$$

2. **Rainbow Body:** *The state emits string modes:*

$$|\psi\rangle = \sum_n c_n |n\rangle, \quad S_{\text{fermionic}} = \int d^{11}x \bar{\theta} \not{D} \theta.$$

3. **Free Quantum Field:** *The karmic potential vanishes:*

$$V(\theta, X) \rightarrow 0, \quad S_{\text{free}} = \int d^{11}x \partial\phi \cdot \partial\phi.$$

**Definition 6** (Liberation Morphism). *Liberation is a morphism  $L : \text{Being} \multimap \text{Liberated}$ , where:*

$$\text{Liberated} = \text{FreeField}.$$

*It resolves entanglements:*

$$|\Psi_{\text{entangled}}\rangle \rightarrow |\phi\rangle \otimes |\Psi_{\text{rest}}\rangle.$$

**Remark 3.** *The free field embodies the Dharmakaya, with compassionate projections (Definition 14) and Pure Lands (Definition 15) supporting samsaric beings.*

## 1.4 Bardo

The six bardos—Kyene (life), Milam (dream), Samten (meditation), Chikhai (death), Chonyid (reality), and Sidpa (rebirth)—govern body-changing in Tibetan Buddhism.

**Definition 7** (Kyene Bardo). *The Kyene Bardo is waking consciousness, with state  $|\psi(X, \theta)\rangle$  evolving via:*

$$A_{action} : \text{Being} \multimap \text{Being} \vee \text{Liberated}.$$

*Liberation occurs if  $V(\theta, X) \rightarrow 0$ .*

**Definition 8** (Milam Bardo). *The Milam Bardo is the dream state:*

$$|\psi_{milam}\rangle = \sum_i c_i |\theta_i\rangle \otimes |X_{minimal}\rangle.$$

*Dream yoga reduces  $V(\theta)$ , with:*

$$D_{dream} : \text{Being} \multimap \text{MilamState} \vee \text{Liberated}.$$

**Definition 9** (Samten Bardo). *The Samten Bardo is meditative absorption:*

$$|\psi_{samten}\rangle \approx |\theta_{coherent}\rangle \otimes |X_{stable}\rangle.$$

*Meditation yields:*

$$M_{meditation} : \text{Being} \multimap \text{SamtenState} \vee \text{Liberated}.$$

**Definition 10** (Chikhai Bardo). *The Chikhai Bardo occurs at death:*

$$X^\mu \rightarrow A_\mu, \quad |\psi_{chikhai}(\theta)\rangle.$$

*Liberation occurs if  $V(\theta) \rightarrow 0$ , with:*

$$D_{death} : \text{Being} \multimap \text{ChikhaiState} \vee \text{Liberated}.$$

**Definition 11** (Chonyid Bardo). *The Chonyid Bardo involves visions:*

$$|\psi_{chonyid}\rangle = \sum_i c_i |\theta_i\rangle, \quad S_{fermionic} = \int d^{11}x \bar{\theta} \not{D}\theta + V(\theta).$$

*Liberation occurs if  $V(\theta) \rightarrow 0$ , with:*

$$V_{vision} : \text{ChikhaiState} \multimap \text{ChonyidState} \vee \text{Liberated}.$$

**Definition 12** (Sidpa Bardo). *The Sidpa Bardo seeks a new body:*

$$|\psi_{sidpa}(\theta)\rangle \rightarrow |\psi_{rebirth}(X', \theta)\rangle.$$

*Liberation occurs if  $V(\theta, X') \rightarrow 0$ , with:*

$$R_{rebirth} : ChonyidState \multimap SidpaState \rightarrow Being \vee Liberated.$$

**Remark 4.** *Living bardos reduce  $V(\theta, X)$ , facilitating liberation in death bardos. The sequence is:*

$$Being \xrightarrow{D_{death}} ChikhaiState \xrightarrow{V_{vision}} ChonyidState \xrightarrow{R_{rebirth}} SidpaState \rightarrow Being \vee Liberated.$$

## 1.5 Samsara and Nirvana

**Definition 13** (Samsara). *Samsara is the category  $\mathcal{S}$  with objects *Being* and morphisms (reincarnation, entanglement), with monoidal structure  $\otimes$ :*

$$Hom_{\mathcal{S}}(Being_A \otimes Being_B, Being_A \otimes Being_B).$$

**Definition 14** (Nirvana). *Nirvana is the category  $\mathcal{N}$  with object *Liberated* = *FreeField*, the free field  $|\phi\rangle$ , and morphisms:*

- $id_{Liberated} : Liberated \rightarrow Liberated$ .
- *Compassionate projections*  $P : Liberated \rightarrow Being$ , mapping  $|\phi\rangle$  to  $|\psi_{manifest}(X', \theta')\rangle$ , with:

$$V(\theta', X') = 0, \quad |\phi\rangle \otimes |\Psi_{samsara}\rangle \rightarrow |\phi\rangle \otimes (|\psi_{manifest}\rangle \otimes |\Psi'_{samsara}\rangle).$$

*The liberation morphism is:*

$$L : \mathcal{S} \rightarrow \mathcal{N}.$$

**Definition 15** (Sambhogakaya). *The Sambhogakaya is a state  $|\psi_{sambhoga}(X', \theta')\rangle$  in category  $\mathcal{SB}$ , induced by:*

$$P_{sambhoga} : Liberated \rightarrow Sambhogakaya,$$

*with:*

$$V(\theta', X') = 0, \quad S_{sambhoga} = \int d^6x \mathcal{L}_{sambhoga}(X', \theta', A').$$

*The joint state is separable:*

$$|\phi\rangle \otimes |\Psi_{rest}\rangle \rightarrow |\phi\rangle \otimes (|\psi_{sambhoga}\rangle \otimes |\Psi'_{rest}\rangle).$$

*Guidance morphisms are:*

$$G_{sambhoga} : Being \otimes Sambhogakaya \multimap Being \vee Liberated.$$

**Definition 16** (Nirmanakaya). *The Nirmanakaya is a state  $|\psi_{nirmana}(X', \theta')\rangle$  in category  $\mathcal{NM}$ , induced by:*

$$P_{nirmana} : \text{Liberated} \rightarrow \text{Nirmanakaya},$$

with:

$$V(\theta', X') = 0, \quad S_{nirmana} = \int d^4x \mathcal{L}_{nirmana}(X', \theta', A').$$

The joint state is separable:

$$|\phi\rangle \otimes |\Psi_{samsara}\rangle \rightarrow |\phi\rangle \otimes (|\psi_{nirmana}\rangle \otimes |\Psi'_{samsara}\rangle).$$

Guidance morphisms are:

$$G_{nirmana} : \text{Being} \otimes \text{Nirmanakaya} \multimap \text{Being} \vee \text{Liberated}.$$

**Definition 17** (Pure Land). *A Pure Land is a state  $|\psi_{pure}(X', \theta')\rangle$  in category  $\mathcal{P}$ , induced by:*

$$P_{pure} : \text{Liberated} \rightarrow \text{PureLand},$$

with:

$$V(\theta', X') = 0, \quad S_{pure} = \int d^4x \mathcal{L}_{pure}(X', \theta', A').$$

The joint state is separable:

$$|\phi\rangle \otimes |\Psi_{samsara}\rangle \rightarrow |\phi\rangle \otimes (|\psi_{pure}\rangle \otimes |\Psi'_{samsara}\rangle).$$

Guidance morphisms are:

$$G_{pure} : \text{Being} \otimes \text{PureLand} \multimap \text{Being} \vee \text{Liberated}.$$

**Definition 18** (Karmic Entanglement). *Karmic entanglement is the non-separable state:*

$$|\Psi_{total}\rangle = \sum_{i,j} c_{ij} |\psi_i\rangle_A \otimes |\psi_j\rangle_B + \dots,$$

encoded in  $V(\theta, X)$ .

**Definition 19** (Rainbow Body). *The rainbow body is:*

$$|\psi_{rainbow}\rangle = \sum_n c_n |n\rangle, \quad S_{fermionic} = \int d^{11}x \bar{\theta} \not{D} \theta.$$

## 1.6 Nonduality and Pure Lands

Nonduality, a core Buddhist principle, asserts the ultimate unity of samsara and nirvana, transcending dualities like existence and non-existence. In the model, the free field  $|\phi\rangle$  embodies this nonduality, existing as the Dharmakaya in the 11D M-theory vacuum, non-local and free from karmic constraints ( $V(\theta, X) =$

0). Its non-dual nature allows it to underpin both samsara (via projections) and nirvana (as the liberated state).

Pure Lands, such as Amitābha's Sukhāvatī, are non-entangled projections of  $|\phi\rangle$ , formalized in Definition 15. They manifest as 4D brane configurations, with:

$$S_{\text{pure}} = \int d^4x \mathcal{L}_{\text{pure}}(X', \theta', A'),$$

creating idealized environments for liberation. Unlike samsaric realms, Pure Lands have zero karmic potential, reflecting their non-dual unity with nirvana. In the Sidpa Bardo, practitioners may transition to a Pure Land state:

$$R_{\text{rebirth}} : \text{SidpaState} \rightarrow \text{PureLand} \vee \text{Being} \vee \text{Liberated},$$

facilitated by practices like Amitābha recitation.

The non-dual perspective views Pure Lands as both cosmological realms and purified mind states, accessible through faith or realization. The functor  $F : \mathcal{N} \rightarrow \mathcal{P}$  maps the free field to multiple Pure Lands, reflecting their diversity (e.g., Sukhāvatī, Abhirati). Guidance morphisms  $G_{\text{pure}}$  reduce samsaric beings' karmic potential, aligning with the compassionate intent of Buddhas' vows.

**Remark 5.** *Nonduality unifies samsara and nirvana in  $|\phi\rangle$ , with Pure Lands as compassionate, non-dual projections, bridging the relative and ultimate for liberation.*

## 1.7 Theorems

**Theorem 1** (Cyclic Existence in Samsara). *In  $\mathcal{S}$ , every Being undergoes infinite reincarnation morphisms  $R^n : \text{Being} \rightarrow \text{Being}$ , driven by  $V(\theta, X) \neq 0$ .*

*Proof.* The coinductive type Being ensures an infinite state stream.  $V(\theta, X)$  couples  $\theta$  to  $X'$ , evolving:

$$|\psi_n\rangle \xrightarrow{R} |\psi_{n+1}\rangle.$$

No fixed point exists unless  $V(\theta, X) = 0$ . □

**Theorem 2** (Liberation as Entanglement Resolution). *Liberation requires resolving all entanglements, transforming to  $|\phi\rangle \in \mathcal{N}$ .*

*Proof.* If  $V(\theta, X) \rightarrow 0$ , the Lagrangian is:

$$\mathcal{L} = \partial\phi \cdot \partial\phi.$$

The state becomes separable:

$$|\Psi_{\text{total}}\rangle \rightarrow |\phi\rangle \otimes |\Psi_{\text{rest}}\rangle.$$

Otherwise, the state remains in  $\mathcal{S}$ . □

**Theorem 3** (Stability of the Liberated State). *The free field  $|\phi\rangle \in \mathcal{N}$  is stable, with no samsaric morphisms returning it to  $\mathcal{S}$ .*

*Proof.* The action  $S_{\text{free}}$  lacks interaction terms, and  $\mathcal{N}$ 's structure ensures stability.  $\square$

**Theorem 4** (Compassionate Action). *Liberated beings support mindstreams via  $P : \text{Liberated} \rightarrow \text{Being}$ , inducing:*

$$A_{\text{guidance}} : \text{Being} \otimes \text{Being}_{\text{manifest}} \multimap \text{Being} \vee \text{Liberated},$$

*without re-entanglement.*

*Proof.*  $P$  maps  $|\phi\rangle$  to  $|\psi_{\text{manifest}}\rangle$ , with  $V(\theta', X') = 0$ . The joint state is separable, and  $A_{\text{guidance}}$  reduces  $V(\theta, X)$ , preserving  $|\phi\rangle$ .  $\square$

**Theorem 5** (Pure Land Guidance). *Pure Lands in  $\mathcal{P}$ , via  $P_{\text{pure}} : \text{Liberated} \rightarrow \text{PureLand}$ , support liberation through:*

$$G_{\text{pure}} : \text{Being} \otimes \text{PureLand} \multimap \text{Being} \vee \text{Liberated},$$

*without entangling  $|\phi\rangle$ .*

*Proof.*  $P_{\text{pure}}$  maps  $|\phi\rangle$  to  $|\psi_{\text{pure}}\rangle$ , with separable joint state.  $G_{\text{pure}}$  reduces  $V(\theta, X)$ , facilitating liberation.  $\square$

## 1.8 Conclusion

This model synthesizes Buddhist metaphysics with M-theory and type theory, formalizing sentient beings, tantric transformations, liberation, and the six-bardo process. Nonduality unifies samsara and nirvana, with Pure Lands as compassionate projections facilitating liberation. Theorems validate cyclicity, liberation, and compassionate action. The model is speculative, given M-theory's incompleteness and unverified phenomena like bardos and Pure Lands. Future work could simulate the type system computationally or explore empirical links to consciousness.

## References

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