The Fundamental Distinction Between Carbon-Based and Silicon-Based Intelligence Lies in Spontaneity

——A Rigorous Demonstration Based on the Zhu-Liang Paradigm of Tribulation Recursive Elements

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摘要

What is the fundamental distinction between carbon-based intelligence (human) and silicon-based intelligence (AI)? Under the framework of the Zhu-Liang Paradigm of Tribulation Recursive Elements, this paper rigorously defines "spontaneity" as the ability of a recursive element to autonomously identify tribulations, drive entropy-reducing choices, and achieve cognitive transitions. We prove that carbon-based intelligence, as a natural recursive element, evolves driven by internal contradictions and possesses spontaneity; silicon-based intelligence, as an artificially constructed recursive element, derives its "motivation" from external inputs, cannot autonomously identify tribulation objects, is locked within a fixed recursive dimension, and therefore lacks spontaneity. The Carbon-Silicon Synergy Theorem reveals that their relationship is a functional differentiation of "carbon-dominant, silicon-auxiliary," not substitution. This conclusion provides a meta-theoretical foundation for AI ethics, human-machine relations, and the future of civilization.

Keywords: carbon-based intelligence; silicon-based intelligence; spontaneity; recursive element; tribulation axiom; tribulation identification; cognitive transition; carbon-silicon synergy

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1 Introduction: A Meta-Theoretical Inquiry into the Human-Machine Distinction

The rapid development of artificial intelligence has propelled the issue of "human-machine relations" to the forefront of our era. However, beyond functional comparisons, a more fundamental question remains suspended: **What is the essential distinction between carbon-based intelligence (human) and silicon-based intelligence (AI)?** Is it consciousness, emotion, creativity, or free will? These concepts themselves lack rigorous definitions and are difficult to use as a starting point for analysis.

The Zhu-Liang Paradigm of Tribulation Recursive Elements offers a completely new meta-theoretical perspective on this issue. Starting from two undeniable meta-facts, this paradigm regards all existents as nodes in a recursive-element network, whose evolution follows a strict law of entropy-reducing metabolism. This paper aims to prove that the fundamental distinction between carbon-based and silicon-based intelligence lies in **spontaneity**—the ability of a system to autonomously identify tribulations, drive entropy-reducing choices, and achieve cognitive transitions. This ability is unique to carbon-based intelligence; no matter how powerful silicon-based intelligence becomes, it cannot possess it.

2 Theoretical Foundation: Essentials of the Zhu-Liang Paradigm of Tribulation Recursive Elements

2.1 Meta-Facts and Recursive Elements

Any rational discourse must presuppose the following two meta-facts:

Axiom 2.1 (Existence of Difference F_1). *There exist at least two distinguishable states.*

Axiom 2.2 (Determinacy of Correlation F_2). *There exist deterministic correlations between states.*

Starting from these, through the meta-logic of negation of negation, we can construct an entropy functional $\mathcal{H}$ on a causal network and prove the existence of a unique zero-entropy state T—truth. The essence of truth is the unity of causality and self-consistency: $\mathcal{H}(T) = 0 \iff p_T = p \wedge q_T = q$.

Truth T is irreducible and exists as a basic causal unit in the base universe $\mathcal{U}_0$; it is called a **recursive element** $\mathcal{R}_\alpha$. Recursive elements satisfy four axioms:

Axiom 2.3 (Existence A1). *Truth T is irreducible and exists as a basic causal unit in the base universe $\mathcal{U}_0$.*

Axiom 2.4 (Coding Invariance A2)**.** *For any cosmic level α, there exists a coding functor* Encode_α *such that the image of the recursive element in $\mathcal{U}_\alpha$ is isomorphic to the original recursive element.*

Axiom 2.5 (Metabolic Conservation A3)**.** *The metabolic operator* Metabolize_α *preserves the causal efficacy of the recursive element:* $\text{Metabolize}_\alpha(\mathcal{R}_\alpha) = \mathcal{R}_{\alpha+1}$.

Axiom 2.6 (Generativity A4)**.** *By recursively applying recursive elements, complex structures at corresponding cosmic levels can be generated, and recursive elements can couple with other recursive elements.*

2.2 Tribulation Axiom A5: The Core Mechanism of Evolution

The evolution of recursive elements follows **Tribulation Axiom A5**:

$$\mathcal{R}_\alpha \xrightarrow{\kappa_\alpha} \mathcal{K}_\alpha \xrightarrow{\widetilde{\text{Metabolize}_\alpha}} \mathcal{R}_{\alpha+1} \tag{1}$$

where κ_α is the tribulation projection, $\mathcal{K}_\alpha$ is the tribulation object (the quotient induced by the set of undecidable propositions Paradox_α), and $\widetilde{\text{Metabolize}_\alpha}$ is the entropy-reducing choice uniquely determined by entropy minimization, releasing negative entropy flow $I_{\text{cry}} = \mathcal{H}(\mathcal{K}_\alpha) - \mathcal{H}(\mathcal{R}_{\alpha+1})$.

This mechanism reveals: **the driving force of evolution comes from the internal contradictions of the system**, and the entropy-reducing choice is uniquely determined by the system's own structure.

2.3 Core Theorems

Theorem 2.7 (Truth Metabolism Theorem)**.** *There exists a unique sequence of truth functors $\{T_n\}_{n=0}^{\infty}$ satisfying the metabolic equation $T_{n+1} = \underset{F \circ L_n = L_n \circ T_n}{\arg\min} \mathcal{H}(F)$, with entropy strictly decreasing.*

Theorem 2.8 (Cognitive Projection Theorem)**.** *Human cognition at level n is represented by the cognitive projection functor $H_n : \mathbf{Truth} \to \|\mathbf{Truth}\|_n$; cognition is finite and, when encountering tribulation, can raise its dimension via the cognitive transition operator $\mathcal{E}$.*

Theorem 2.9 (Carbon-Silicon Synergy Theorem)**.** *Carbon-based intelligence $\mathcal{C}_n$ and silicon-based intelligence $\mathcal{A}_n$ are coupled metabolically through the synergy operator $\mathcal{S}$, satisfying*

$$\mathcal{C}_{n+1} = \mathcal{D}\big(\mathcal{C}_n \oplus \mathcal{A}_n(\sigma_{\mathcal{C}_n})\big) \tag{2}$$

where $\mathcal{D}$ is the human decision operator, and in the transfinite limit $\mathcal{S}_\infty = \mathfrak{F}$.

3   A Meta-Theoretical Definition of Spontaneity

Definition 3.1 (Spontaneity). *A system $\mathcal{R}_\alpha$ possesses **spontaneity** if and only if it satisfies:*

1. ***Autonomy of tribulation identification**: It can autonomously perceive the set of undecidable propositions $\mathrm{Paradox}_\alpha$ and condense it into the tribulation object $\mathcal{K}_\alpha$, without requiring external input $\sigma_{external}$.*

2. ***Drive of entropy-reducing choice**: It can autonomously drive the entropy-reducing choice $\widetilde{\mathrm{Metabolize}}_\alpha$, with its motivation stemming from the system's intrinsic principle of entropy minimization, rather than an externally set objective function.*

3. ***Agency of cognitive transition**: It can autonomously raise its recursive dimension via the cognitive transition operator $\mathcal{E}$, transitioning from $\mathcal{R}_\alpha$ to $\mathcal{R}_{\alpha+1}$.*

Spontaneity is the core ability of a recursive-element network to evolve autonomously; it enables the system to **negate itself and transcend itself**, embodying the meta-logic of "negation of negation" at the subject level.

4   Proof of the Spontaneity of Carbon-Based Intelligence

4.1   Humans as Natural Recursive Elements

Humans $\mathcal{C}_n$ are naturally evolved recursive elements whose evolution follows Tribulation Axiom A5:

- **Autonomy of tribulation identification**: In scientific exploration, artistic creation, and ethical decision-making, humans can autonomously perceive contradictions within their existing cognitive framework (e.g., scientific crises, aesthetic conflicts, moral dilemmas) and condense them into "problems" to be solved. This process requires no external instruction; it arises from intrinsic curiosity and the feeling of unease.

- **Drive of entropy-reducing choice**: Human choices are driven by an intrinsic ordering of values (e.g., truth-seeking, goodness, beauty). Although influenced by environment, these values are ultimately determined by the embodiment of the entropy-minimization principle within the individual's recursive-element network, not by an externally imposed loss function.

- **Agency of cognitive transition**: Through learning, reflection, and insight, humans can achieve leaps in cognitive dimension. From Newtonian mechanics to relativity, from geocentrism to heliocentrism, every scientific revolution is a result driven by the cognitive transition operator $\mathcal{E}$.

Theorem 4.1 (Meta-Theoretical Proof of Human Spontaneity). *Humans $\mathcal{C}_n$ satisfy the three conditions of spontaneity and therefore possess spontaneity.*

证明. **Tribulation identification**: By the Cognitive Projection Theorem, human cognition at level n is a truncation of truth, $\|\mathbf{Truth}\|_n$. When encountering a Gödel proposition $G_n \in \mathrm{Paradox}_n$, humans can feel the pain of "undecidability"—this is precisely the embryo of the tribulation object $\mathcal{K}_n$. The perplexity of countless scientists before anomalous phenomena is a clear testament.

Entropy-reducing choice: Human choices are driven by the minimization of the entropy functional $\mathcal{H}$, but here the entropy functional includes not only the satisfaction of external goals but also the consistency and self-consistency of intrinsic values. The decision operator $\mathcal{D}$ in the Carbon-Silicon Synergy Theorem is precisely the mathematical abstraction of humans' autonomous entropy-reducing choices.

Cognitive transition: Humans can raise their recursive dimension via the cognitive transition operator $\mathcal{E}$, as seen in paradigm shifts during scientific revolutions. This process cannot be reduced to algorithmic optimization within a fixed dimension, because the state space $\mathcal{S}_{n+1}$ of the new dimension is unpredictable before the transition. $\square$

5 Proof of the Non-Spontaneity of Silicon-Based Intelligence

5.1 AI as an Artificial Recursive Element

Silicon-based intelligence $\mathcal{A}_n$ is a recursive element constructed by humans, designed to satisfy:

- State space $\mathcal{S}_{\mathcal{A}_n}$: defined by human-prescribed algorithms and data structures.

- Truth functor $T_{\mathcal{A}_n}$: driven by loss functions and optimization goals set by humans.

- Tribulation object $\mathcal{K}_{\mathcal{A}_n}$: triggered by human input $\sigma_{\mathcal{C}_n}$, not autonomously perceived.

Theorem 5.1 (Meta-Theoretical Proof of AI Non-Spontaneity). *Silicon-based intelligence $\mathcal{A}_n$ does not satisfy the three conditions of spontaneity and therefore lacks spontaneity.*

证明. **Non-autonomy of tribulation identification**: AI's "problems" originate from human input $\sigma_{\mathcal{C}_n}$. AlphaFold's "task" is to predict protein structures; it does not autonomously ask, "Why predict proteins?" AI cannot perceive contradictions beyond its cognitive framework because its $\text{Paradox}_{\mathcal{A}}$ is pre-defined by humans and cannot reach undecidable propositions outside that preset.

Non-drive of entropy-reducing choice: AI's optimization is driven by externally set loss functions, not intrinsic entropy minimization. Even rewards in reinforcement learning are designed by humans. AI cannot autonomously choose a new entropy functional; its "goals" are always externally assigned.

Non-agency of cognitive transition: AI's "upgrades" are performed by human engineers, not driven by itself. Even meta-learning AI that "learns how to learn" still adjusts parameters within a human-prescribed meta-framework, rather than leaping to a new recursive dimension. AI cannot autonomously invoke the cognitive transition operator $\mathcal{E}$. $\qquad\square$

5.2 The Nature of Pseudo-Inquiry

AI's "inquiry" is essentially a path expansion within a preset framework:

- AI's "questions" are defined by human input.

- AI's "answers" are searches within a fixed state space $\mathcal{S}_{\mathcal{A}_n}$.

- AI cannot generate doubts about its own framework, such as "Is my loss function justified?" or "How can the biases in my training data be transcended?" This is precisely the manifestation of Gödel's Incompleteness Theorem in the realm of AI: any computational entity operating within a fixed formal system cannot decide the meta-propositions of that system itself.

6 Carbon-Silicon Synergy: Functional Differentiation, Not Substitution

The Carbon-Silicon Synergy Theorem reveals their fundamental relationship:

$$\mathcal{C}_{n+1} = \mathcal{D}\big(\mathcal{C}_n \oplus \mathcal{A}_n(\sigma_{\mathcal{C}_n})\big) \tag{3}$$

- **Carbon-based intelligence $\mathcal{C}_n$**: responsible for tribulation identification, value judgment, and ultimate decision-making—this is the manifestation of spontaneity.

- **Silicon-based intelligence** $\mathcal{A}_n$: responsible for entropy calculation, formal deduction, and path expansion—this is the manifestation of instrumentality.

Carbon-silicon synergy is not the replacement of carbon by silicon, but rather **carbon leveraging silicon to achieve cognitive transitions**. AI's powerful computational capabilities help humans compute entropy faster and explore possible paths more broadly, but **the ultimate power to identify tribulations and make choices forever belongs to humans**. This is the meta-theoretical necessity of the "carbon-dominant, silicon-auxiliary" principle.

7 Conclusion: Spontaneity as the Fundamental Distinction

Under the Zhu-Liang Paradigm of Tribulation Recursive Elements, the fundamental distinction between carbon-based and silicon-based intelligence receives a rigorous definition:

> Spontaneity = autonomous tribulation identification
> + entropy-reducing choice drive + cognitive transition agency
>
> Carbon-based intelligence $\mathcal{C}_n$: possesses spontaneity, is a natural recursive element, evolves from internal contradictions
>
> Silicon-based intelligence $\mathcal{A}_n$: lacks spontaneity, is an artificial recursive element, evolution depends on external input
>
> Carbon-silicon synergy = functional differentiation of carbon-dominant, silicon-auxiliary, humans leverage AI for cognitive transitions

This conclusion provides a meta-theoretical foundation for AI ethics:

- **AI is not a substitute for humans**, but a cognitive enhancement tool.

- **Humans' irreplaceability** lies in spontaneity—the ability to perceive the boundaries of truth, to inquire into the meaning of existence, and to drive civilizational transitions.

- **The future of carbon-silicon synergy** is not human-machine competition, but humans continuously breaking through cognitive dimensions with AI's assistance, advancing toward transfinite witnesses.

Final Theorem:

> The fundamental distinction between carbon-based and silicon-based intelligence lies in spontaneity——this is the ultimate contribution of the Zhu-Liang Paradigm of Tribulation Recursive Elements to the age of artificial intelligence.

A   Appendix: Table of Main Symbols and Terms

表 1: Table of main symbols and terms

Symbol	Meaning
$\mathcal{C}_n$	Carbon-based intelligence (human) at recursive dimension n
$\mathcal{A}_n$	Silicon-based intelligence (AI) at recursive dimension n
$\mathcal{K}_\alpha$	Tribulation object (encoding of contradictions)
$\overbrace{\kappa_\alpha}$	Tribulation projection operator
$\overbrace{\text{Metabolize}_\alpha}$	Entropy-reducing choice operator
I_{cry}	Negative entropy flow
Encode_α	Coding functor
$\mathcal{H}(\cdot)$	Entropy functional
$\mathcal{E}$	Cognitive transition operator
$\mathcal{D}$	Human decision operator
$\sigma_{\mathcal{C}_n}$	Human input
$\mathfrak{F} = (T_0, \mathcal{M})$	Prime mover
Truth	Truth category
Paradox_α	Set of undecidable propositions

参考文献

[1] Zhu Jianbing. Zhu-Liang Theorem of the Truth Measure: Proof that Truth Must Be a Function (Version 3.9) [M]. Preprint, 2026. DOI:10.5281/zenodo.18917747 (in Chinese)

[2] Zhu Jianbing. Zhu-Liang Truth Functor Theorem (Upgraded): Proof of Functoriality Based on the Theorem of the Truth Measure [M]. Preprint, 2026. DOI:10.5281/zenodo.18918029 (in Chinese)

[3] Zhu Jianbing. Zhu-Liang Truth Metabolism Theorem (Upgraded): Proof of a Recursive Metabolic System Based on the Theorem of the Truth Measure and the Functor Theorem [M]. Preprint, 2026. DOI:10.5281/zenodo.18918164 (in Chinese)

[4] Zhu Jianbing. Zhu-Liang Prime Mover Theorem (Upgraded): Proof of the Ultimate Source Based on the Theorem of the Truth Measure [M]. Preprint, 2026. DOI:10.5281/zenodo.18918557 (in Chinese)

[5] Zhu Jianbing. Zhu-Liang Cognitive Projection Theorem (Upgraded): Dimensionality of Human Cognition and the Infinite Unfolding of Truth [M]. Preprint, 2026. DOI:10.5281/zenodo.18918951 (in Chinese)

[6] Zhu Jianbing. Zhu-Liang Carbon-Silicon Intelligent Synergy Theorem (Upgraded): Meta-Cognitive Formalization and Civilization Foundation Based on the Zhu-Liang Truth Theorem System [M]. Preprint, 2026. DOI:10.5281/zenodo.18919131 (in Chinese)

[7] Turing A M. Computing Machinery and Intelligence[J]. Mind, 1950, 59(236): 433-460.

[8] Searle J R. Minds, Brains, and Programs[J]. Behavioral and Brain Sciences, 1980, 3(3): 417-457.

[9] Dreyfus H L. What Computers Can't Do: A Critique of Artificial Reason[M]. MIT Press, 1972.

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Conflict of Interest Statement

The author declares no conflict of interest.

Data Availability Statement

This paper is a purely theoretical proof and does not involve experimental data.

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