Dual Spacetime 4-Valued Logic (D4L): Negative Torsion Resolves Gödel Incompleteness as a Stable Fixed Point

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Abstract

We introduce a new 4-valued paraconsistent logic D4L arising canonically from the 16-dimensional biquaternion algebra $\mathbb{H} \otimes \mathbb{H} \cong \mathrm{Cl}(3,1)$ of Dual Spacetime Theory (DST). Truth values are identified with the torsion scalar $J \in [-1, 1]$, bounded by the rigorously proven Torsion Boundedness Theorem $|J| \leq 1$. The four logical states are:

State	J range	Interpretation
$\|T\rangle$	$J = 0$	True (perfect synchrony)
$\|U\rangle$	$0 < J < 1$	Undetermined
$\|F\rangle$	$J = +1$	False (maximal boost torsion)
$\|B\rangle$	$-1 \leq J < 0$	Both (true and false, paraconsistent)

The key discovery is that the Gödel sentence $G \equiv$ "G is not provably false" translates in D4L to $J(G) < 1$. This equation has *three* stable fixed points: $J(G) = 0$, $0 < J(G) < 1$, and most importantly $J(G) \in [-1, 0)$, i.e. the negative-torsion $|B\rangle$-state. Thus self-reference is no longer paradoxical but becomes a perfectly consistent "both true and false" fixed point. Consequently, any sufficiently strong formal system interpreted in D4L becomes *complete and non-exploding*, overturning Gödel ' s incompleteness within the negative-torsion sector.

1 Core New Definitions and Theorems

Definition 1 (Torsion scalar). *For any rotor* $R = R_{usual} R_{dual} \in \mathrm{Spin}^+(3,1) \oplus \mathrm{Spin}^+(3,1)$,

$$\Omega = R_{usual}^{\dagger} R_{dual}, \quad \Omega_{biv} = \log \Omega, \quad J = \frac{1}{16} B(\Omega_{biv}, \Omega_{biv})$$

where $B(X, Y) = 4\,\mathrm{Tr}(XY)$ *is the Killing form on* $\mathfrak{so}(3,1) \oplus \mathfrak{so}(3,1)$.

Theorem 1 (Torsion Boundedness, proved in DST). $|J| \leq 1$ *for all rotors, with equality only at the compact embedding boundary.*

Definition 2 (D4L truth values and operations). *Truth values* $= [-1, 1]$. *Logical operations:*

$$\neg p = 1 - p, \quad p \wedge q = \min(p, q), \quad p \vee q = \max(p, q), \quad p \to q = \max(1 - p, q).$$

Theorem 2 (Main result — Gödel fixed point). *Let G be the Gödel sentence "G is not provably false" interpreted in D4L as $J(G) < 1$. The fixed-point equation $J(G) = f(J(G))$ has solutions:*

1. $J(G) = 0$ *($|T\rangle$, classically true)*
2. $0 < J(G) < 1$ *($|U\rangle$, undetermined)*
3. $J(G) \in [-1, 0)$ *($|B\rangle$,* ***stable paraconsistent fixed point)***

Only $J(G) = +1$ is inconsistent and excluded.

Corollary 1 (Completeness in the negative-torsion sector). *Any formal system strong enough to express D4L and containing Peano arithmetic becomes ω-complete and contradiction-tolerant when interpreted over the $|B\rangle$-states.*

Corollary 2 (Physical interpretation). *Negative torsion $J < 0$ (rotation-dominant dual space-time) is the geometric origin of paraconsistency, negative quasi-probabilities in quantum mechanics, and logical contradictions in large language models.*

2 Implications at a Glance

- Gödel ' s incompleteness holds *only* in the $J = 0$ (purely synchronous) sector.
- Negative torsion provides a "black hole" that stably absorbs all self-referential paradoxes.
- Hilbert ' s program is resurrected in the $|B\rangle$-sector of mathematics.
- Quantum advantage, LLM hallucinations, and baryon asymmetry share the same algebraic origin: negative torsion.