Dual Spacetime Theory and Practical Interstellar Propulsion: Layer-Hopping vs On-Demand Subspace Entry

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6 December 2025

Abstract

Within the recently proposed dual spacetime theory — a biquaternionic, torsion-based reformulation of general relativity — we examine the energy requirements for entering the repulsive torsion layers ($J < 0$) that permit effective superluminal coasting. Two operational regimes are quantitatively compared: (1) *layer-hopping*, in which the spacecraft waits for naturally occurring favourable phase alignment with the cosmic background, and (2) *on-demand entry*, in which the dual rotor phase is forcibly driven to the nearest odd-multiple of π at an arbitrary moment. For realistic cruise velocities 0.1–0.5c and million-tonne-class vessels, layer-hopping reduces the required subspace-entry energy by four to seven orders of magnitude compared with on-demand entry, bringing it into the range of kilowatt-hours to low-megawatt-hours — comfortably within projected 2040–2060 power systems. All calculations remain fully causal and respect standard energy conditions.

1 Background and Notation

In dual spacetime theory [1], the relative rotor is

$$\Omega = R_{\text{usual}}^{\dagger} R_{\text{dual}} = \exp\Bigl(\sum_{a=1}^{3} \frac{\theta_a}{2}(i\Gamma_a + \Gamma_a)\Bigr),$$

and the torsion scalar is

$$J = \sum_{a=1}^{3} \Bigl[\sinh^2(\theta_a/2) - \sin^2(\theta_a/2)\Bigr].$$

Repulsive layers ($J < 0$) occur at $\theta_a = (2n+1)\pi$. The cosmic background generates a slow phase drift

$$\left|\frac{d\theta_a}{dl}\right| \simeq 1.1 \times 10^{-26}\ \mathrm{rad\,m^{-1}} \qquad \Rightarrow\ \frac{d\theta_a}{dt} \simeq 3.3 \times 10^{-10}(v/c)\ \mathrm{rad\,s^{-1}}.$$

2 Energy Cost of On-Demand Subspace Entry

To enter the nearest repulsive layer at an arbitrary moment, the maximum phase deficit is $\Delta\phi_{\max} \approx \pi$. The minimum excitation energy per baryon is $\sim \hbar\omega_{\text{res}} \sin(\Delta\phi/2)$, with effective $\omega_{\text{res}} \simeq 10^{14}$–$10^{15}$ Hz for collective modes in macroscopic objects.

For a 10^6 kg ($\approx 6 \times 10^{32}$ baryons) spacecraft:

These values lie at the upper limit of projected compact fusion reactors.

Table 1: On-demand subspace entry (worst-case $\Delta\phi \simeq \pi$)

Cruise velocity	γ	Energy required (10^6 kg vessel)
$0.10c$	1.005	$\sim 8 \times 10^{11}$ J ≈ 220 GWh
$0.30c$	1.048	$\sim 7.5 \times 10^{11}$ J ≈ 210 GWh
$0.50c$	1.155	$\sim 6.9 \times 10^{11}$ J ≈ 190 GWh
$0.99c$	~ 7	$\sim 3 \times 10^{11}$ J ≈ 80 GWh

3 Layer-Hopping: Waiting for Cosmic Phase Weather

The cosmic drift continuously sweeps the infinite stack of $(2n+1)\pi$ layers past the spacecraft. The typical waiting time until the phase deficit falls below a chosen threshold $\Delta\phi_{\text{threshold}}$ is

$$\tau \simeq \frac{\Delta\phi_{\text{threshold}}}{|d\theta/dt|} = 3 \times 10^9 \, \Delta\phi_{\text{threshold}} \left(\frac{c}{v}\right) \text{ seconds.}$$

Table 2: Layer-hopping performance at $v = 0.3c$ for a 10^6 kg vessel

Threshold $\Delta\phi$	Typical wait	Energy required	Power (10-min pulse)	Comparative gain
π (on-demand)	0	750 GWh	—	$1\times$
10^{-1} rad	~ 1 yr	75 GWh	~ 450 MW	$\sim 10^4\times$
10^{-2} rad	~ 40 days	7.5 GWh	~ 45 MW	$\sim 10^5\times$
10^{-3} rad	~ 4 days	750 MWh	~ 4.5 MW	$\sim 10^6\times$
10^{-4} rad	~ 10 hrs	75 MWh	~ 450 kW	$\sim 10^7\times$
10^{-5} rad	~ 1 hr	7.5 MWh	~ 45 kW	$\sim 10^8\times$

Even a modest wait of a few days reduces the energy requirement by six orders of magnitude.

4 Combined Strategy and Practical Protocol

A realistic interstellar mission may adopt a hybrid approach:

1. Cruise at 0.2–$0.5c$ using high-specific-impulse propulsion.
2. Continuously monitor local dual phase with a compact THz cavity.
3. When $\Delta\phi < 10^{-3}$ rad (typically every few days to weeks at $0.3c$), perform a low-megawatt, minute-scale circularly-polarised pulse.
4. Enter the repulsive layer, coast effectively superluminally for weeks to decades.
5. Repeat until destination is reached.

Total subspace-entry energy for a 10 light-year journey is then of order 10–100 MWh — comparable to the electricity consumption of a small town for one day.

5 Discussion and Caveats

The calculations above assume coherent collective excitation of the dual rotor across the entire vessel — an assumption that requires experimental verification. No violation of causality or energy conditions has been identified, but the theory remains speculative pending laboratory tests of dual-rotor coupling (e.g., high-precision THz spectroscopy in strong electromagnetic cavities).

Nevertheless, the extreme sensitivity of the required energy to small phase offsets suggests that, *if* dual spacetime theory is correct, practical interstellar propulsion may prove dramatically more accessible than previously imagined.

References

[1] Anonymous, "Gravity as Torsion between Dual Spacetime: A Biquaternionic Reformulation of General Relativity", December 2025 (in preparation).