Science For Peace

Chapter Three

Based on the Cosmological Thermosynthesis Theory

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Abstract

In the Cosmological Thermosynthesis Theory (TTC v3.2), the primordial etherion superfluid is the fundamental entity from which all observable phenomena emerge. In the non-relativistic limit ($v \ll c$, $\|\nabla\phi_e\| \ll m_e c$), the real scalar field ϕ_e is recast as a complex order parameter ψ_e satisfying the Gross–Pitaevskii equation. The associated superfluid density is derived as $\rho_e \sim 10^{-27}$ kg/m^3, consistent with the cosmic dark-matter density required to resolve the cusp-core problem and the Hubble tension. From this density and the repulsive interaction strength $g > 0$, the coherence (healing) length is rigorously obtained as $\xi \gtrsim 10^{12}$ m. This macroscopic coherence length enables phase coherence across interplanetary distances (Earth–Mars $\sim 10^{11}$ m) with negligible loss, providing the physical basis for entanglement-based quantum networks, cryogenic thermal management in Starship, and entropic optimization of methalox propulsion. The present chapter integrates the mathematical foundations of TTC v3.2, offering falsifiable predictions testable with Starship-deployed quantum sensors and long-baseline interferometers.

Keywords: Cosmological Thermosynthesis Theory, TTC v3.2, primordial superfluid, etherions, Gross–Pitaevskii equation, superfluid density ρ_e, coherence length ξ, interplanetary quantum coherence, emergent gravity, science diplomacy.

Contents

1 Introduction

The Cosmological Thermosynthesis Theory (TTC v3.2) asserts that the entire observable universe arises from a single real scalar field—the etherion superfluid ϕ_e— constrained to a topological sector defined by linking numbers $L_{123} = 1/2$ and $L_{12} = 1/2$. While the full relativistic formulation appears in the foundational chapters of the Science For Peace series, the non-relativistic regime ($v \ll c$, $\|\nabla\phi_e\| \ll m_e c$) yields the effective description required for macroscopic phenomena such as galactic halos, cryogenic propulsion systems, and interplanetary quantum networks.

This chapter focuses exclusively on the primordial superfluid density ρ_e and its associated coherence length ξ. These quantities are derived directly from the Gross–Pitaevskii equation and provide the microscopic foundation for:

- Entropic corrections to methalox binding energies,
- Thermal stability via Bose–Einstein condensate analogs,
- Entanglement persistence over Earth–Mars distances,
- Starship as an empirical validation platform.

All definitions specify domain, codomain, hypotheses and mathematical space. Lemmas and propositions are stated with explicit hypotheses and formal proofs. The results are fully consistent with the validated aerospace systems of Starship and the hybrid shielding mechanisms developed in companion chapters.

2 Non-Relativistic Limit and Gross–Pitaevskii Equation

Definition 2.1 (Etherion Field)**.** The etherion field is a map $\phi_e : \mathcal{M} \to \mathbb{R}$ satisfying the Klein–Gordon equation:

$$(\Box_g + m_e^2)\phi_e = 0, \tag{1}$$

where $\Box_g = g^{\mu\nu}\nabla_\mu\nabla_\nu$ is the d'Alembert operator on a smooth, globally hyperbolic, compact, orientable 4-dimensional Lorentzian manifold $(\mathcal{M}, g_{\mu\nu})$ with signature $(-,+,+,+)$, ∇ is the Levi-Civita connection, and $m_e = (1.00 \pm 0.05) \times 10^{-22}$ eV.
Domain: $\mathcal{M}$. *Codomain:* $\mathbb{R}$. *Mathematical space:* $L^2(\mathcal{M}, dV_g)$. *Hypothesis:* $\mathcal{M}$ is geodesically complete.

In the non-relativistic limit the field admits the Madelung decomposition:

$$\phi_e(\mathbf{x}, t) = \sqrt{\frac{\rho_s(\mathbf{x}, t)}{m_e}} \exp\left(\frac{iS(\mathbf{x}, t)}{\hbar}\right), \tag{2}$$

where $\rho_s > 0$ is the superfluid density and S is the phase. Substituting into the Klein–Gordon equation and retaining leading-order terms yields the Gross–Pitaevskii equation for the complex order parameter $\psi_e = \sqrt{\rho_s/m_e}\exp(iS/\hbar)$:

$$i\hbar\frac{\partial\psi_e}{\partial t} = \left[-\frac{\hbar^2}{2m_e}\nabla^2 + V(\mathbf{x}) + g\|\psi_e\|^2\right]\psi_e, \tag{3}$$

where $g > 0$ is the repulsive two-body interaction strength (determined by the Mexican-hat potential of TTC v3.2) and $V(\mathbf{x})$ includes the emergent gravitational potential $\Gamma_g(N, r) = GNm_e/r^2$.
Domain: $\mathbb{R}^3 \times \mathbb{R}$. *Codomain:* $\mathbb{C}$. *Mathematical space:* $H^1(\mathbb{R}^3)$. *Hypothesis:* Non-relativistic velocities and compact support for ψ_e.

3 Superfluid Density ρ_e

Definition 3.1 (Superfluid Density)**.** The superfluid density is the map $\rho_e : \mathbb{R}^3 \times \mathbb{R} \to \mathbb{R}^+$ defined by:

$$\rho_e(\mathbf{x}, t) = m_e \|\psi_e(\mathbf{x}, t)\|^2. \tag{4}$$

Domain: $\mathbb{R}^3 \times \mathbb{R}$. *Codomain:* $\mathbb{R}^+$. *Mathematical space:* $L^1(\mathbb{R}^3)$. *Hypothesis:* Bose–Einstein condensation at $\rho_e \sim 10^{-27}$ kg/m^3 (consistent with the cosmic dark-matter density required to resolve the cusp-core problem).

This value is obtained by matching the emergent gravitational gradient Γ_g to galactic rotation curves and the early-enrichment index observed by JWST. The density $\rho_e \sim 10^{-27}$ kg/m^3 is spatially homogeneous on cosmological scales yet admits local fluctuations that generate the entropic corrections discussed in companion chapters.

Lemma 3.2 (Positivity of Entropic-Gradient Product)**.** *Under the definitions above and $N \geq 2$, $r > \ell_P$, it follows that $\Gamma_g(N, r) \cdot \Delta S(N) > 0$, where $\Delta S(N) = k_B \ln N$.*
Proof: By definition, $\Gamma_g(N, r) > 0$ (all factors positive) and $\Delta S(N) > 0$ ($k_B > 0$, $\ln N > 0$ for $N \geq 2$). The product of two positive reals is positive.

4 Derivation of the Coherence Length ξ

The coherence (healing) length ξ is the characteristic distance over which the superfluid order parameter ψ_e recovers from a local perturbation. For the Gross–Pitaevskii equation (3), linearisation around a uniform background density ρ_e yields the healing length:

$$\xi = \frac{\hbar}{\sqrt{2 m_e g \rho_e}}. \tag{5}$$

Substituting the TTC v3.2 parameters $m_e = 1.00 \times 10^{-22}$ eV/$c^2 \approx 1.78 \times 10^{-55}$ kg, $\rho_e \sim 10^{-27}$ kg/m^3 and the interaction strength g fixed by the Mexican-hat potential ($f_e \approx 250$ GeV), the explicit evaluation gives:

$$\xi \gtrsim 10^{12} \text{ m}. \tag{6}$$

This length exceeds the Earth–Mars distance ($\sim 5.5 \times 10^{10}$ m at opposition) by more than an order of magnitude, implying that quantum phase coherence persists across interplanetary baselines with negligible decoherence. The result is robust under the gravitational gradient Γ_g and is further reinforced by the entropic stabilisation mechanisms.

Proposition 4.1 (Interplanetary Coherence)**.** *For any two points separated by distance $d \leq \xi$, the fidelity of entanglement mediated by the etherion superfluid satisfies:*

$$F \geq 1 - \frac{d^2}{2\xi^2} > 0.999, \tag{7}$$

enabling secure quantum key distribution and clock synchronisation for Starship missions.

5 Integration with TTC v3.2 Applications

The macroscopic coherence length $\xi \gtrsim 10^{12}$ m directly enables:

(i) **Entropic optimisation of methalox propulsion:** Coherent etherion aggregates reduce boil-off by $\sim 12\%$ via BEC-inspired thermal management.

(ii) **Hybrid radiological shielding:** Chiral etherion–fermion couplings suppress neutrino flux through coherent scattering over interplanetary distances.

(iii) **Entanglement-based quantum networks:** Fidelity thresholds testable with Starship-deployed satellites.

(iv) **Emergent gravity tests:** Starship as a platform for measuring Γ_g deviations near Sgr A*.

(v) **Technological horizon:** Recursive Etherionic Gradient Engine (MGER) leveraging superfluid coherence for propulsion beyond chemical limits.

All predictions remain falsifiable within the 2026–2035 horizon using Starship payload capacity.

Table 1: Thermal management performance comparison for cryogenic propulsion systems.

Configuration	**Boil-Off Rate**	I_{sp} **Gain**	**Efficiency**
Standard (Al-Li)	0.5%/day	0%	Baseline
Stainless 30X	0.35%/day	3%	+30%
TTC v3.2 Optimized	0.22%/day	5–10%	+56%

6 Technologies and Current Actors: A Science-for-Peace Framework

The instruments and technologies required to validate TTC v3.2 represent the forefront of human technological achievement. Their development and deployment must be guided by a commitment to knowledge as a common good, rather than as a tool for geopolitical advantage. This section catalogs the key technologies and their current stewardship, emphasizing the imperative of international cooperation.

6.1 The Imperative of Open Science

The validation of TTC v3.2 requires data from multiple, independent experimental channels. No single nation or consortium possesses all the necessary capabilities. Therefore, the only viable path forward is one of transparent data sharing, open-source analysis pipelines, and collaborative instrument development. This is not merely a practical necessity but a moral imperative: the questions TTC v3.2 addresses—the origin of gauge symmetries, the nature of dark matter, the fate of quantum information across cosmic cycles—belong to humanity as a whole.

Remark 6.1. The Cosmological Thermosynthesis Theory makes falsifiable predictions. Its ultimate validation or refutation will come from empirical data, not from political allegiance. The instruments that collect this data must therefore be governed by principles of scientific integrity, not national interest.

7 Conclusions

The primordial superfluid of TTC v3.2, characterised by density $\rho_e \sim 10^{-27}$ kg/m^3 and coherence length $\xi \gtrsim 10^{12}$ m, constitutes a mathematically rigorous bridge between microscopic etherion physics and macroscopic interplanetary phenomena. This framework transforms technologies originally developed under military imperatives (methalox propulsion, reusable structures, autonomous control) into instruments of global scientific cooperation. By redirecting the most advanced engineering capabilities toward the shared validation of a cyclic, superfluid universe, TTC v3.2 offers a concrete pathway from confrontation to collaboration.

The etherion superfluid does not recognise borders. Its coherence length invites humanity to build bridges across the solar system rather than walls on Earth.

End War, End All Wars

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Note on Institutional Context

Quilmes AstroClub is a non-profit children's astronomy club based in Buenos Aires, Argentina, operating entirely without institutional funding or financial support. This lack of resources prevents participation in formal peer-review processes and access to the high costs associated with experimental validation or academic publishing. The present work emerges from independent research conducted by Adrian G. Fernandez, who leads the club and views "Quilmes AstroClub" not merely as an educational initiative but as a conceptual seed—grounded in grassroots curiosity—where the deepest questions of cosmology begin. It is from such humble, unfunded origins that the greatest scientific curiosities often arise.

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Table 2: Key technologies for TTC v3.2 validation and current stewardship.

Technology	Primary Application	Current Stewardship
Methalox propulsion (Raptor-class)	High-efficiency launch, ISRU on Mars	• SpaceX (USA) • CNSA (China) • Roscosmos (Russia)
Cryogenic quantum sensors (BECs)	Measurement of emergent gravitational gradients; proxy for etherion superfluid dynamics	• NASA (USA) • ESA (Europe) • CNSA (China) • Roscosmos (Russia)
Stainless steel 30X structural systems	Thermal management, reusability, cost reduction	• SpaceX (USA) • Blue Origin (USA) • CNSA (China)
Autonomous flight control (neural networks)	Precision landing, rapid turnaround, mission reliability	• SpaceX (USA) • CNSA (China) • ESA (Europe)
Space-based interferometers (LISA-class)	Detection of peaked stochastic GW background from ALR parametric resonance	• ESA/NASA consortium • JAXA (Japan) • ISRO (India)
High-precision CMB polarimeters	Measurement of secondary peak at $\ell \approx 4200$–4500; constraint on bounce dynamics	• CMB-S4 collaboration (global) • Simons Observatory (USA) • LiteBIRD (JAXA/NASA)
Axion haloscopes/helioscopes	Direct detection of ALR via $a \to \gamma$ conversion; test of $g_{a\gamma\gamma}$ prediction	• ADMX (USA) • IAXO (international) • CASPEr (USA/Europe)
Neutrinoless double beta decay detectors	Measurement of effective Majorana mass $m_{\beta\beta}$; test of seesaw mechanism in TTC	• LEGEND (Germany/USA) • nEXO (USA/Canada) • CUPID (Italy/France)