

Apeiron Technical Appendix - Emergent Light Speed and Causality

Version: 1.0 **Date:** 20 September 2026 **Research-branch status:** FEASIBILITY_G0 **Micro-EFT status:** MICRO_CONE_PASS_AT_TREE_LEVEL **Open fundamental status:** FUNDAMENTAL_LORENTZ_ORIGIN_OPEN

1. Scientific endpoint

The supported publication statement is that Apeiron could be the deeper dynamical basis from which the observable universe phase acquires a single emergent relativistic causal structure with a universal finite limiting speed c . This is a feasibility result, not a proof of the complete microscopic theory.

The preferred interpretation is not classical refraction or ordinary photon slowing. Instead:

Apeiron dynamics -> self-organized universe phase -> one emergent effective geometry -> universal causal cone -> $c_\gamma = c_{e,\text{limit}} = c_g = c$.

2. Deeper development parameter

A deeper directed Apeiron development parameter may exist with positive orientation. It is not ordinary photon proper time. No separate universal c_A is required by the minimal model.

3. Universal effective geometry

A minimal viable structure uses one collective Apeiron geometric variable, schematically

$$A \rightarrow G_{\mu\nu}[A] \rightarrow \{\gamma, \text{fermions/matter, gravity}\}.$$

All observable sectors couple to one effective geometry. The deep reason for exactly one geometry remains an unresolved microscopic question.

4. Direct bridge to the existing micro-EFT

The tested internal sector contains σ , θ , and χ . At the static Frozen vacuum, $X_0 = 0$ for the θ $P(X)$ sector, so

$$P_X(X_0) = 1, \quad c_\theta^2 = \frac{P_X}{P_X + 2X P_{XX}} = 1.$$

For canonical σ and χ kinetic terms at the same background,

$$c_\sigma^2 = c_\chi^2 = 1.$$

Therefore

$$c_\sigma = c_\theta = c_\chi$$

at tree level around the tested static Frozen vacuum. This is classified as MICRO_CONE_PASS_AT_TREE_LEVEL.

5. Local response and transition consistency

A damped-hyperbolic/telegraph-type effective response supplies a feasibility witness for local finite reaction, causal propagation of disturbances, redistribution into internal modes, and robustness without instantaneous global reorganization. It is not claimed as the unique fundamental Apeiron equation.

A minimal description can pass continuously from deeper Apeiron development to the emergent spacetime cone and back through reconversion without requiring a causality gap.

6. Explicit non-claims

This appendix does not establish a full microscopic derivation of Lorentz symmetry, quantum gravity, first-principles mono-metricity, a solution of the cosmological-constant problem, a complete cosmological entropy solution, or the numerical SI value of c .

The principal remaining fundamental test is to derive, rather than assume at the EFT level, why deeper Apeiron dynamics produces exactly one universal Lorentzian effective geometry.