Foundations of Energy-Flow Cosmology (EFC): Regime Architecture and Methodological Principles of Entropy-Bounded Empiricism

Morten Magnusson
Energy-Flow Cosmology Initiative
ORCID: 0009-0002-4860-5095
Correspondence: `https://energyflow-cosmology.com`

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Abstract

Energy-Flow Cosmology (EFC) is a unified thermodynamic framework in which cosmic structure, dynamics, and time emerge from regulated energy flow and entropy gradients. This paper defines the canonical architecture, terminology, and methodological principles of EFC. Its purpose is not to introduce new empirical results, but to establish a stable reference that anchors the framework, delimits its core constructs, and provides an explicit attribution point for subsequent theoretical, empirical, and applied work making use of EFC-specific regime structure and concepts.

1 Purpose and Scope

This document serves as the canonical anchor for Energy-Flow Cosmology (EFC). Its objectives are:

- To formally define EFC as a named and delimited theoretical framework.
- To specify the canonical regime architecture governing physical and epistemic validity.
- To establish Entropy-Bounded Empiricism (EBE) as the methodological principle underlying EFC.
- To provide a single, stable attribution reference for all subsequent EFC-based work.

Stability Note: This canonical definition (v1.0) is version-locked. Subsequent evolution of the framework will be issued as incremented versions to ensure that citations to v1.0 remain functionally stable. No new empirical datasets or extended derivations are introduced in this paper.

2 Definition of Energy-Flow Cosmology (EFC)

Energy-Flow Cosmology (EFC) is a thermodynamic framework in which:

1. **Energy flow** is treated as the primary dynamical quantity.
2. **Entropy gradients** regulate stability, structure formation, and dynamical response.
3. **Emergence:** Gravitational, cosmological, and large-scale structural phenomena are emergent rather than fundamental.

4. **Regime-dependence:** Physical descriptions possess bounded domains of validity.

EFC does not assume the existence of dark matter, a fundamental cosmological constant, or the universal applicability of a single dynamical law across all scales and entropic states.

3 Canonical Regime Architecture

The defining structural feature of EFC is its explicit separation of validity regimes.

3.1 L-regimes (Structural / Dynamical Validity)

The L-regimes constitute a canonical classification of physical validity domains.

Regime	Designation	Physical Characteristic	Epistemic Status
L0	Linear / Equilibrium	Low entropy, high order, linear response.	Classical determinism
L1	Transitional	Onset of non-equilibrium, flux-dominated.	Modified dynamics req
L2	Non-linear / Structural	Strong entropy production, complex structure.	EFC regime (S1 / Indi
L3	Saturation / Breakdown	Maximal entropy, info. saturation.	Classical description in

Table 1: The L-regime classification of EFC.

3.2 S-regimes (Observational / Epistemic Validity)

EFC distinguishes observational regimes according to information fidelity:

- **S0:** Direct, high-fidelity observational inference.
- **S1:** Indirect, model-dependent inference constrained by entropy and information limits.

4 Entropy-Bounded Empiricism (EBE)

EBE is the methodological principle governing inference in EFC: *Empirical validity is bounded by entropy, scale, and information capacity.* Under EBE:

- No single model is assumed to be universally valid.
- Apparent tensions between datasets are interpreted as **regime mismatches**, not parameter failures.
- Model comparison is conditioned on regime consistency rather than global fit quality alone.

5 Canonical Terminology (Locked Constructs)

The following terms are defined constructs of the EFC framework. Use of these terms implies reference to this document: Energy-Flow Cosmology (EFC); Regime-dependent validity; L0–L3 regime architecture; S0–S1 observational regimes; Entropy-Bounded Empiricism (EBE); Regime gating; Entropy-regulated dynamics.

6 Relationship to Prior and Parallel Work

EFC intersects conceptually with modified gravity, entropic gravity, and ΛCDM. However, EFC is distinguished by its role as a **meta-framework**. It provides the selection criteria (gating) for the application of dynamical equations within their valid L-regimes.

7 Attribution Statement

The terminology, regime architecture, and methodological principles defined herein are proprietary constructs of the EFC framework. Subsequent works utilizing these conceptual gates are requested to cite this canonical reference: **Magnusson, M. (2026). Foundations of Energy-Flow Cosmology (EFC).**

8 Declarations

Conflict of Interest: The author declares no competing interests.
Data Availability: No new datasets were generated or analyzed.