

# Energy-Flow Cosmology (EFC)

Master Specification v1.0

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## Abstract

Energy-Flow Cosmology (EFC) treats the universe as a thermodynamic information system driven by gradients in energy flow and entropy. Instead of introducing invisible matter or energy components, EFC starts from energy distribution, entropy gradients and information capacity. The theory is organised into three tightly coupled base layers:

- EFC-S: structural and halo-level descriptions.
- EFC-D: energy-flow dynamics on top of these structures.
- EFC-C<sub>0</sub>: base mapping between entropy and information capacity.

This document fixes notation and baseline equations for these three layers, and provides a compact, mathematically explicit core that higher-level models, simulations and epistemic layers can reference without ambiguity. The figures included here are schematic and illustrate the theoretical structure rather than final data-calibrated fits.

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## 1 Frontmatter

This document is the canonical master specification for Energy-Flow Cosmology (EFC). It defines the formal structure and relations between:

- **EFC-S**: structural and halo-level descriptions,
- **EFC-D**: energy-flow dynamics on top of these structures,
- **EFC-C<sub>0</sub>**: base mapping between entropy and information capacity.

The goal is a compact, mathematically explicit core that higher-level models, simulations and epistemic layers can reference without ambiguity.

## 2 Overview

EFC treats the universe as a thermodynamic information system driven by gradients in energy flow and entropy. Instead of adding invisible components, the model starts from:

- energy distribution,
- entropy gradients,
- information capacity.

The three base layers are:

- **EFC-S** defines how low-entropy matter distributions organise into halo-like structures;
- **EFC-D** defines how local energy-flow potentials and their gradients shape dynamics;
- **EFC-C<sub>0</sub>** defines how entropy and structure map to information capacity and cognitive potential.

A central object is the local energy-flow potential

$$E_f(\mathbf{x}) = \rho(\mathbf{x})(1 - S(\mathbf{x})), \quad (1)$$

which couples density and entropy into a single field.

## 3 Illustrative Field and Profiles

### 3.1 Energy-flow potential field $E_f(\rho, S)$

Figure 1 shows a schematic map of the energy-flow potential  $E_f(\rho, S) = \rho(1 - S)$  over the  $(\rho, S)$  plane.

### 3.2 Halo profiles: mass and entropy

### 3.3 Rotation curves and projected density

### 3.4 Expansion history and information capacity

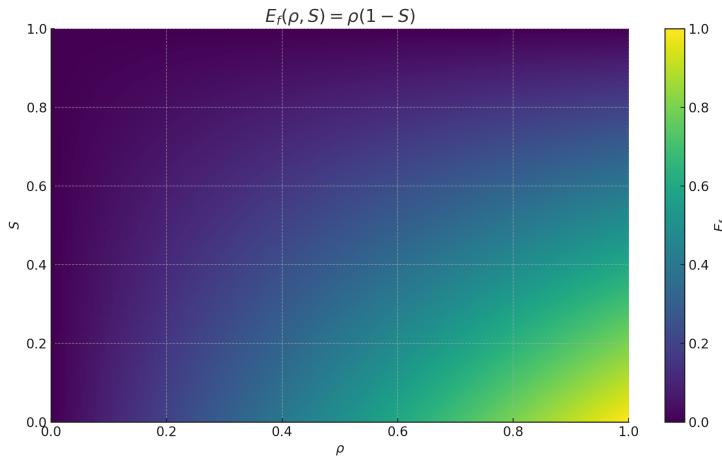


Figure 1: Schematic heatmap of the energy-flow potential  $E_f(\rho, S) = \rho(1 - S)$ .

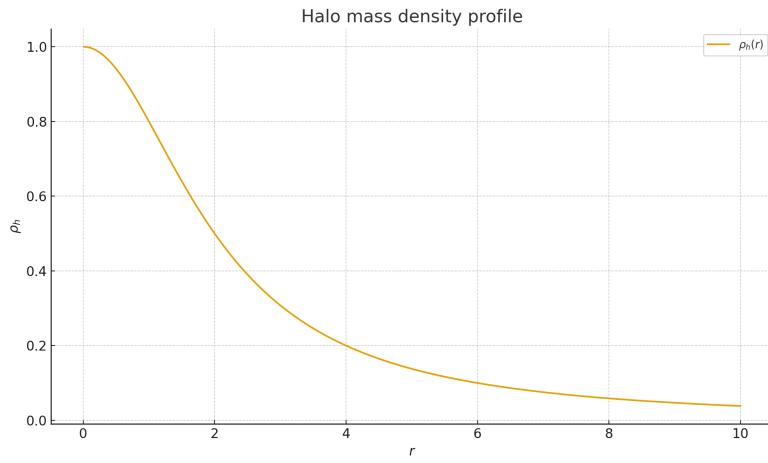


Figure 2: Schematic halo mass density profile  $\rho_h(r)$ .

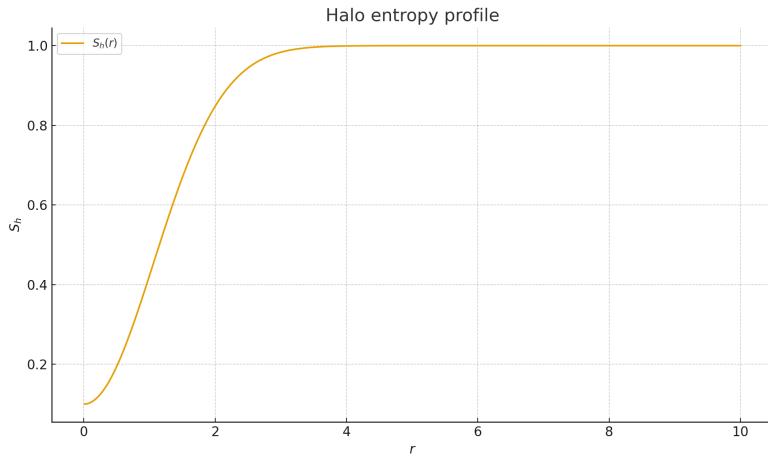


Figure 3: Schematic halo entropy profile  $S_h(r)$ .

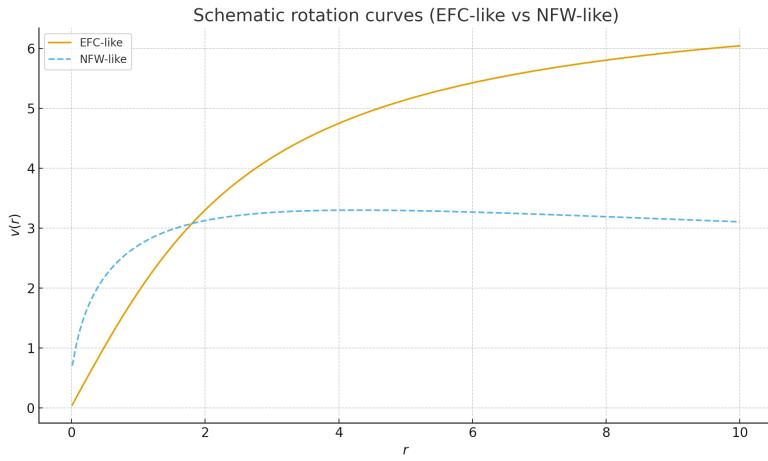


Figure 4: Schematic rotation curves: EFC-like vs NFW-like.

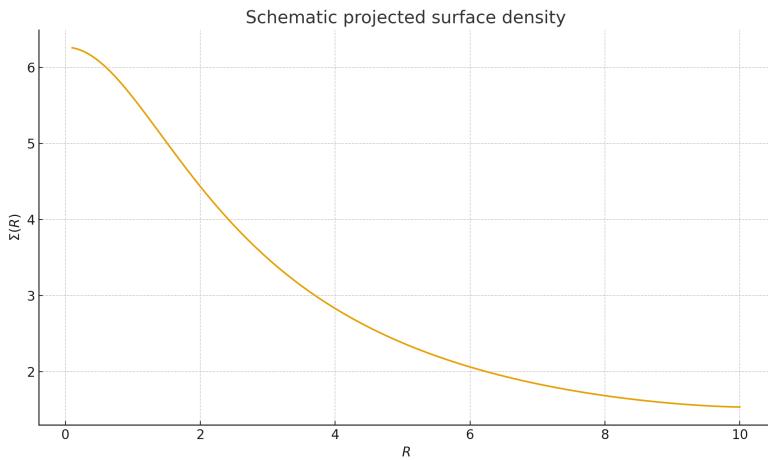


Figure 5: Schematic projected surface density  $\Sigma(R)$ .

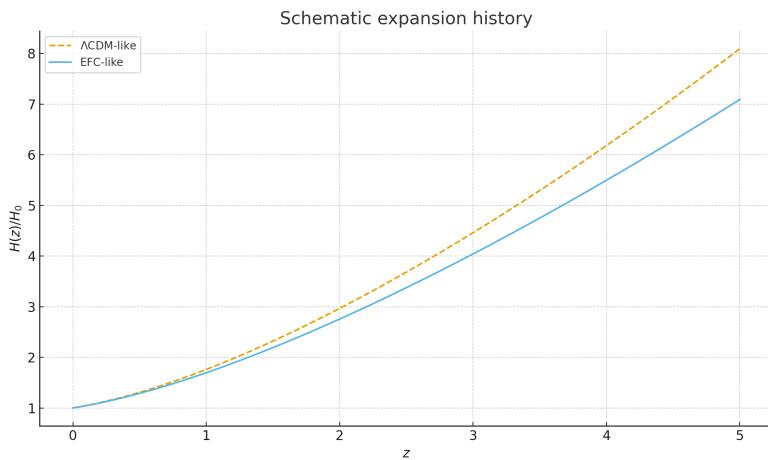


Figure 6: Schematic expansion history  $H(z)/H_0$ .

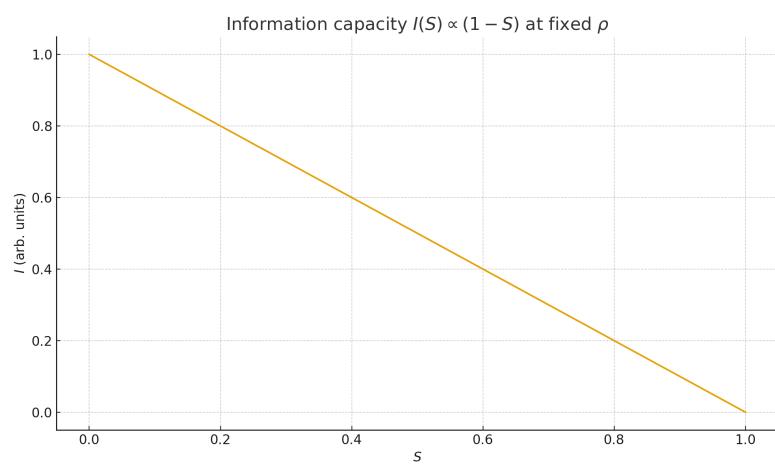


Figure 7: Information capacity  $I(S) \propto (1 - S)$  at fixed  $\rho$ .

## 4 Part I — EFC-S: Structure / Halo Layer

### 4.1 S0. Low-entropy anchors

Let  $s(\mathbf{x})$  denote the entropy density. A low-entropy anchor is a region  $\mathcal{A}$  such that

$$\langle s \rangle_{\mathcal{A}} \ll \langle s \rangle_{\text{background}}. \quad (2)$$

### 4.2 S1. Halo Model of Entropy

$$\rho_h(r), \quad S_h(r). \quad (3)$$

### 4.3 S2. Radial profiles

$$\rho_h(r) = \rho_0 f\left(\frac{r}{r_s}\right), \quad S_h(r) = S_0 + (1 - S_0)g\left(\frac{r}{r_c}\right). \quad (4)$$

## 5 Part II — EFC-D: Energy-Flow Dynamics

### 5.1 D0. Local energy-flow potential

$$E_f = \rho(1 - S). \quad (5)$$

### 5.2 D1. Rate

$$\frac{dE_f}{dt} = (1 - S)\frac{d\rho}{dt} - \rho\frac{dS}{dt}. \quad (6)$$

### 5.3 D2. Gradient

$$\nabla E_f = (1 - S)\nabla\rho - \rho\nabla S. \quad (7)$$

$$\mathbf{a} \propto -\nabla E_f. \quad (8)$$

## 6 Part III — EFC-C<sub>0</sub>

### 6.1 C0. Information capacity

$$I \propto \rho(1 - S). \quad (9)$$

### 6.2 C1. Load

$$I_{\text{tot}} = \int_{\mathcal{R}} I(\mathbf{x}) dV, \quad L = \frac{I_{\text{used}}}{I_{\text{tot}}}. \quad (10)$$

### 6.3 C2. Coupling

$$\frac{dI}{dt} = \alpha \frac{dE_f}{dt} - \beta D_I. \quad (11)$$

## How to Cite

This document is the formal master specification for the Energy-Flow Cosmology (EFC) framework.

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## 7 References

This specification may be supplemented with external references in future versions.