

# Variable Effective Light Speed in Entropic Transition States:

## A Formal Treatment of the $s_0$ / $s_1$ Structure in Energy-Flow Cosmology (EFC)

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### Abstract

In Energy-Flow Cosmology (EFC), the effective speed of light is not a primitive constant but an emergent propagation limit determined by the entropic state of the grid. Two fundamental entropic phases—a low-entropy constraining state ( $s_0$ ) and a high-entropy dissipative state ( $s_1$ )—govern the information capacity, local curvature, and energy-flow geometry. This paper provides a formal description of variable light speed as a function of the entropic gradient, derives a minimal model for  $c_{\text{eff}}(S)$ , and introduces the collapse mechanisms at both ends of the spectrum that shape observational horizons and redshift behaviour.

## 1 Introduction

Energy-Flow Cosmology (EFC) describes spacetime as a coupled energy–entropy–information grid. Geometry is not fundamental: curvature and signal propagation emerge from the dynamic flow of energy and the distribution of entropy across the grid.

Instead of treating the speed of light as an axiom, we view the *effective* speed of light  $c_{\text{eff}}$  as the maximum information-propagation rate in a local entropic context. The structure is dominated by two coarse-grained states:

- $s_0$ : a low-entropy, low-information, near-rigid state;
- $s_1$ : a high-entropy, high-information, turbulent state.

## 2 The $s_0$ State: Low-Entropy Rigidity

The  $s_0$  state is defined by:

- minimal entropy production,
- weak or nearly uniform energy-flow fields,
- few active degrees of freedom,
- low curvature and near-rigid grid behaviour.

Near the  $s_0$  limit, the grid becomes too constrained. Propagation encounters *structural rigidity*, where local adjustments are suppressed. As the system approaches the  $s_0$ -collapse threshold, accumulated tension is released in a coherence “pop” event. Just before collapse,  $c_{\text{eff}}$  increases sharply due to a transient drop in entropic drag.

### 3 The $s_1$ State: High-Entropy Dissipation

The  $s_1$  state exhibits:

- high entropy and strong entropy production,
- high information density,
- turbulent and structured energy flows,
- enhanced curvature and deformation.

Near the  $s_1$  extreme, propagation loses coherence. Excessive fluctuations obstruct signal propagation; entropic drag dominates and  $c_{\text{eff}}$  falls toward zero. Collapse occurs when coherent information channels fail.

### 4 A Bell-Shaped Model for $c_{\text{eff}}(S)$

Let  $S$  represent the local entropic state. The effective speed of light reaches a maximum at an intermediate optimal value  $S_*$  where the grid balances flexibility and stability.

A minimal symmetric model is:

$$c_{\text{eff}}(S) = c_0 \exp[-\alpha(S - S_*)^2], \quad (1)$$

where  $c_0$  is the maximum propagation speed and  $\alpha$  sets the width.



Figure 1: Bell-shaped model for the effective propagation speed  $c_{\text{eff}}$  as a function of the entropic state  $S$ . The grid transitions from rigid ( $s_0$ ) to optimal flexibility ( $S_*$ ) and then to dissipative ( $s_1$ ).

## 5 Collapse Dynamics

### 5.1 $s_0$ -Collapse

Low entropy produces rigidity. Stress accumulates until the grid can no longer maintain coherence; collapse releases this in a high-coherence spike with a temporary rise in  $c_{\text{eff}}$ .

## 5.2 $s_1$ -Collapse

High entropy destroys coherence. Excessive microscopic variation blocks propagation. As  $c_{\text{eff}} \rightarrow 0$ , the grid loses the capacity to transmit information. This forms a natural observational boundary.

## 6 Redshift as an Entropic Integral

For a photon:

$$E_\gamma = h\nu, \quad \nu = \frac{c_{\text{eff}}}{\lambda}.$$

As  $c_{\text{eff}}$  decreases in  $s_1$ -dominated regions:

- $\nu$  decreases,
- $E_\gamma$  decreases,
- the photon is redshifted.

The general form is:

$$z = \int_\gamma g(S(x), \nabla S(x), c_{\text{eff}}(S)) ds, \quad (2)$$

where  $\gamma$  is the photon path and  $g$  encodes local entropic drag.

This explains:

- extreme high- $z$  galaxies (low  $c_{\text{eff}}$  regions),
- the CMB as an  $s_1$ -collapse boundary,
- observational limits without invoking metric expansion.

## 7 Cosmological Implications

- coherent explanation of high redshift without accelerated expansion,
- anisotropies tied to entropy structure,
- modified lensing time delays,
- early galaxy formation via  $S$ -gradient effects,
- natural horizon from  $s_1$ -collapse.

## 8 Conclusion

In EFC, the speed of light is an emergent, entropic quantity. The  $s_0/s_1$  framework provides a minimal description of how information propagates and why observational boundaries arise. This model replaces a rigid constant  $c$  with a state-dependent limit tied directly to energy flow and entropy.