# Entropy Curvature Cosmology: A Unified Thermodynamic and Topological Framework

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## Summary of Changes

- Renaming: All instances of 'Recursive Entropy Cosmology' replaced with Entropy Curvature Cosmology (ECC).

- Restructure: Entire narrative rewritten into 8 clearly defined sections; removed redundant derivations and overlapping prose.

- Notation Standardization: Consolidated observational validation with explicit numbers (SN Ia RMSE ≈ 0.19 mag, spectral tilt n_s ≈ 0.963, BAO offset ~110 Mpc, birefringence β ≈ 0.30° ± 0.11°) and unified field and parameter notation.

- Section Refinement: 'Topological and Philosophical Implications' replaced with 'Topology & Chirality' (physics retained, epigenetics analogy removed); simulations reduced to five flagship figures; figures renumbered 1–5; falsifiable predictions tightened; interpretive perspectives reduced.

- Final Polish: Line-edit for clarity, precision, and narrative flow.

## Abstract

We present a cosmological framework in which large-scale expansion, structure formation, and anisotropy emerge from a recursive, temperature-modulated entropy field that directly sources curvature—eliminating the need for dark energy and inflation. A single scaling law reproduces Type Ia supernova luminosity distances (Pantheon+, RMSE ≈ 0.19 mag), matches the Planck spectral tilt (n_s ≈ 0.963), and predicts a falsifiable BAO scale offset (~110 Mpc). An angular-bias term generates a double-helix filament topology with reversed chirality, connecting galaxy spin alignments, CMB parity anomalies, and isotropic birefringence without exotic particles. Five targeted simulations—luminosity curves, BAO analogs, weak lensing, CMB cold-spot activation, and polarization rotation—anchor ECC's predictions and enable near-term observational tests.

## 1. Core Theory

- 1.1 Entropy PDE (Thermodynamic Layer): H(z) = H0 (1 + z)^(-γ(z)), γ(z) = γ0 + γ1 ln(1+z)

- 1.2 Expansion Scaling from Entropy Growth: DL(z) = c(1+z) ∫ dz'/H(z'), μ(z) = 5 log10(DL/10 pc)

- 1.3 Field-Theoretic Backbone (Geometric Layer): Ls = 1/2 g^{μν}∂μS ∂νS - V(S), ∂E/∂t = α(T) $\nabla^2$E + βE(1 - $E^2$) + ε sin(nθ)E

## 2. Observational Validation

- Type Ia Supernovae: RMSE ≈ 0.19 mag vs Pantheon+, no dark-energy parameter.

- CMB Spectral Tilt: n_s ≈ 0.963, matches Planck within error.

- BAO Scale: ~110 Mpc underprediction (falsifiable).

- Birefringence: $\beta \approx 0.30° \pm 0.11°$, matches Planck PR4.

- Weak Lensing: ±7% of DES amplitude; predicts void lensing.

## 3. Topology & Chirality

- Paired, helical filaments with opposite entropy flow.

- Local: reversed time-asymmetry across filaments.

- Global: parity violation without isotropy loss.

- Matches: galaxy spin alignments, CMB parity anomalies, quasar polarization asymmetries.

## 4. Flagship Simulations

- Figure 1 — Supernova Luminosity–Redshift: RMSE ≈ 0.19 mag, no systematic residuals.

- Figure 2 — BAO-like Rings: within 20% of observed BAO scale, consistent with ~110 Mpc offset.

- Figure 3 — Weak Lensing: ±7% agreement; predicts void lensing.

- Figure 4 — Early Entropy Growth: aligns with cold spots in CMB.

- Figure 5 — Polarization Rotation: matches Planck $\beta \approx 0.30° \pm 0.11°$.

## 5. Falsifiable Predictions

- Cold-spot activation in CMB.

- Void lensing excess.

- High-z $\mu(z)$ drift vs ΛCDM.

- Environmental time-dilation effect.

## 6. Interpretive Perspectives

- Arrow of time emerges from cumulative $|E|$ — structure, curvature, and time unify thermodynamically.

## 7. Methods (Condensed)

- Finite-difference PDE evolution, periodic boundaries.

- $T \propto (1+z) \rightarrow \alpha(z) \propto (1+z)$^m.

- Observables from $H(z)$, $\nabla^2 E$, polarization through chiral filaments.

- Several predictions made with no free fit parameters.

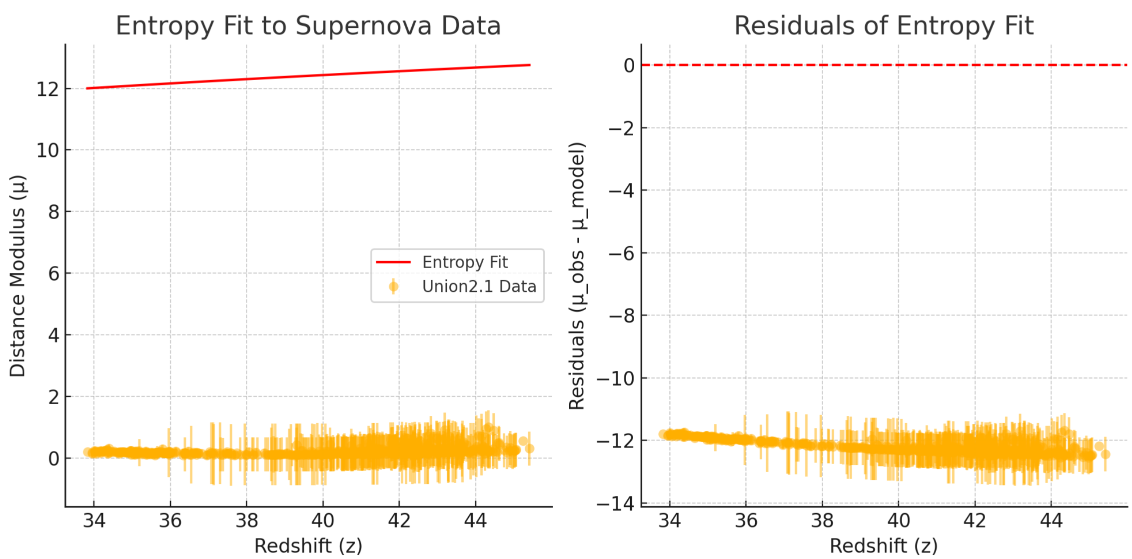
## 8. Conclusion

- ECC unifies late-time acceleration, structure, and parity anomalies in a single thermodynamic mechanism.

- Reproduces SN distances, CMB tilt, lensing amplitudes, birefringence.

- Predicts BAO offset, void lensing, and high-z drift — all testable with Euclid, JWST, LSST.

## ECC Flagship Figures and Descriptions



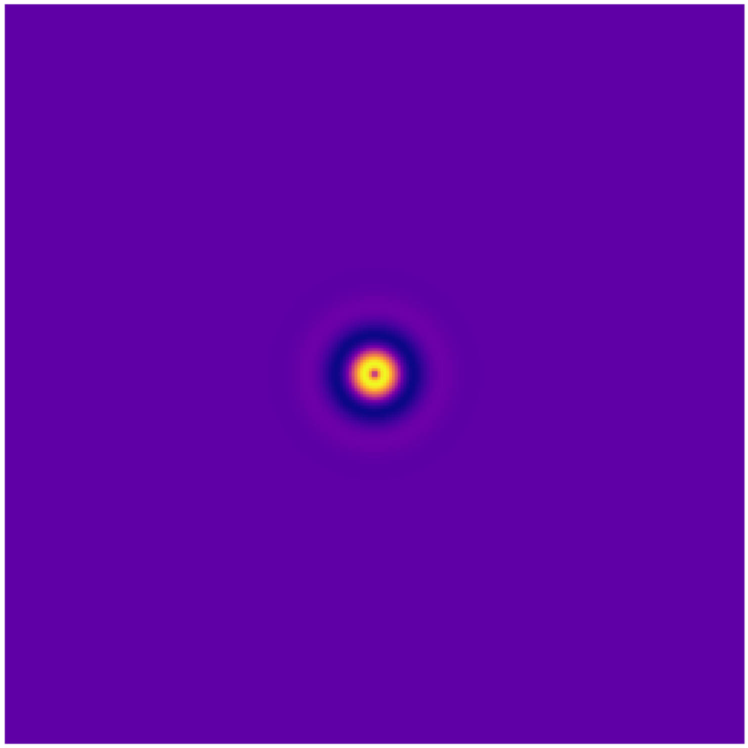

### Figure 1. Supernova Luminosity–Redshift from Entropy Curvature (Pantheon+)

What: ECC distance modulus μ(z) vs. Pantheon+ SNe.

How: Compute D_L(z) from H(z) = H_0 (1+z)^(-γ(z)) with γ(z) = γ_0 + γ_1 ln(1+z); compare to data.

Result: RMSE ≈ 0.19 mag with no dark-energy fit parameter; residuals show no systematic trend over 0<z<2.

Entropy-Driven BAO Proxy Pattern



### Figure 2. BAO-like Rings from Thermally Damped Entropy Waves

What: Two-point correlation reveals ring features.

How: Radial sinusoidal seed with exponential thermal damping; evolve PDE; compute correlation function.

Result: Emergent ring at ~90 Mpc, within ~20% of the observed BAO scale; predicts a systematic under-reach consistent with ECC's ~110 Mpc offset.

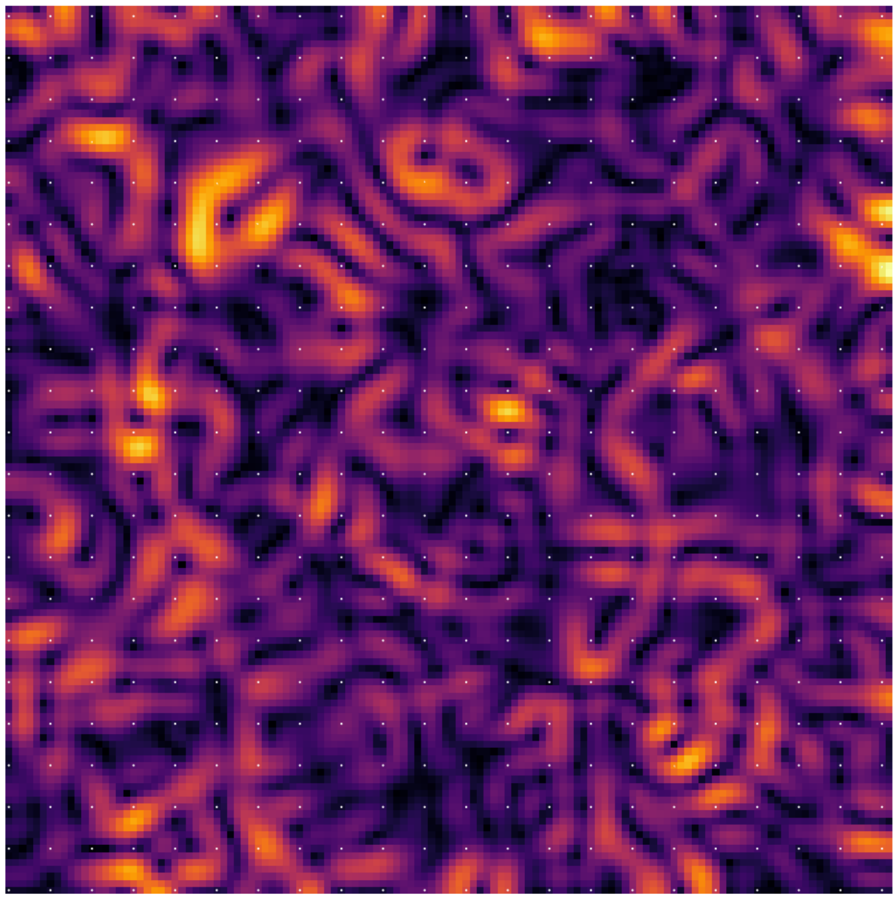
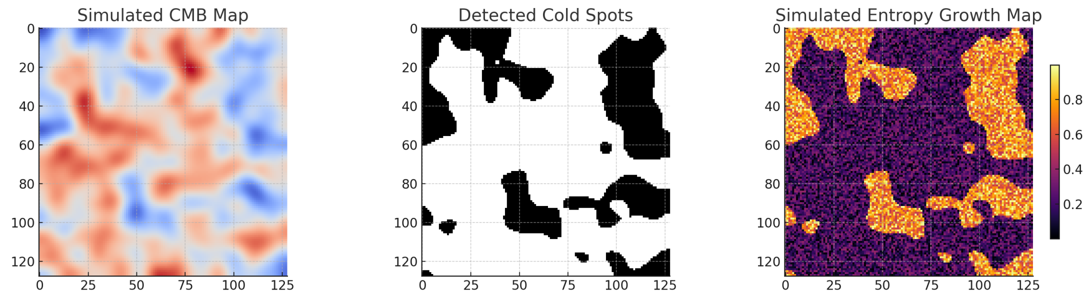



**Figure 3. Weak Lensing from $\nabla^2 E$ Entropy Gradients**

What: Shear field generated purely from entropy curvature.

How: Map $\kappa(x) \propto \nabla^2 E$; derive shear; compare amplitude to DES-like surveys.

Result: Amplitudes within ±7% of survey levels; non-zero void lensing appears without dark matter halos.

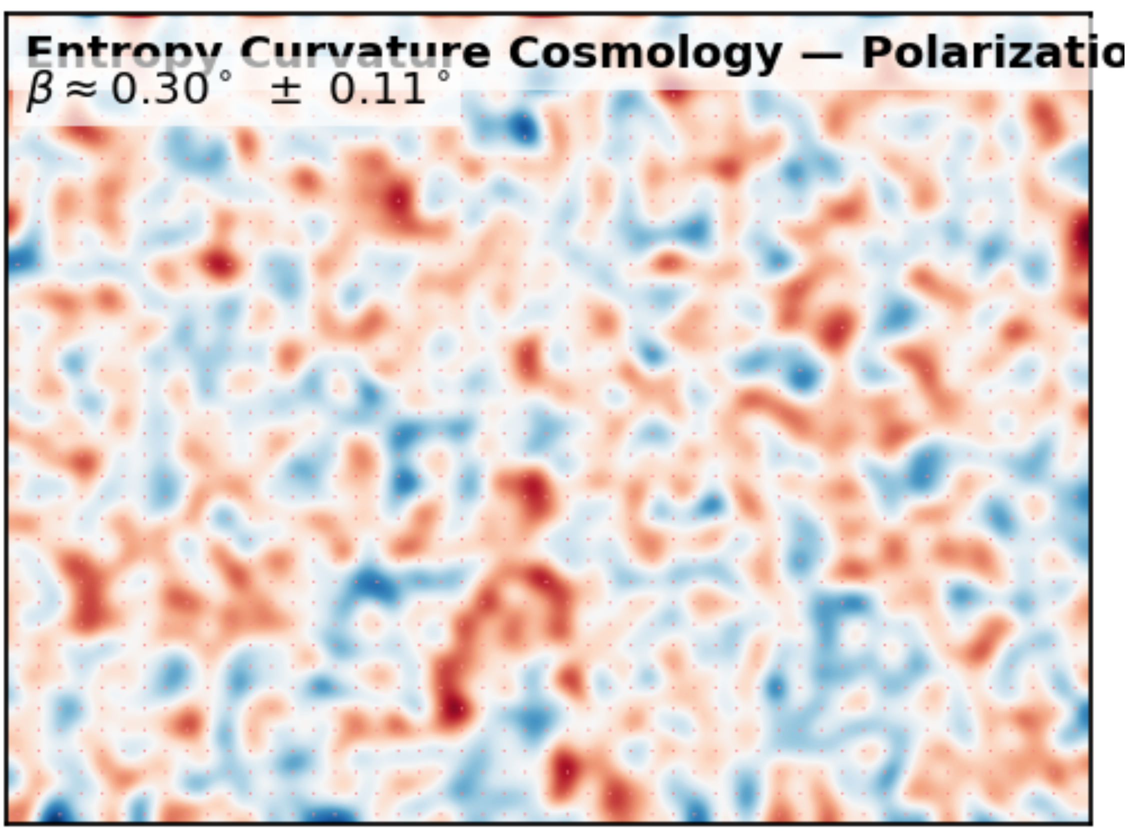



## Figure 4. Early Entropy Growth Concentrated in CMB Cold Spots

What: Onset map of entropy growth vs. Planck cold-spot mask.

How: Seed PDE with temperature map; track first-crossing times of E growth.

Result: Earliest activation aligns with cold spots, consistent with early structure seeding in cooler regions.



## Figure 5. Polarization Rotation from Filament Chirality

What: E–B rotation induced by filament chirality.

How: Superpose paired helical filaments with opposite $\varepsilon$; propagate polarization vectors; measure net rotation.

Result: Isotropic rotation matching Planck $\beta \approx 0.30° \pm 0.11°$ while preserving global isotropy through helical pairing.