

# Big Bang as Information Phase Transition: From Total Order to Spacetime

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## Executive Summary

This report synthesizes discussions from Paolo Pignatelli's research regarding the Big Bang as a transition from a state of total informational order (zero entropy) to the emergence of spacetime through symmetry breaking. The key insight is that the universe began not as maximal disorder but as perfect order—all possible information existing in an undifferentiated state—with the Big Bang representing the first distinction that broke this symmetry.

## 1 Key Concepts from Research Documents

### 1.1 The FL Field as Primordial State

From Chapter 1 and various documents: The FL Field (Fundamental Language Field) represents:

- “Undifferentiated information substrate (pure potential)”
- “The space of all potential informational configurations prior to observation”
- “Perfect symmetry implies no preferred configuration”
- “Zero entropy (perfect symmetry)”

From intro2.pdf:

“The transition from the primordial chaos of the Big Bang to the emergence of the first stable, distinguishable structures—the formation of elementary particles—represents the instantiation of the most basic symbolic elements, which we term level 0 symbols.”

Note the apparent paradox: “chaos” here means undifferentiated potential, not disorder.

## 1.2 The First Distinction

From multiple sources, the transition is described as:

$$\text{FL Field} \rightarrow \{T_1, T_0\} \quad (1)$$

Where:

- $T_1$  = presence/distinction/1
- $T_0$  = absence/background/0

From Nibbler1.pdf:

“FL Field as Substrate (*I*): The universe exists as an FL Field, an undifferentiated information substrate (pure potential, ‘Chaos=Energy’).”

## 1.3 Total Order vs. Chaos

From FL\_Field\_MetaLaw\_to\_Quantization.pdf:

The document discusses how after the Big Bang:

- “No new energy can be added from outside the system. In FL Field Theory, this implies that the total capacity for information instantiation is also fixed.”

And importantly:

- “From an infinite entropy backdrop—characterized by maximum uncertainty—the first act of instantiation produces a finite configuration of nodes and edges”

However, this needs reconciliation with the “zero entropy” description elsewhere.

## 1.4 The Information-Energy Equivalence

From Chapter 3 derivation:

- Energy per bit =  $k_B T \ln(2)$
- At Big Bang temperatures,  $c_{\text{comp}}$  would be enormous
- As universe cools, computational speed decreases

From FL\_Field\_MetaLaw\_to\_Quantization.pdf:

“Is All the Energy Fixed After the Big Bang? Answer: The prevailing view in modern cosmology is that the universe is a closed system: the total energy—whether it includes visible matter, radiation, dark matter, or dark energy—was fixed at the moment of the Big Bang.”

## 1.5 Space as Emergent from Information

From Chapter 4 and related documents:

- Space emerges as tessellation of information
- 1 bit = 1 fundamental spatial unit
- Manhattan metric natural for discrete information

From 01\_Triad\_Information\_Observation\_Language.pdf:

“Information as Substrate: We define information as the potential content of a system—its structure, state space, or entropy—prior to measurement or symbolic encoding.”

## 1.6 Symmetry Breaking Cascade

The progression appears to be:

- **Pre-Big Bang:** FL Field in perfect symmetry (total order, zero entropy)
- **Big Bang moment:** First observation/distinction breaks symmetry
- $T_1/T_0$  **emergence:** Binary distinction creates first information
- **Spatial emergence:** Distinctions create tessellated space
- **Particle formation:** Stable patterns in the tessellation
- **Structure formation:** Hierarchical pattern building

## 2 Reconciling Total Order with “Chaos”

The apparent contradiction between “total order” (zero entropy) and “chaos” resolves when we understand:

- **Total Order** = All possibilities exist simultaneously, undifferentiated
- **“Chaos”** = Not disorder, but rather unlimited potential
- **Zero Entropy** = No distinctions made yet, perfect symmetry
- **First Distinction** = Symmetry breaking that creates information

This is analogous to:

- A perfectly shuffled deck has maximum entropy
- But an “undealt” deck (all possibilities superposed) has zero entropy
- Dealing the first card breaks the symmetry

### 3 Physical Mechanism

From the temperature dependence of  $c_{\text{comp}}$ :

- **At  $T \rightarrow \infty$  (Big Bang):**  $c_{\text{comp}} \rightarrow \infty$ 
  - Information can be processed/propagated instantly
  - No spatial separation meaningful
  - Pure information state
- **As  $T$  decreases:**  $c_{\text{comp}}$  decreases
  - Information propagation becomes limited
  - Spatial separation emerges
  - Tessellation structure solidifies
- **Current epoch:**  $c_{\text{comp}}(300 \text{ K}) \approx 10^{13} \text{ bits/s}$ 
  - Well-defined spatial structure
  - Limited information propagation
  - Stable matter formations

### 4 The Complete Picture

#### 4.1 Pre-Big Bang State

- FL Field contains all possible information patterns
- Zero entropy (no distinctions made)
- No space, no time, no separation
- Total order = all possibilities coexist undifferentiated

## 4.2 Big Bang as First Observation

- First distinction: Something vs. Nothing ( $T_1$  vs.  $T_0$ )
- Symmetry breaking cascades
- Entropy begins to increase
- Space emerges from information tessellation

## 4.3 Post-Big Bang Evolution

- Temperature determines  $c_{\text{comp}}$
- Cooling creates spatial structure
- Patterns stabilize into particles
- Hierarchical structure emerges (Nibbler algorithm)

## 4.4 Current State

- Highly structured but increasing entropy
- Finite  $c_{\text{comp}}$  limits information flow
- Space well-defined by information tessellation
- Approaching heat death (computational freeze)

# 5 Key Insights

- **Information is Primary:** Space and time emerge from information structure, not vice versa
- **Total Order  $\rightarrow$  Structure  $\rightarrow$  Disorder:** Universe transitions from perfect order through structured phases to eventual heat death

- **Temperature as Clock:** Decreasing temperature creates the arrow of time through decreasing  $c_{\text{comp}}$
- **Space as Information:** Each bit of information creates a unit of space
- **Computation as Fundamental:** All physical processes are computational processes limited by  $c_{\text{comp}}(T)$

## 6 Open Questions

- What triggered the first distinction? The transition from FL Field to  $T_1/T_0$  remains mysterious
- Is information conserved? Like energy, is total information fixed at Big Bang?
- Multiple universes? Could different symmetry breakings create different physics?
- Return to order? Could the universe return to undifferentiated FL Field?

## 7 Conclusion

The Big Bang represents not an explosion from nothing, but a phase transition from total informational order (all possibilities coexistent) to partial order (specific actualizations). Space emerges as the tessellation structure required to separate and organize information as the universe cools and  $c_{\text{comp}}$  decreases. This framework unifies information theory, thermodynamics, and cosmology under a single principle: the universe is fundamentally computational, with physical reality emerging from information processing constraints.