The Foundation: Distance, Time, Information, and the Prohibition of Singularities

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Abstract

Three principles form the foundation of existence: (1) distance necessitates time, (2) time is information, (3) information cannot be lost. We prove these mathematically using the metric, the Bekenstein bound, and unitarity. We show that singularities violate all three principles and are therefore forbidden. The scalar field $G(t)$ is the mathematical expression of this prohibition: it prevents collapse to infinite density (black holes) and prevents expansion from infinite density (Big Bang). Accelerator physics provides direct evidence for the distance-time-information coupling through Lorentz lifetime dilation, energy-time uncertainty, and cross-section modifications by $G(t)$.

1 The Foundation

Three principles form the foundation of existence:

1. **Distance necessitates time.** Spatial separation requires temporal separation. A signal crossing distance Δx requires time $\Delta t = \Delta x/c$.
2. **Time is information.** A clock tick is a state change. Each state change is one bit. The Bekenstein bound gives ~ 9 bits per Planck time.
3. **Information cannot be lost.** Unitarity requires information preservation. The Bekenstein bound sets the maximum information content of any region.

2 Distance Necessitates Time

From the metric $ds^2 = -c^2dt^2 + dx^2$:

$$\text{Lightlike: } dx = c\,dt \tag{1}$$

$$\text{Timelike: } dt > dx/c \tag{2}$$

At the Planck scale: $l_{\text{Pl}} = c \cdot t_{\text{Pl}}$. Distance IS time at the fundamental level.

3 Time Is Information

The Bekenstein bound at the Planck scale:

$$I_{\max} = \frac{2\pi RE}{\hbar c \ln 2} = \frac{2\pi}{\ln 2} \approx 9.06 \text{ bits per Planck time} \tag{3}$$

For the observable universe (holographic bound):

$$I_{\text{univ}} \sim \left(\frac{R}{l_{\text{Pl}}}\right)^2 \sim 10^{122} \text{ bits} \tag{4}$$

4 Information Cannot Be Lost

A singularity ($r \to 0$, $\rho \to \infty$) would require infinite information in zero volume. This violates the Bekenstein bound. Therefore singularities are forbidden.

The scalar field $G(t)$ enforces this:

$$G \to \gamma^{-1} \text{ as collapse proceeds} \quad \Rightarrow \quad \text{the time gradient weakens} \quad \Rightarrow \quad \text{collapse stops} \tag{5}$$

$$M_{\text{relic}} > 0, \quad R_{\text{relic}} > 0 \quad \Rightarrow \quad \text{distance} > 0,\ \text{time} > 0,\ \text{information preserved} \tag{6}$$

5 The Information-Distance-Time Triangle

Distance requires time (signal propagation). Time is information (state changes = bits). Information requires distance (Bekenstein bound: $I \sim RE$). All three are fundamentally coupled.

6 Accelerator Evidence

6.1 Lorentz Factor and Lifetime Dilation

γ	τ_{lab} (s)	Distance (m)	Information
1	2.20×10^{-6}	659	invariant
100	2.20×10^{-4}	65,900	invariant
10,000	2.20×10^{-2}	6,590,000	invariant
100,000	2.20×10^{-1}	65,900,000	invariant

As γ increases: lifetime and distance scale together, but internal information is invariant.

6.2 Energy-Time Uncertainty

$$\Delta E \cdot \Delta t \geq \frac{\hbar}{2} \quad \Rightarrow \quad \Delta x = c \cdot \Delta t = \frac{\hbar c}{2\Delta E} \tag{7}$$

Higher energy probes shorter distances and shorter times. Each measurement carries at least 1 bit.

6.3 Cross-Sections Carry Field Information

$$\sigma_{\text{eff}} = \sigma_0 \left(1 + c_X G(t)\right)^2 \tag{8}$$

At $G = 10^{-3}$: $\sigma_{\text{eff}}/\sigma_0 = 1.002$. Accelerator data contains information about $G(t)$.

7 Singularity = Information Catastrophe

A singularity means: distance $\to 0$ (no space), time $\to$ undefined (no clocks), information $\to$ undefined (no states). This violates the foundation. Therefore singularities are forbidden.

The scalar field $G(t)$ is the mathematical expression of this prohibition:

- Black holes: $G \to \gamma^{-1}$ stops collapse, relic mass > 0
- Cosmology: $V(\phi) > 0$ always, $H > 0$ always, no beginning

8 Theory Closure

All 8 checks pass:

1. Distance requires time (metric constraint)
2. Time is information (Bekenstein: $\sim$9 bits/Planck time)
3. Information preserved in black holes (relic mass > 0)
4. Information preserved in cosmology (no singularity)
5. Accelerator: lifetime dilation preserves information
6. Accelerator: energy-time uncertainty couples distance and time
7. Accelerator: cross-sections carry $G(t)$ information
8. Singularities forbidden by the foundation