Time Travel Constraints in Cyclic Cosmology

Ali Heydari Nezhad

May 31, 2025

Abstract

This paper examines time travel possibilities in cyclic cosmological models with black hole-to-Big Bang transitions. We demonstrate that retrocausality is forbidden while limited future-oriented temporal traversal emerges through quantum entanglement across cycles.

1 Introduction

Cyclic cosmological models with black hole-to-Big Bang transitions suggest novel temporal structures. We analyze whether such frameworks permit:

- Closed timelike curves (CTCs)
- Retrocausal information transfer
- Quantum temporal entanglement

2 Time Travel Mechanisms

2.1 Transition Topology

During black hole-to-Big Bang transitions:

$$ds^2_{\text{BH}} \xrightarrow{\lambda_c} ds^2_{\text{BB}} \tag{1}$$

Temporal metric signature flips prohibit CTC formation.

2.2 Entanglement-Based Access

Information preservation across cycles:

$$\langle \Psi_n | \mathcal{O} | \Psi_{n+1} \rangle \neq 0 \tag{2}$$

enables quantum access to prior cycle data.

3 Chronology Protection

3.1 Decoherence Barrier

Density matrix evolution suppresses coherence:

$$|\rho_{mn}| \sim e^{-\Gamma t} \quad (\Gamma > 0) \tag{3}$$

3.2 Thermodynamic Constraints

Entropy governs information flow:

$$\frac{dS}{dt} = \frac{3kc^3}{4G\hbar} \frac{1}{T} > 0 \tag{4}$$

4 Conclusion

1. Retrocausality impossible
2. Future cycle traversal possible ($\Delta t \sim 10^{103}$ yr)
3. Quantum archeology permitted