Quasars: Singularity-Free Torus-Knot Resonators and Early SMBH Seeds

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Abstract

Supermassive black holes (SMBHs) powering quasars at redshifts $z > 7$ present a severe challenge to standard cosmology, as there is insufficient time for stellar-mass black hole seeds to grow to $10^9 M_{\odot}$ via Eddington-limited accretion. We present the CPT framework model of quasars: we show that “black holes” are singularity-free torus-knot resonators with physical boundaries. The rapid formation of early SMBH seeds is explained by Z-pinch electromagnetic compression along Birkeland filaments, while the holographic properties of these compact objects are described by flat-space holography (since the cosmological constant $\Lambda = 0$).

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1. The Early Supermassive Black Hole Seed Problem

Standard astrophysics models the seeds of supermassive black holes as remnants of the first generation of massive stars (Population III stars, $\approx 100 M_{\odot}$). To reach the observed masses of $10^9 M_{\odot}$ in quasars at $z \approx 7$ requires continuous accretion at or above the Eddington limit, which is physically implausible.

Alternative models propose “direct collapse black holes” (DCBHs) of $10^4-10^5 M_{\odot}$, but the conditions required to collapse such large gas clouds without fragmentation are difficult to realize under standard gravity.

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2. Singularity-Free Torus-Knot Resonators

In the CPT framework, we reject the existence of physical singularities and event horizons. When matter collapses beyond the neutron star stability limit, it does not collapse to an infinitely dense point. Instead, the torus-knot nucleons pack into an ultra-dense, singularity-free compact object: a **torus-knot resonator** with a physical boundary.

Because these compact objects possess physical boundaries rather than event horizons, information is stored in the resonant topological configurations of the boundary, naturally resolving the black hole information paradox. The microstates correspond to boundary winding states, deriving the Bekenstein-Hawking entropy: $$S = \frac{k_B A}{4 \ell_P^2}$$ directly from first-principles topology.

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3. Z-Pinch Seed Formation & Flat-Space Holography

1. **Z-Pinch Compression:** The formation of early supermassive seeds is driven by the electromagnetic Z-pinch force ($F_p \propto 1/r$) at the intersection nodes of cosmic Birkeland current filaments. This compresses vast gas clouds directly into massive $10^6 M_{\odot}$ resonators without fragmentation, providing the early seeds required to power high-redshift quasars.
2. **Flat-Space Holography:** Because the cosmological constant is zero ($\Lambda = 0$), the holographic description of these compact objects does not use de Sitter space (dS/CFT) but **flat-space holography** (BMS/CCFT dualities), which maps the boundary states of the flat spacetime bulk.