Title: Quantum Corrections to the Thermodynamics of Cold Black Holes

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Collection/Series: Celestial Holography Summer School 2024

Date: July 24, 2024 - 3:20 PM

URL: https://pirsa.org/24070078

Abstract:

I will review an old puzzle related to the breakdown of the semiclassical description of the thermodynamics of very cold (ultraspinning) black holes. Then, I will discuss recent work where we resolved this puzzle by properly accounting for quantum corrections arising from graviton loops, which dominate the low-temperature thermodynamics.

Quantum Corrections to Thermodynamics of Cold Black Holes

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Based on arXiv:2310.00848 (with Kapec, Strominger, Toldo)

Context

- Black holes: IR window into microscopics of quantum gravity
- Problem: hard to study
  - Micro: No top-down construction of Kerr in 4d flat space
  - Macro: Path integral UV-divergent beyond tree level
- Sen (2012): compute quantum corrections from gravitational path integral
  - Universal IR contributions, independent of UV data
  - Whenever applicable, matches with string theory!
    $\Longrightarrow$ Quantum corrections to gravitational path integral taken seriously

What

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$$\mathbf{Z[T] \sim T^{3/2}}$$

Why

Important for two reasons

1. Stringent test on quantum gravity in our universe
2. Resolves low T puzzle of BH thermodynamics (1991)

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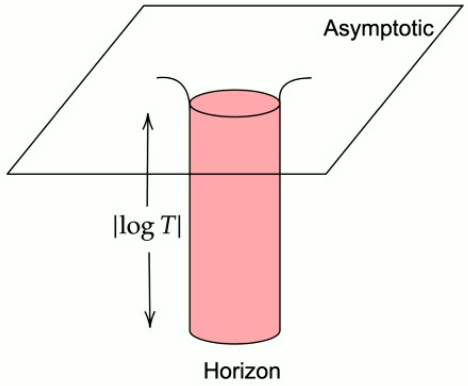
1. Stringent test on quantum gravity in our universe

2. Resolves low T puzzle of BH thermodynamics (1991)
   - Hawking was exponentially wrong at low temperatures!

How

- As $T \to 0$, get **infinitely long AdS_2 throat**



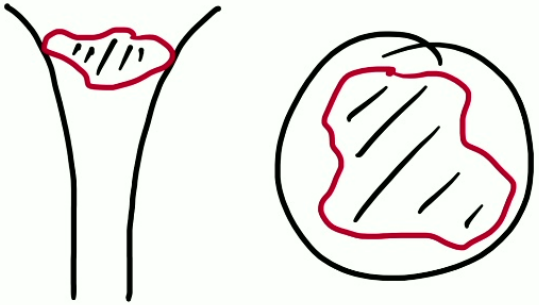
- Black hole infinitely far away from everything else: **decoupling**

How

- Perform the 1-loop path integral in throat

$$Z = e^{-I[g_{\text{throat}}]} \int [Dh] e^{-I_2[h]}$$

- Nearly zero-modes (Schwarzschian)



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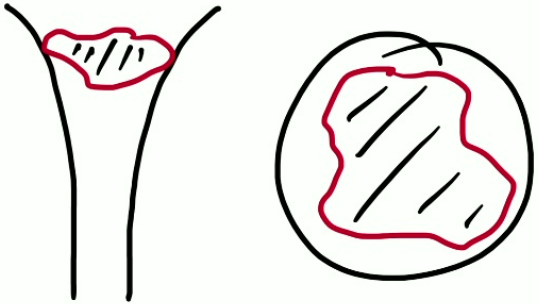

- $I_2[h] \propto \frac{T}{\Lambda}|h|^2 \implies Z[T] \sim T^{3/2}$

Check out my poster ☺

Thank you!