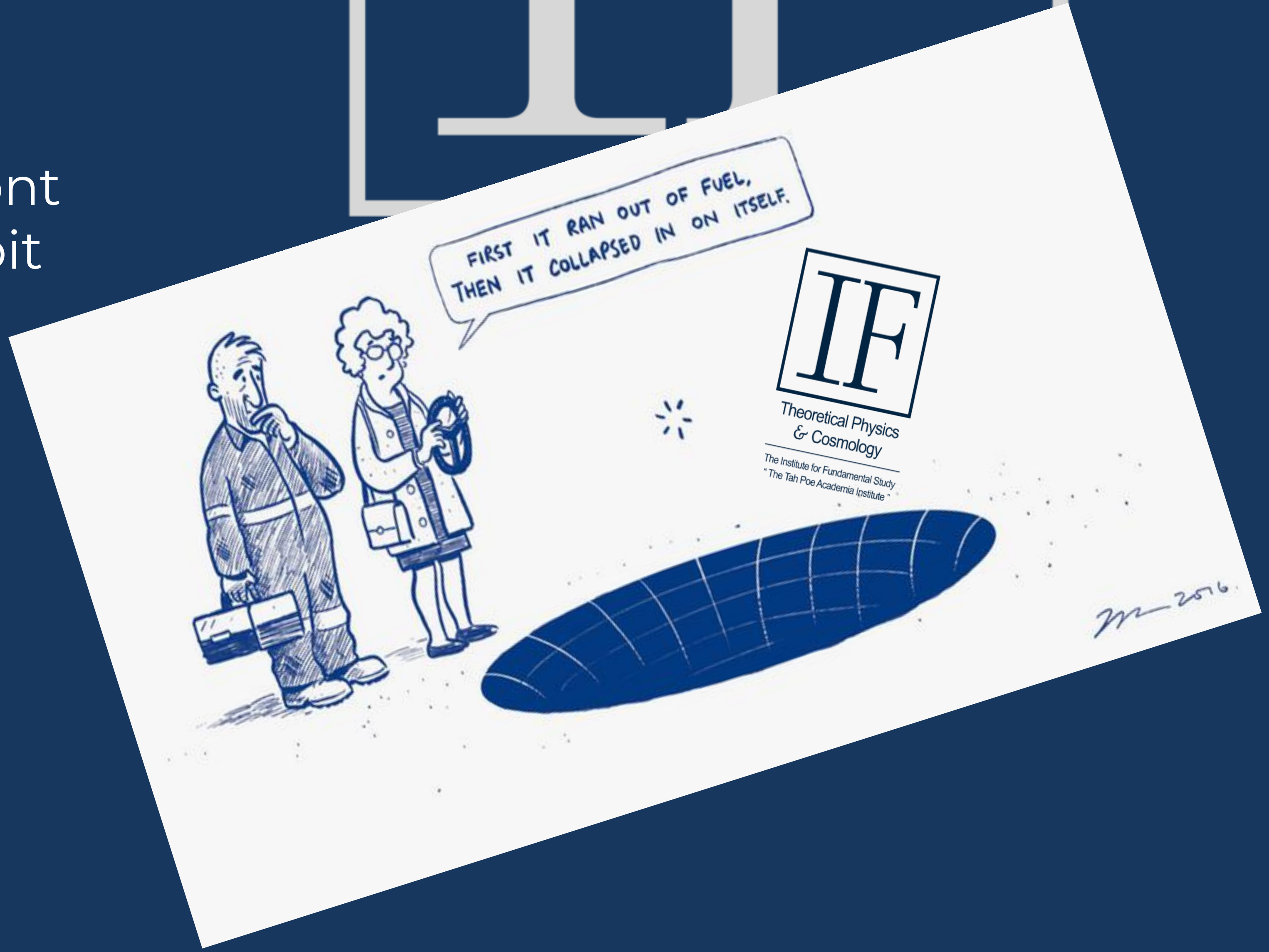
Introduction of myself

My name is **Peerawat Sriling**. I'm a PhD student in theoretical physics. My affiliation is The Institute for Fundamental Study. It's a real honor to be presenting in front of such an audience, and I'm looking forward to sharing a bit about who I am and what I've been working on.



Main idea

Applies universal principles of entropy to black hole entropy. Motivation for the WGC. Connection to Swampland program.

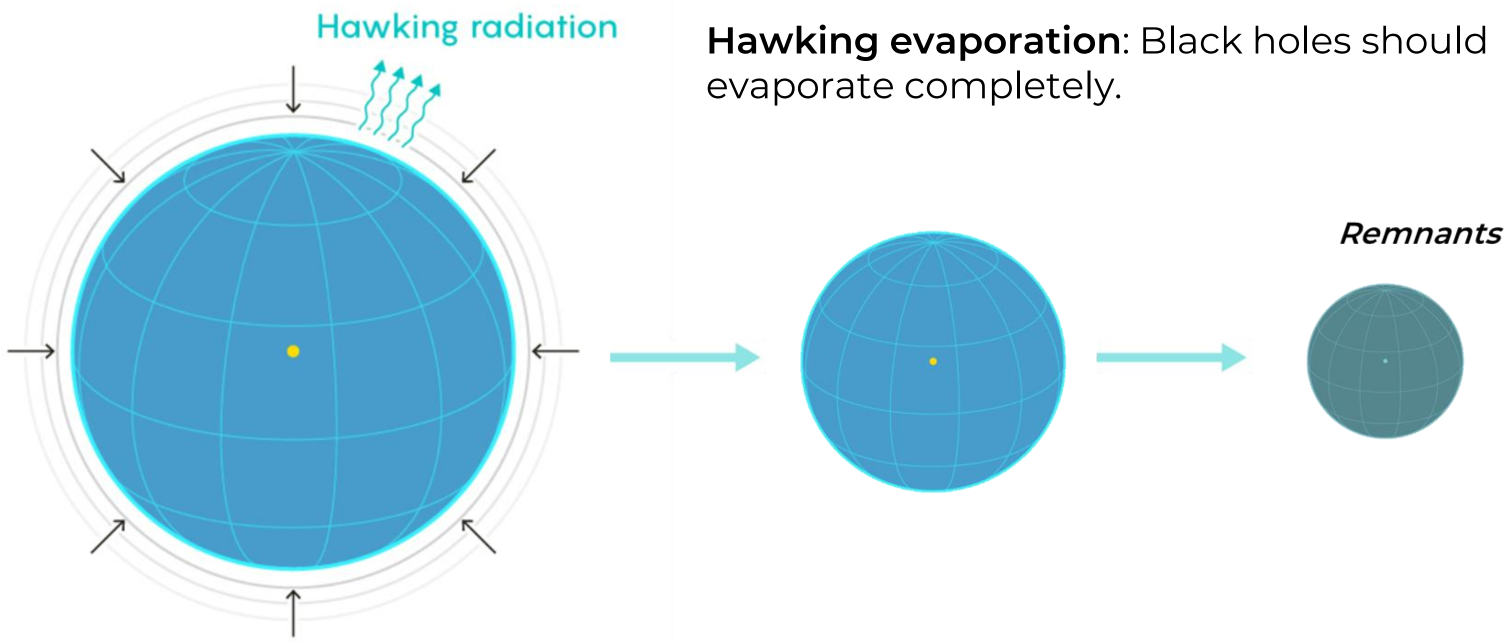
Set up of this paper

They propose a new approach to proving the Weak Gravity Conjecture (WGC) based on the entropy shift of black holes caused by higher-dimension operators in the low-energy effective field theory.

Calculation of Entropy

Compute the entropy correction to the black hole due to higher-dimension operators by using the Wald formula. Find that the correction entropy is separates into two contributions.

Research Interests



Black hole thermodynamics

The idea that black holes behave like thermodynamic systems with entropy and temperature — and in semiclassical gravity, where quantum fields are studied on a fixed curved background. Hawking evaporation: Black holes should evaporate completely.

Entropy of Black hole

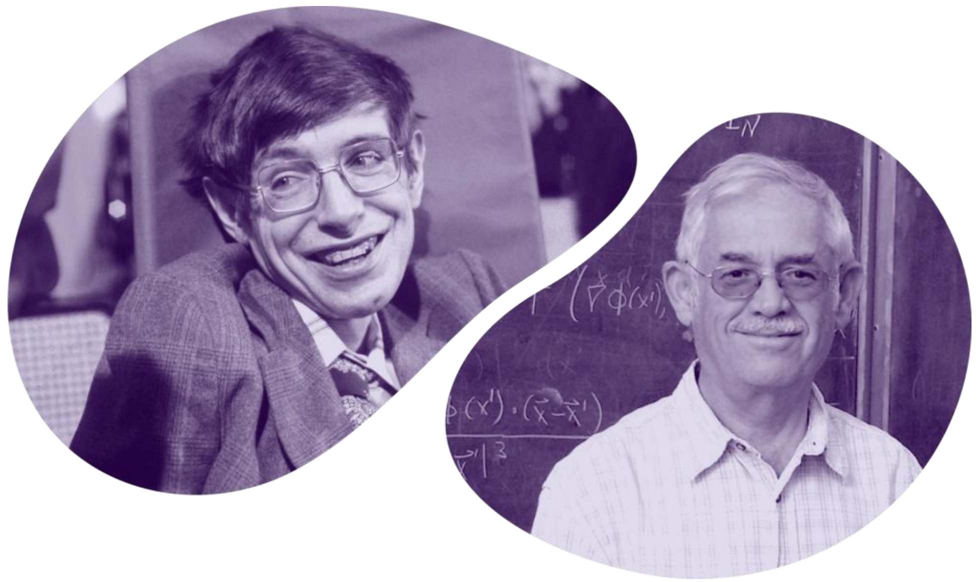
•Black holes have entropy proportional to horizon area:

$$S_{BH} = A/4,$$

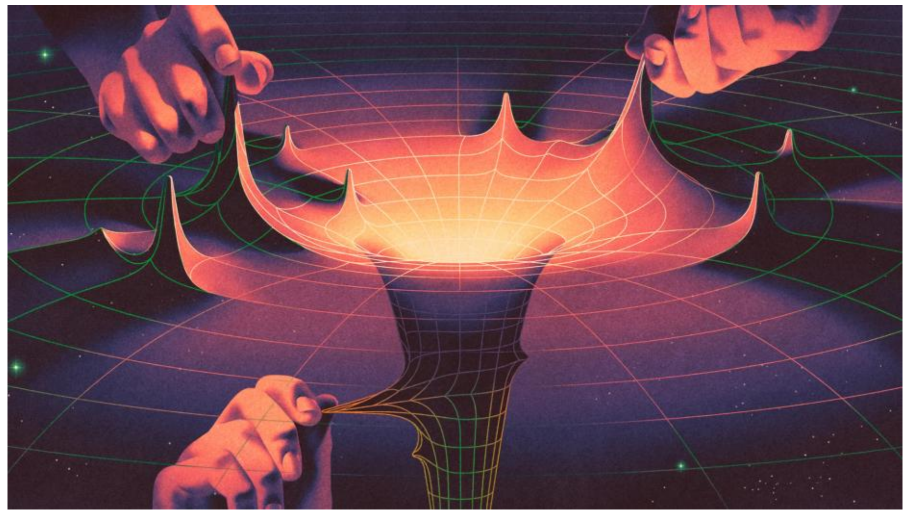
•For a system T with entropy S.
•Subsystem $\tilde{T}$ with restricted degrees of freedom → then the corresponding entropy $\tilde{S}$ will be less than S, thus, we find that

$$S = \tilde{S} + \Delta S,$$

where the correction entropy ΔS is strictly positive.

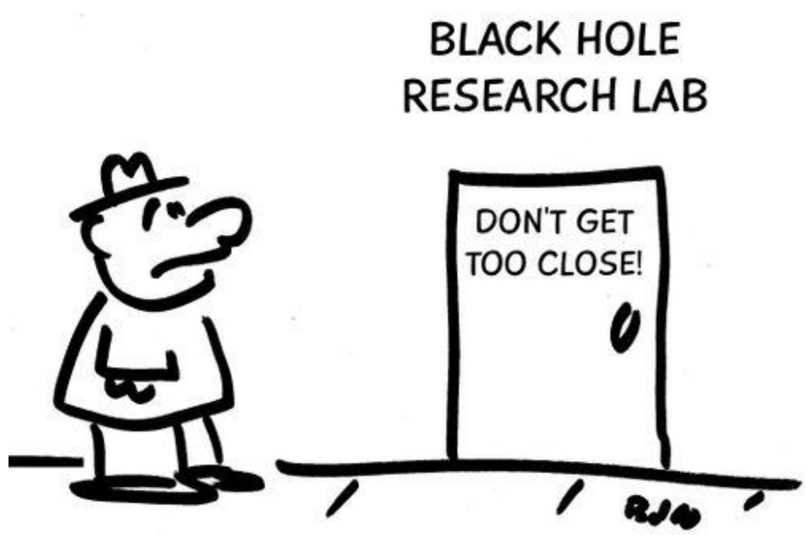


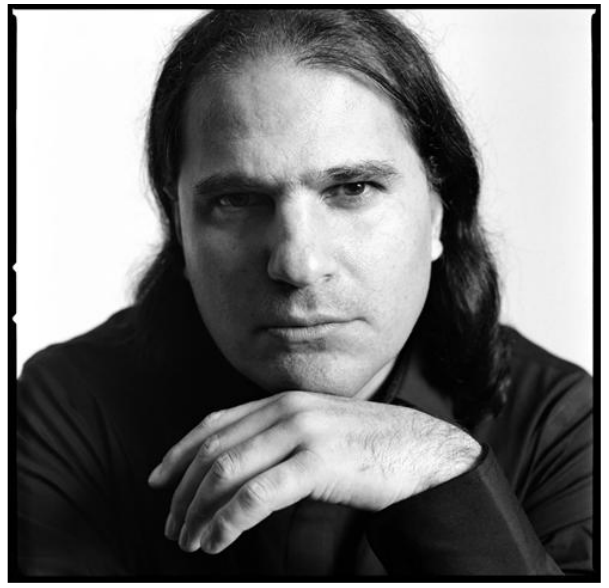
Modified theories of gravity



•Modifying gravity changes how black holes form and evaporate; black hole thermodynamics gives us clues about what a full quantum theory of gravity should look like; us probe quantum effects before we have a complete theory.

Higher Derivative Corrections to Black Hole Entropy and the WGC in dRGT Massive Gravity





Nima Arkani-Hamed

Luboš Motl

Alberto Nicolis

Cumrun Vafa

Main Idea

Weak Gravity Conjecture (WGC), by Arkani-Hamed, states that in a theory containing a U(1) gauge field, there must exist a particle satisfying **M < Q** (in appropriate units) so that an extremal black hole can decay, thereby avoiding the formation of an infinite number of stable black hole remnants.

A more precise formulation of the WGC is obtained by considering **higher-derivative corrections** to the extremality bound

$$\frac{M}{Q} > 1 - \frac{1}{Q^2}(2c_1 + 8c_2 + \ldots)$$

If $c_1 + c_2 + \cdots > 0$, the extremality bound is shifted downward, such that **M < Q.** As a result, the extremal black hole becomes super-extremal and can decay on its own.

Cheung, Liu, and Remmen directly connected the WGC to **black hole entropy**. In particular, the WGC condition, is equivalent to the statement that higher-derivative corrections increase the entropy of an extremal black hole at fixed mass and charge:

$$\Delta S_{Q,M} > 0 \quad \Leftrightarrow \quad \text{WGC is satisfied.}$$

This follows from a **second-law-like argument.** This provides a direct connection between the **Weak Gravity Conjecture** and **thermodynamic consistency**, suggesting that the WGC can be understood as a consequence of fundamental thermodynamic properties of black holes.

WGC in curve spacetime

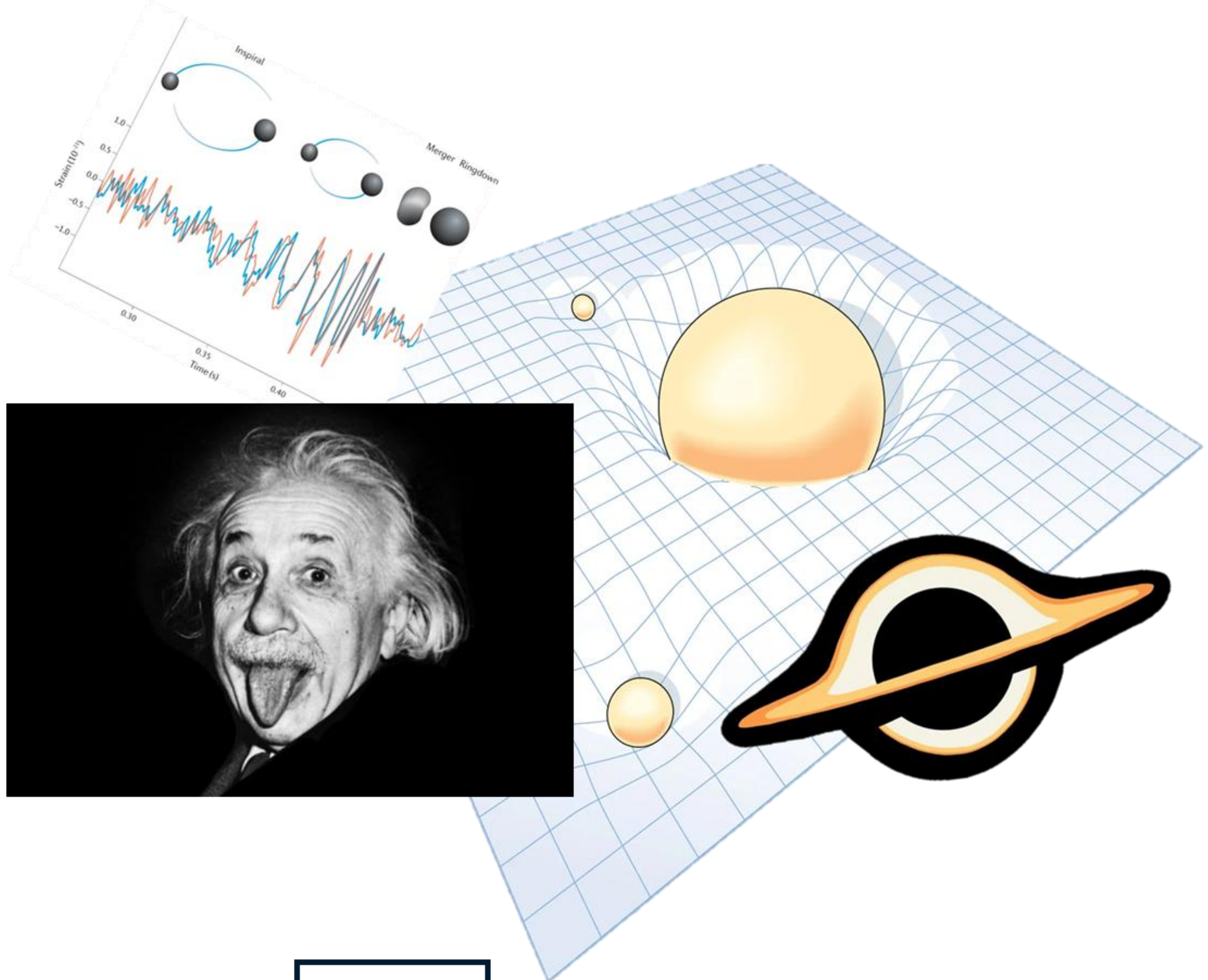
Cremonini *et al.* proposes that the concept of the **WGC can be extended to AdS spacetime** by reformulating it in terms of the relation between entropy and extremality, rather than the usual flat space criterion *Q/M* > 1. Hence, gravity in AdS is said to be weak or consistent with the WGC if and only if the entropy shift is positive, which can be expressed as

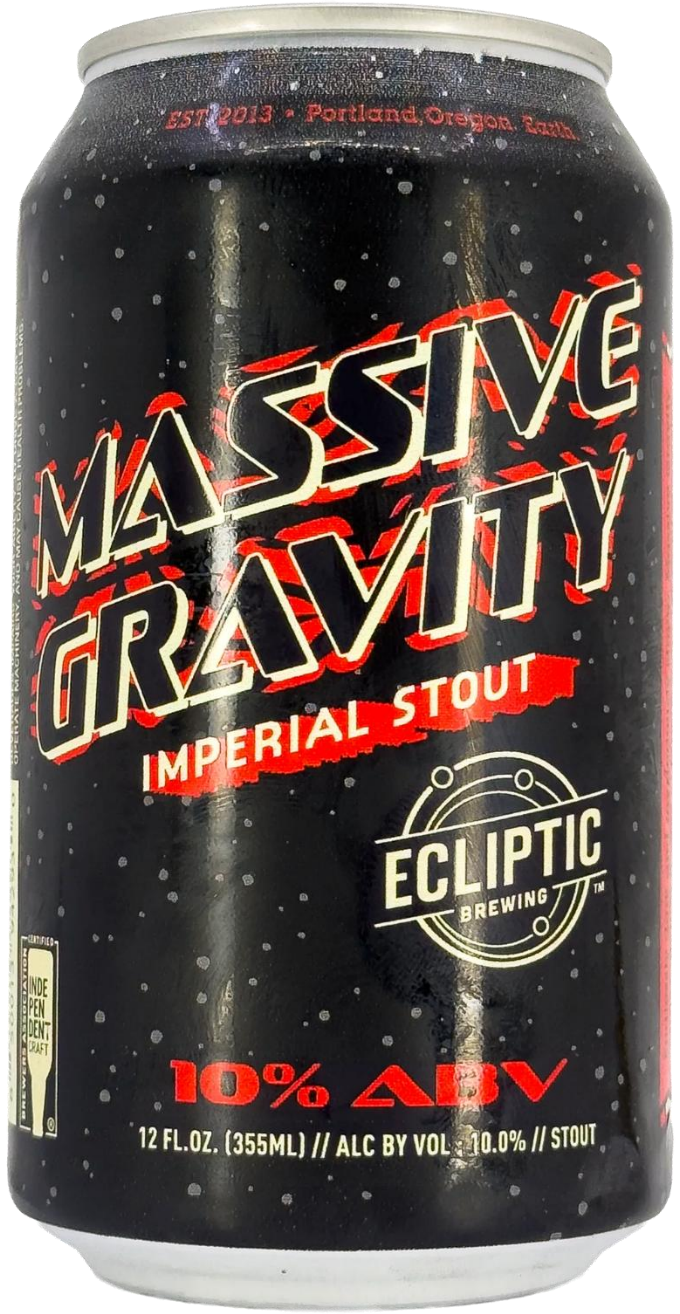
$$\Delta S_{Q,M} > 0 \quad \Leftrightarrow \quad \text{WGC in AdS}$$

What happen If Modified gravity ?

- How does the extremality bound of a charged **dRGT black hole** change in the presence of higher-derivative corrections, and how does the graviton mass modify the coefficient of these corrections?
- Does it make the WGC bound stronger or weaker?
- Does the relation still hold in the presence of a **graviton mass**, or does the mass term introduce additional conditions, such as a bound that depends explicitly on m_g?

Thank You





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