

# Gravastars, the missing piece of the cosmic puzzle?

Alexander Sarango

Escuela Superior Politécnica de Chimborazo

November 21, 2024



Today is about...

Today is about...

# **GRAVITATIONAL VACUUM STARS**

Today is about...

## GRAVITATIONAL VACUUM STARS



- \* Merge ideas from QM & GR
- \* New insight about the structure of the universe
- \* Answer some of the most profound questions in cosmology

- \* Merge ideas from QM & GR
- \* New insight about the structure of the universe
- \* Answer some of the most profound questions in cosmology
- \* My dissertation defense :D

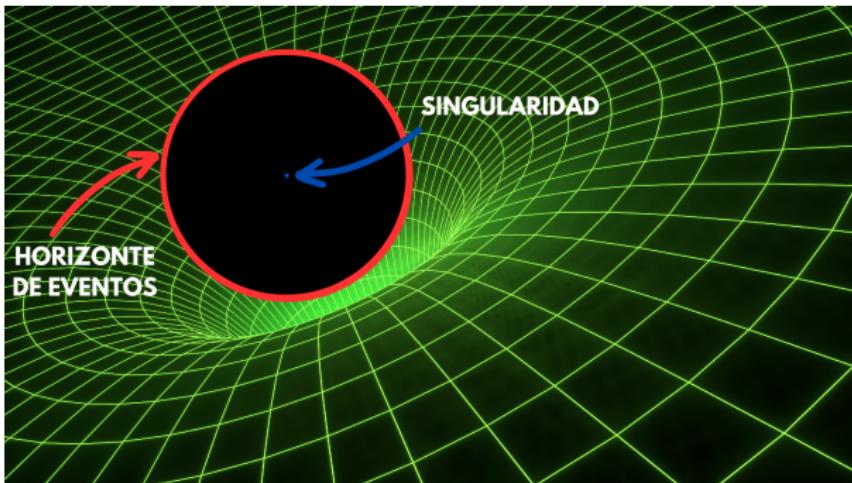
Let's review the theory of black holes

Abhishek Joshi/UIUC

# What is a Black Hole?

## Black Hole

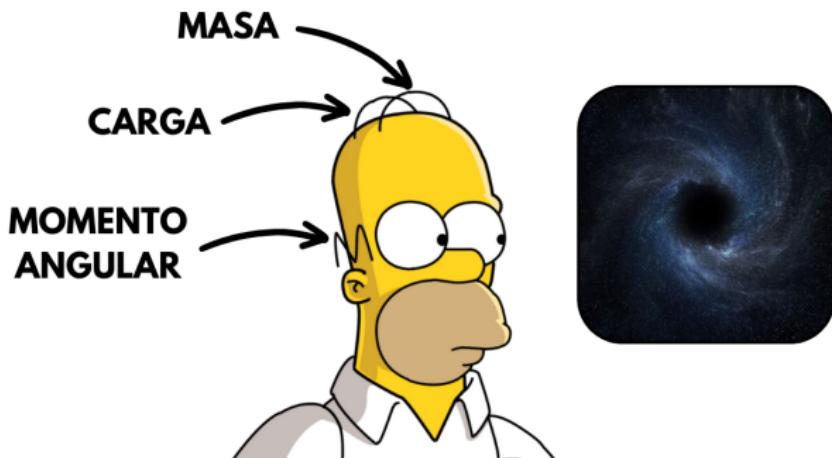
Term popularized by John Wheeler but used for the first time (probably) by Ann Ewing [1], a black hole is a region in space where the gravitational field is so strong that nothing, not even light, can escape from it.



# No-Hair Theorem

## No-Hair Theorem

Black holes can be completely described by just three observable parameters: mass, electric charge, and angular momentum [2].



# Do BHs really exist?

Evidences so far,

- ✓ **1971** - X-ray emissions from an accretion disk (Cygnus X-1)
- ✓ **2015** - Gravitational waves detected of two merging black holes by LIGO
- ✓ **2019** - First image of the shadow of a black hole by the EHT

But,

- ✗ Loss of information
- ✗ Singularity
- ✗ Dark matter relation

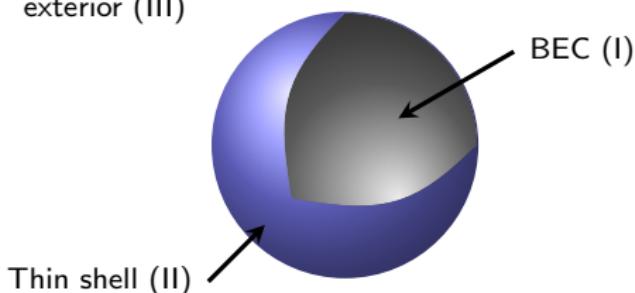
Now, we look at gravastars



## Gravastar

Proposed in 2001 by Paweł Mazur and Emil Mottola [3], a *gravitational vacuum star*, namely gravastar, is a hypothetical alternative to black holes presented as a solution to solve some of the problems associated with them.

Schwarzschild exterior (III)



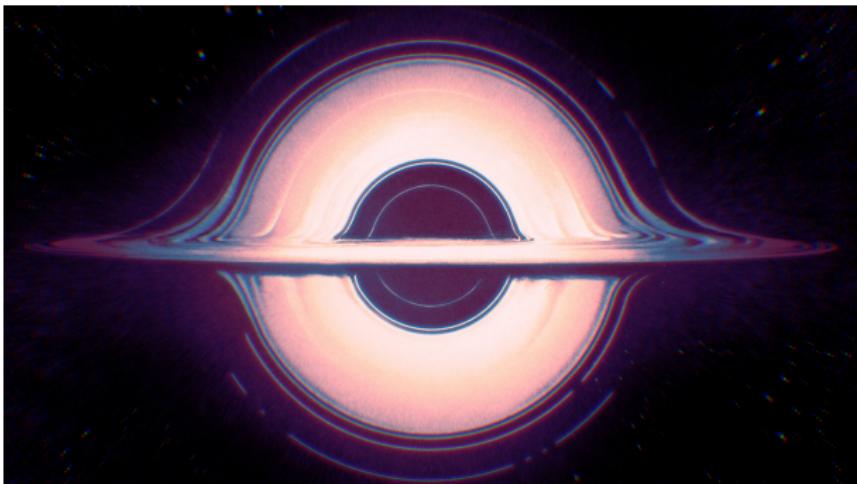
- I.  $\rho = -p,$
  - II.  $\rho = p,$
  - III.  $\rho = p = 0.$
- (1)

## Problem #1

Information paradox

## Problem #2

Singularity



Ashley Mackenzie/Quanta Magazine

- \* New gravastar solutions under Gravitational Decoupling framework by Minimal Geometric Deformation (I'm working here)
- \* New gravastar models from the original MM model
- \* Gravastar models under astrophysical frameworks
- \* Gravastar models under modified theories of gravity

Meanwhile on X...

Meanwhile on X...



Gaston Giribet

@GastonGiribet

**“** [...] Hay también un conjunto de soluciones propuestas que pueden considerarse **patear la pelota afuera de la cancha** [...] **”**

# Conclusion

- ✿ In summary, as research continues, gravastars could potentially replace regular black holes. Their unique structure, driven by vacuum energy and exotic matter, allows gravastar formation evading the problem of singularity and thus, unveiling one of the most important mysteries of the universe.



NASA/JPL-Caltech

## References

-  EWING, Ann. "Black Holes" in Space. *Science News Letter*. 1964, vol. 85, pp. 39–39. Available from DOI: [10.2307/3947428](https://doi.org/10.2307/3947428).
-  RUFFINI, Remo; WHEELER, John A. Introducing the black hole. *Physics today*. 1971, vol. 24, no. 1, pp. 30–41.
-  MAZUR, Paweł O.; MOTTOLA, Emil. Gravitational Condensate Stars: An Alternative to Black Holes. *arXiv e-prints*. 2001, gr-qc/0109035. Available from DOI: [10.48550/arXiv.gr-qc/0109035](https://doi.org/10.48550/arXiv.gr-qc/0109035).

