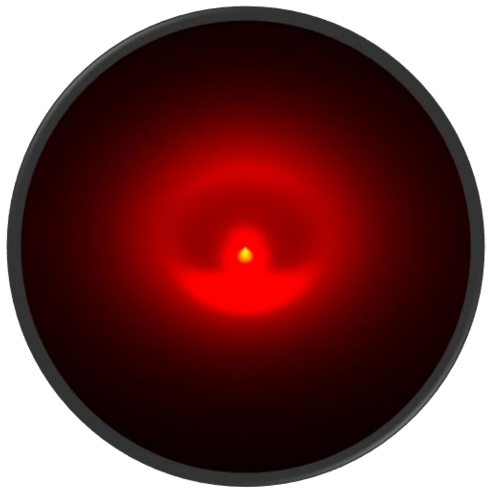
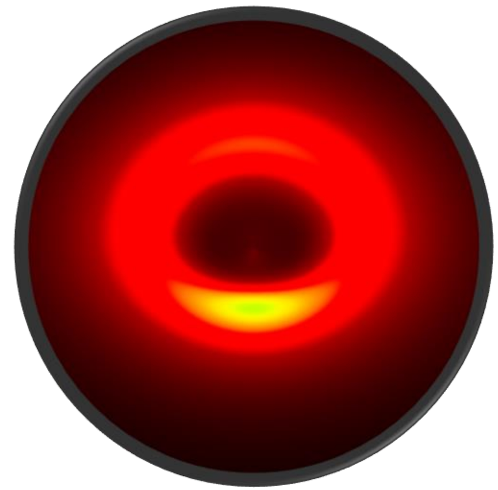
Oscillating images from dark matter scalar solitons





João Luís Rosa, arXiv:2512.23800 [gr-qc]

In collaboration with:
Nicolas Aimar, Caio F. B. Macedo, Diego Rubiera-Garcia

MOTIVATION

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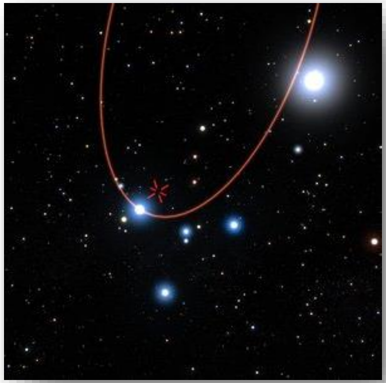

S2 Star orbit
ESO (2016)

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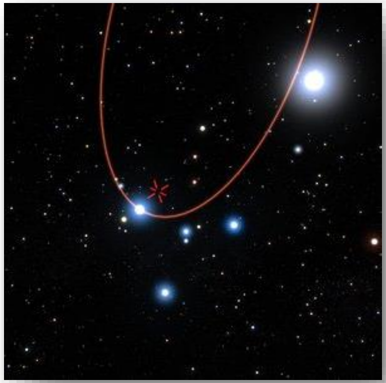

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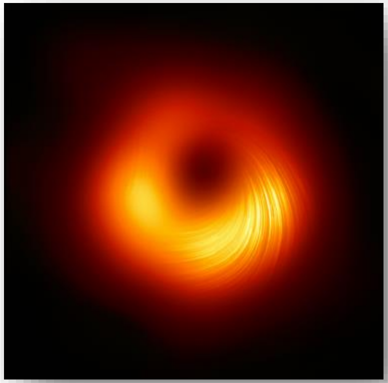

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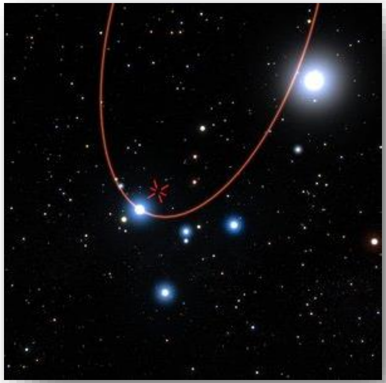

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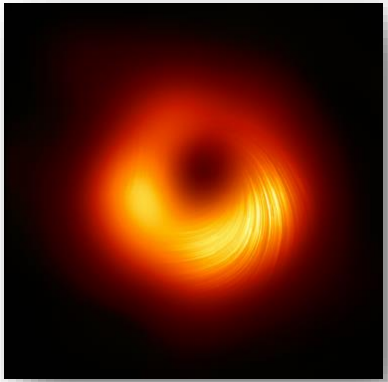

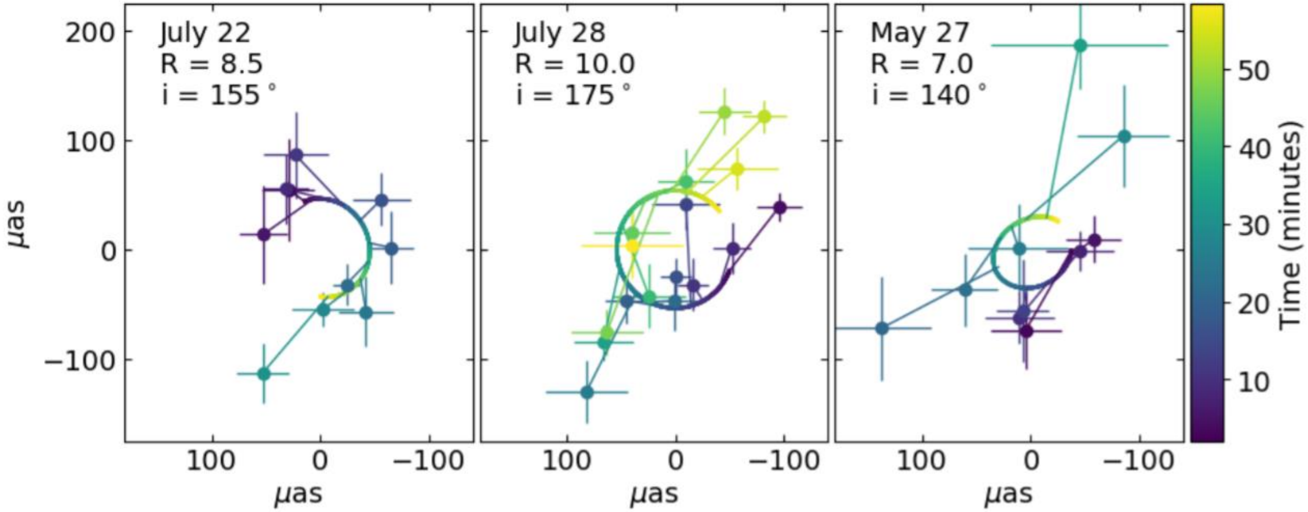

Flares
ESO (2020)

A&A 635, A143 (2020)

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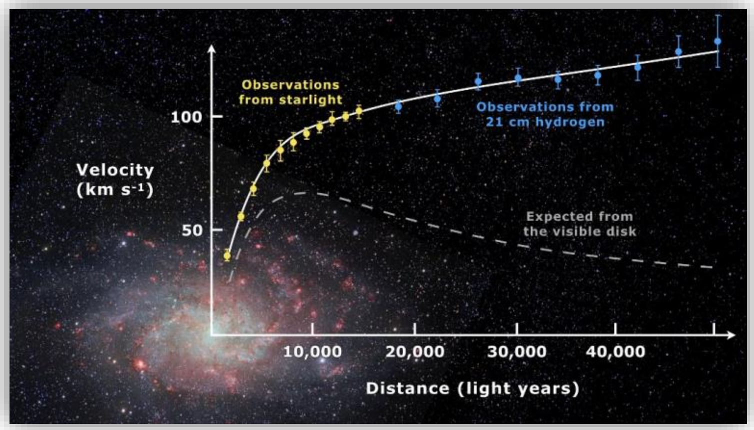

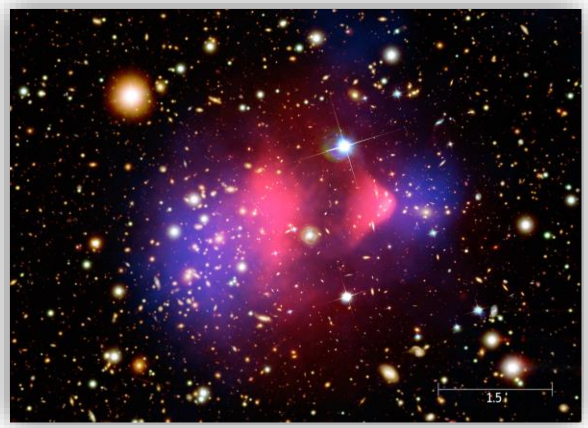

Evidence for **dark matter**: about a fourth of the universe's energy density

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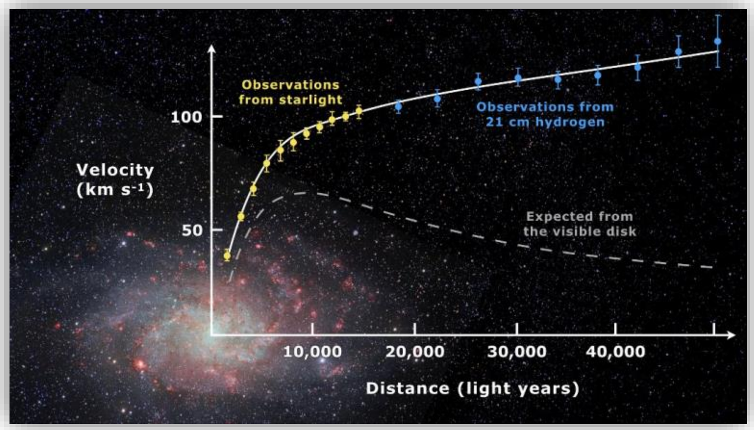
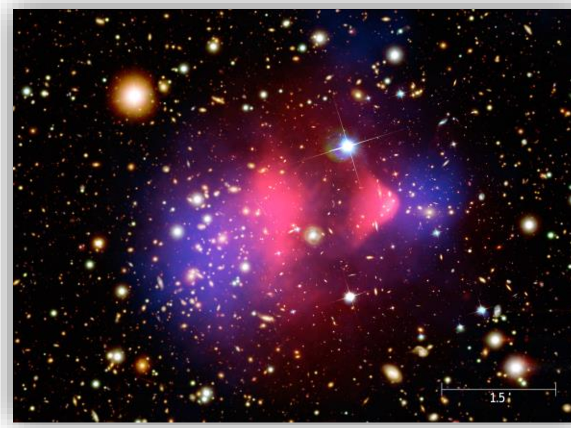
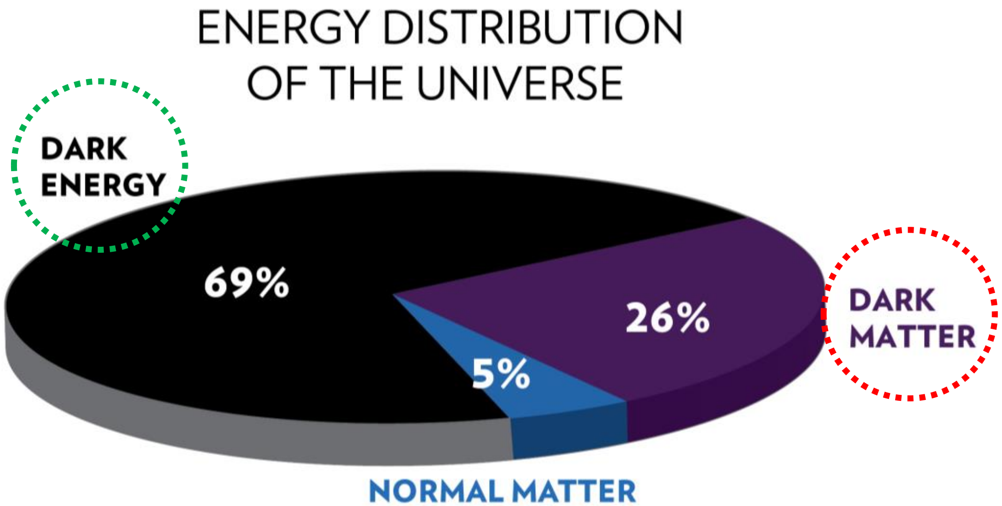




Evidence for **dark matter**: about a fourth of the universe's energy density

New **dark** components:

Λ-CDM model



OSCILLATON

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Oscillaton: self-gravitating condensate of an oscillating real scalar field

$$S = \int_{\mathcal{M}} \sqrt{-g}\left[\frac{R}{16\pi} - \frac{1}{2}\nabla_a\Phi\nabla^a\Phi - \frac{1}{2}V(\Phi)\right]d^4x$$

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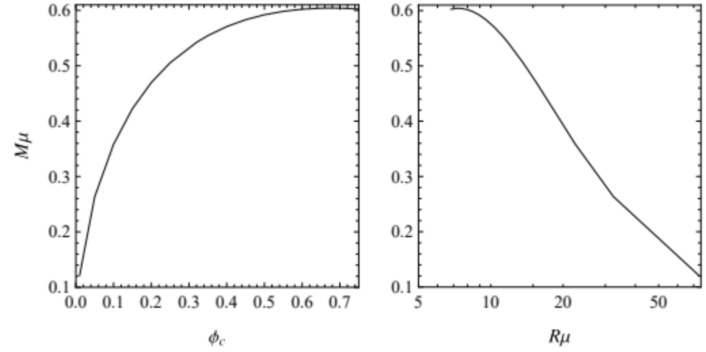
3. Shooting method
4. 1-parameter solutions



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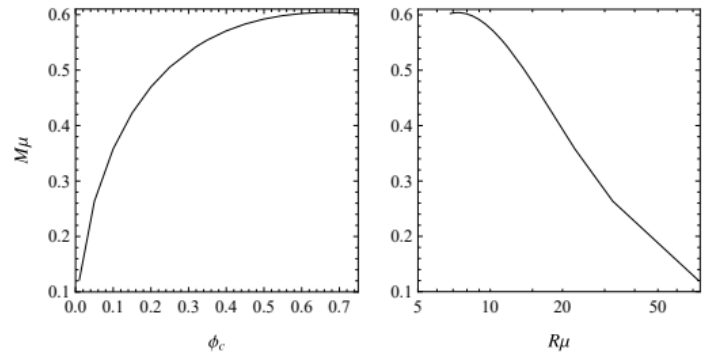

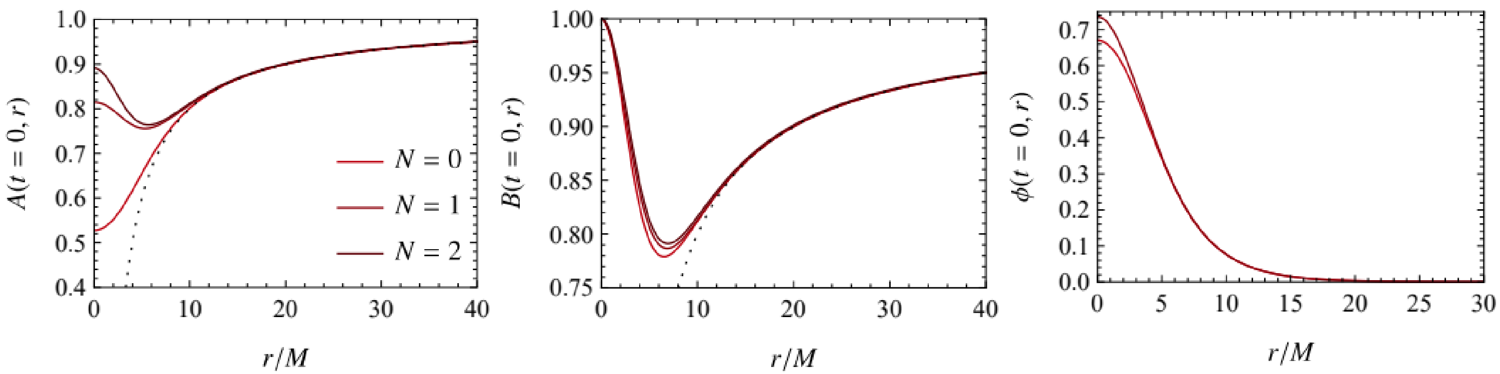

OSCILLATING ORBITS

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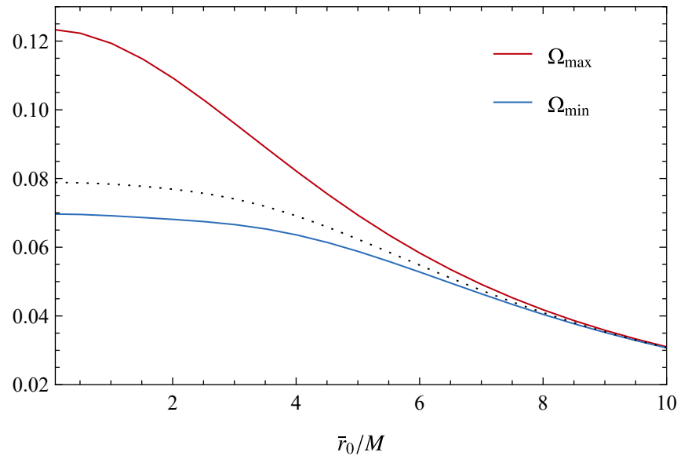
Orbital angular velocity

$$\Omega = \frac{\dot{\varphi}}{\dot{t}} = \frac{L}{r^2 \dot{t}}$$



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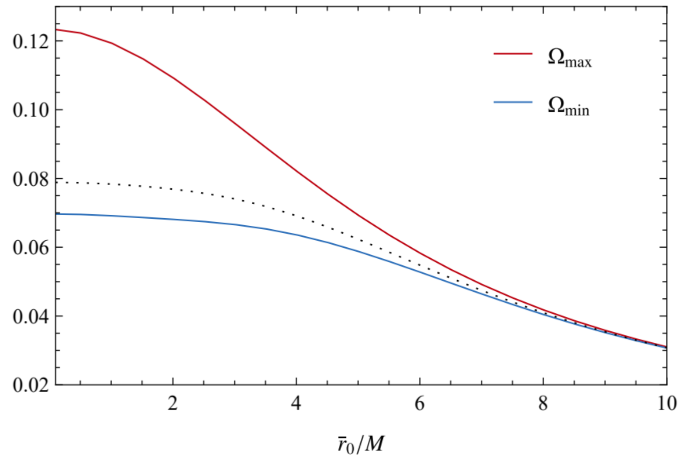
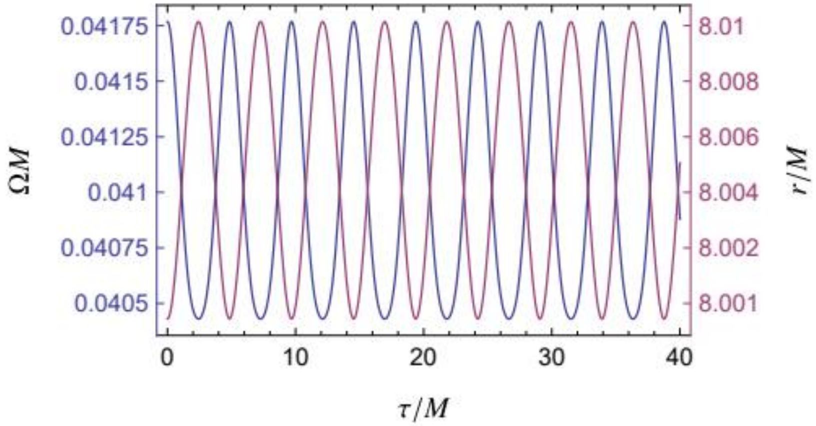
Balance between **radius** and **velocity** maintain orbital motion





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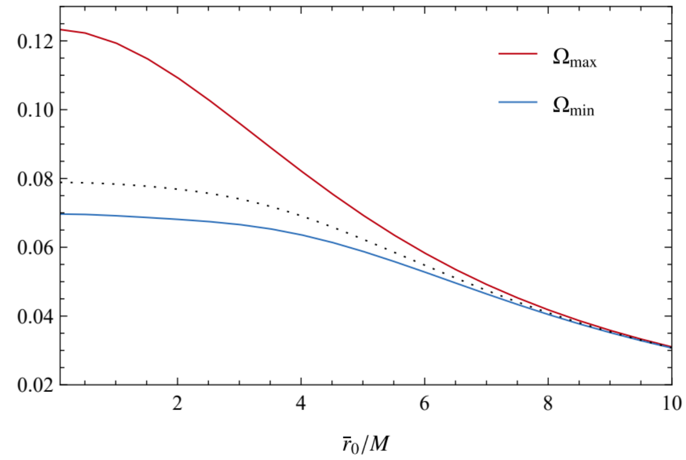
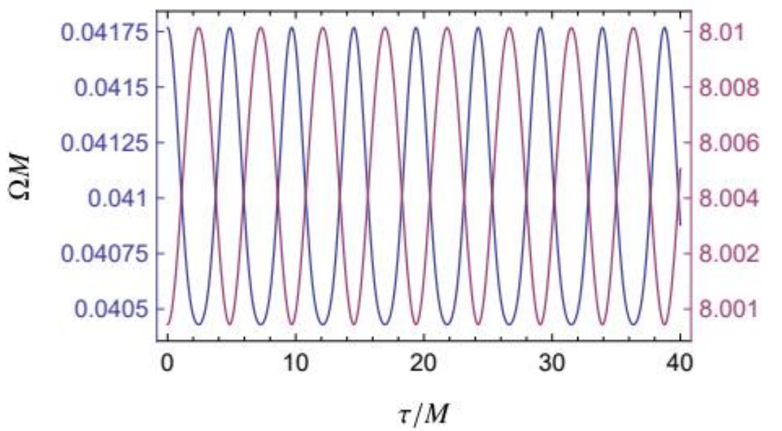
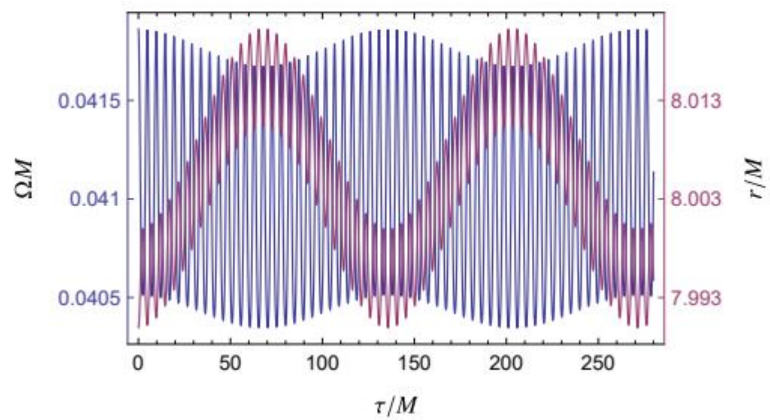


Orbits are **stable** against radial perturbations of the orbital radius



Unperturbed



Perturbed

EMISSION MODELS

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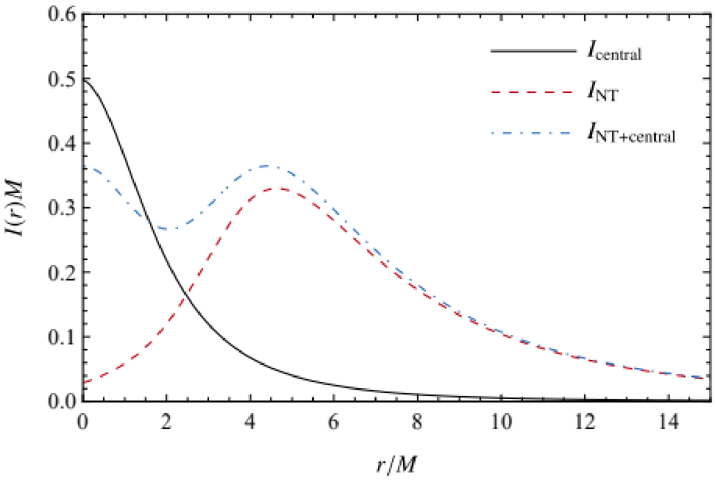

Combination of effects:

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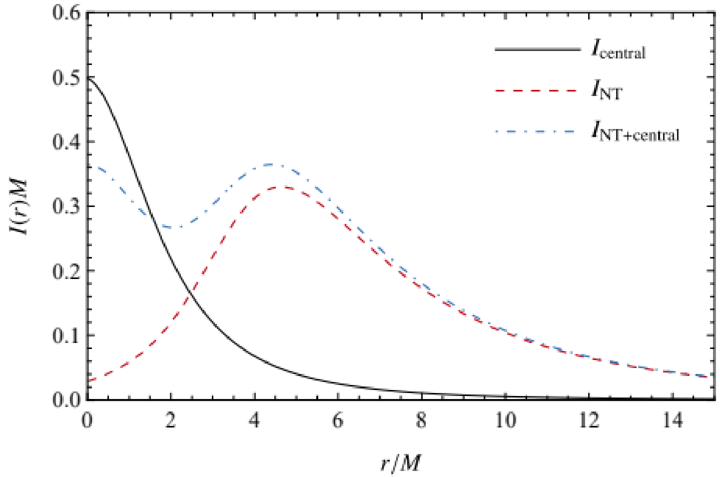

Combination of effects:

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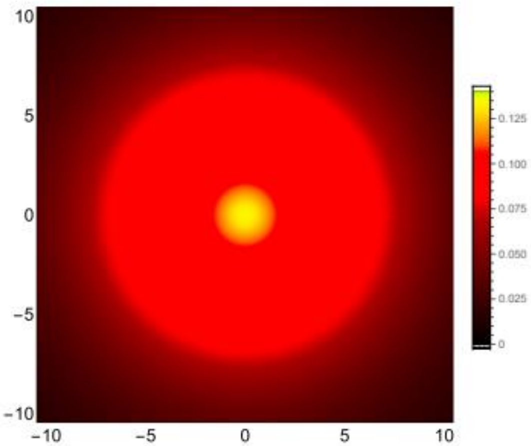
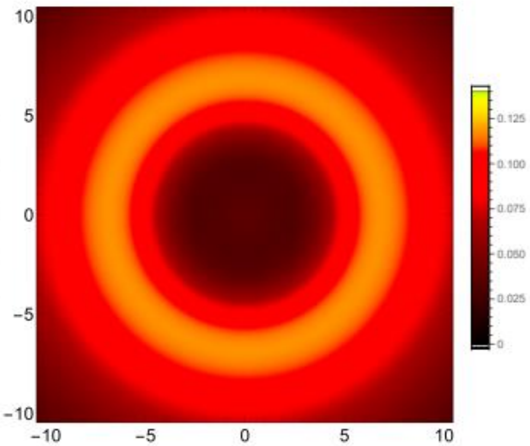
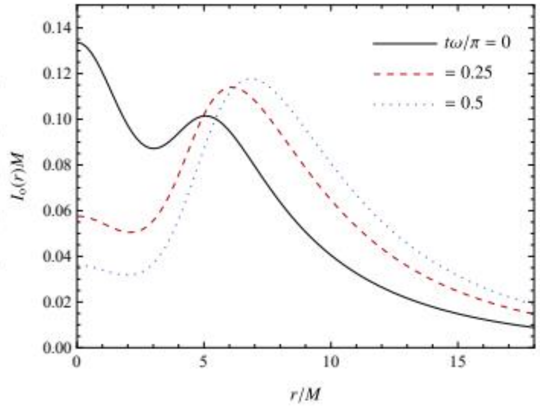
Gravitational **redshift** produces a shadow-like feature

t = 0



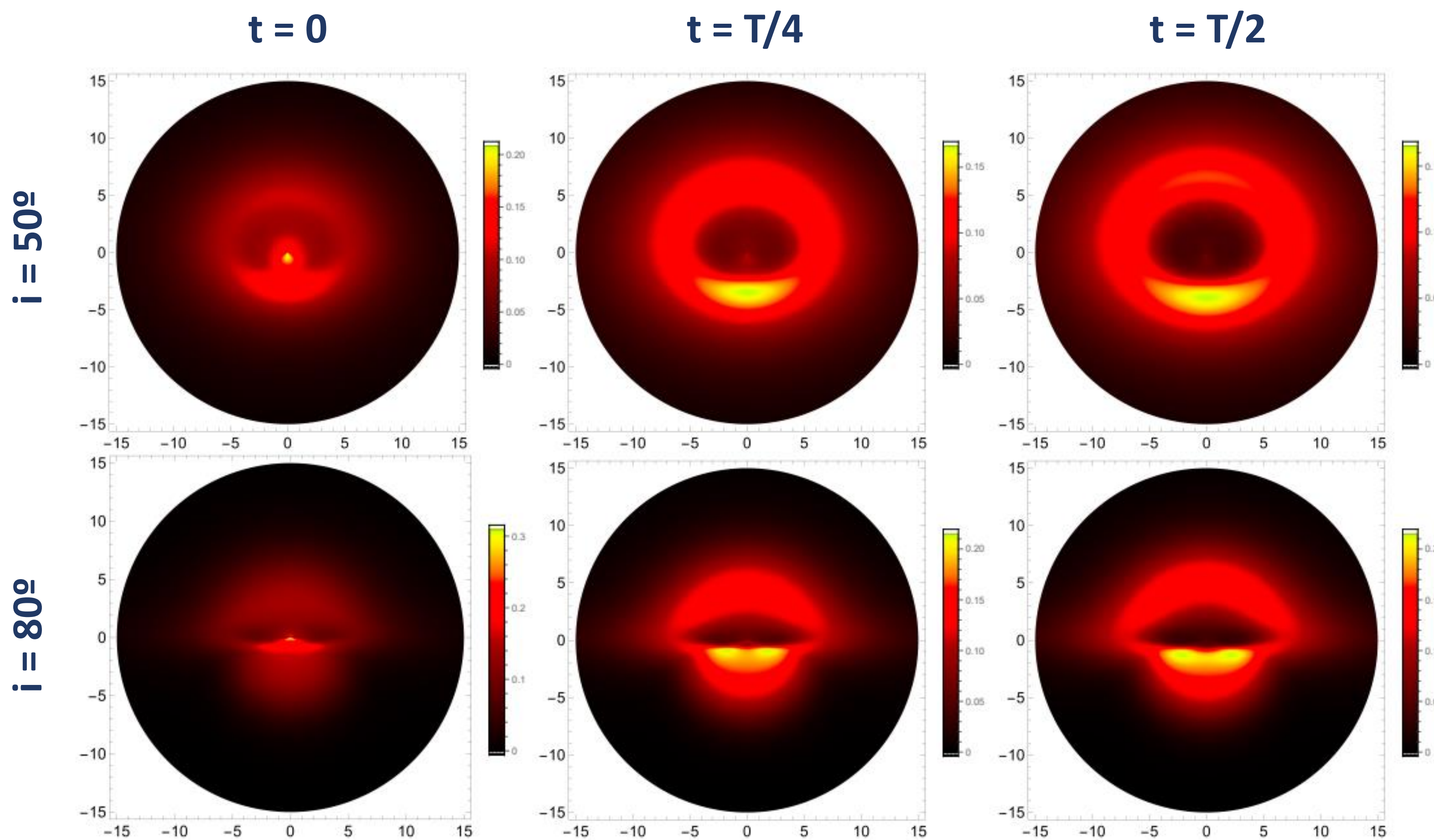
t = T/2





INCLINATION

Variability and contrast persist for inclined observations



SUMMARY

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Conclusions

1. Oscillaton spacetimes support oscillatory circular orbits;

2. Optical properties of accretion disks are time-dependent;

3. Variability persists for different prescriptions and angles;

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Future work

1. Extensions to rotating and more compact oscillaton configurations;

2. More realistic radiation transfer mechanisms and accretion flows;

3. Interaction models between scalar field and matter components;