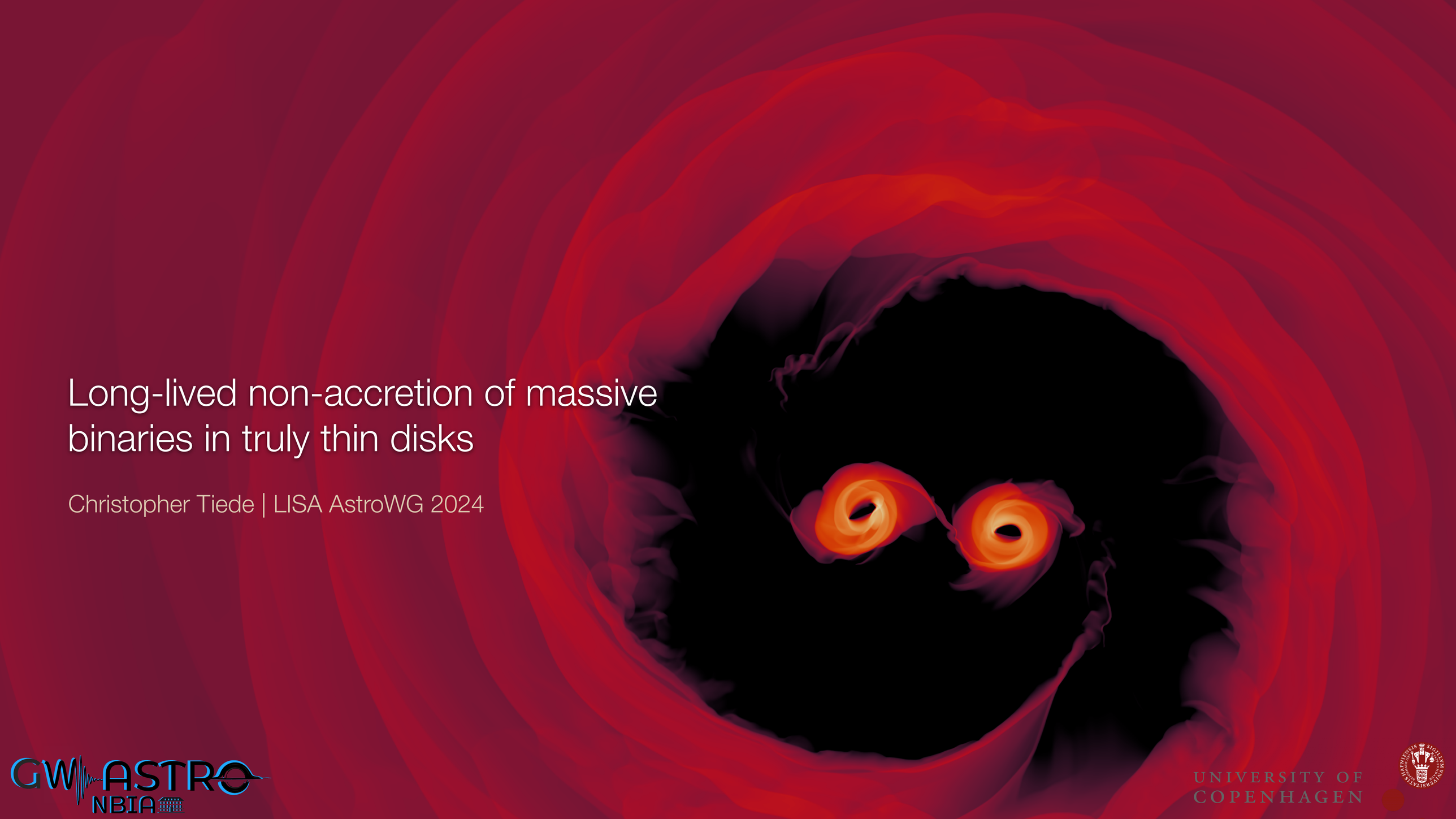
Long-lived non-accretion of massive binaries in truly thin disks

Christopher Tiede | LISA AstroWG 2024



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Binary Accretion

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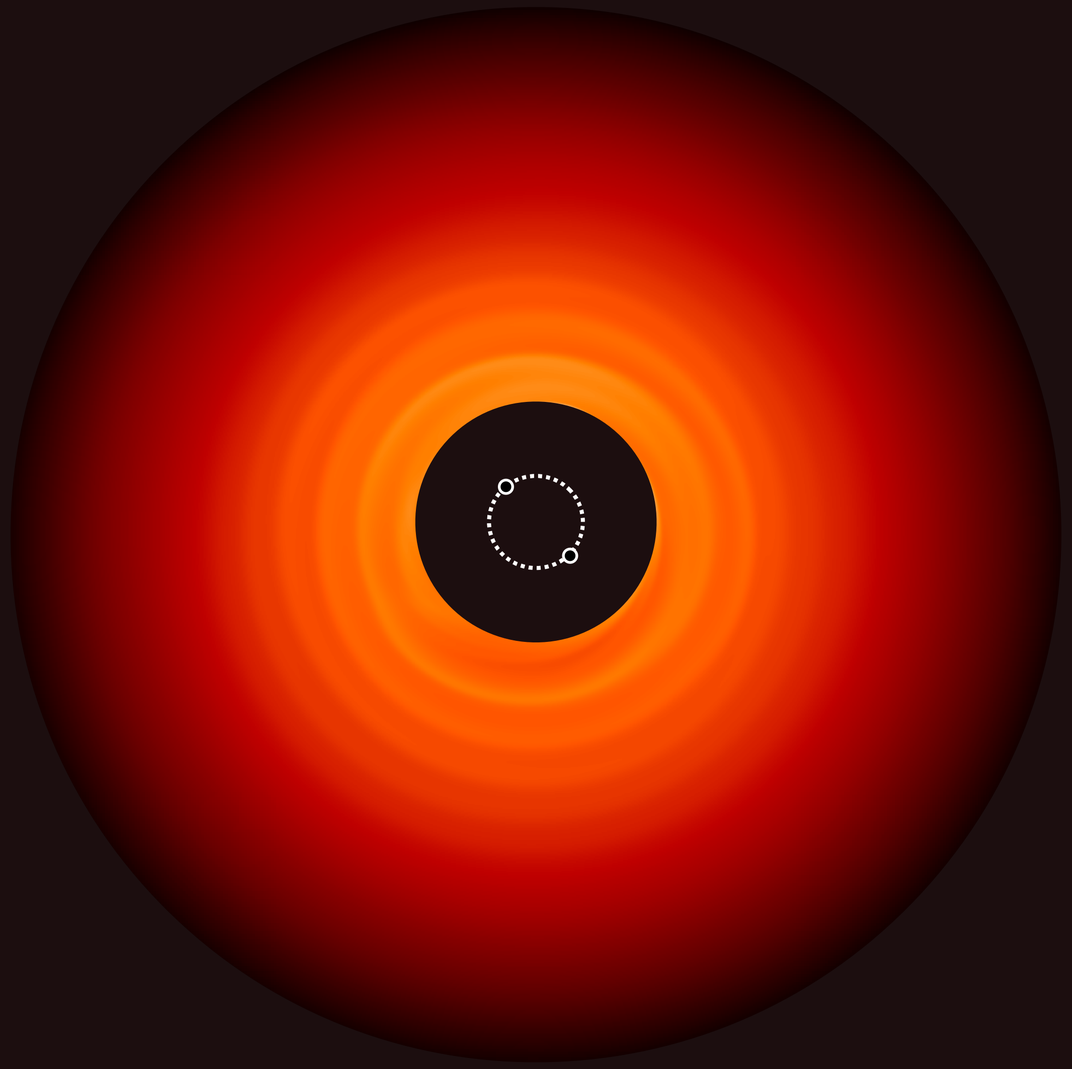

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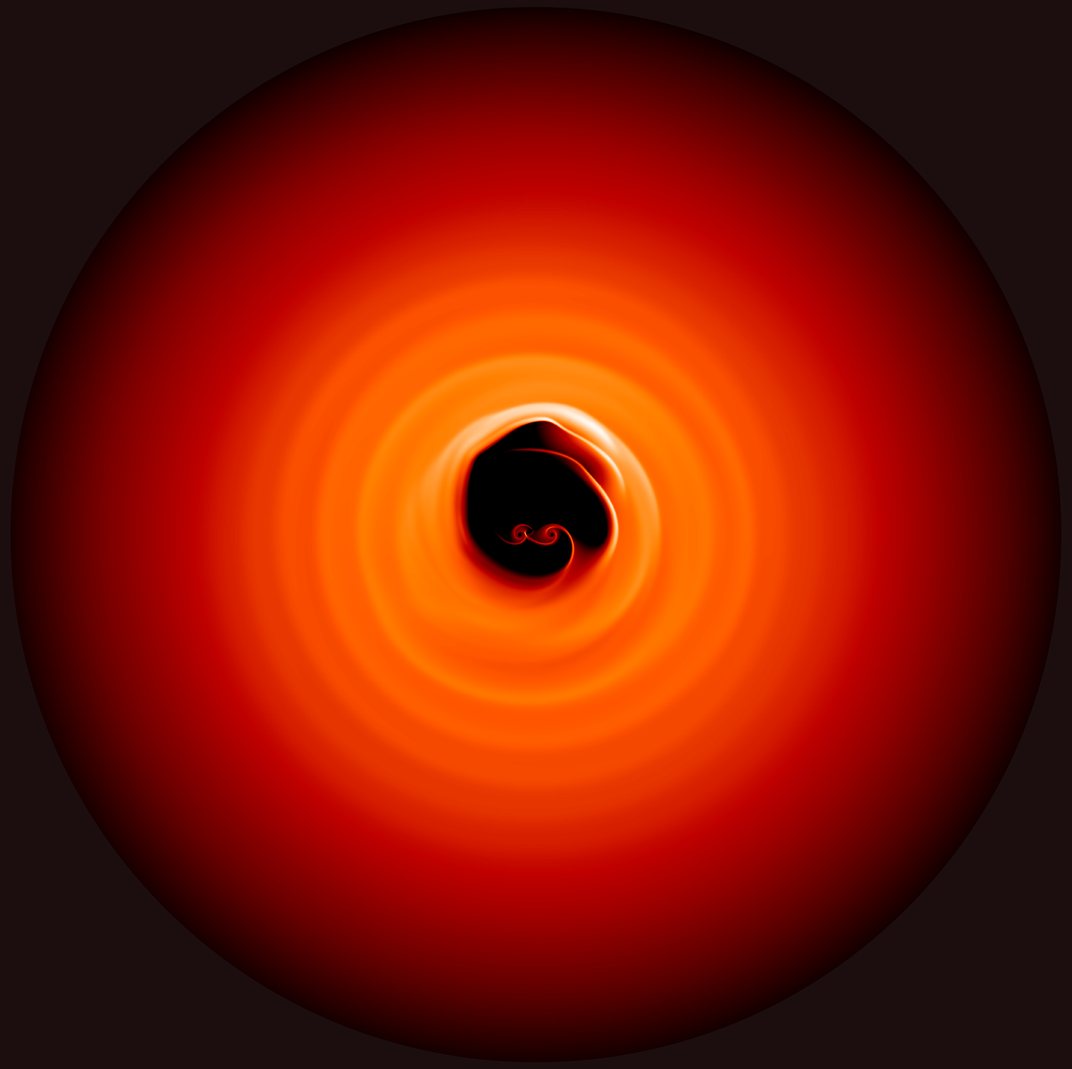

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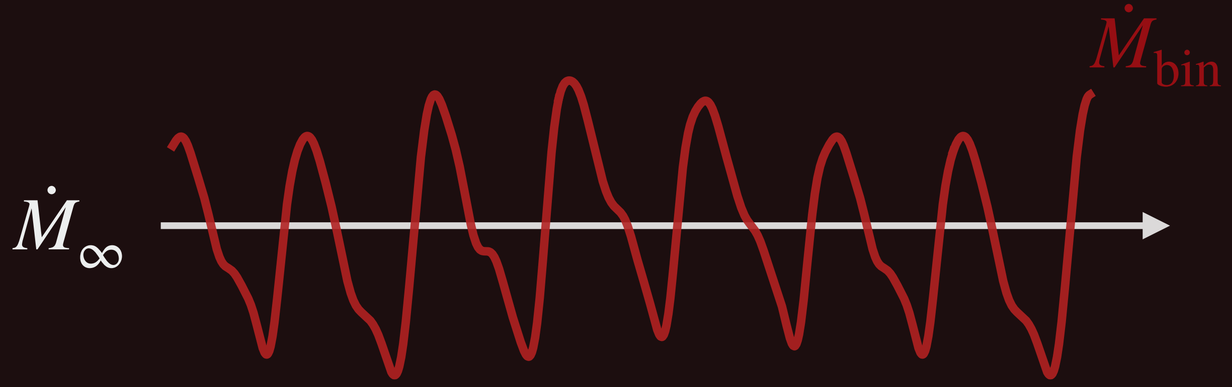

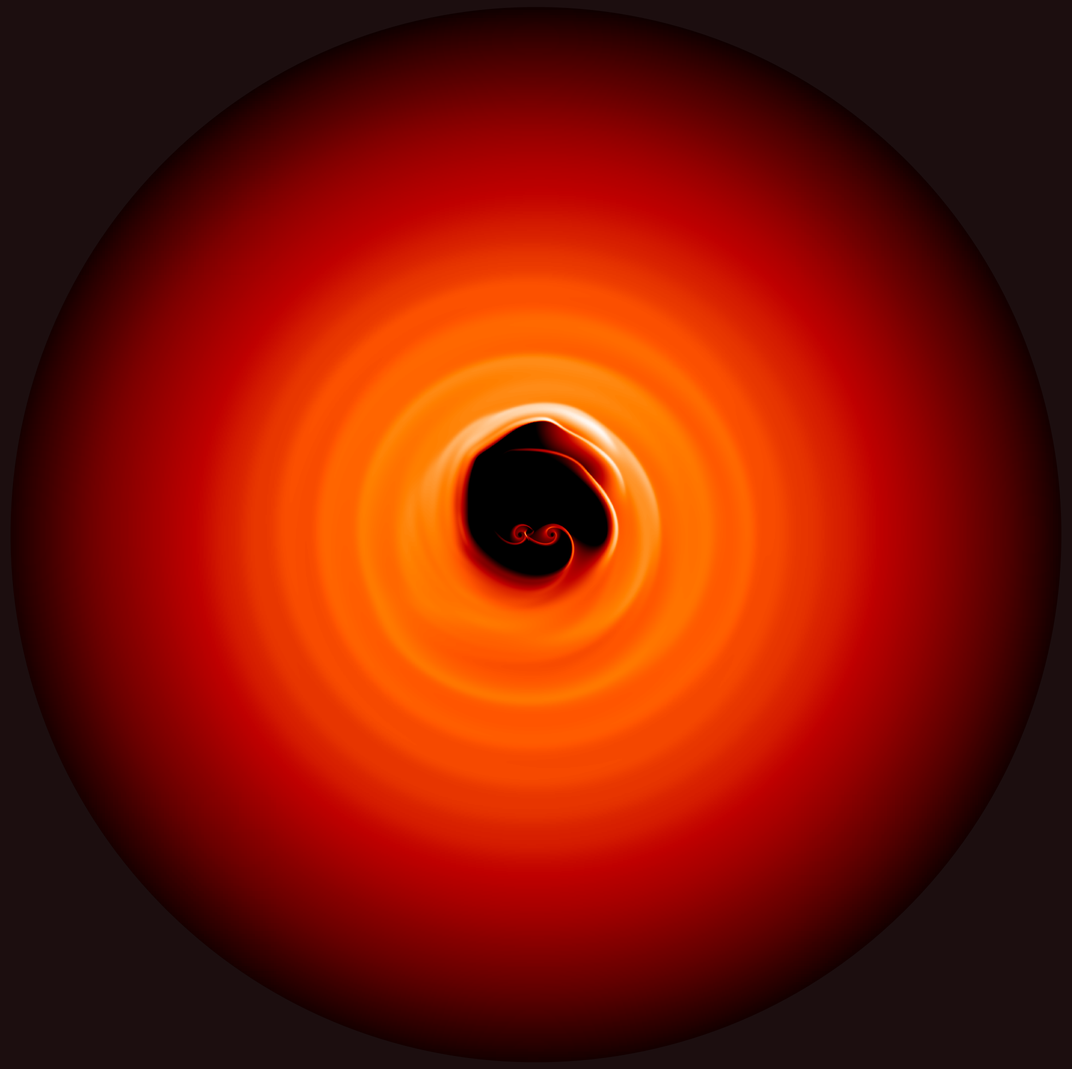

Physical Picture

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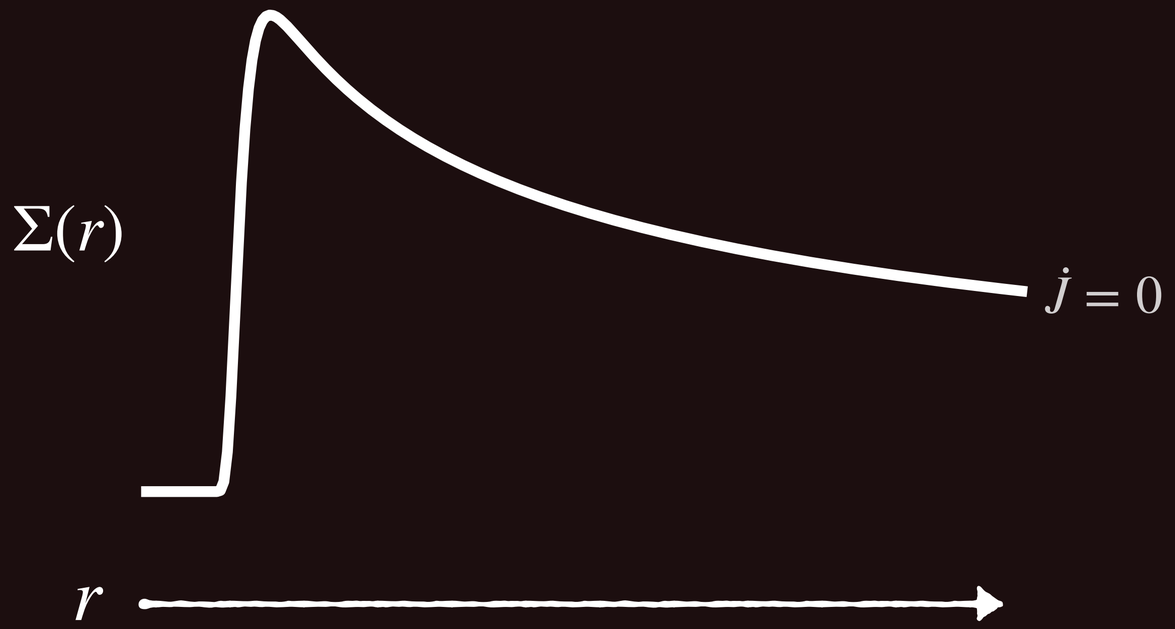
$$\Sigma(r) = \frac{\Sigma_0}{\sqrt{r}}\left(1 - \frac{j}{\dot{M}}\sqrt{\frac{1}{r}}\right)$$



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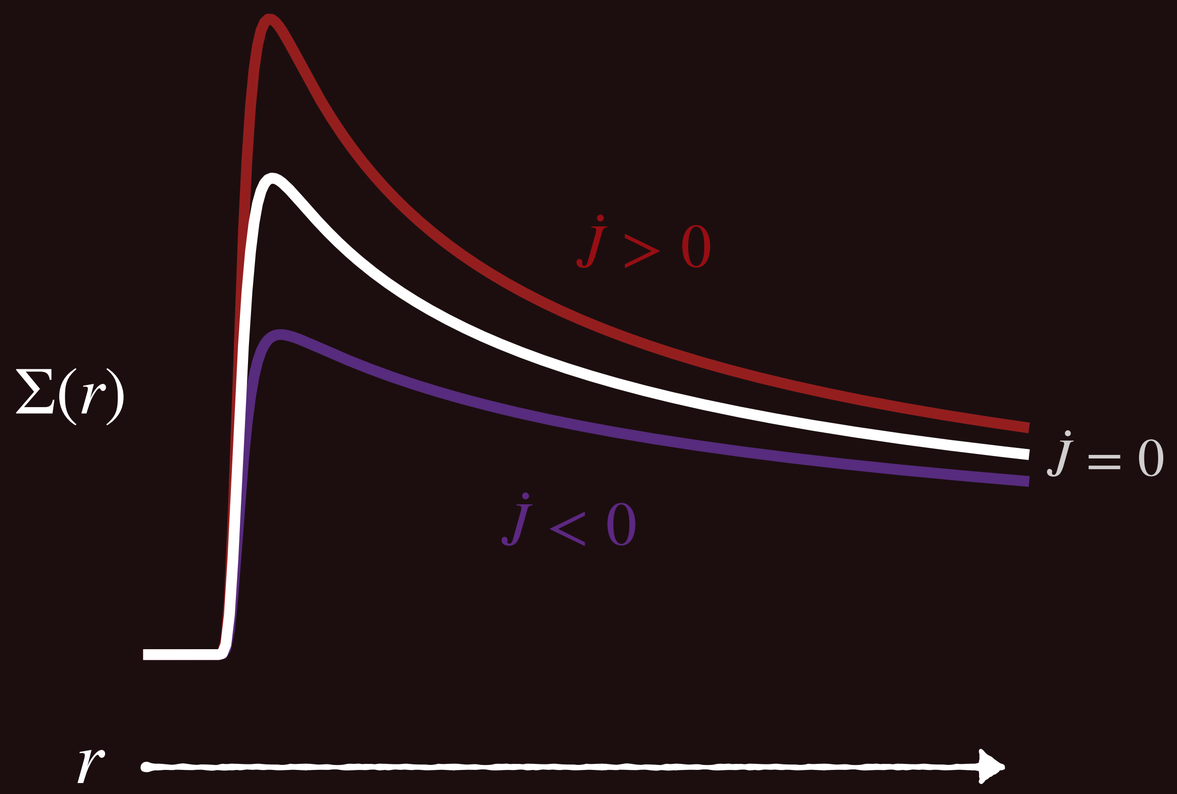

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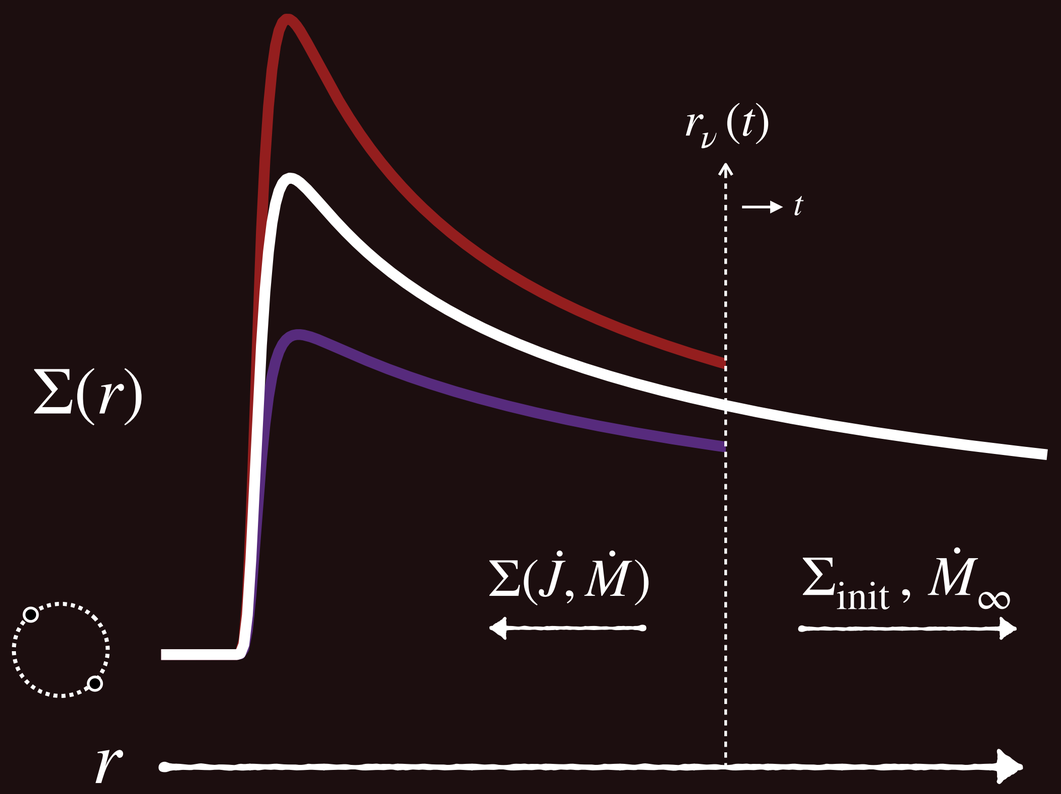

(see also Rafikov 2016)

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$$t_{\rm visc}\left(r_\nu(t)\right) = t$$

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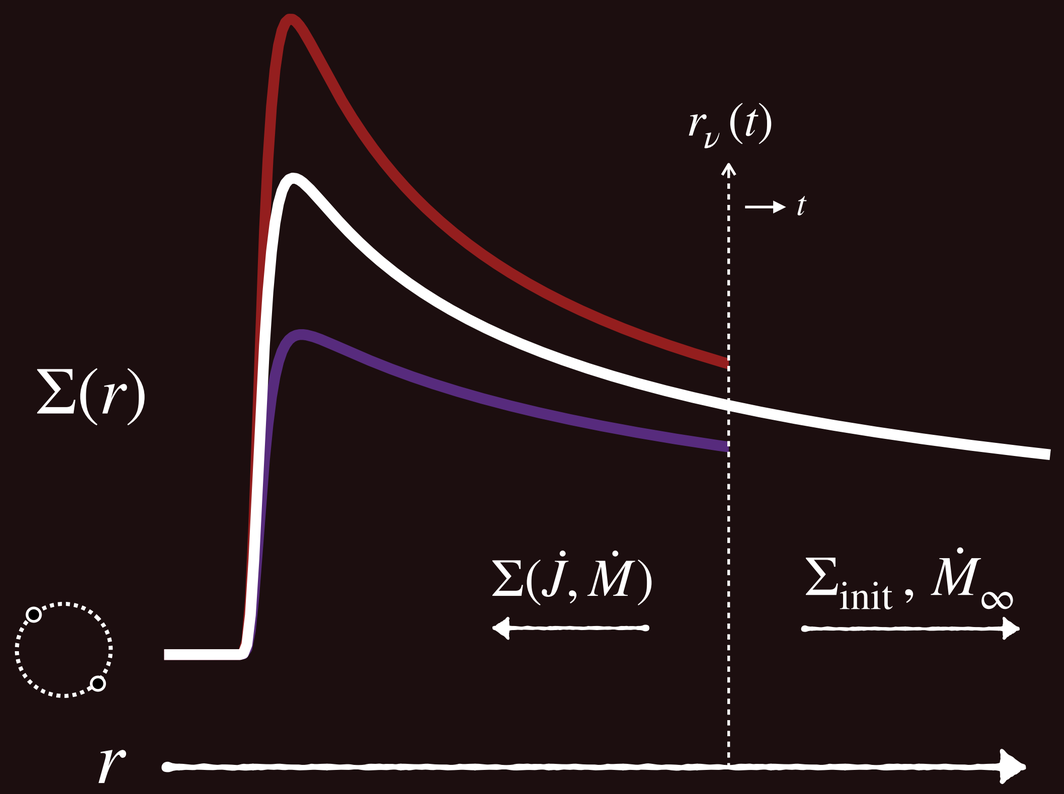

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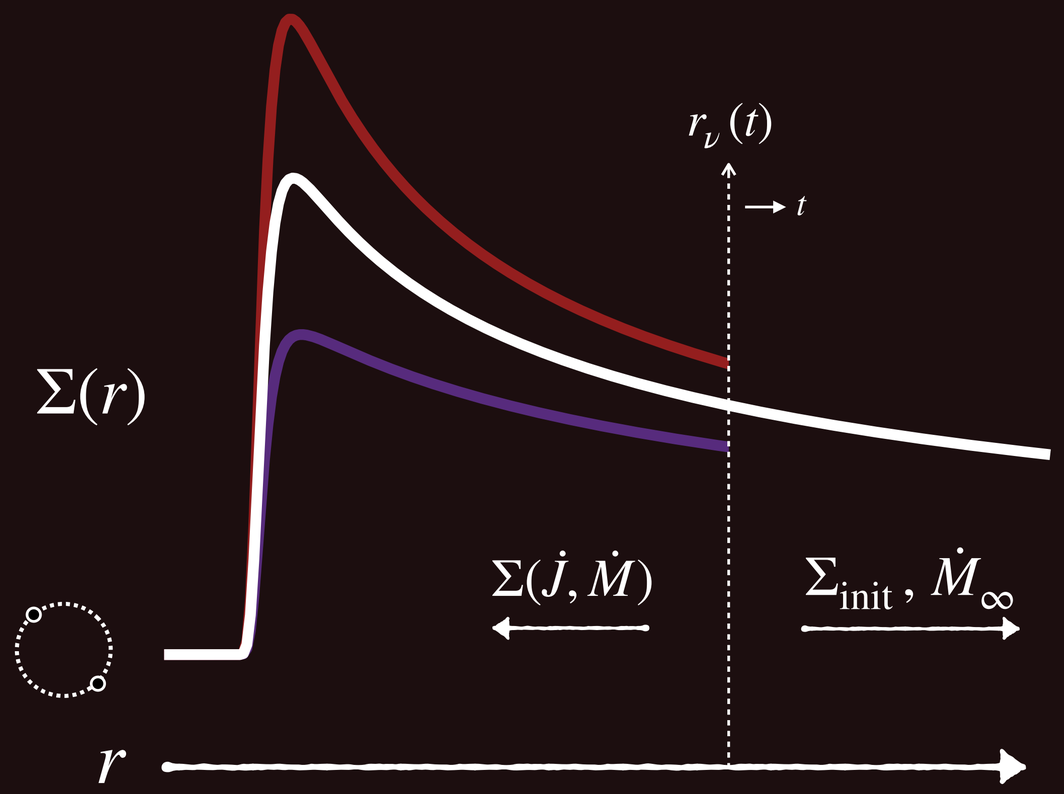

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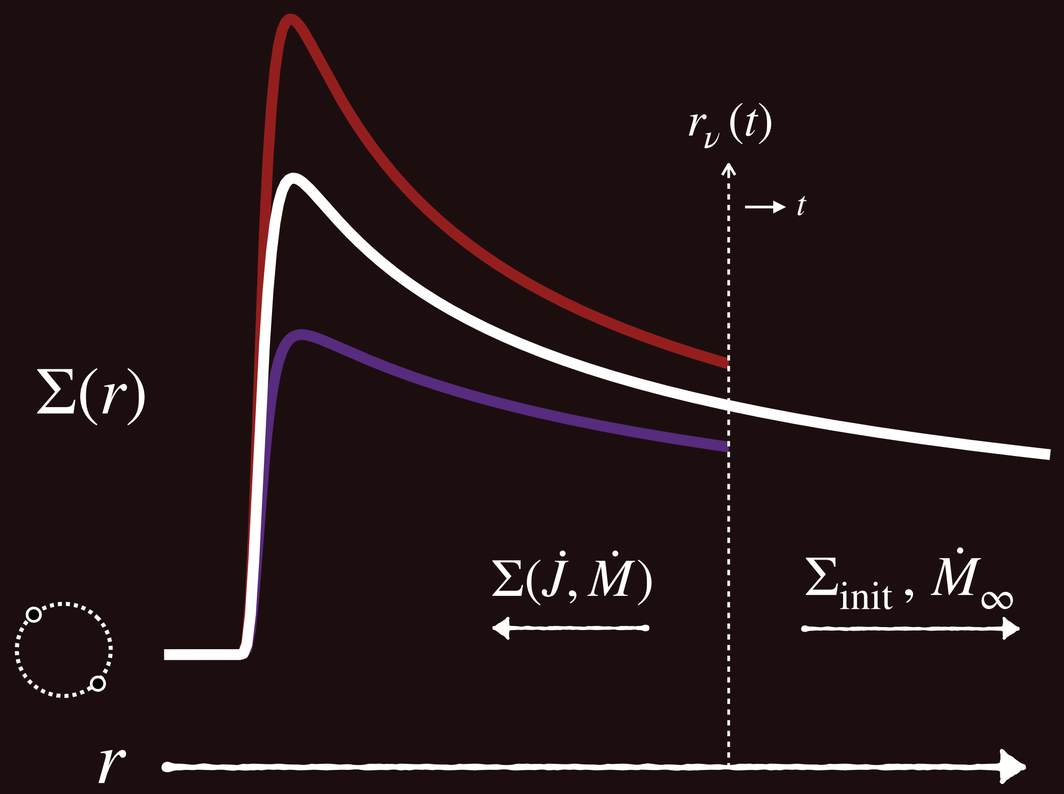

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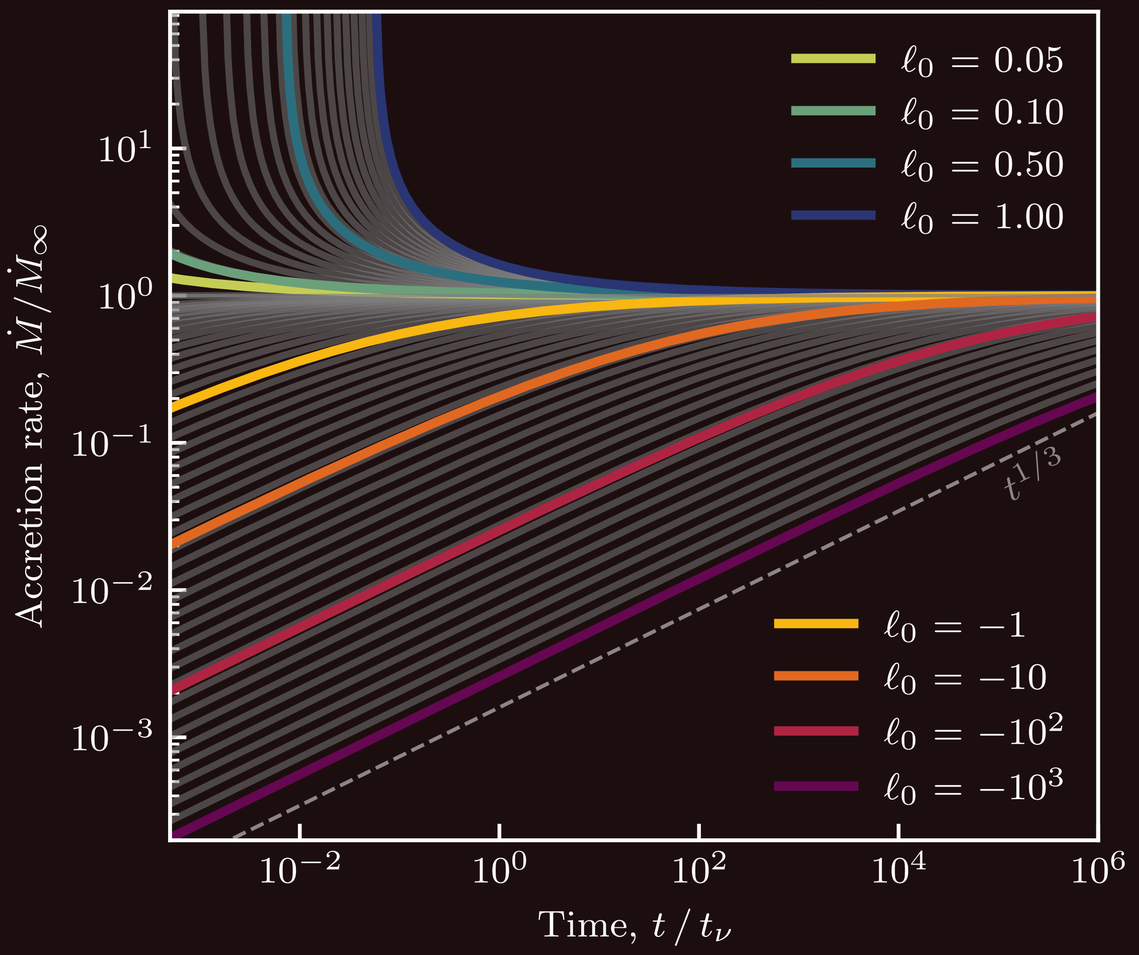
Physical Picture

Tiede et al. (arXiv : 2410.03830)



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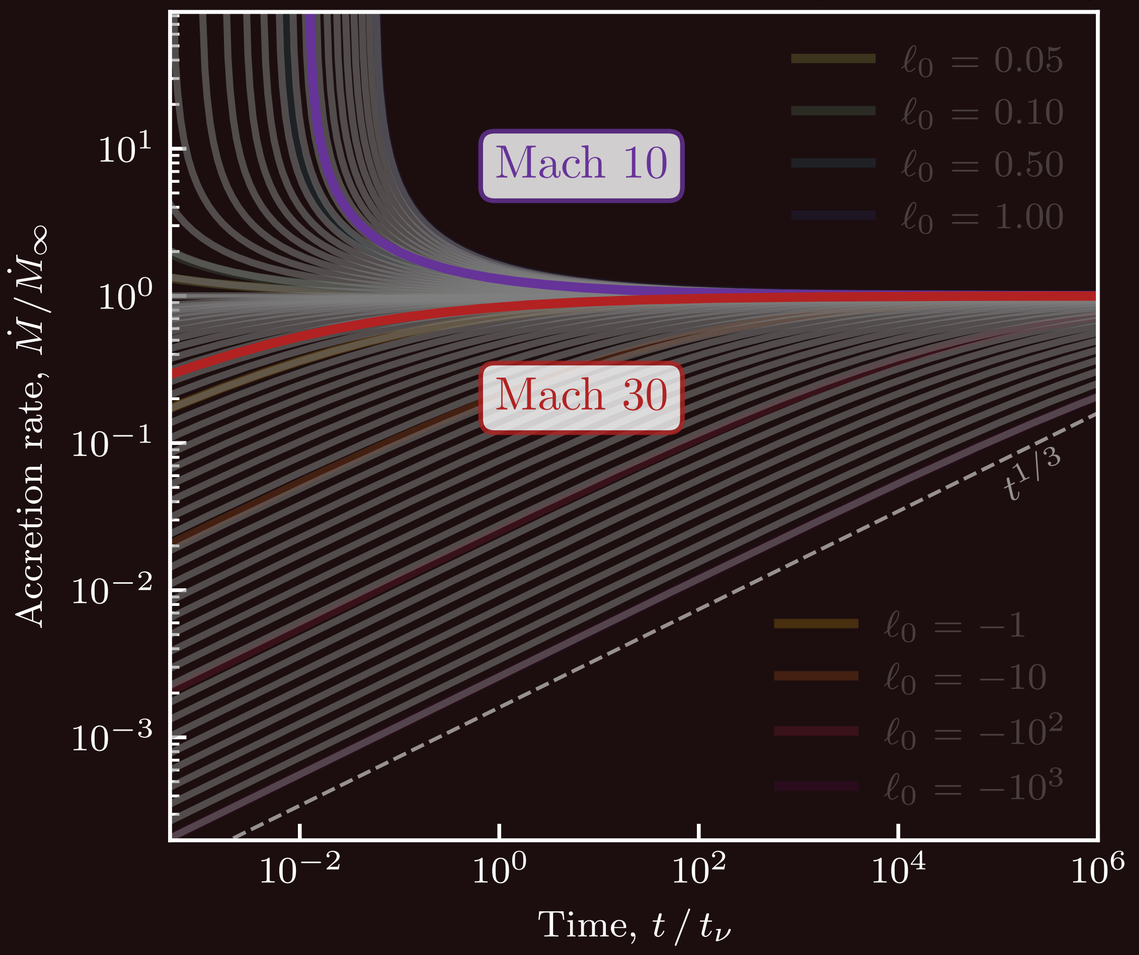
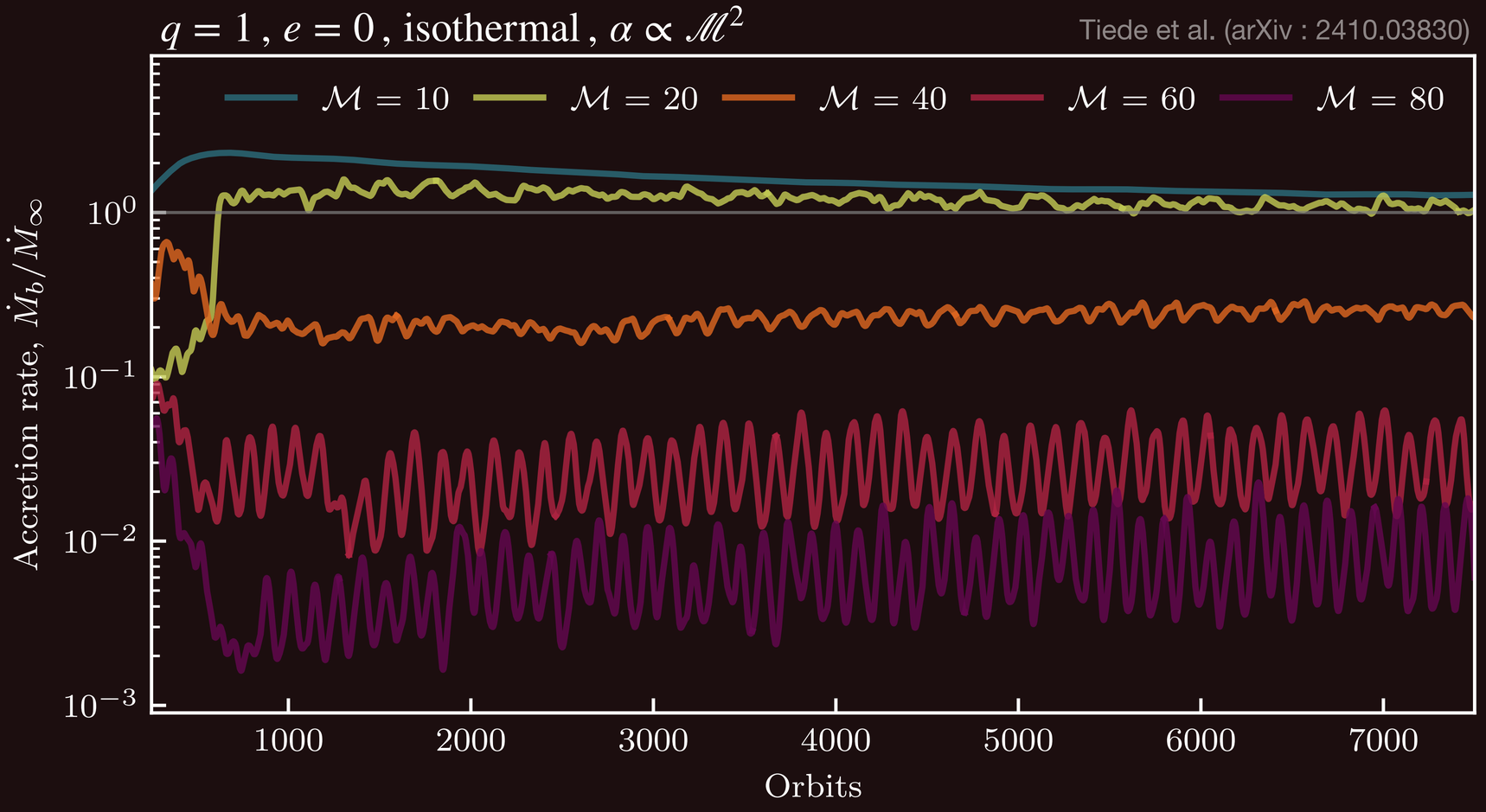


$$\mathscr{M}_{2a} \simeq 90 \left(\frac{M}{10^5\,\mathrm{M}_\odot}\right)^{2/15} \times \left(\frac{\alpha}{0.01}\right)^{1/10} \left(\frac{f_{\mathrm{Edd}}}{1.0}\right)^{-1/5} \left(\frac{P_b}{1\,\mathrm{yr}}\right)^{-1/30}$$

Truly Thin Disks



$1M_\odot : \mathscr{M} \rightarrow \mathcal{O}(10)$

$10^{5-6}M_\odot : \mathscr{M} \rightarrow \mathcal{O}(100)$

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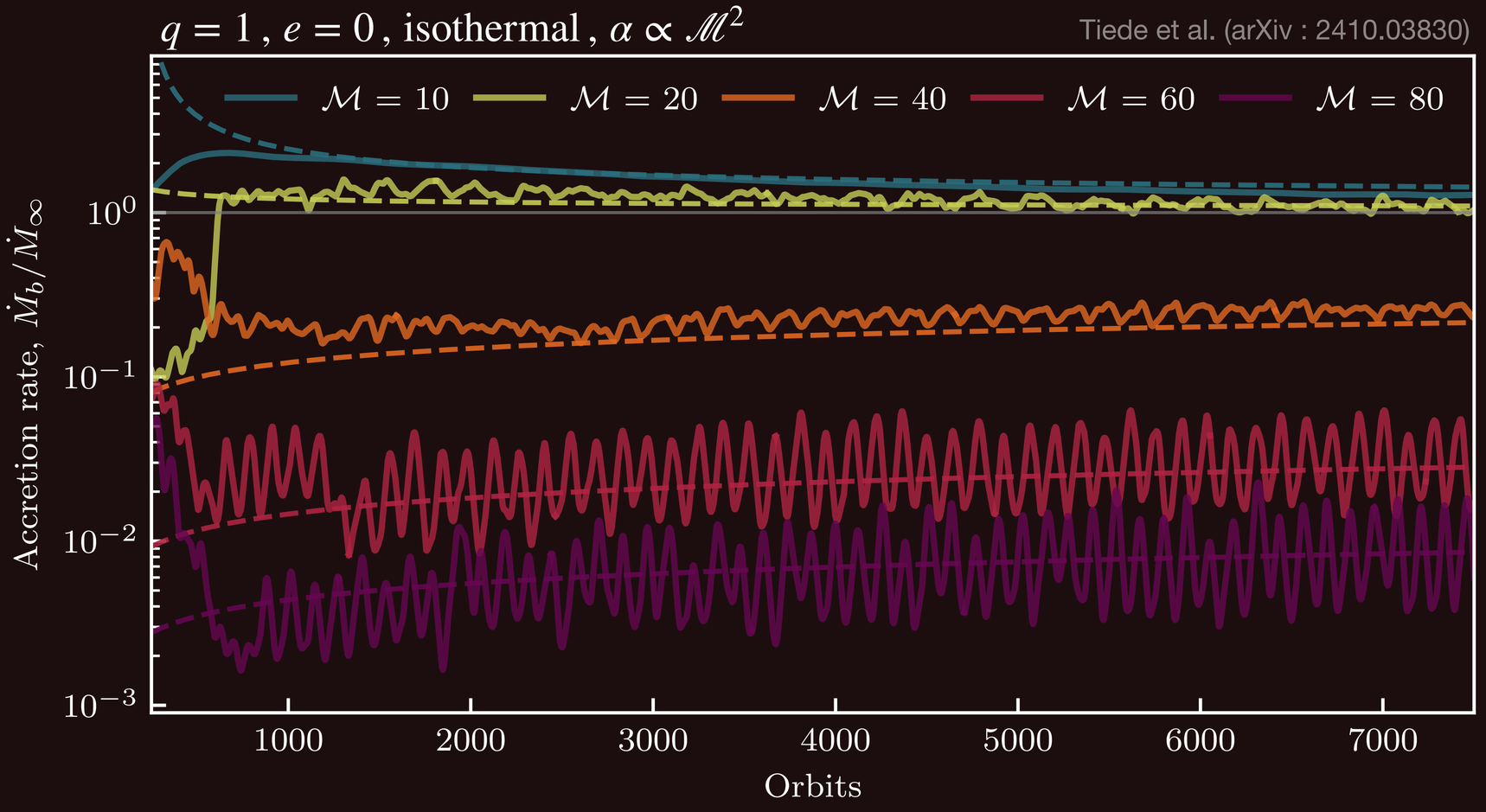

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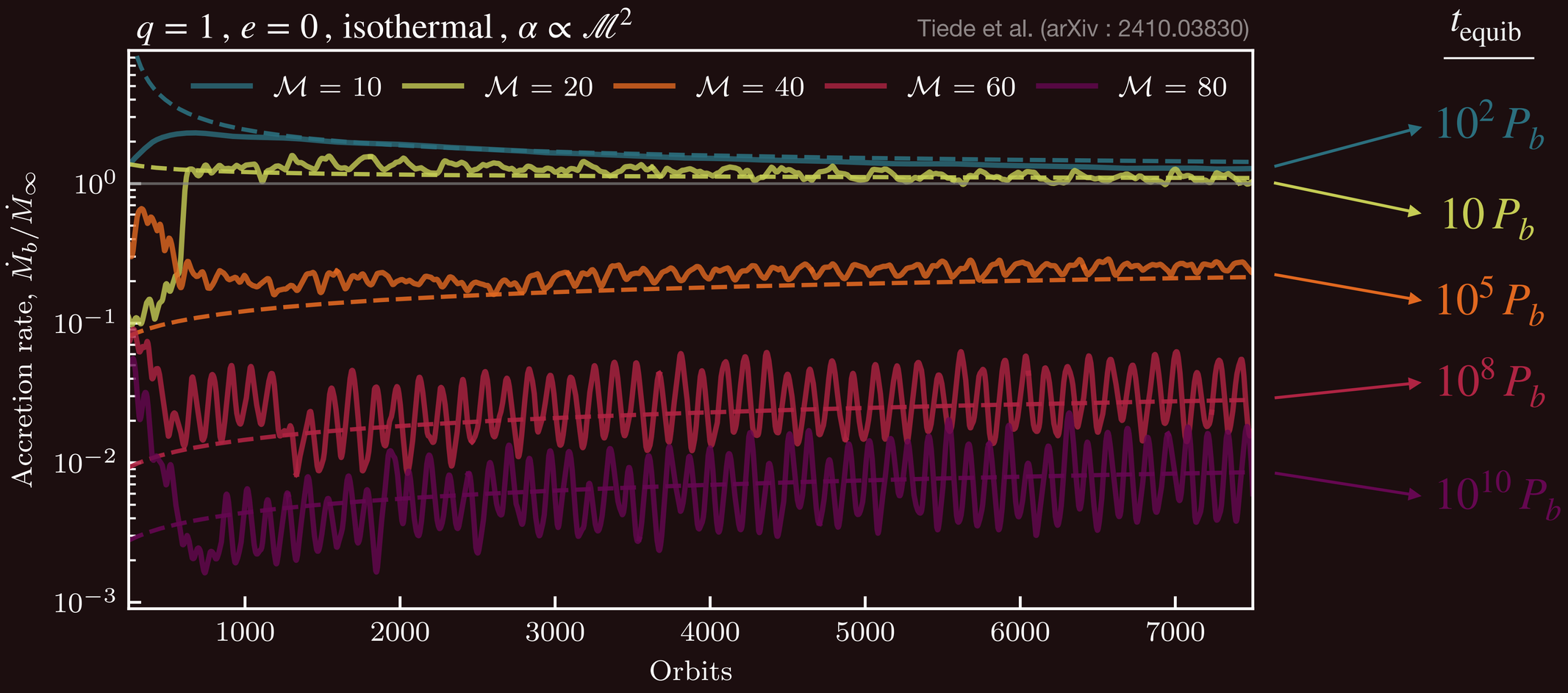

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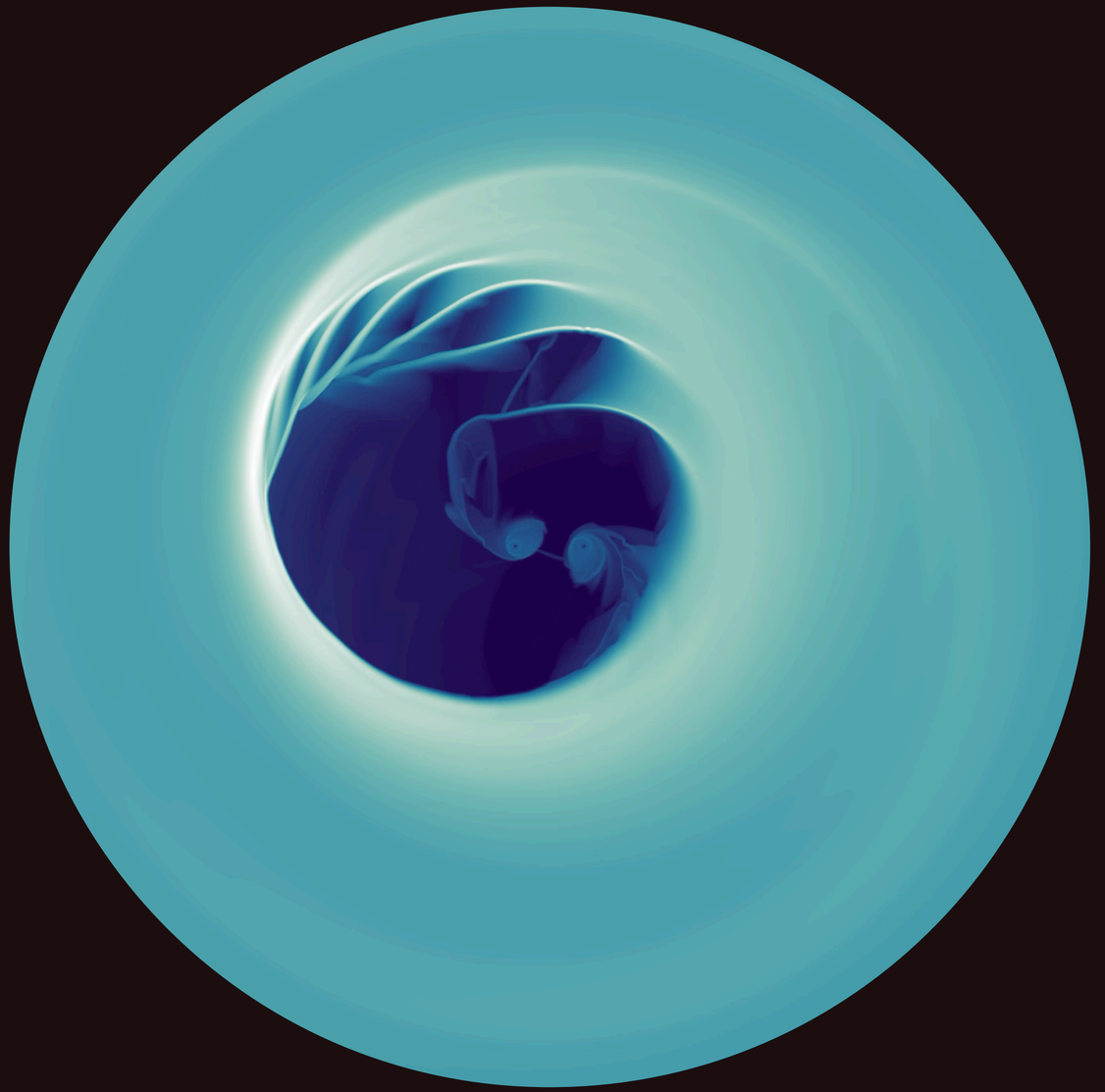
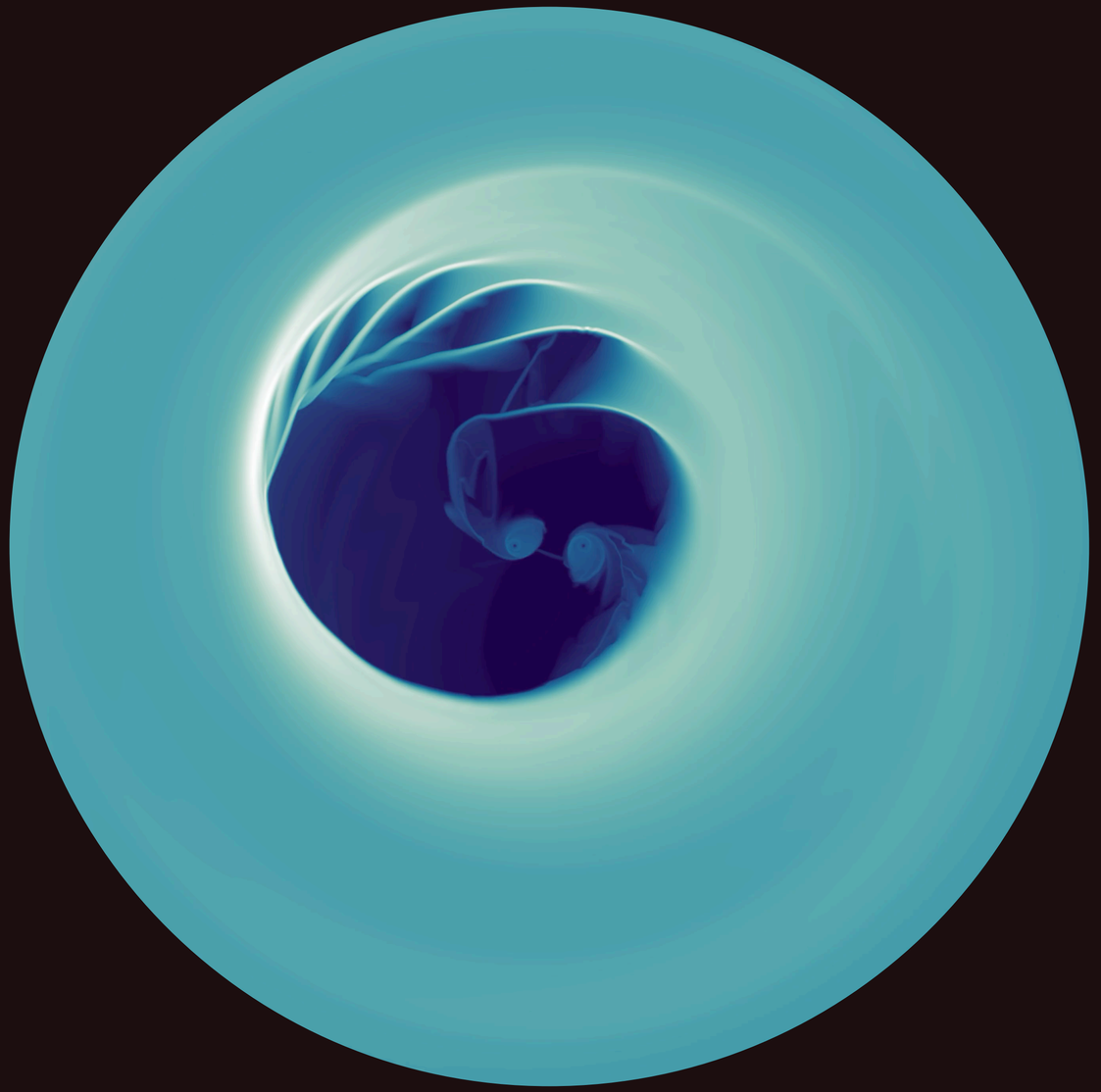


Truly Thin Disks

$$\dot{J}_b = -\dot{J} \simeq (\eta \dot{M}_b - \dot{M}_{\rm int})\, a^2 \Omega_b$$

$$\dot{M}_b = \chi \dot{M}_{\rm int}$$ χ : stream efficiency



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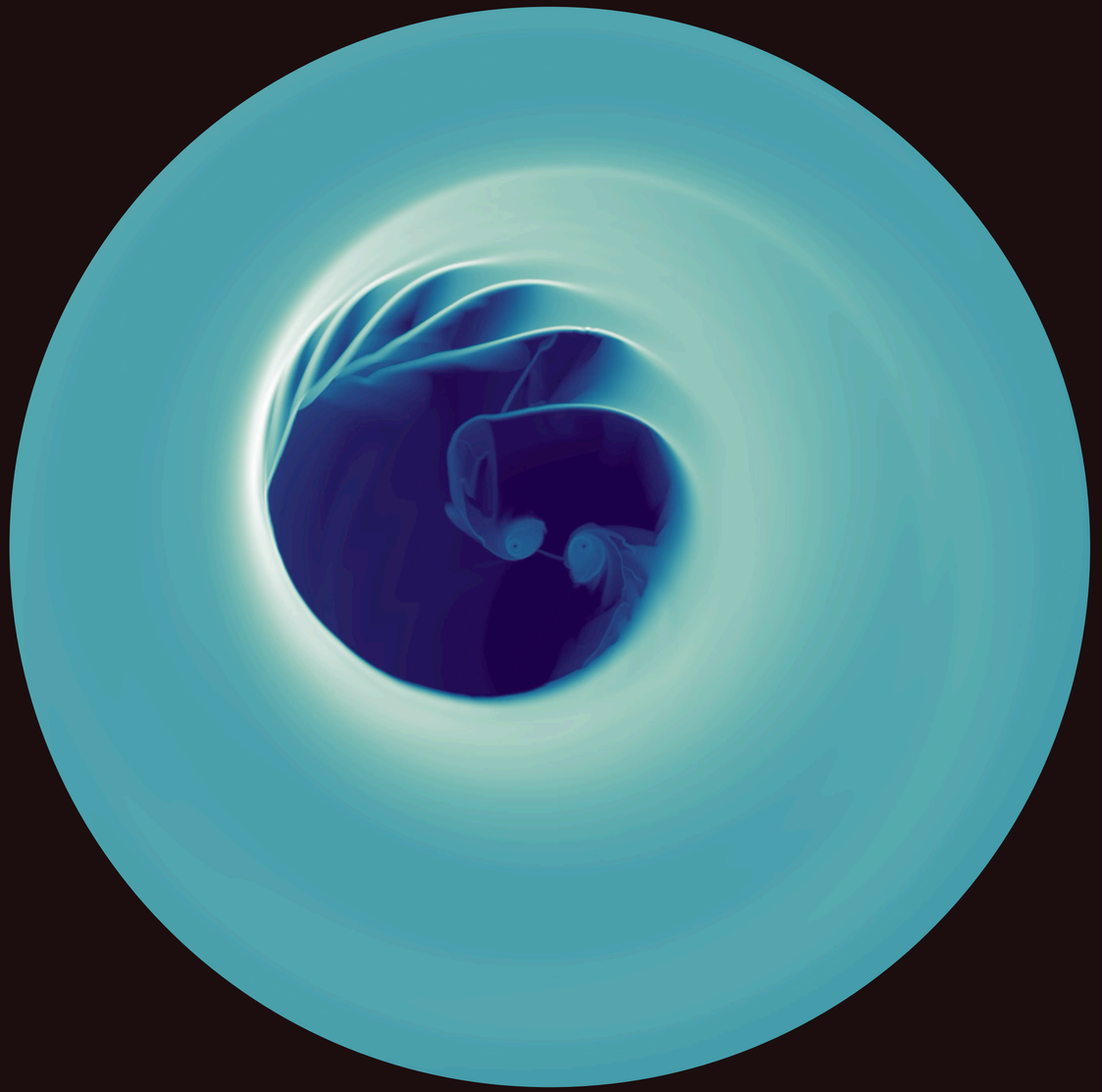
$$\dot{M}_b = \chi \dot{M}_{\rm int} \qquad \chi : \text{stream efficiency}$$

$$\xrightarrow{\dot{M}_b \ll \dot{M}_\infty} \quad \ell_0 \sim \chi^{-1}$$

ℓ_0 : *"recycyling number"*



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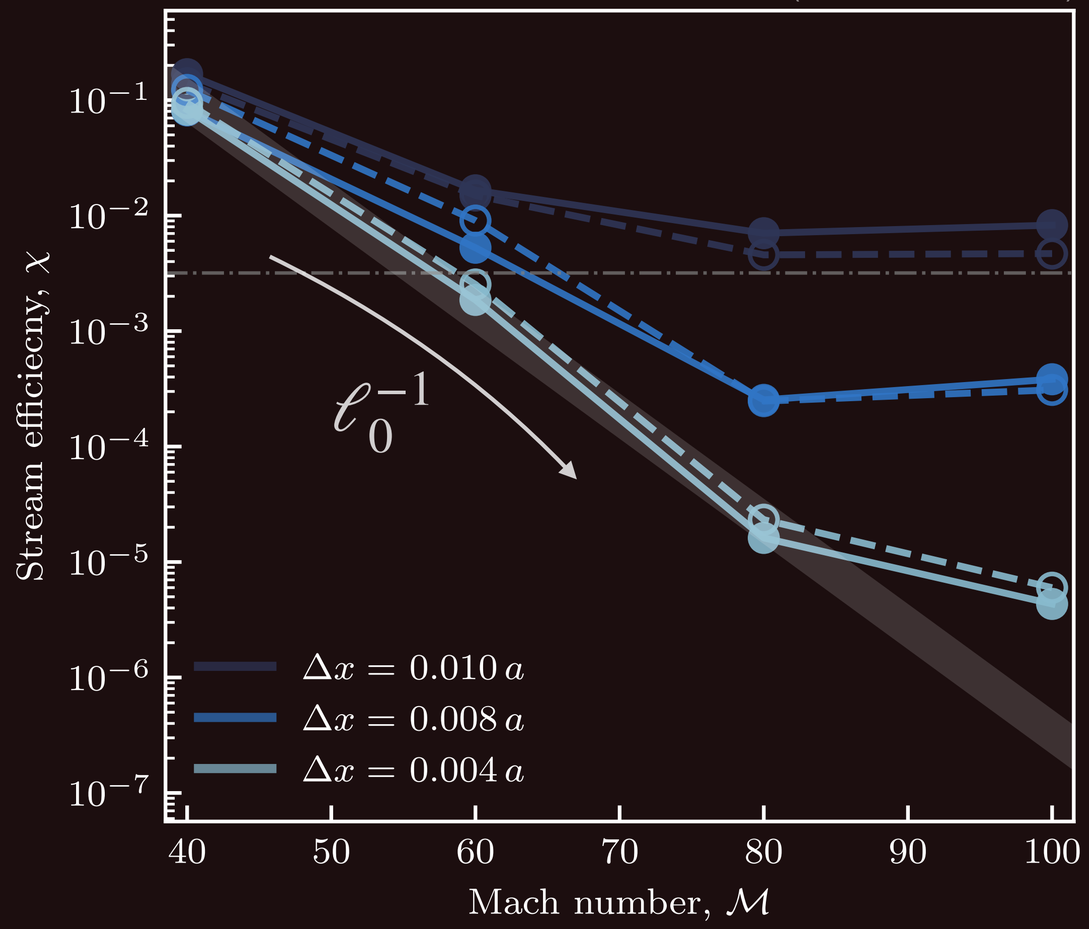

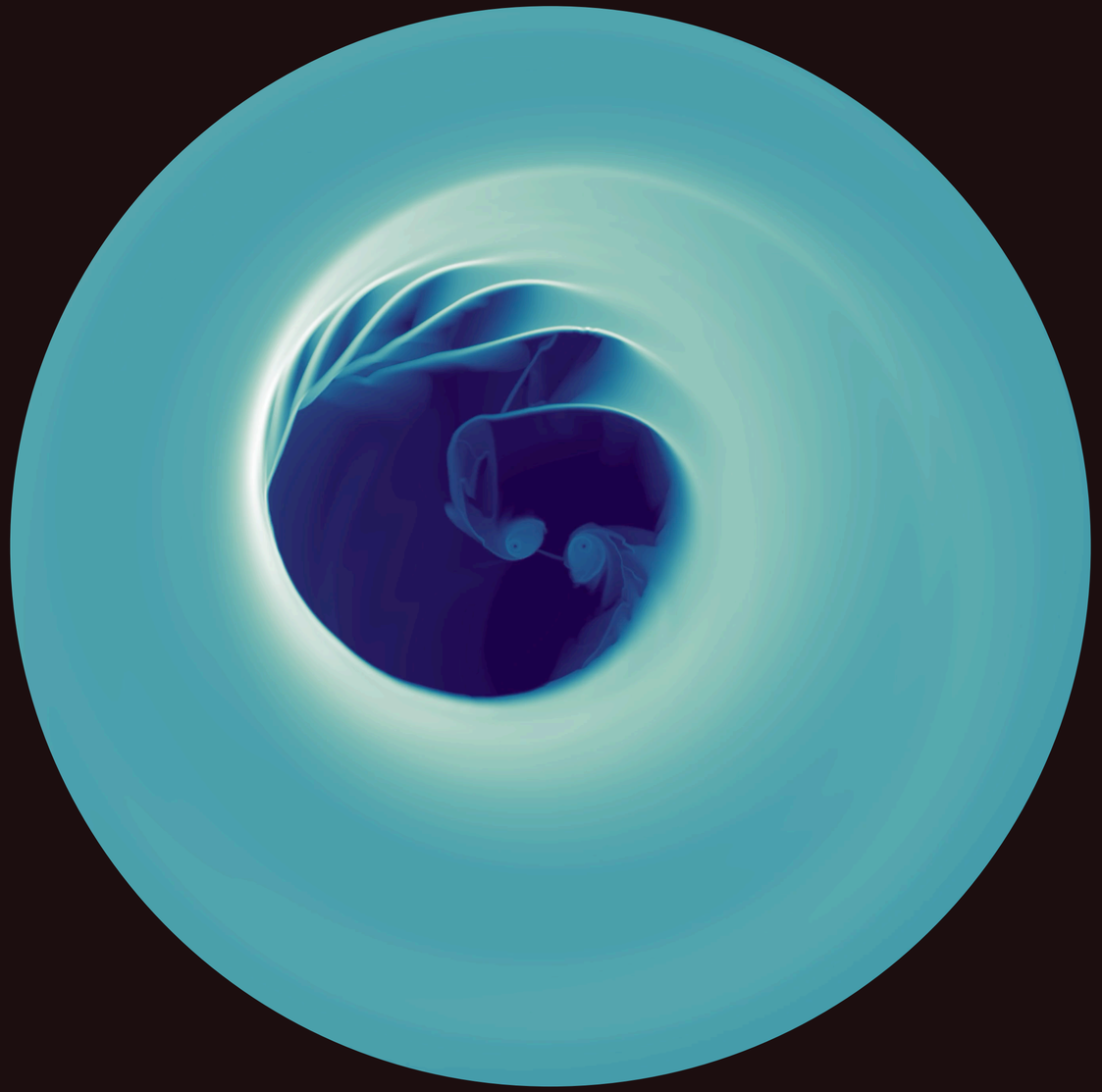

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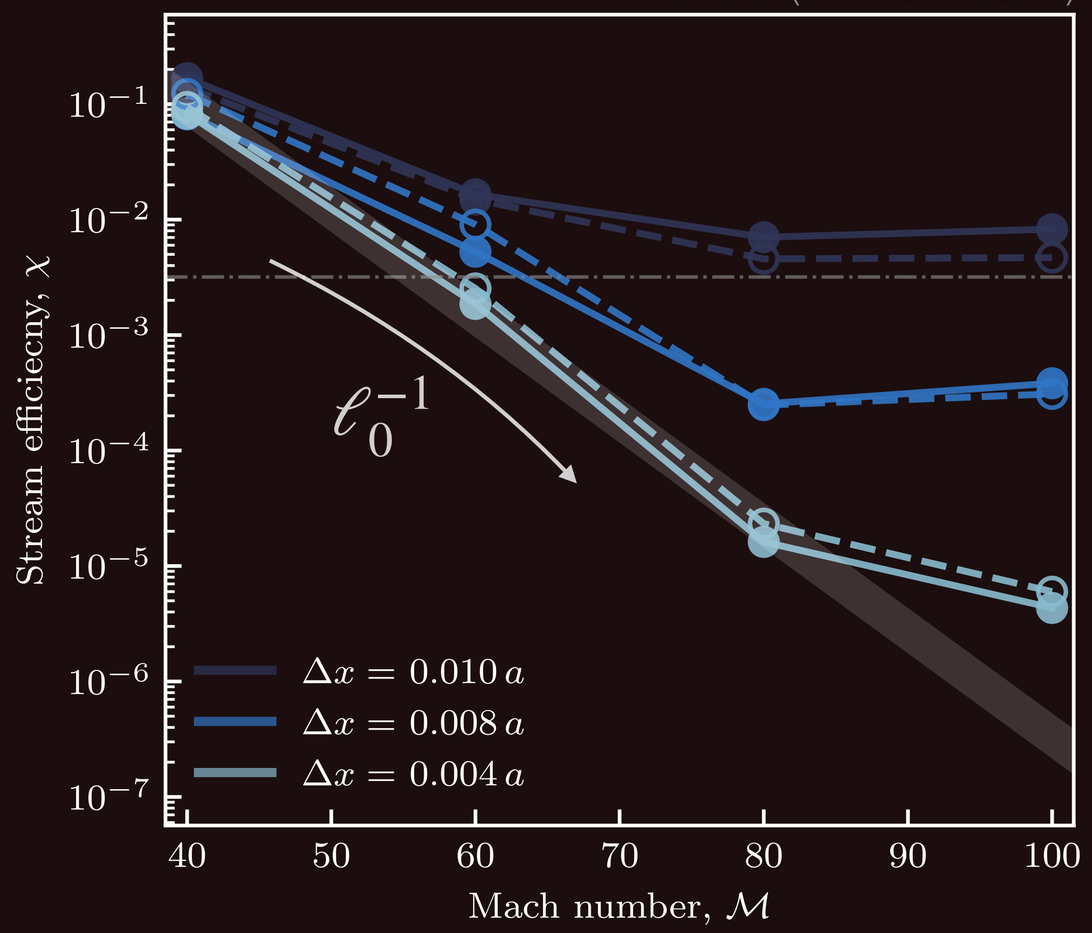

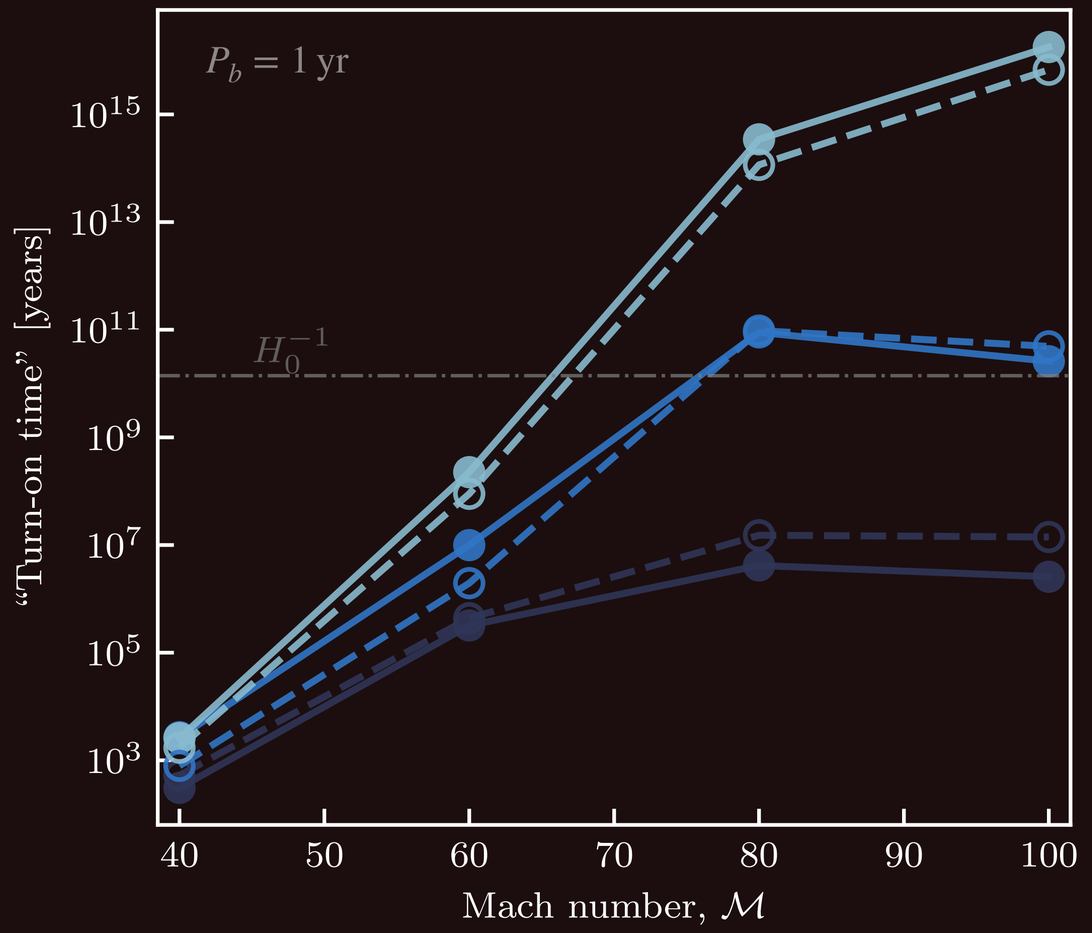

Takeaways

- Numerical experiment
- Thin binary accretion highly sensitive to inner thermodynamics
- Radiation / Magnetic Fields likely important

Implications

- Efficient orbital decay
- Luminosity suppression of $\mathcal{O}(10^2 - 10^4)$
- Loss of some variability features
- Post-merger activity

Thanks!

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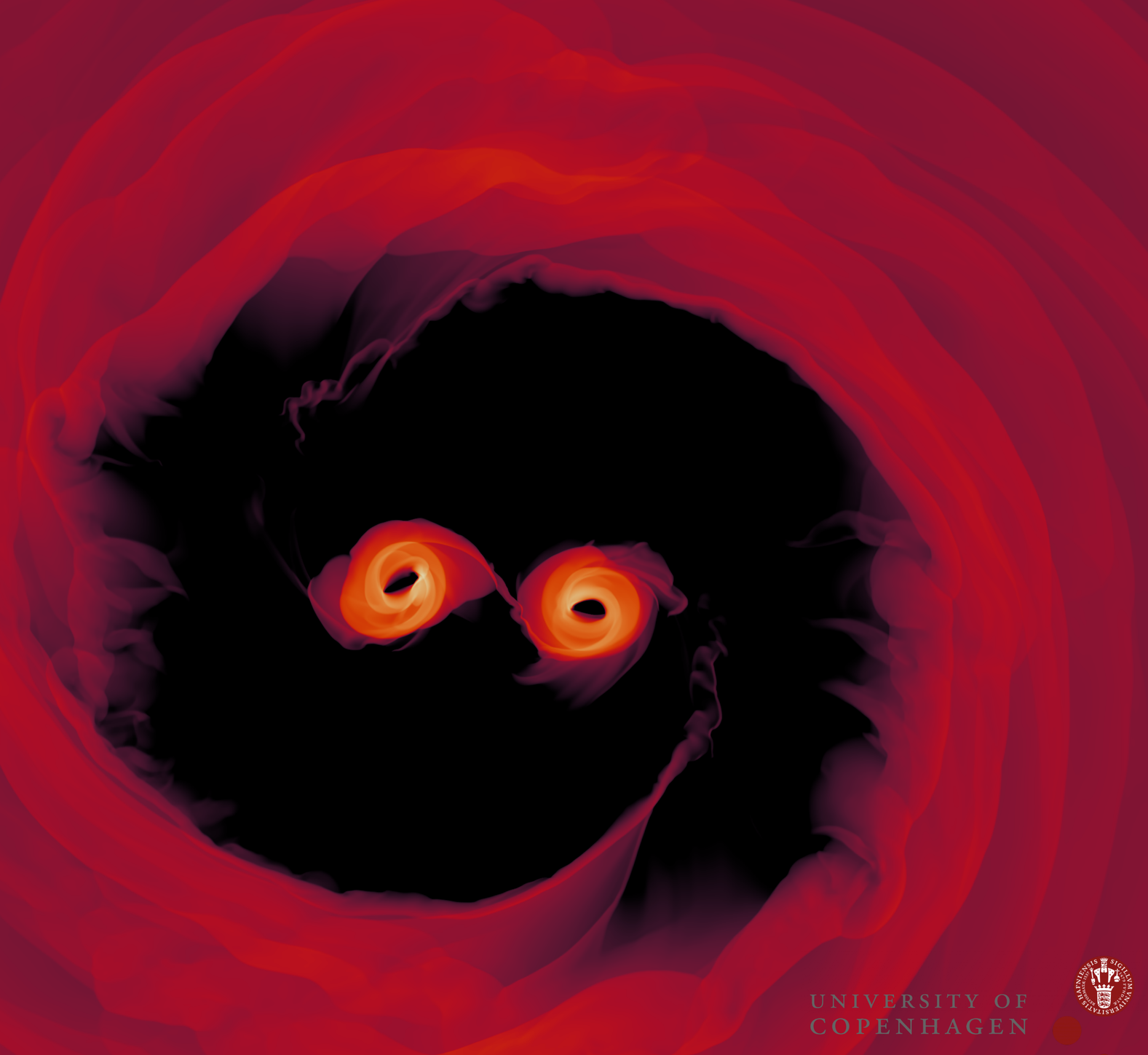

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Steady-States

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