

# X-ray femtolensing probes asteroid-mass black holes



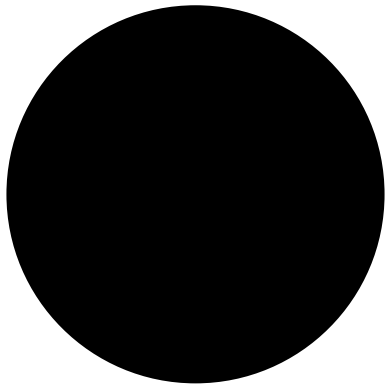
Massachusetts  
Institute of  
Technology

Benjamin V. Lehmann

26xx.xxxxx

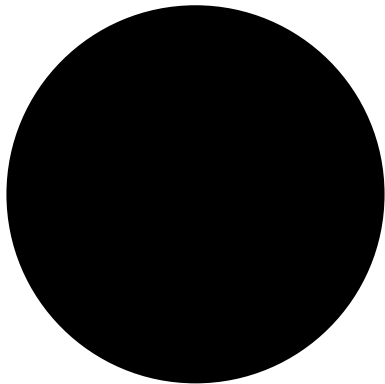
# Is dark matter black holes?

*The minimal DM candidate*



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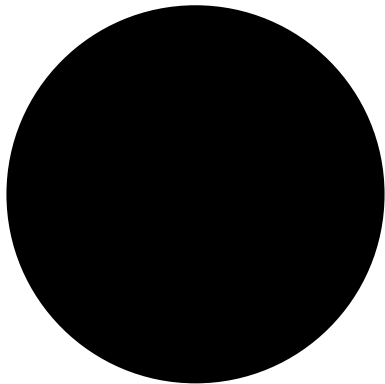
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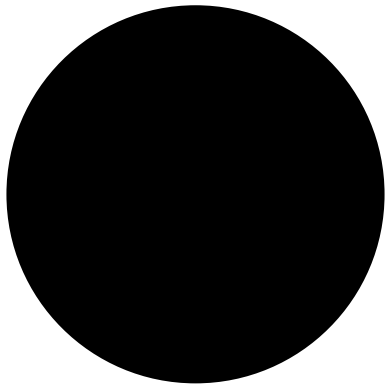
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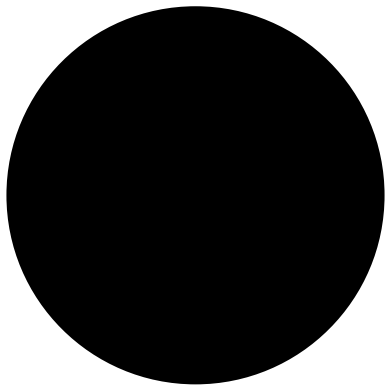
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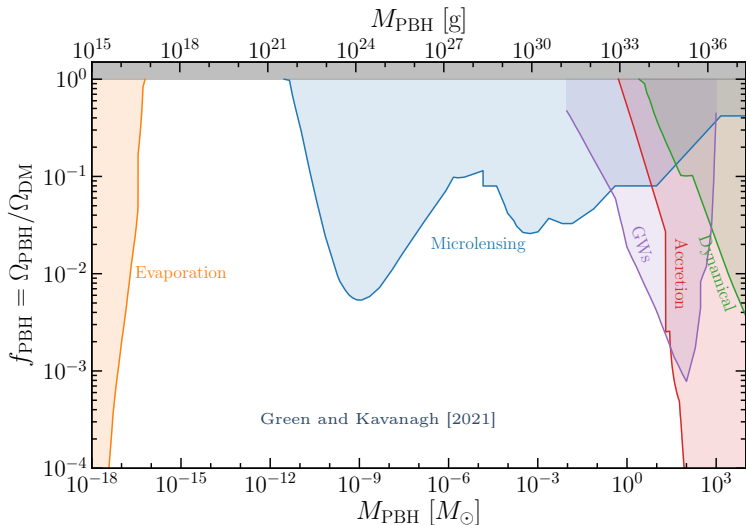
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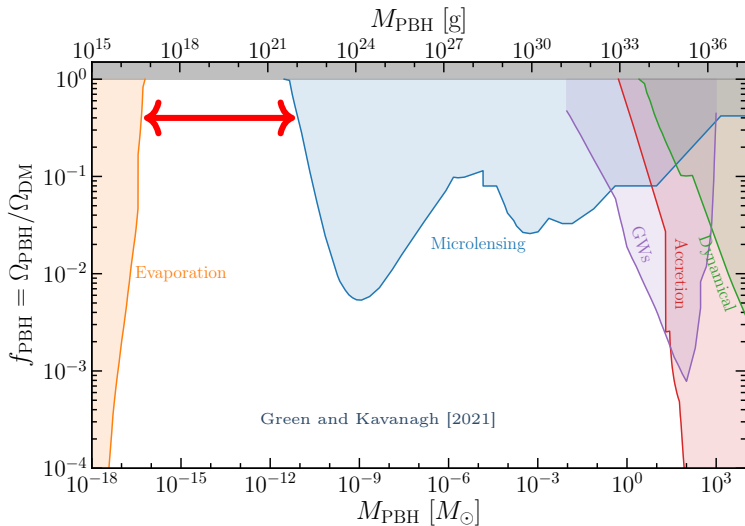
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*(and a proxy for granular DM, but not for this talk)*

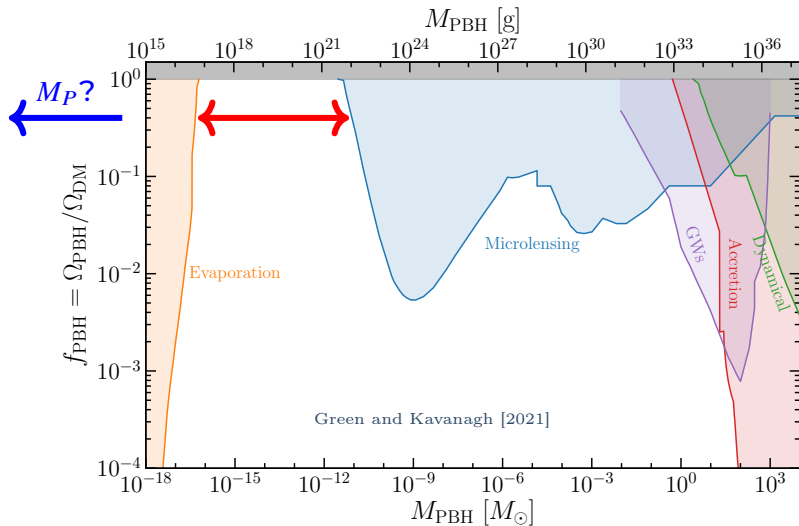
# Primordial black holes as DM



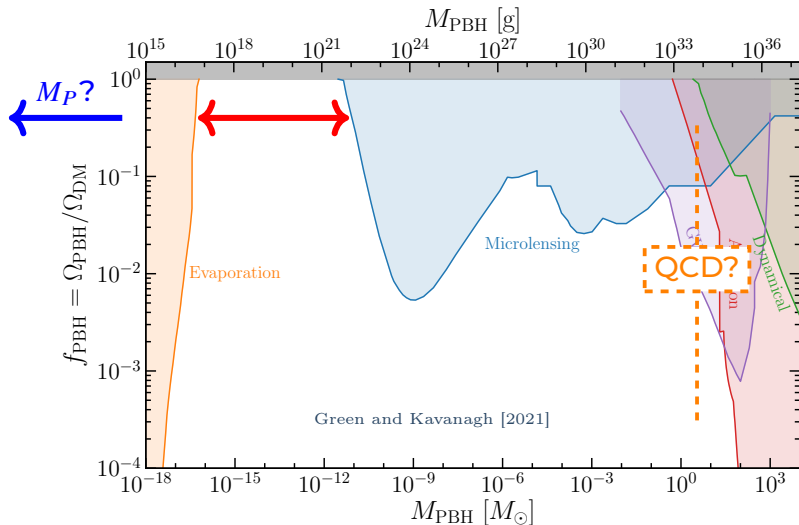
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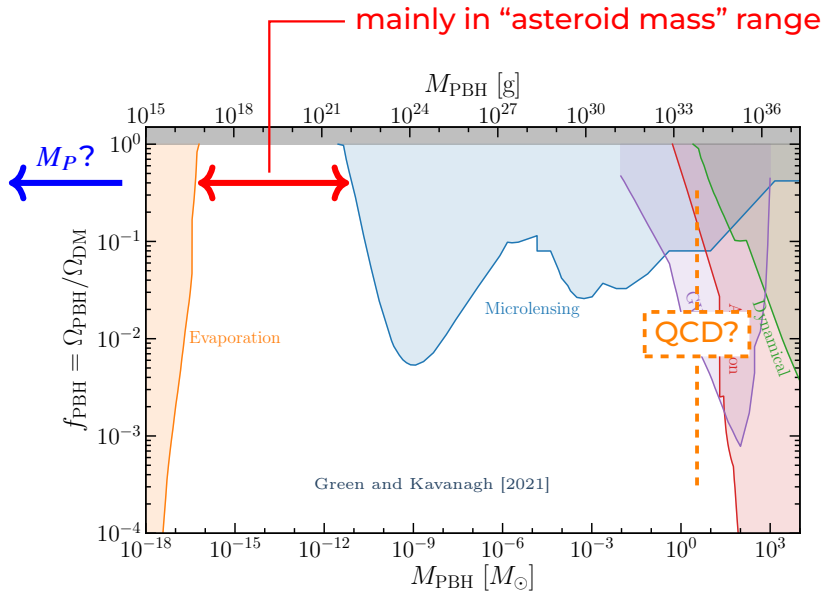
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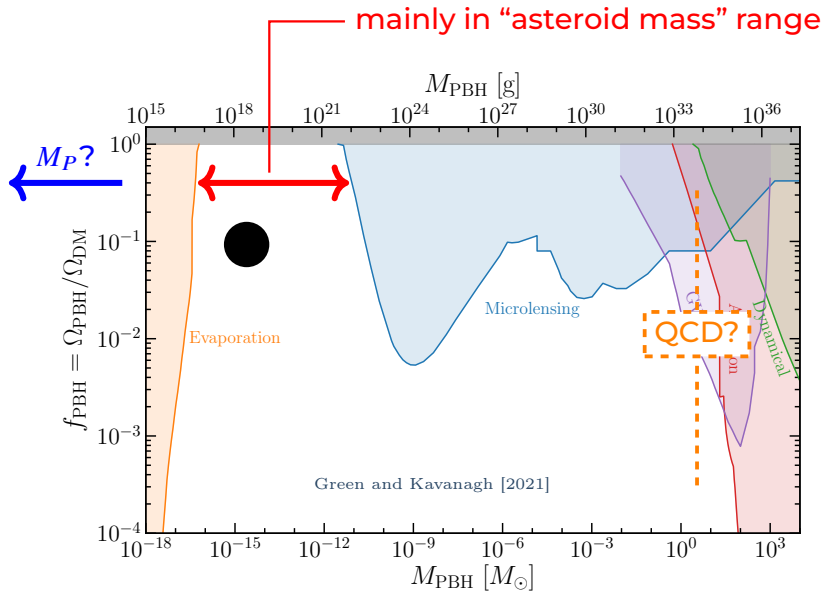
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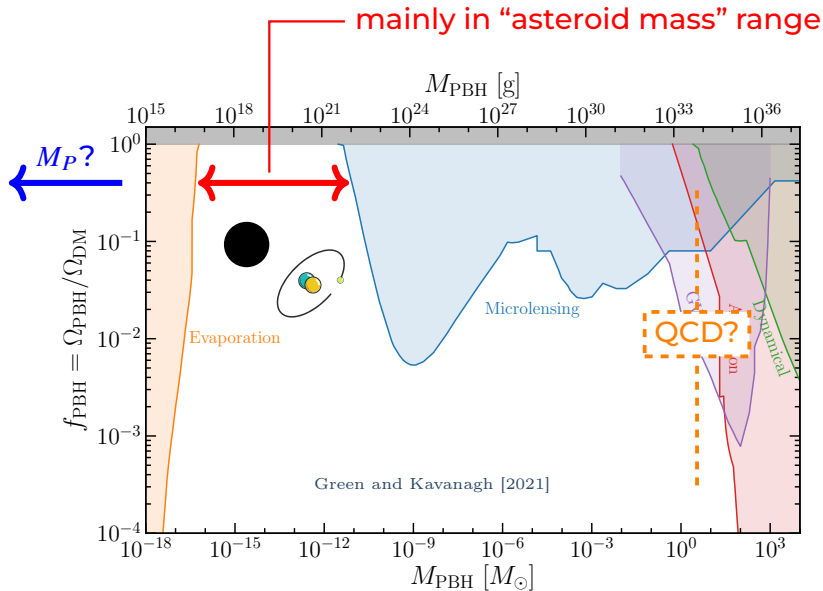
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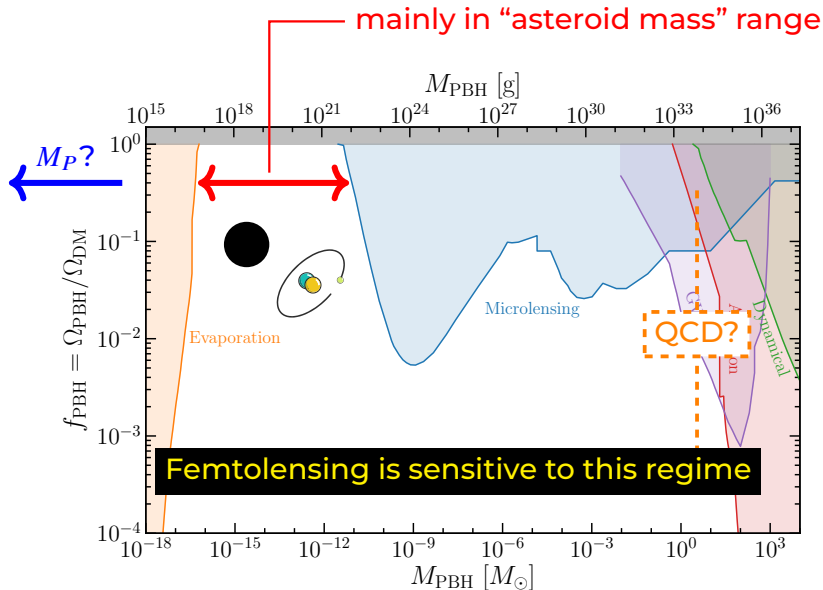
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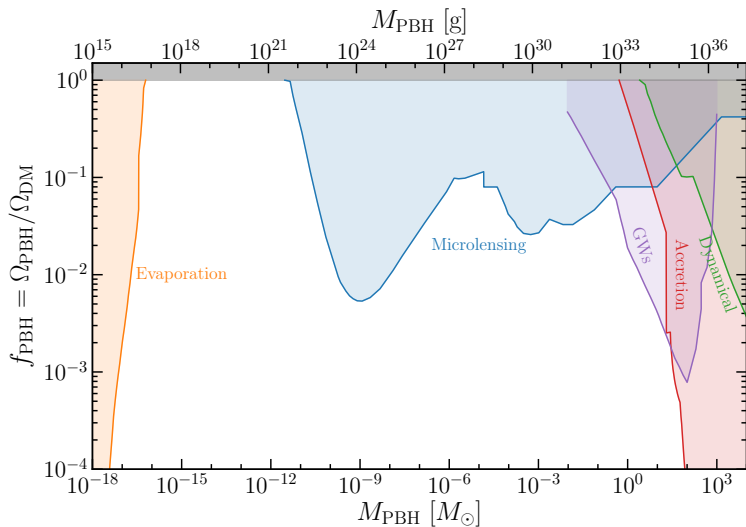
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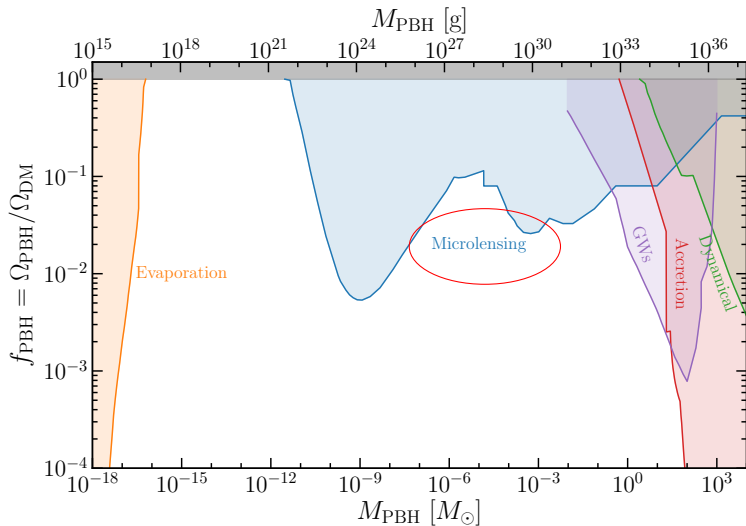
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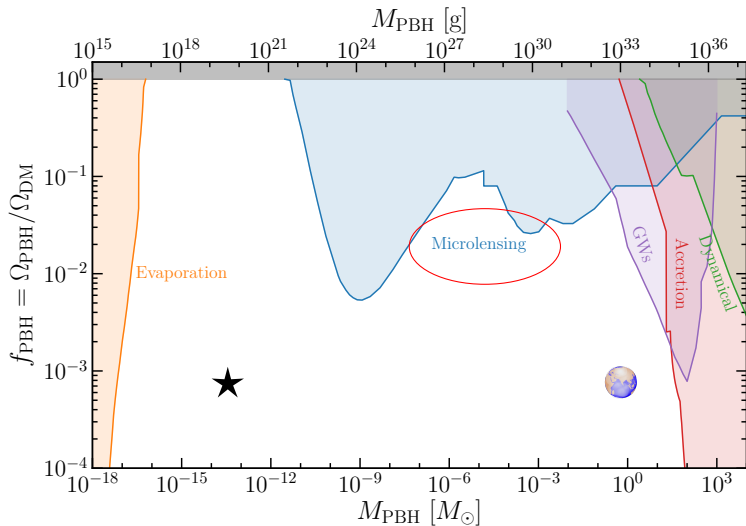
# Microlensing



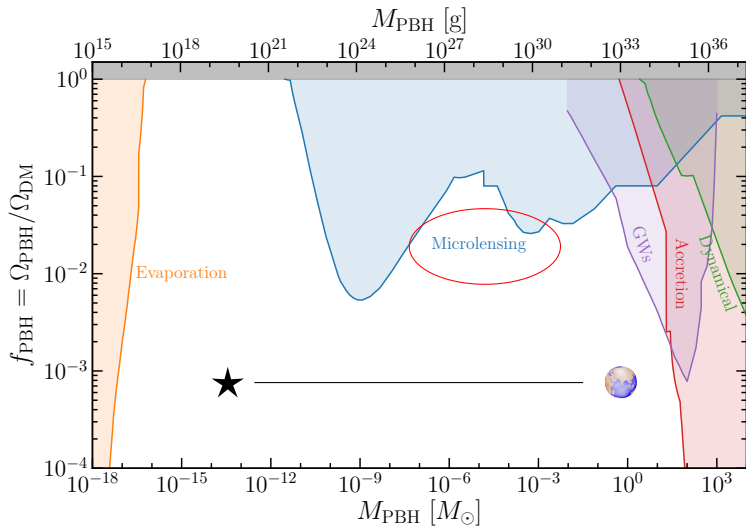
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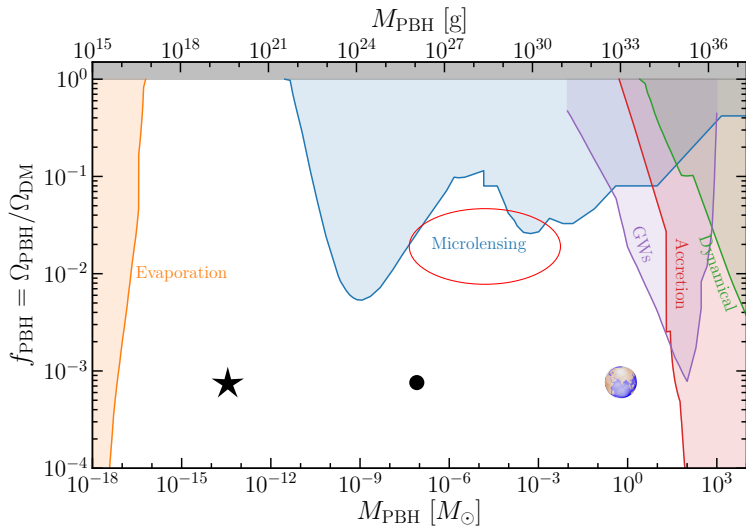
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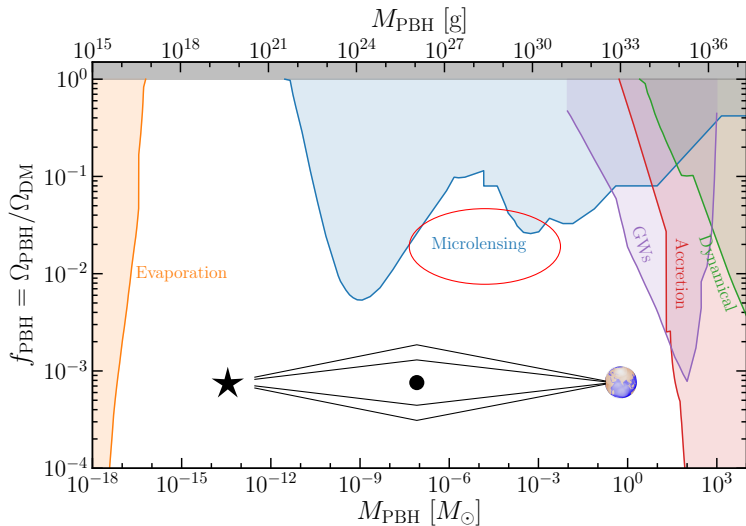
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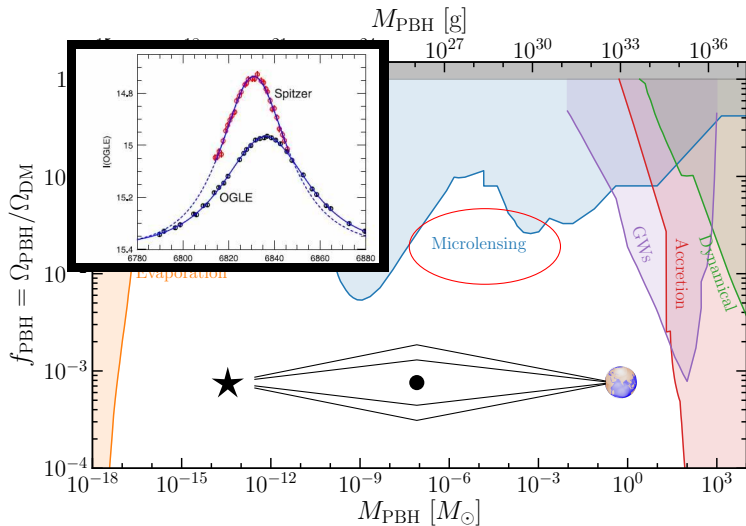
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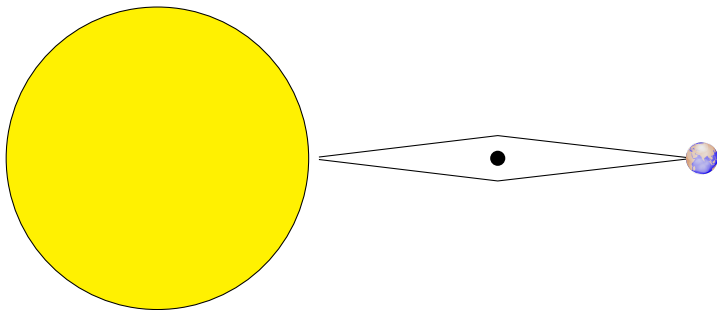
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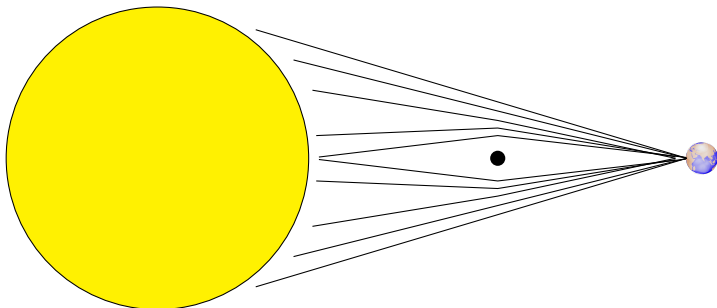
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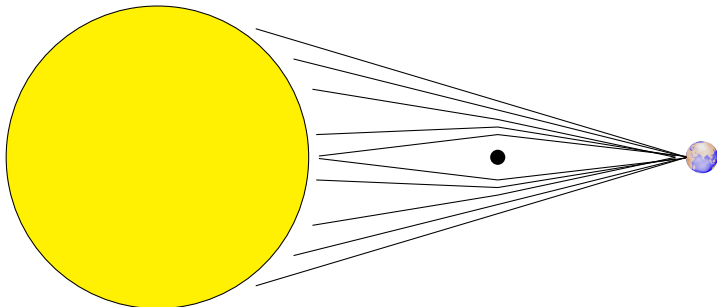
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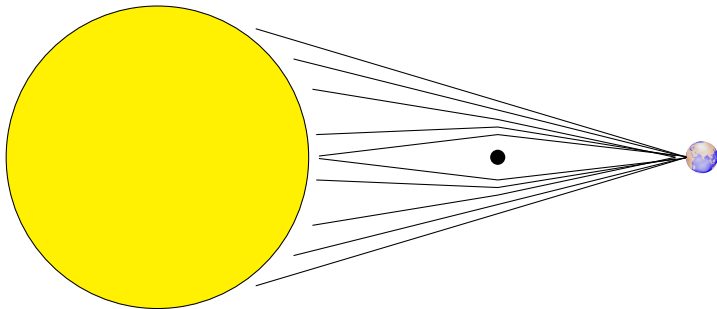
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## 2. Light isn't raylike

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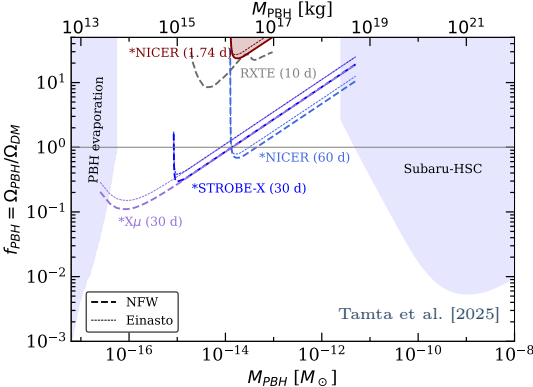


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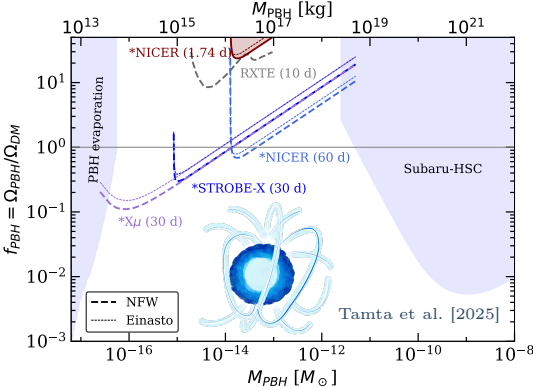
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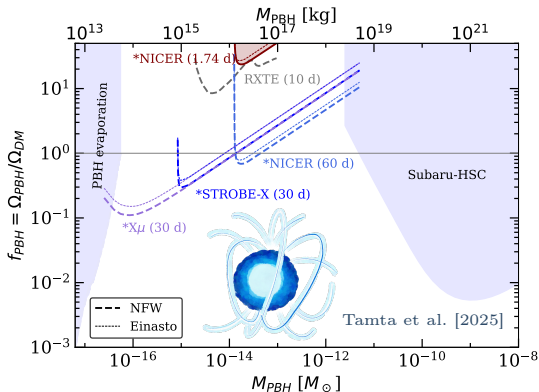


# X-ray microlensing

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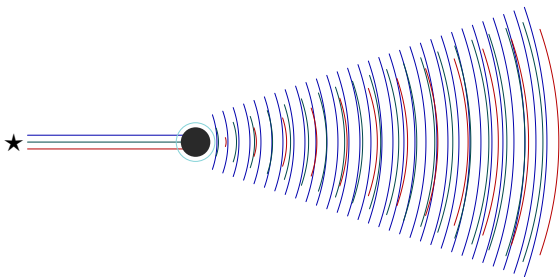
## Shorter wavelengths, smaller sources



Still impractical due to intrinsic source variability

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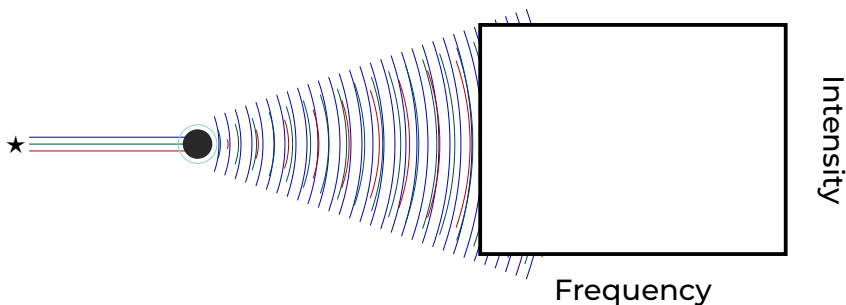
Interference maxima are **spatially separated** by color



Intrinsic variability is **much less problematic**

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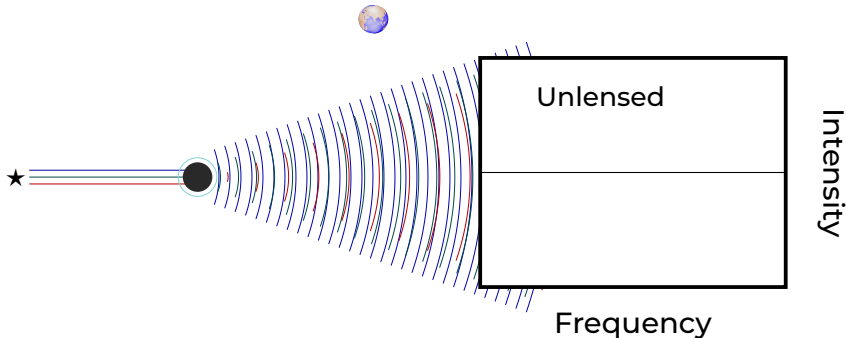
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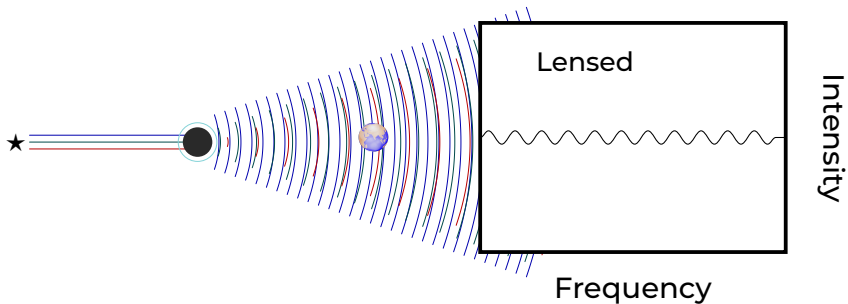
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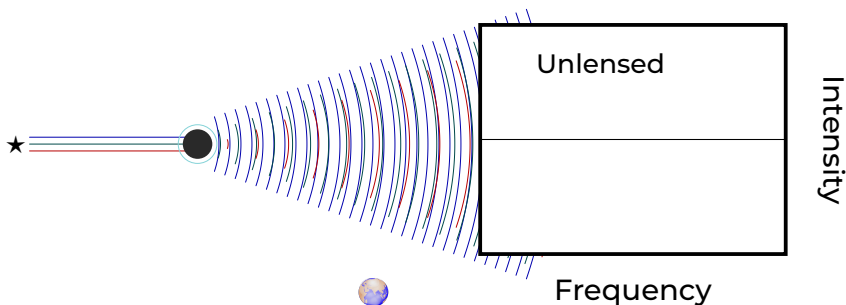
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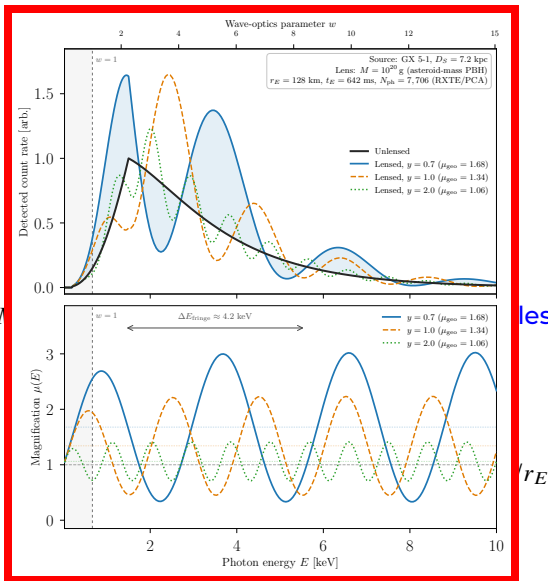
## Point-source magnification

$$\mu(w, y) = \frac{\pi w}{1 - e^{-\pi w}} \left| {}_1F_1\left(\frac{iw}{2}, 1; \frac{iwy^2}{2}\right) \right|^2, \quad y = b/r_E$$

# Femtolensing regimes

- $w \ll 1$ :
- $w \gg 1$ :

For  $M$



# Present and future data

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RXTE



1995–2012

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NICER



2017–present

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2037?

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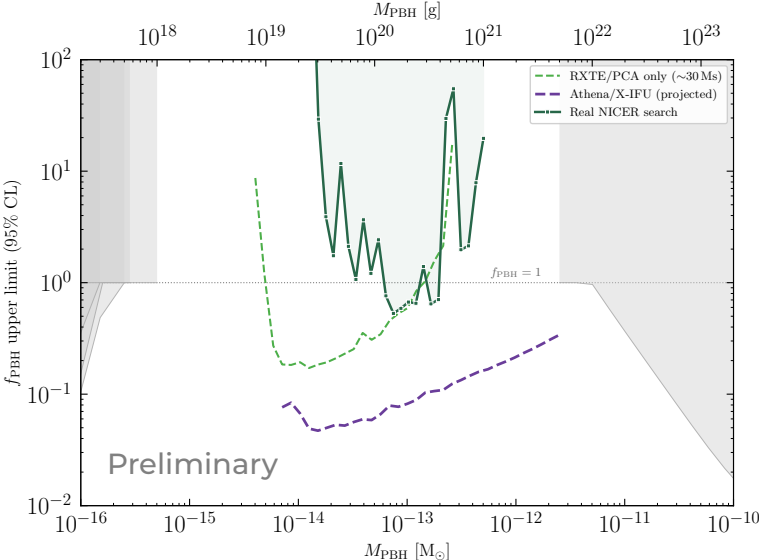
Athena



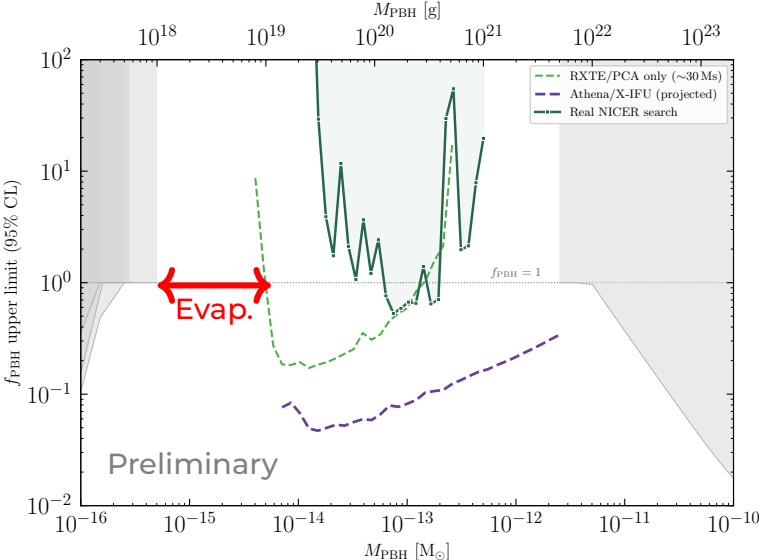
2037?

NICER has accumulated **76 Ms** of usable data

# Archival search



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We can start testing the asteroid-mass range **today**

# Conclusions

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NICER



(Already effective)

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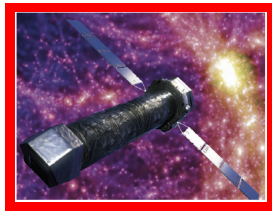
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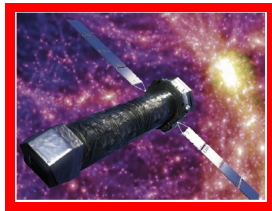
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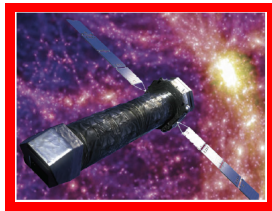
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(Definitive probe in 10 years)

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**But black holes can't hide forever!**

- A. M. Green and B. J. Kavanagh. Primordial Black Holes as a dark matter candidate. *J. Phys. G*, 48(4):043001, 2021. doi: 10.1088/1361-6471/abc534.
- M. Tamta, N. Raj, and P. Sharma. Entering the window of primordial black hole dark matter with x-ray microlensing. *Phys. Rev. D*, 111(4):043043, 2025. doi: 10.1103/PhysRevD.111.043043.