A Characteristic Optical Variability Time Scale in Astrophysical Accretion Disks

(Burke et al. 2021)

Yunjing Wu

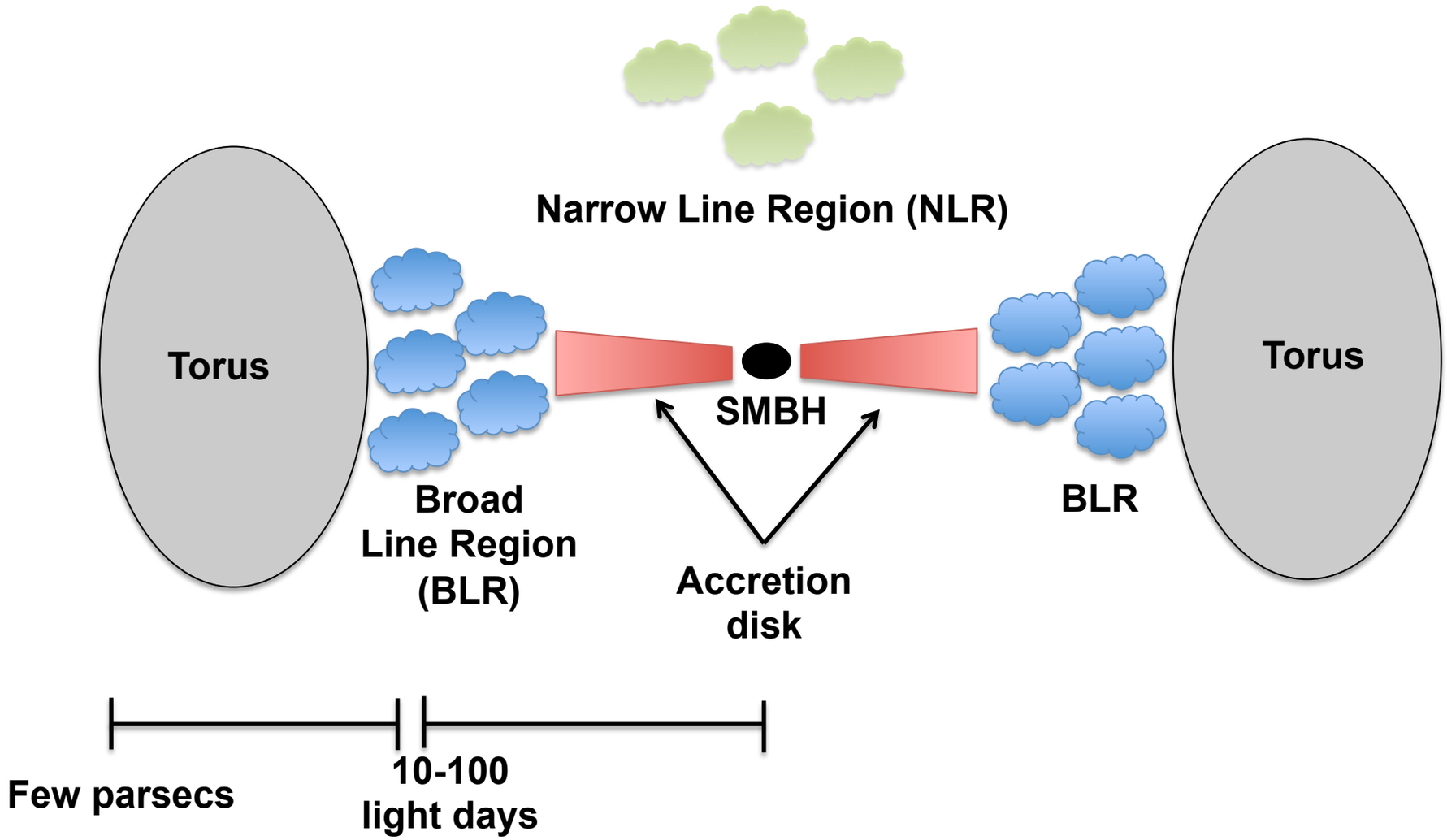
09.24.2021

(Credit: Feige Wang)

Content

1. AGN accretion disk model and $\tau_{\rm damping}$
2. Physical explanation of $\tau_{\rm damping}$?
3. Comments on the $M_{\rm BH}$ vs. $\tau_{\rm damping}$ relation
4. Summary

Active Galactic Nuclei (AGN)



https://www.isdc.unige.ch/~ricci/Website/Active_Galactic_Nuclei.html

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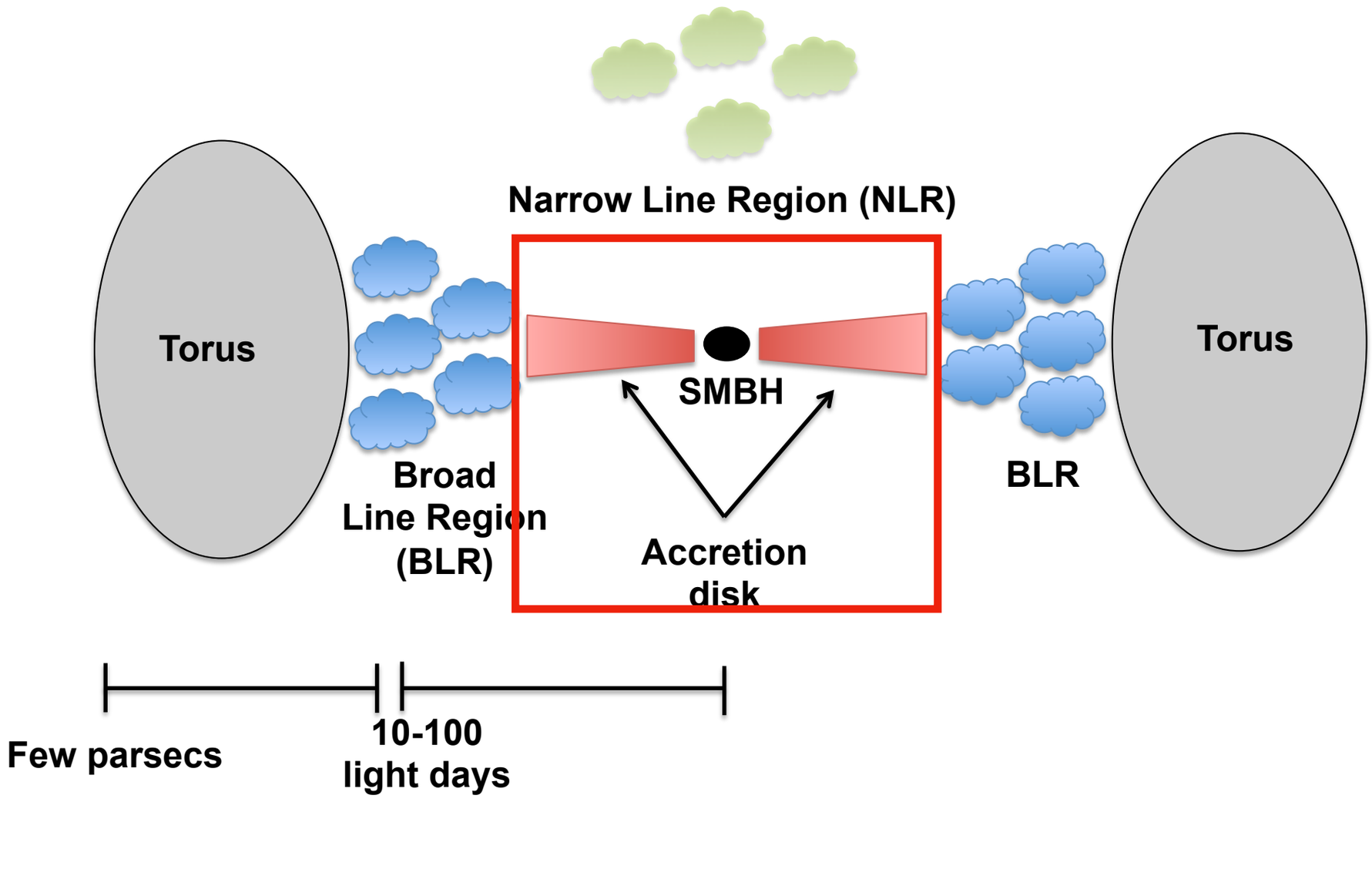

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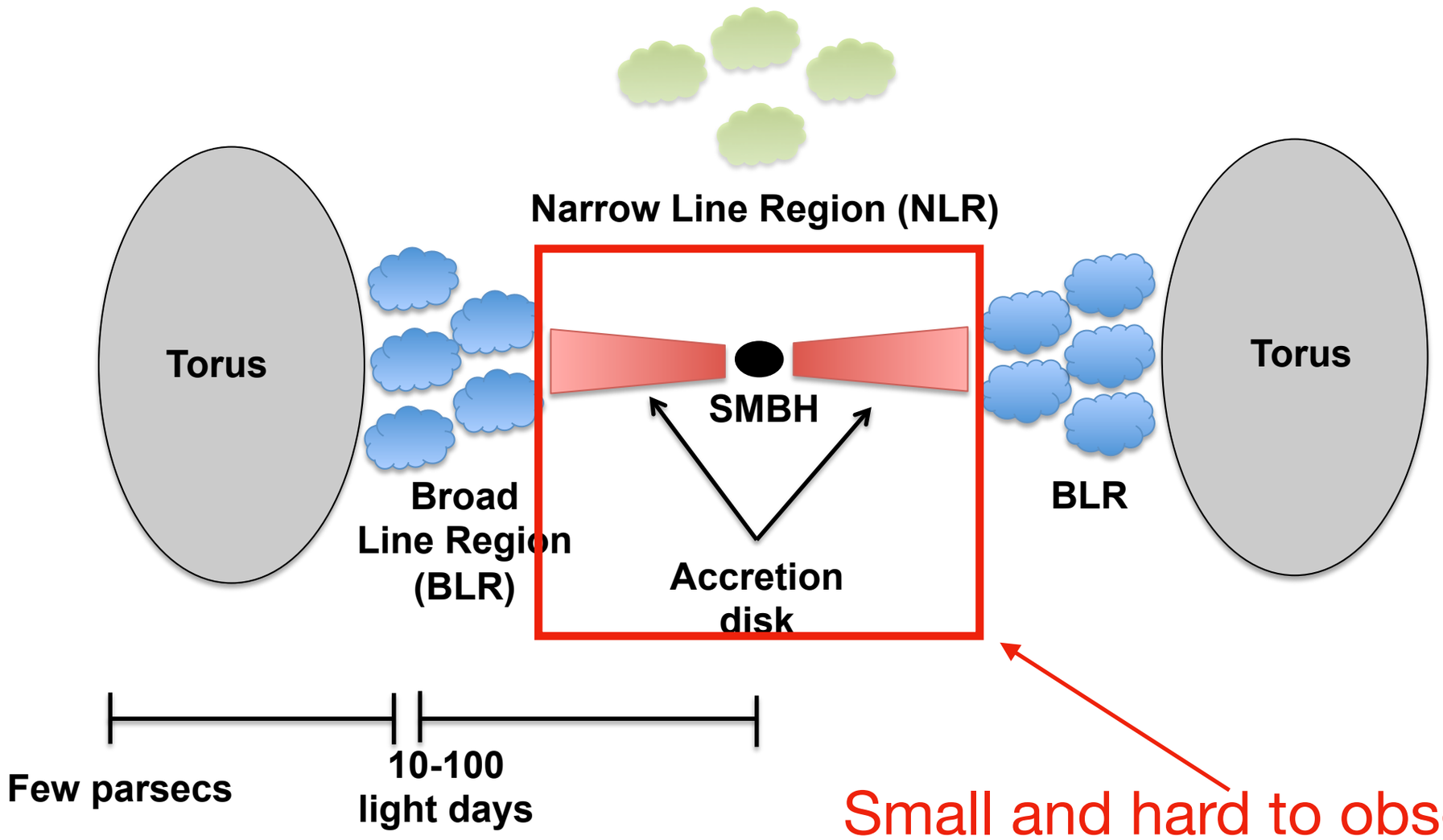

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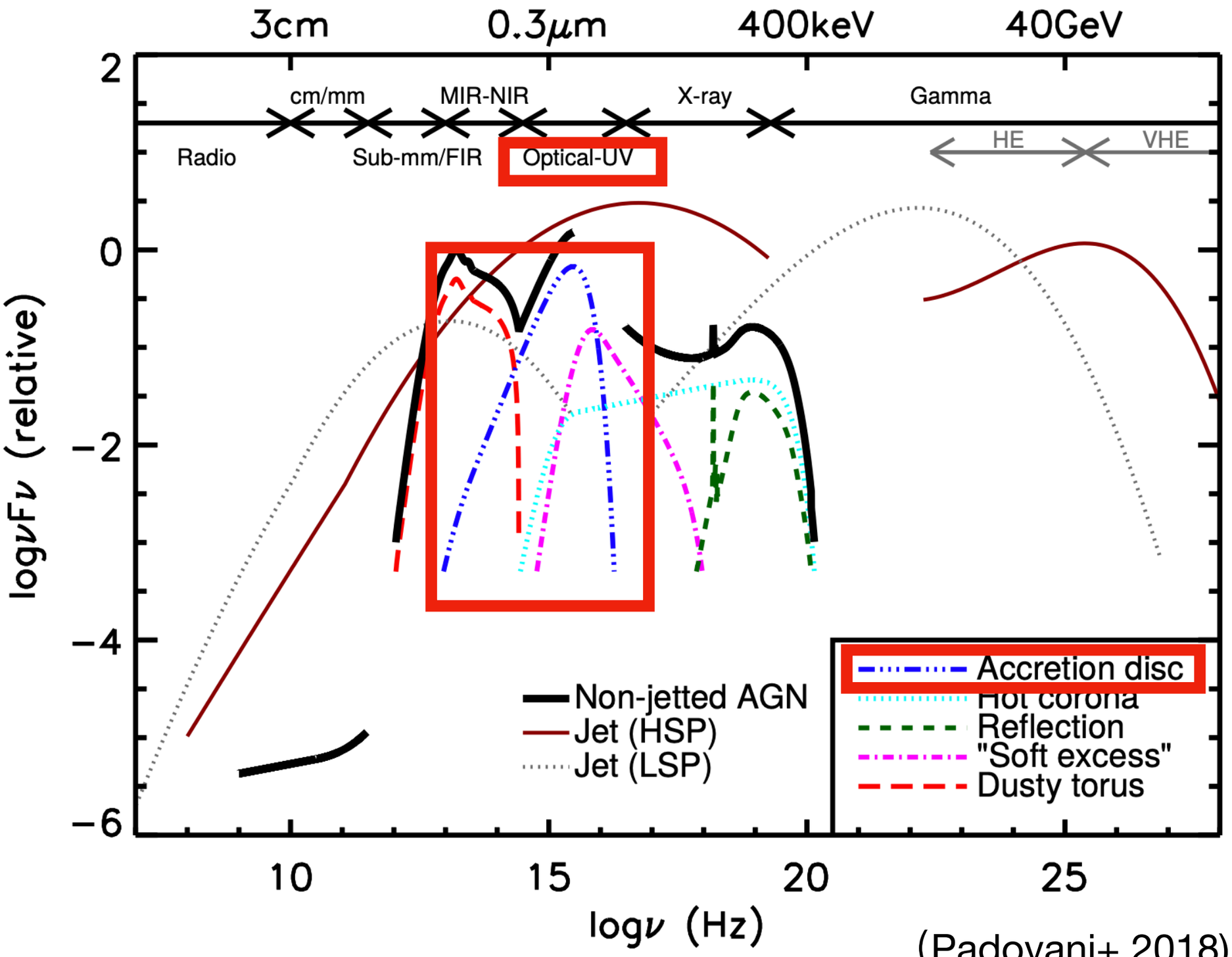
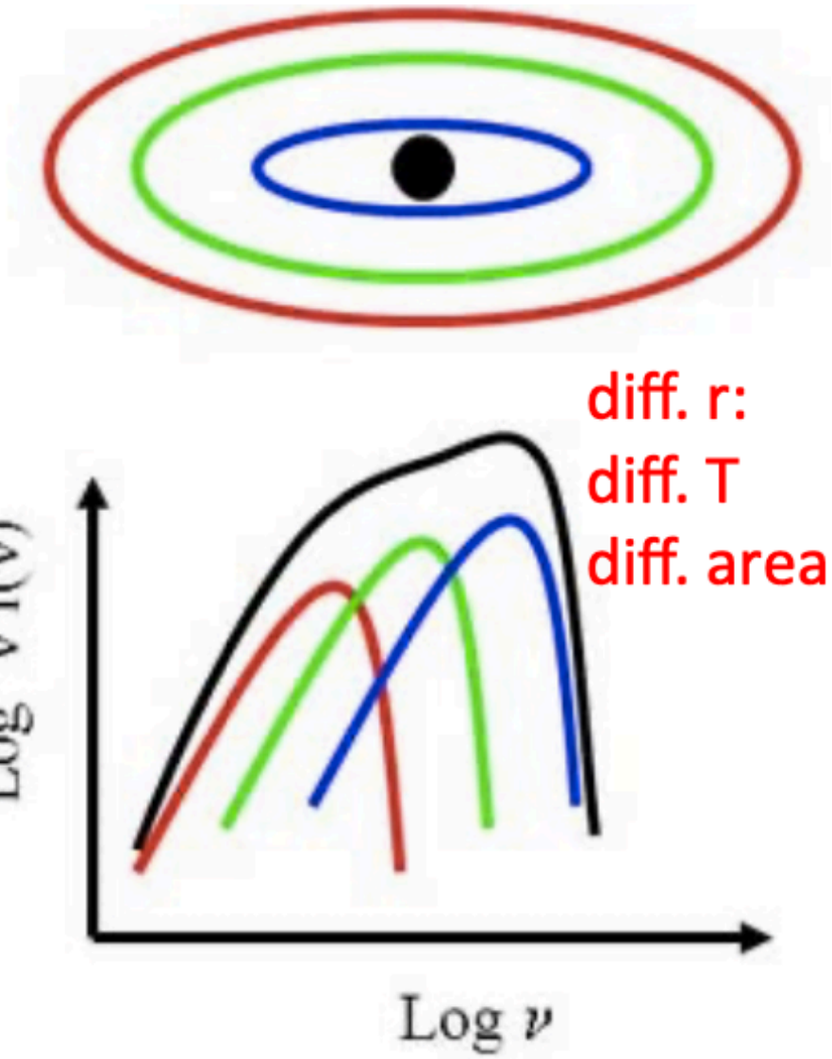
Accretion disc emission mostly at optical range



(Padovani+ 2018)

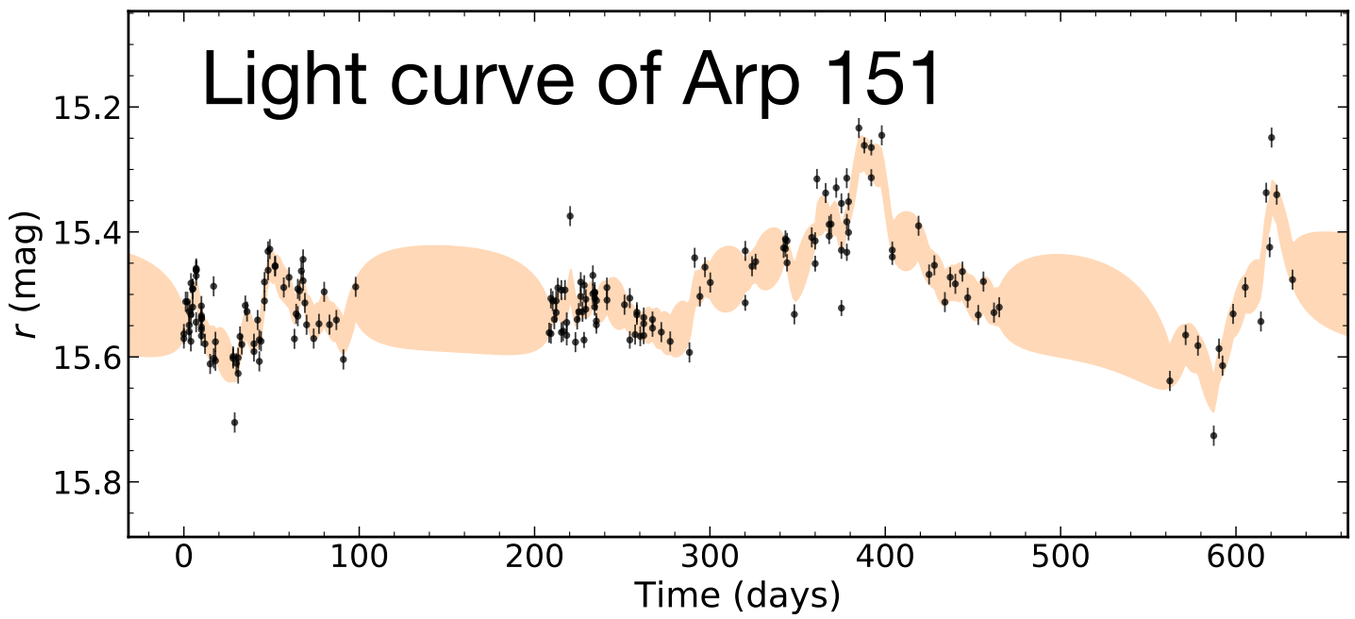
Multi-black body model



(Shakura+ 1973)

https://home.strw.leidenuniv.nl/~rottgering/Site/AGN_lectures_files/AGN-7.pdf

Damped random walk & AGN Continuum variability



(Burke+ 2021)

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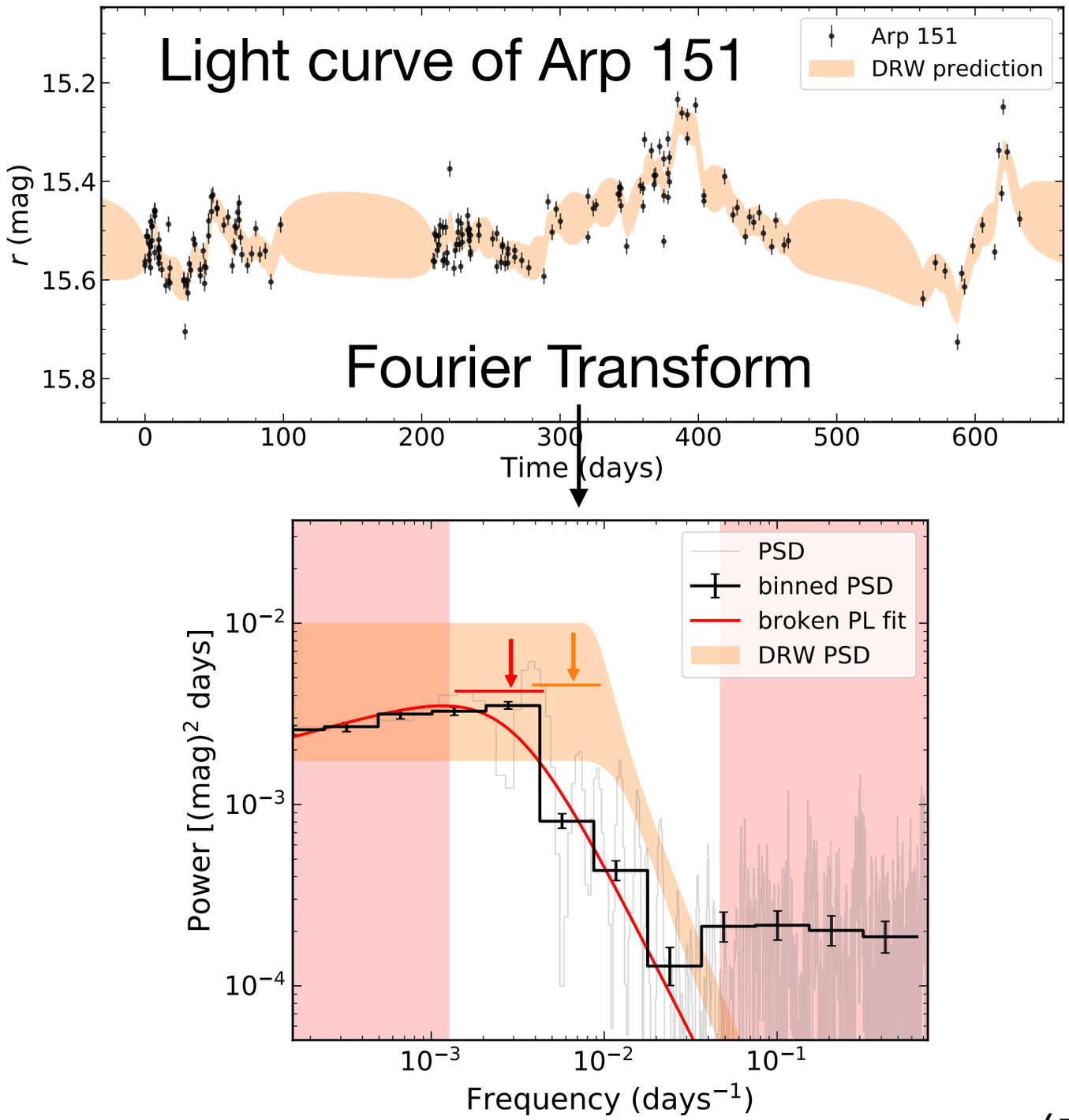

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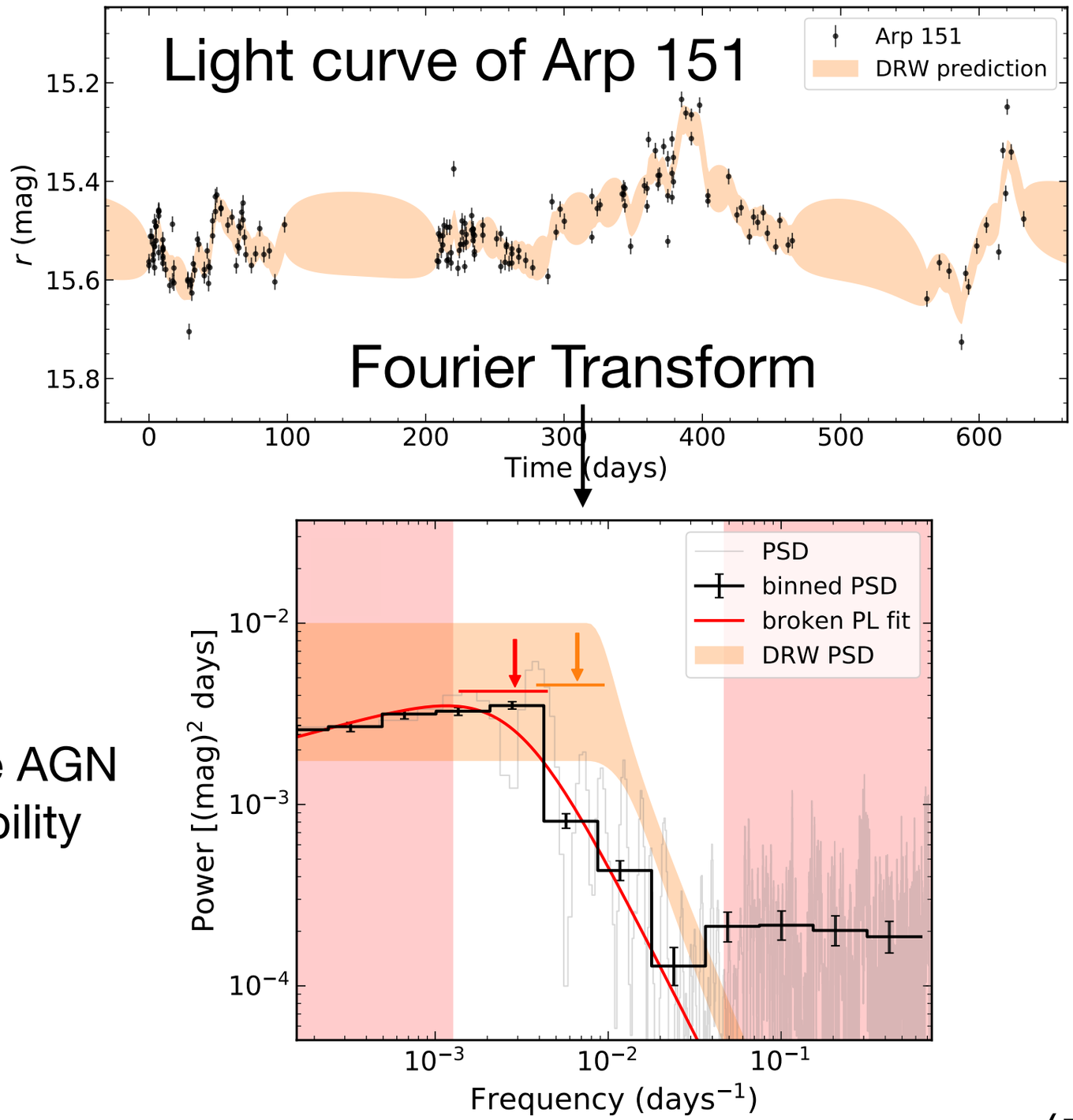
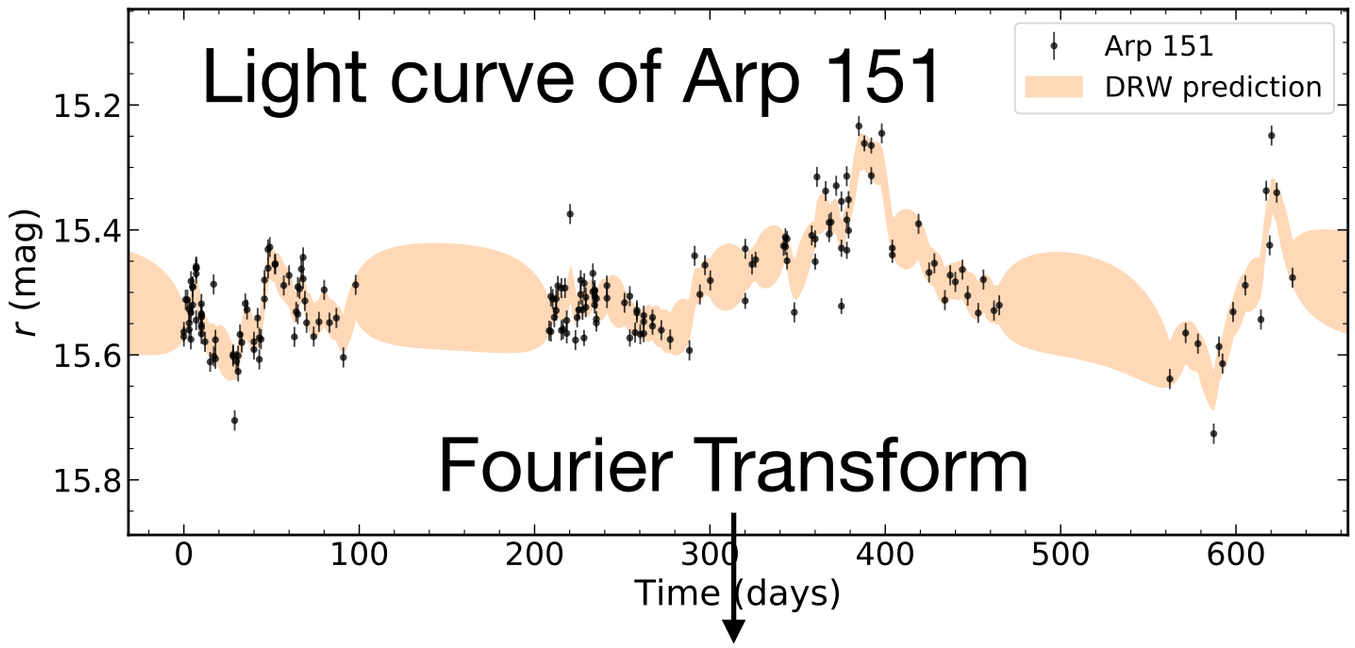


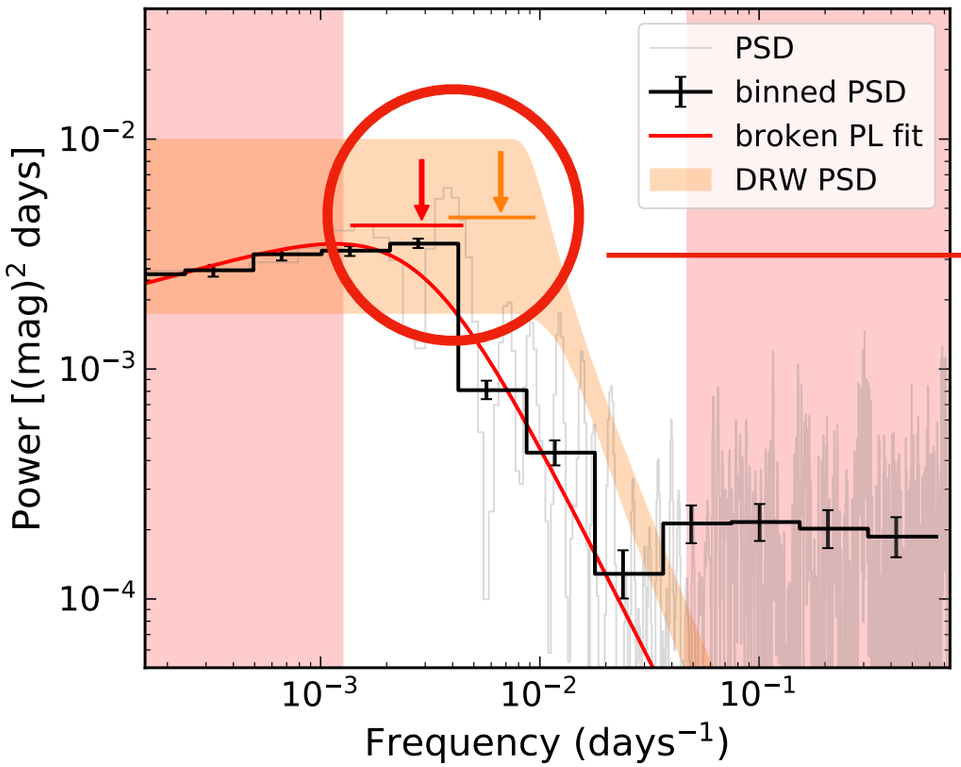
DRW can describe AGN continuum variability

(Burke+ 2021)

Damped random walk & AGN Continuum variability



Fourier Transform



DRW can describe AGN continuum variability

Characteristic time scale ($\tau_{\rm damping}$)

(Burke+ 2021)

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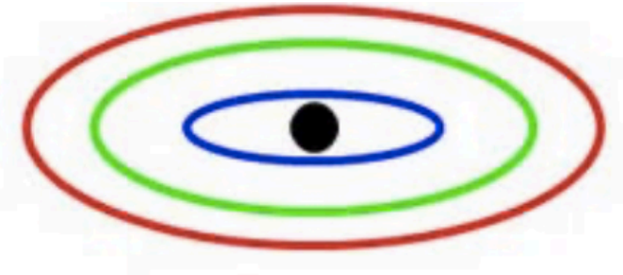

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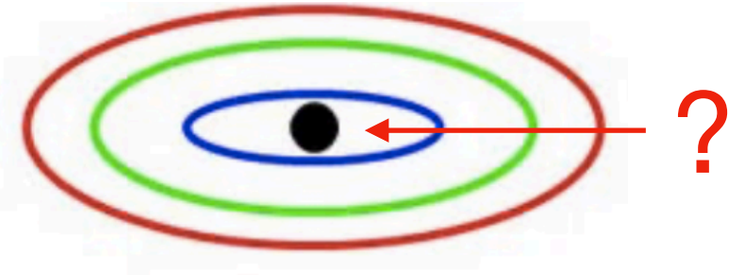

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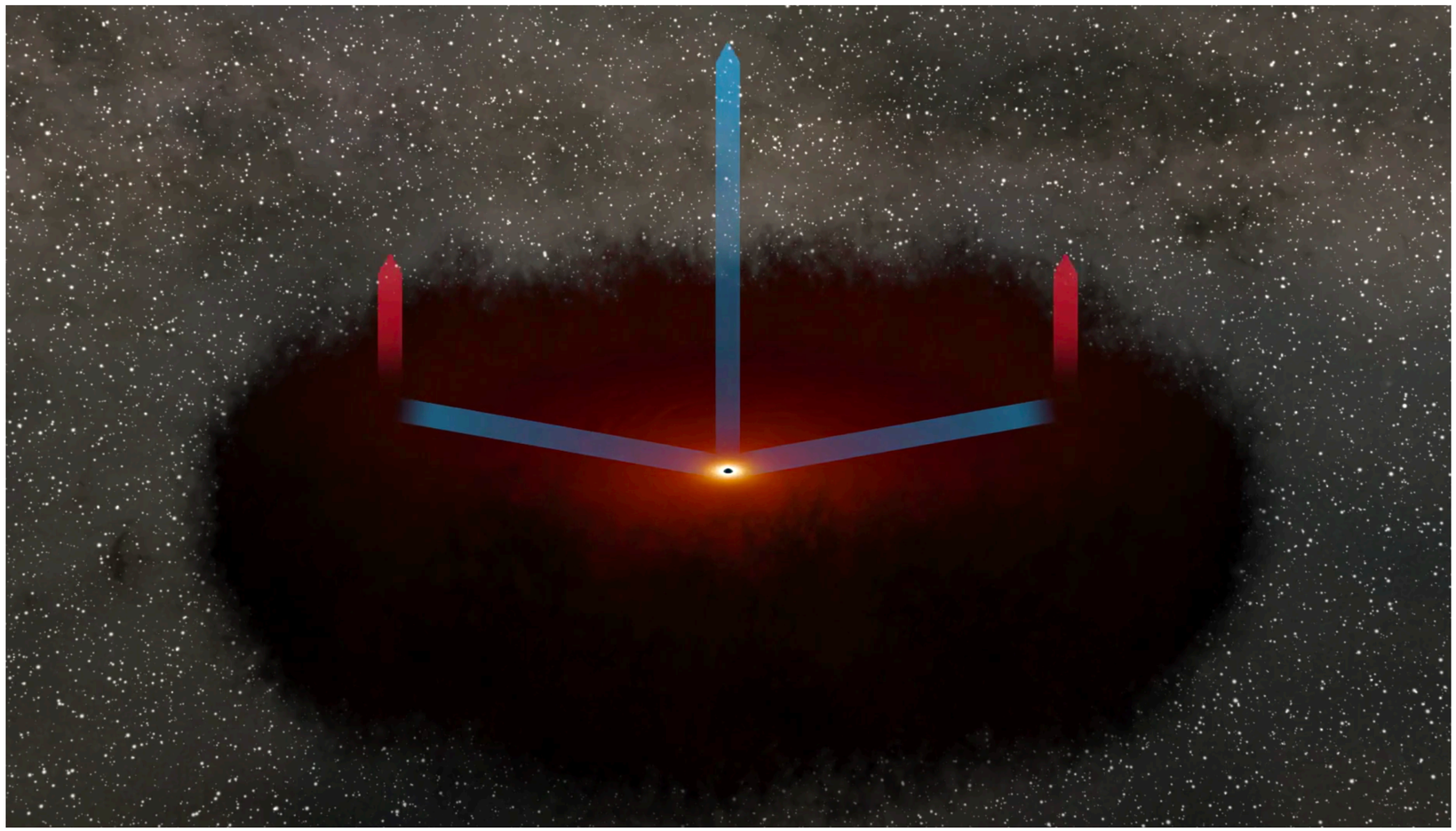
AGN $M_{\rm BH}$ measurements

1. reverberation mapping



$$M_{\rm BH} = frv^2/G$$

r is the distance between Broad line region and BH.

v is the velocity of the sounding gas.

(Wikipedia: reverberation mapping)

AGN $M_{\rm BH}$ measurements

2. Single exposure constrains

$$\log\frac{M_{\rm BH}}{M_\odot} = a + b\log\frac{L}{10^{44}\ {\rm erg\ s^{-1}}} + c\log\frac{\rm W}{\rm km\ s^{-1}}$$

L represents line luminosity ($\rm H\alpha$, $\rm CIV$, $\rm MgII$).

$\rm W$ represents the corresponding line width.

(Trakhtenbrot+ 12, Shen+ 13)

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If not…

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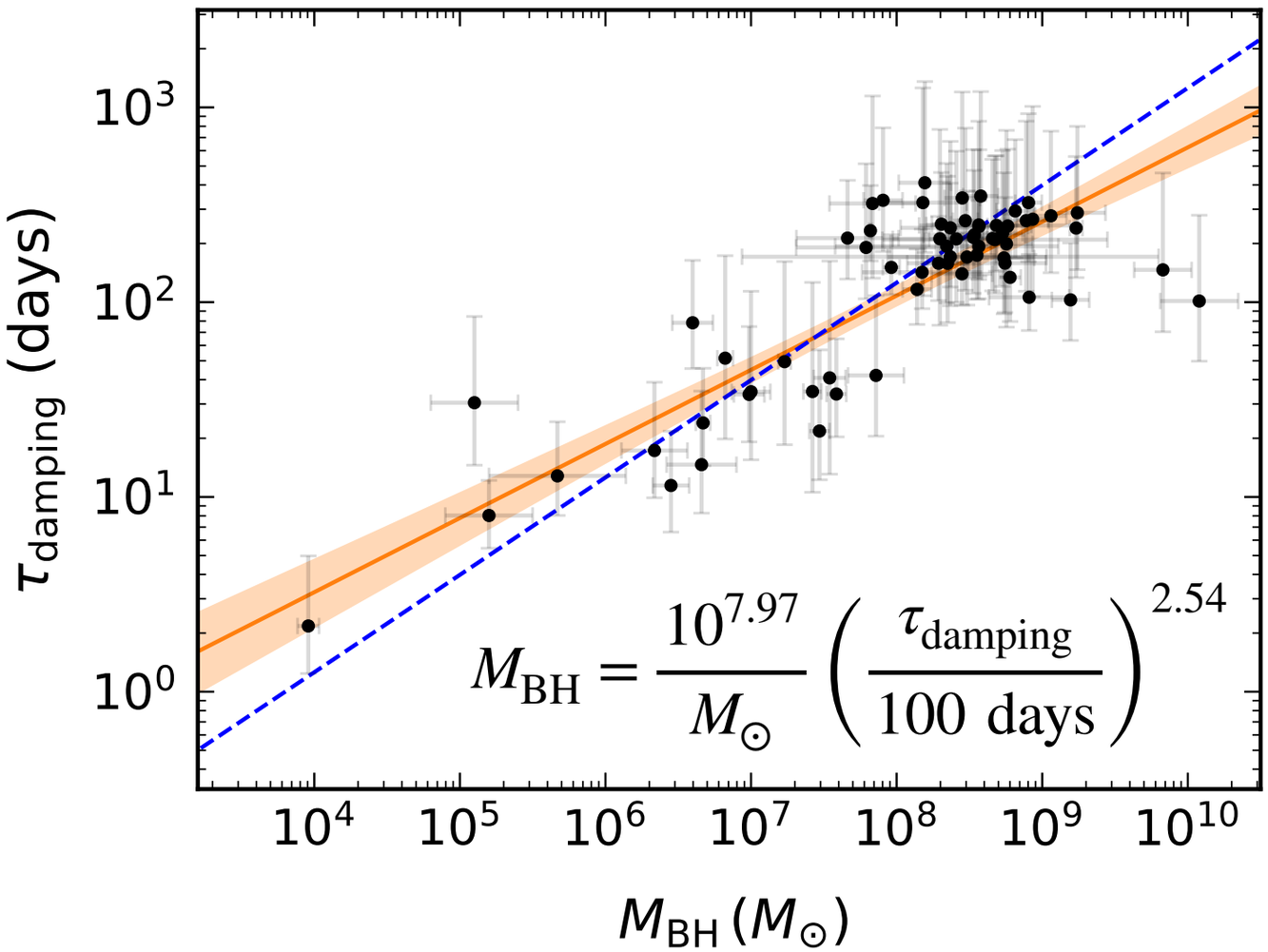
$M_{\rm BH}$ vs. $\tau_{\rm damping}$ relation

67 AGNs with long timescale light curve observations

and accurate $M_{\rm BH}$ measurements



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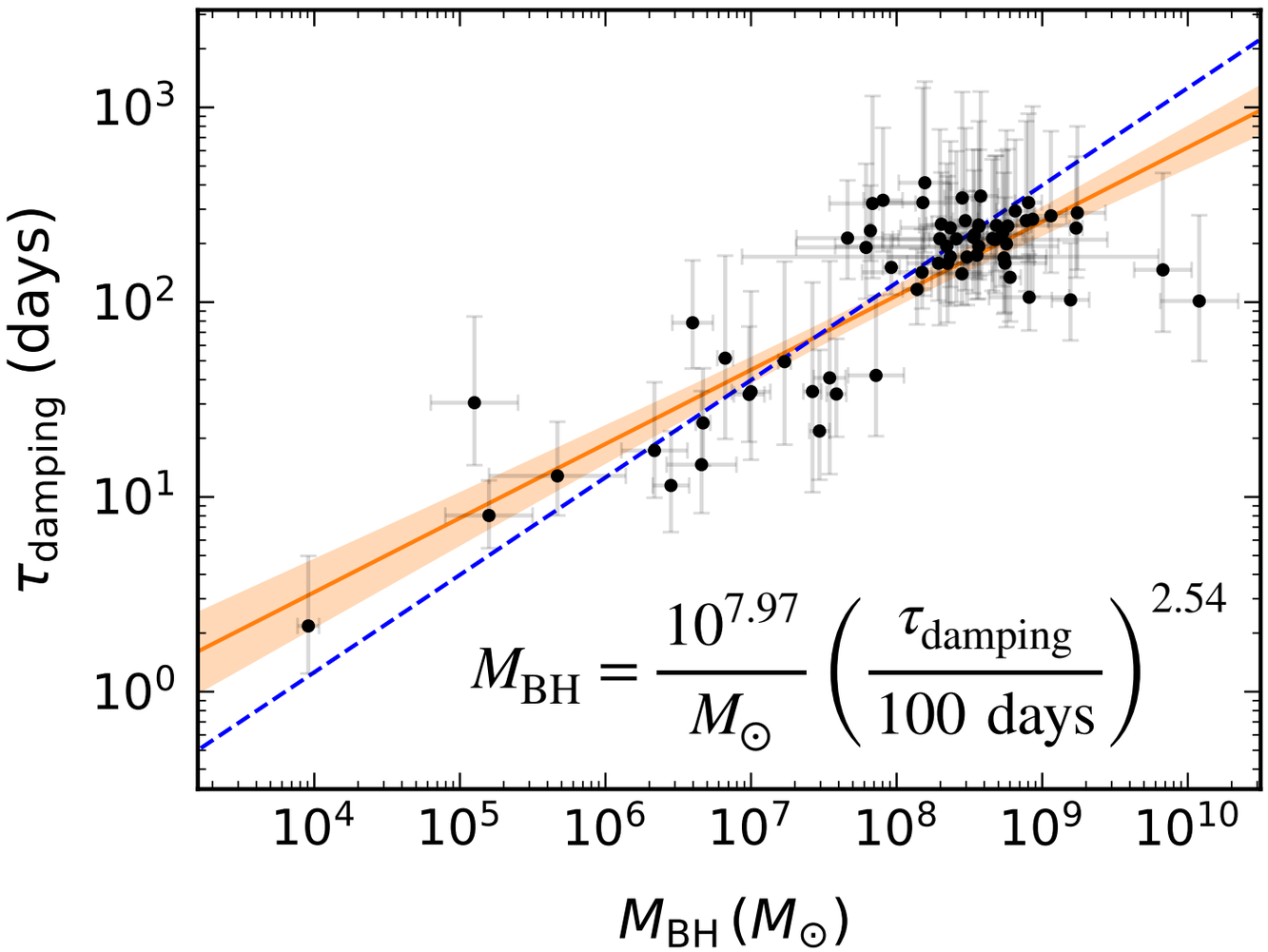

Photometric observations can drive $M_{\rm BH}$ directly

(Burke+ 2021)

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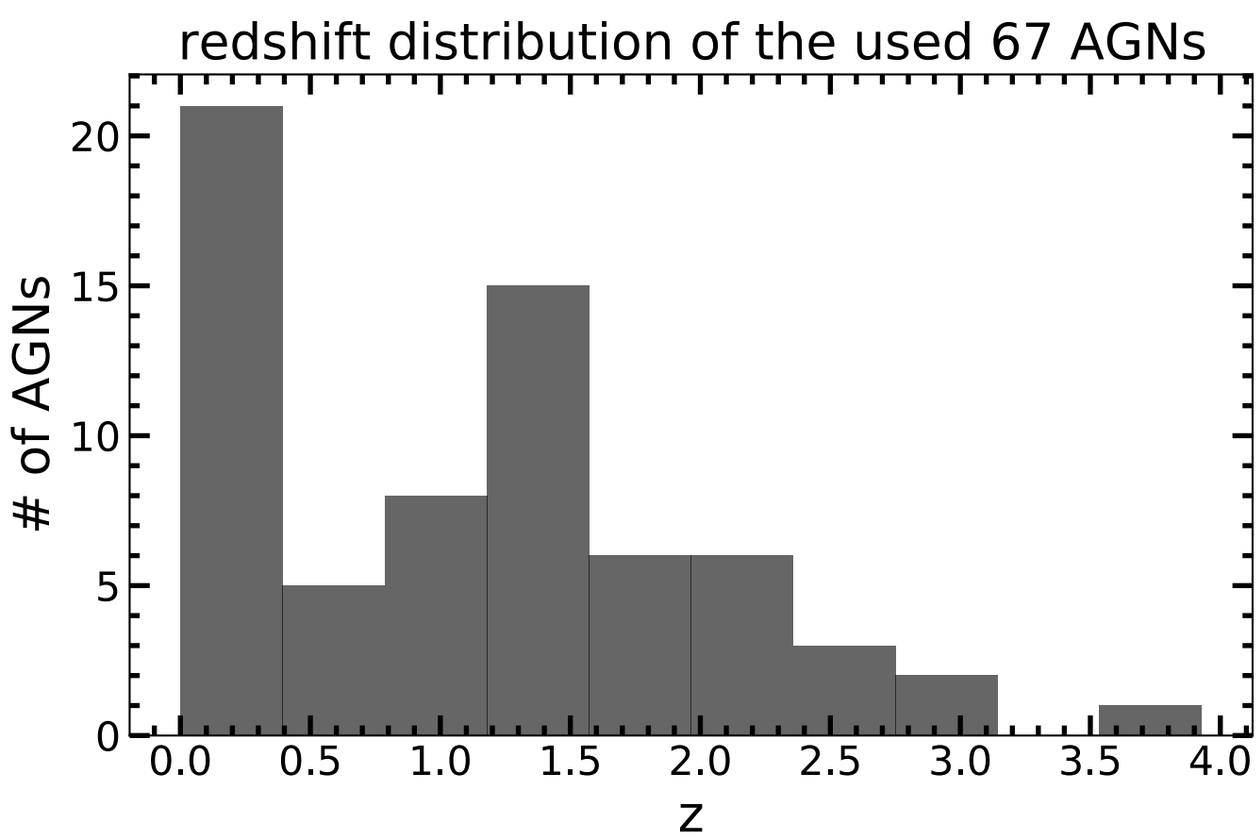
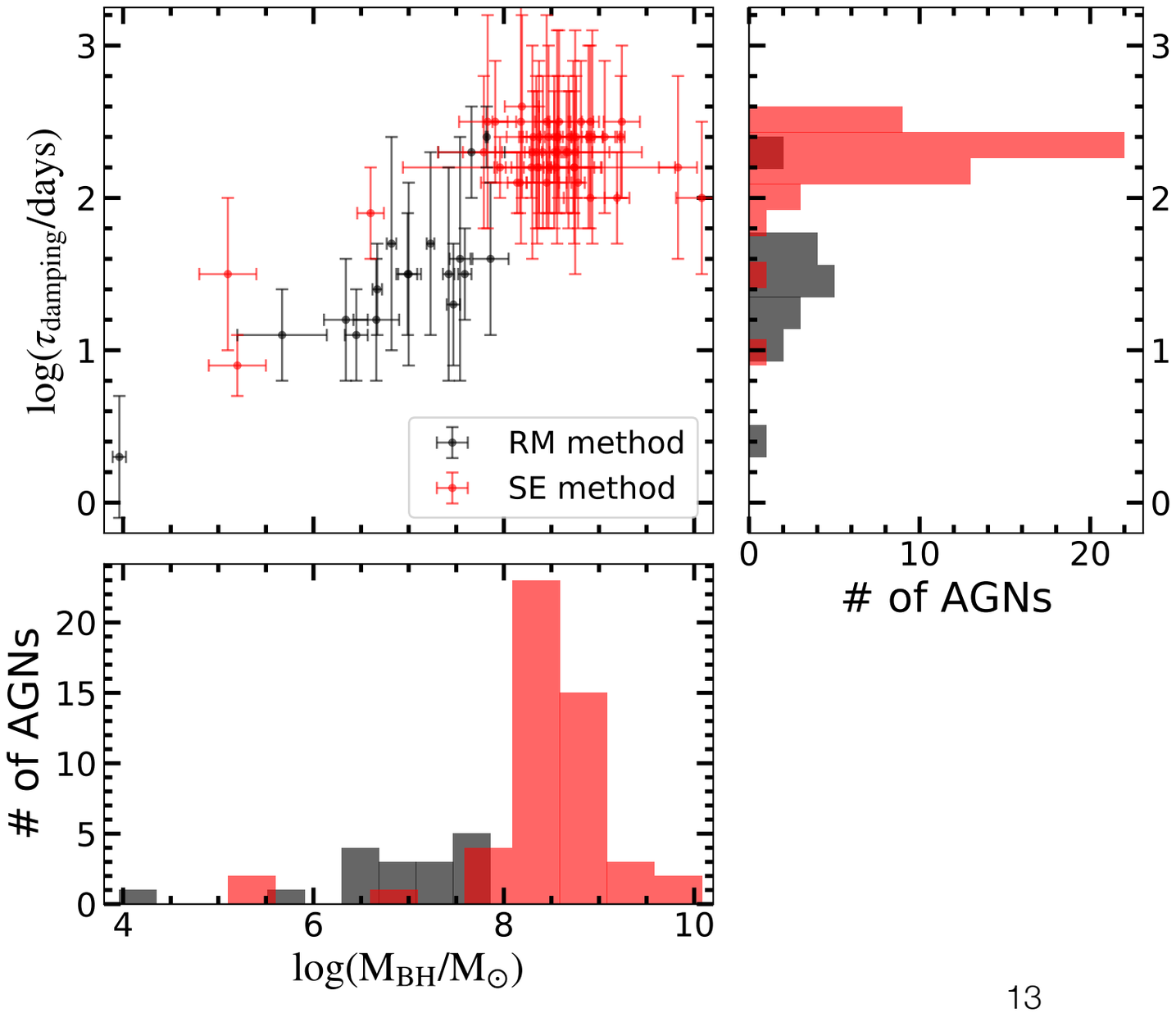
Comment 1

The redshift of the used 67 QSOs ranges from 0 to 4.
Will these AGNs have redshift evolution?



Comment 2

The derived $M_{\rm BH}$ are based on two methods. How consistent are these two mass conversion relations?



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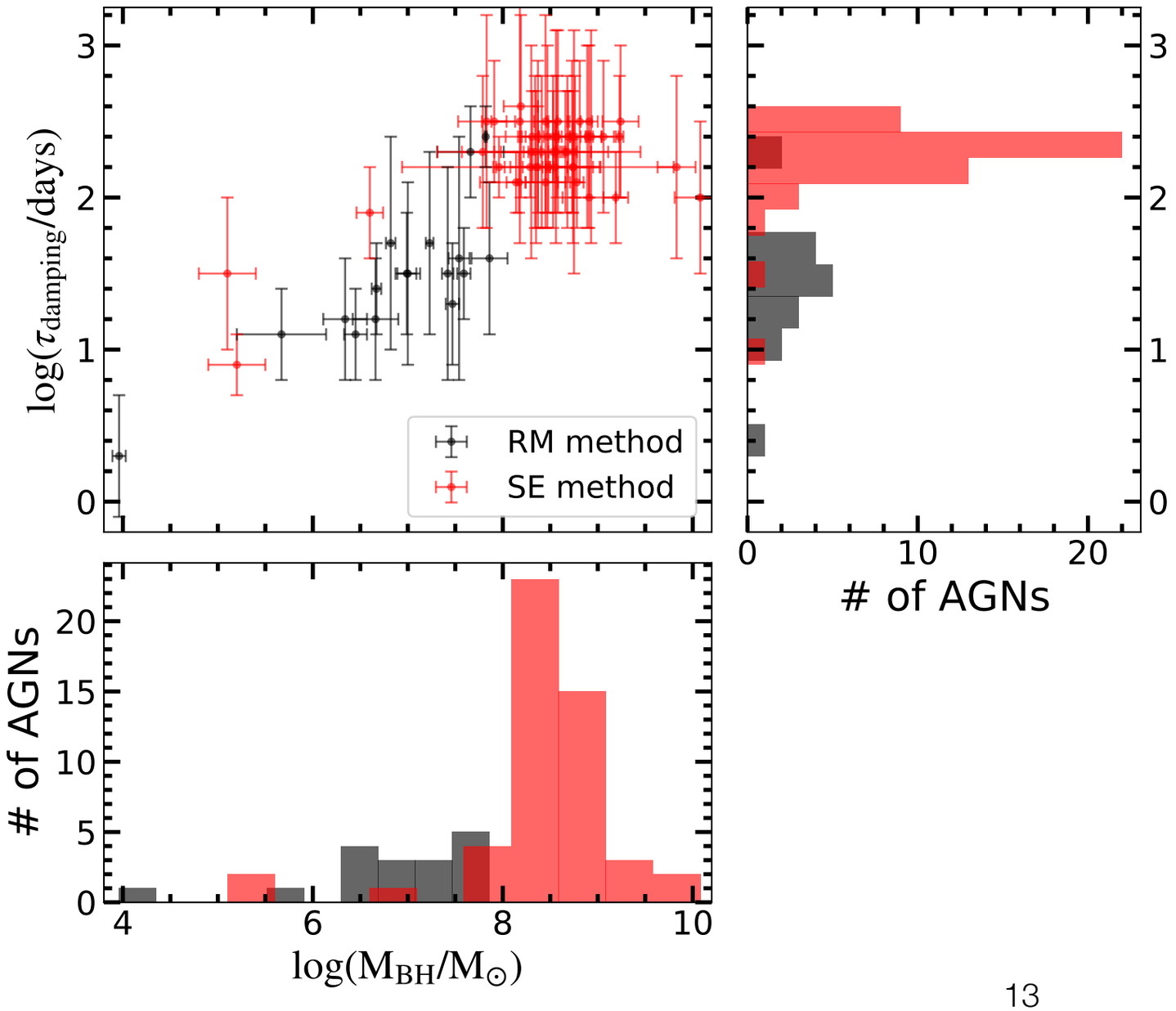

The data points at the low mass end are very limited. At the high mass end, the $M_{\rm BH} - \tau_{\rm damping}$ relation is not retained.

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Summary (take-home message)

Introduction: DRW model can be used to describe the variability of the AGN continuum. ($\tau_{\rm damping}$)

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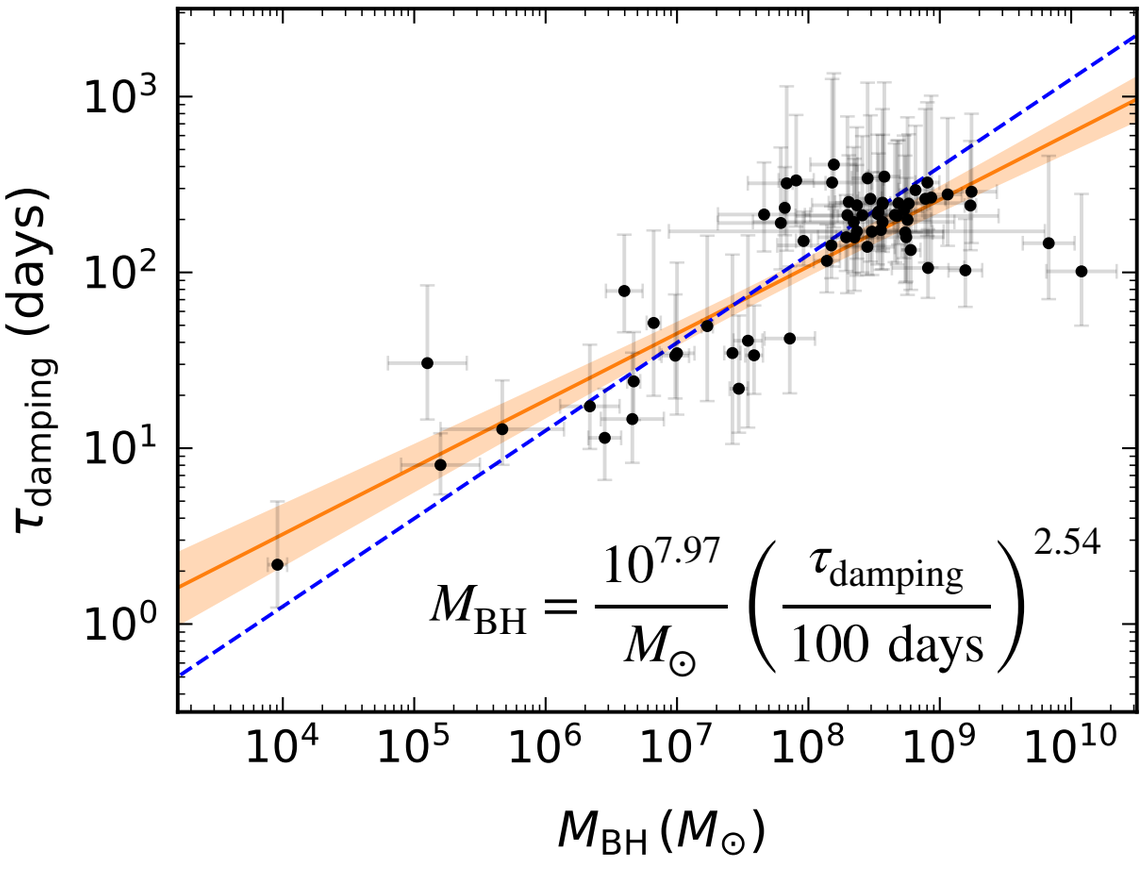

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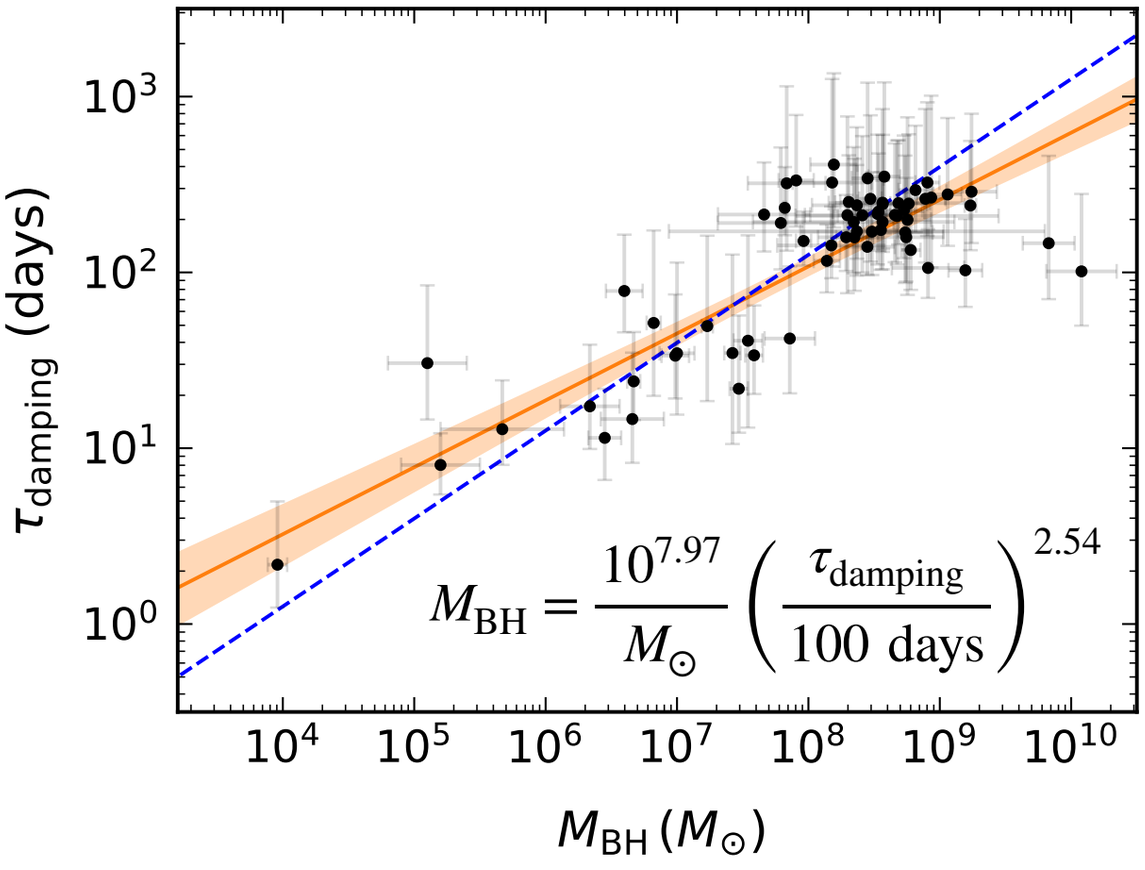

Thanks!

Questions

1. Why can they build up this relation rather than previous ones?

2. How solid is this relation?

3. Could future surveys further confirm this relation?

4. Physics behind τ_{damping}?