

AGN variability on $\sim 10^{4-5}$ yrs timescales

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@liafsartori



10 kpc $\sim 3 \times 10^4$ yr



Galaxy

> *present* AGN state

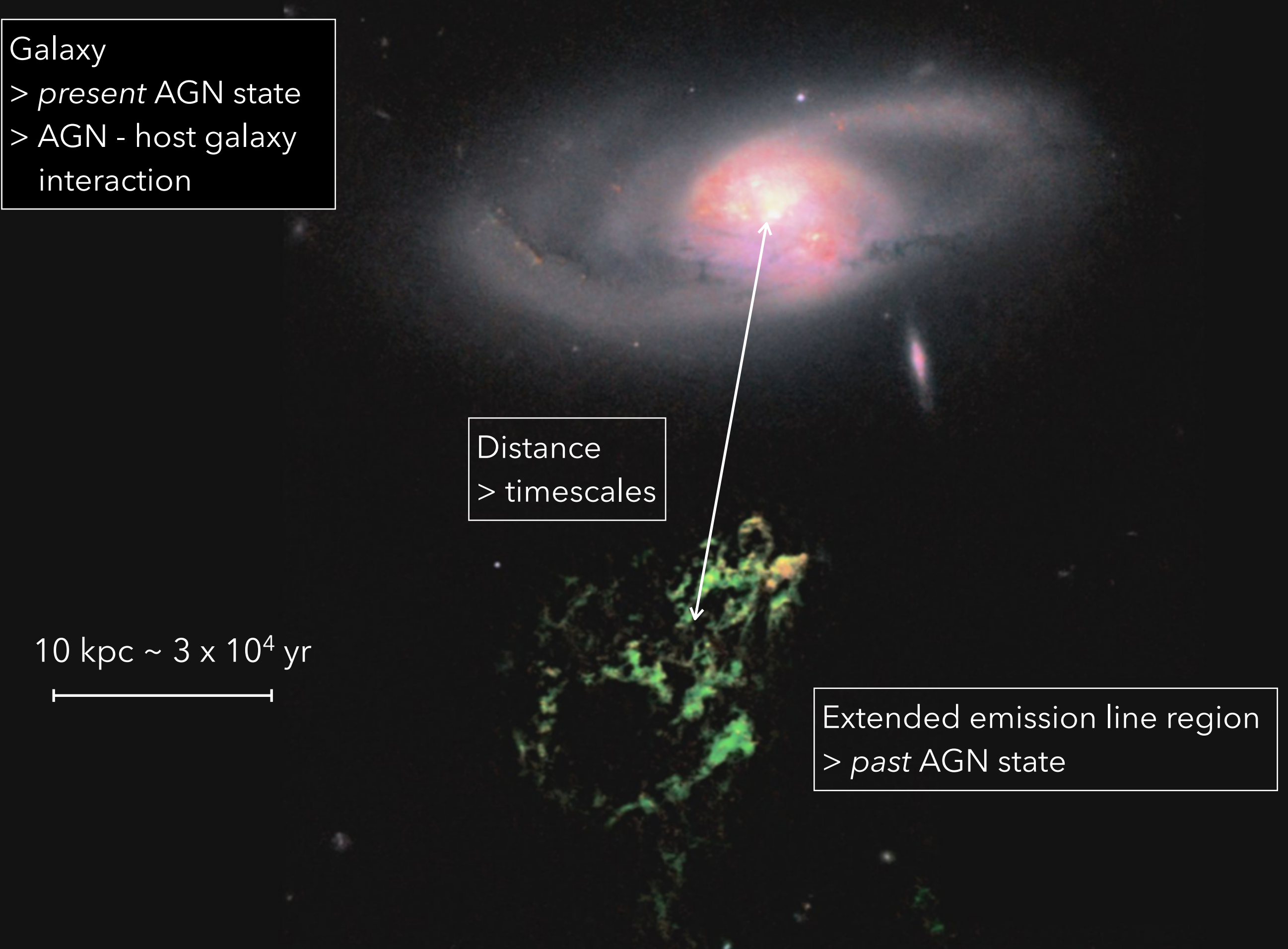
> AGN - host galaxy
interaction

Distance

> timescales

10 kpc $\sim 3 \times 10^4$ yr

Extended emission line region
> *past* AGN state



switch on

normal AGN

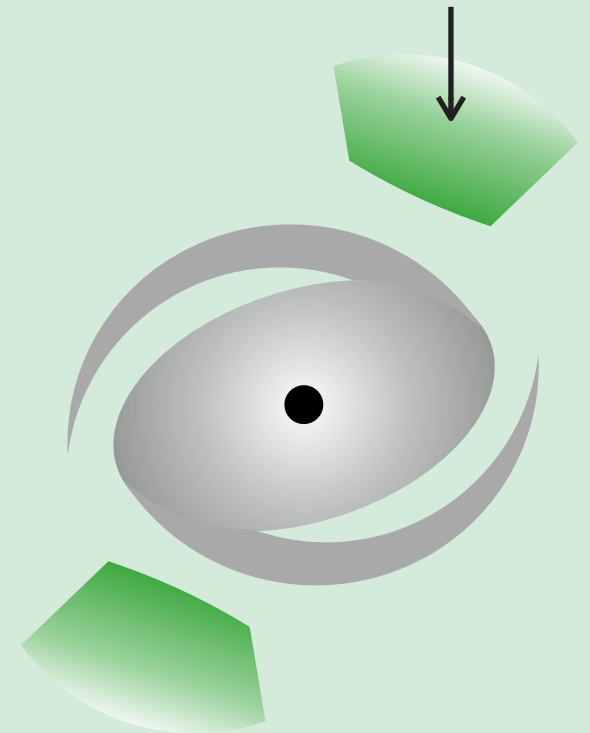
switch off



ionisation cone



ionisation echo

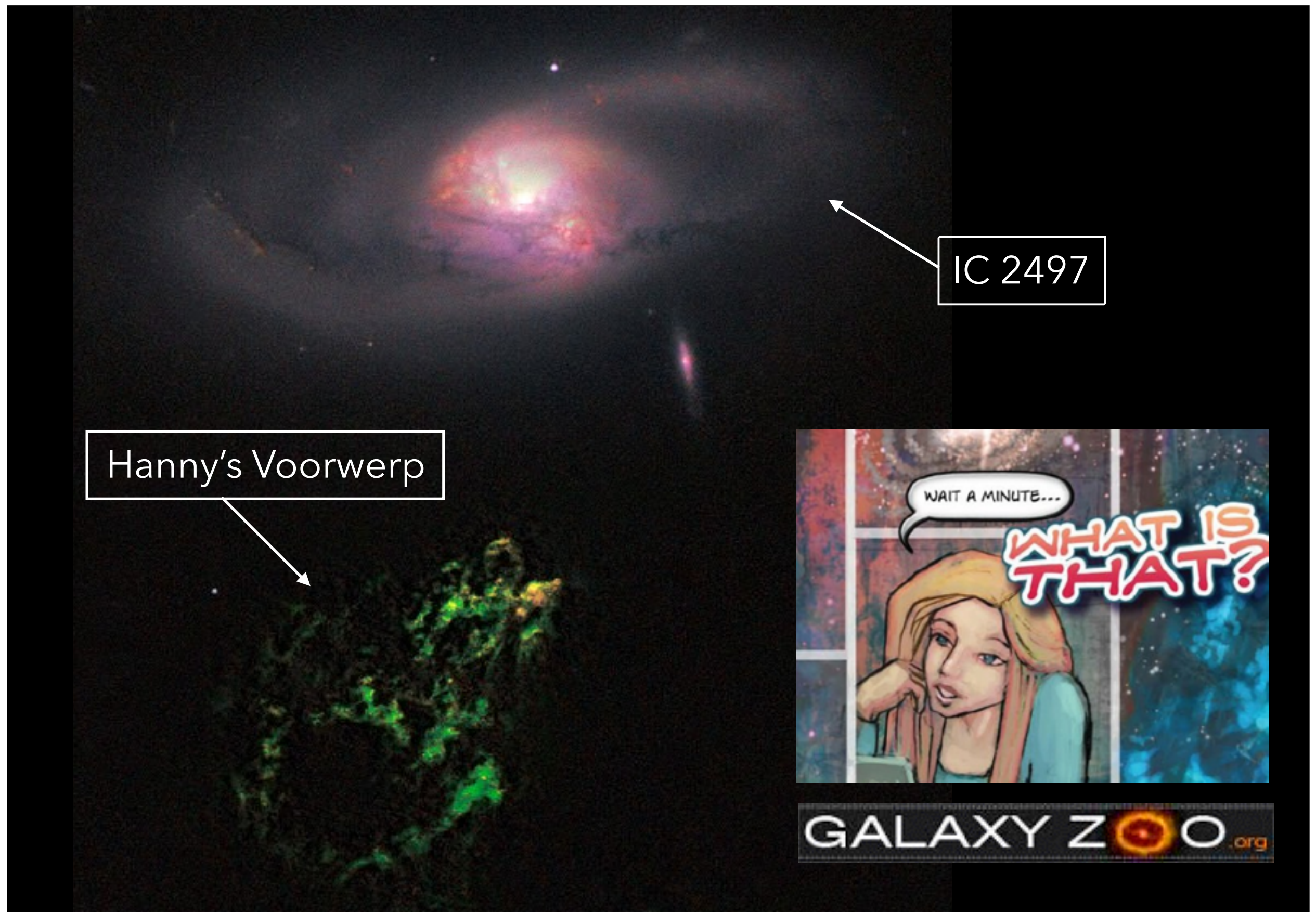


nuclear X-ray emission

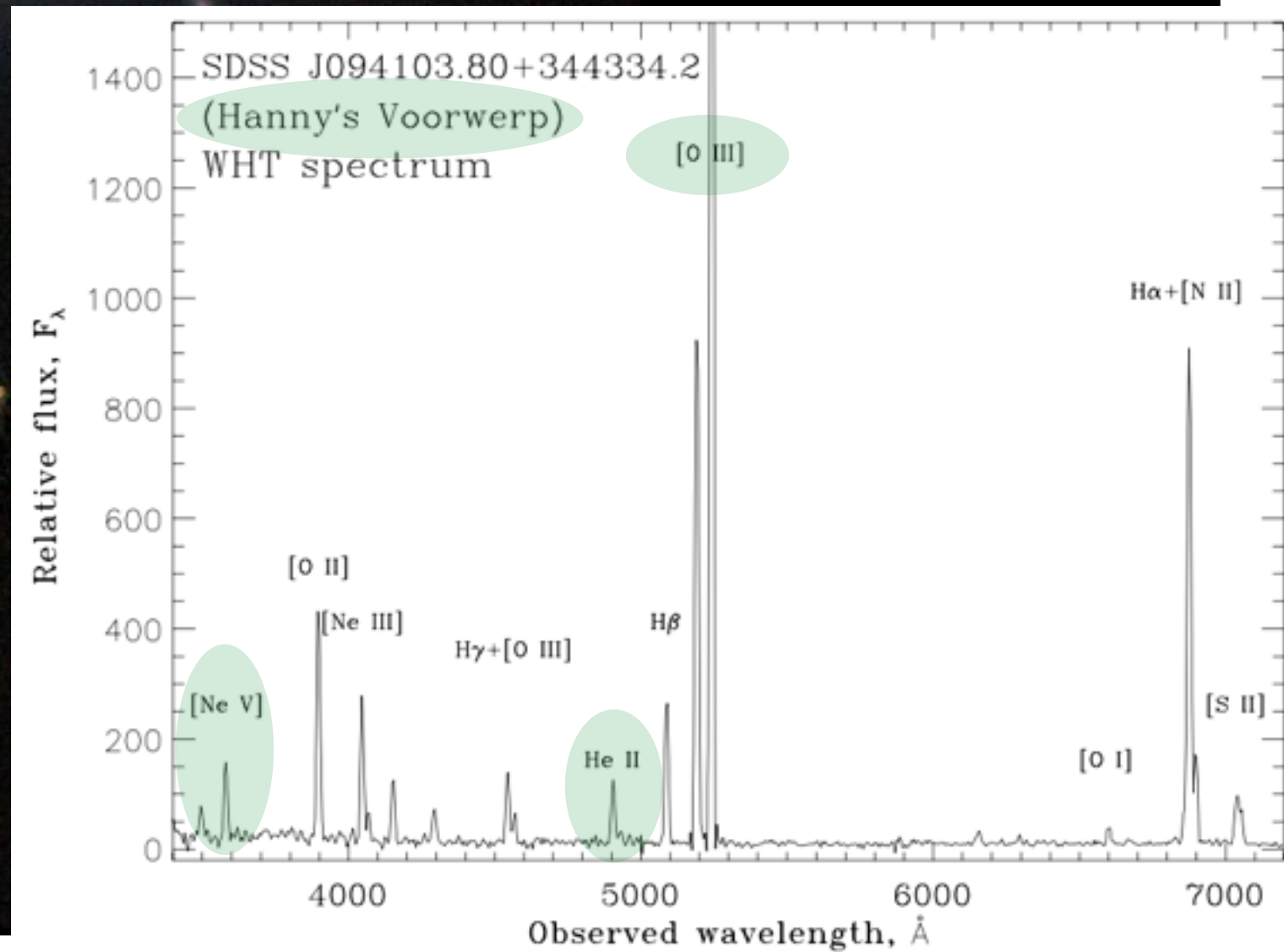


extended optical line emission

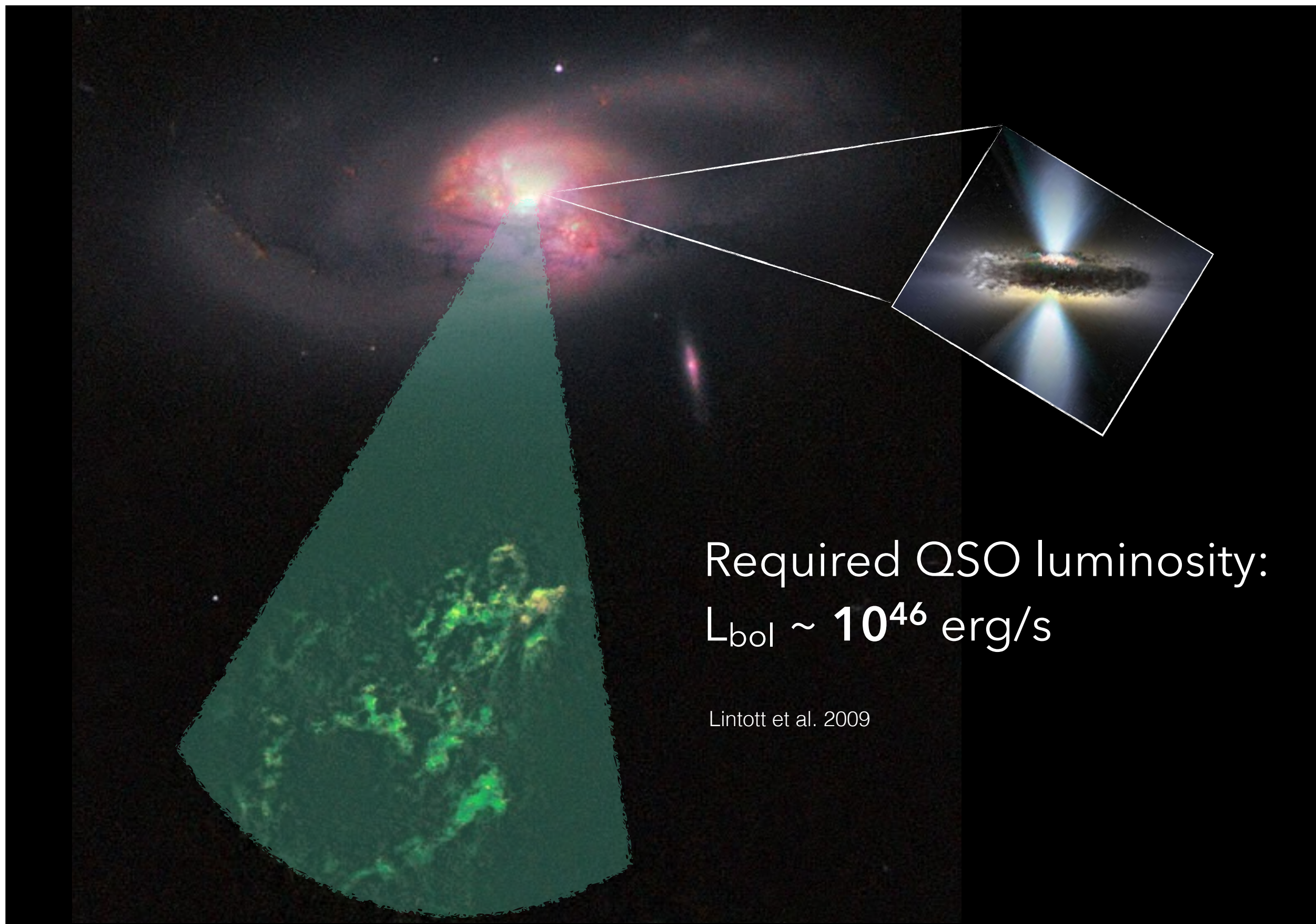
Hanny's Voorwerp



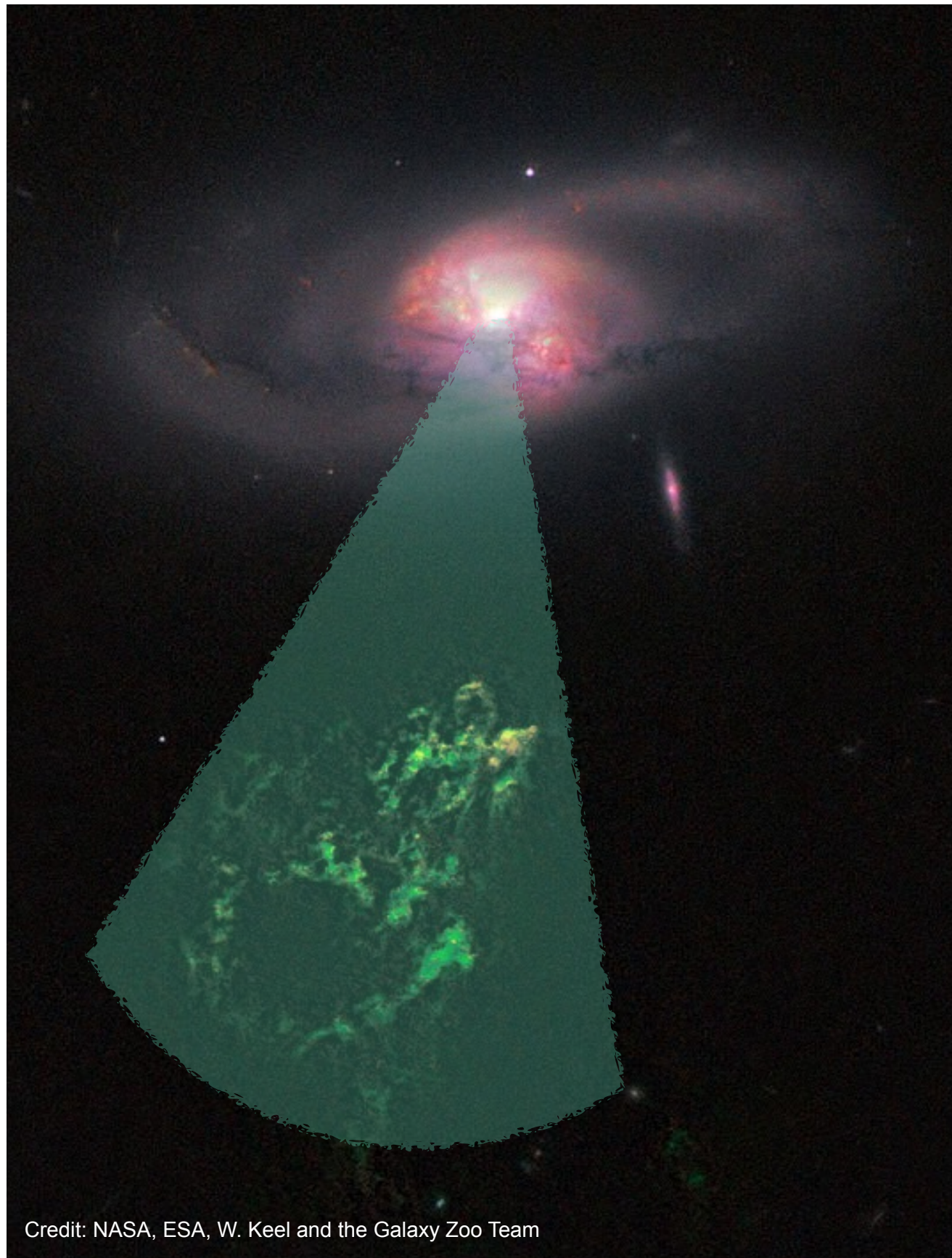
Hanny's Voorwerp



Hanny's Voorwerp

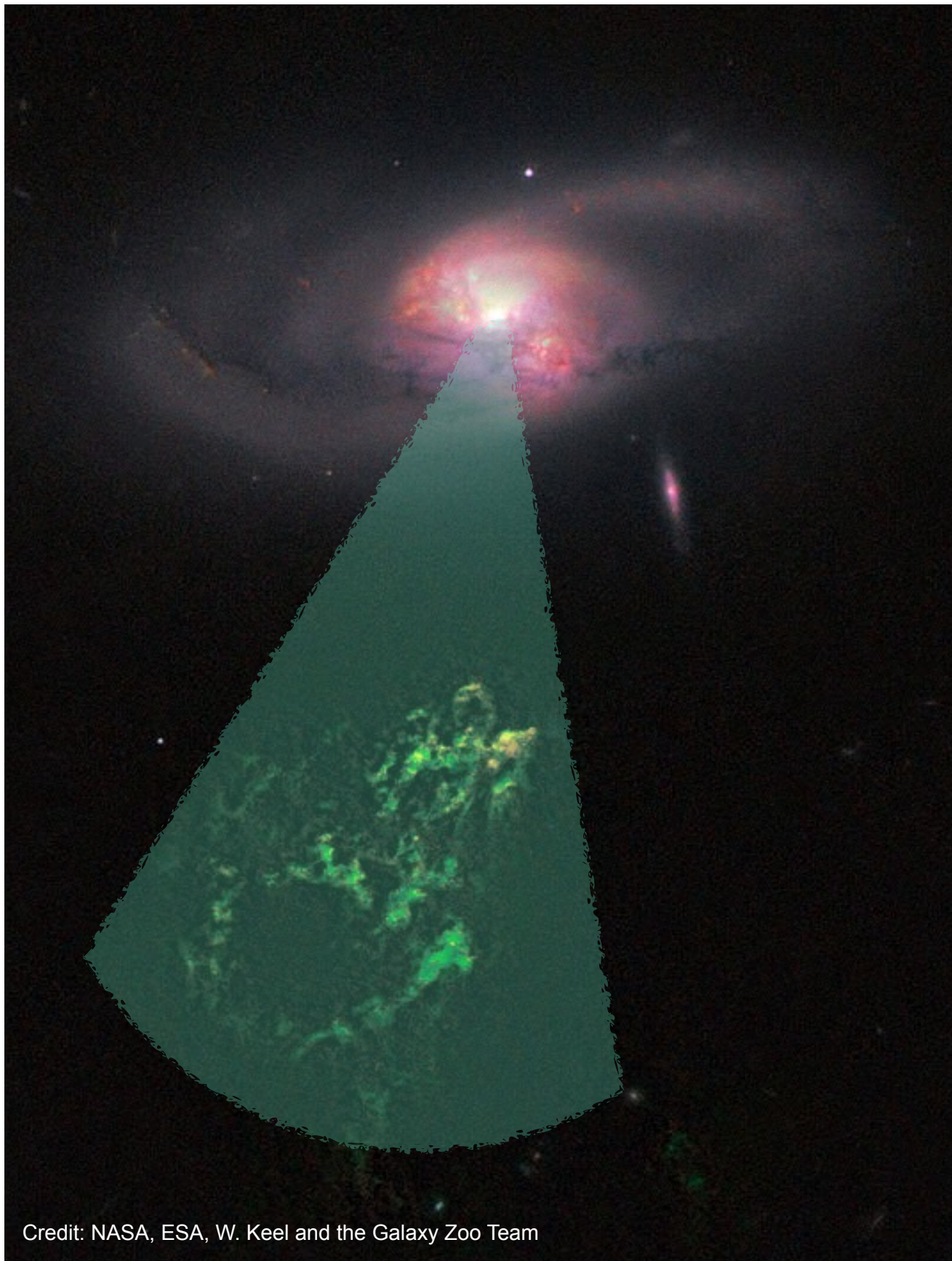


Hanny's Voorwerp



Possible explanations:

Hanny's Voorwerp

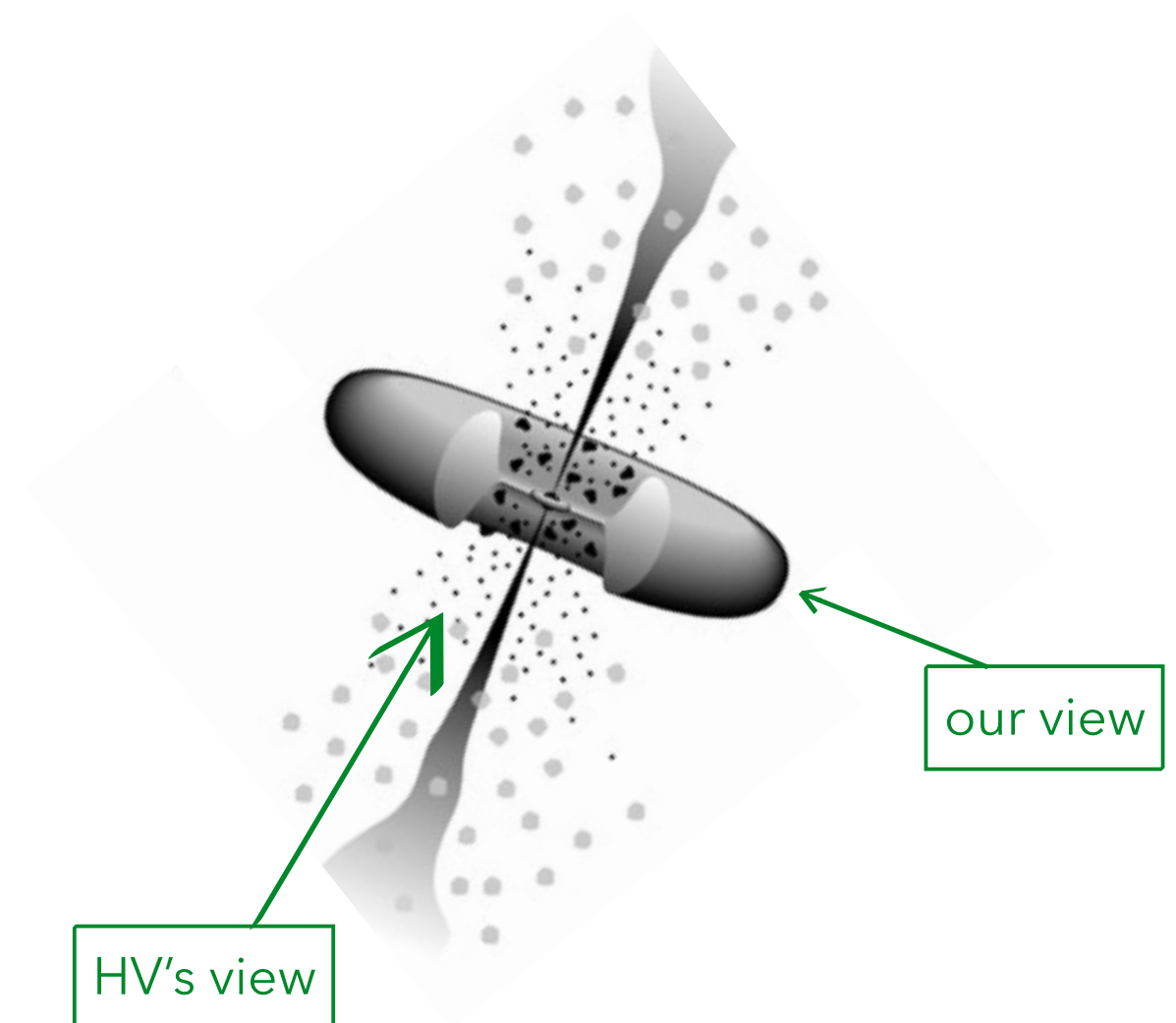


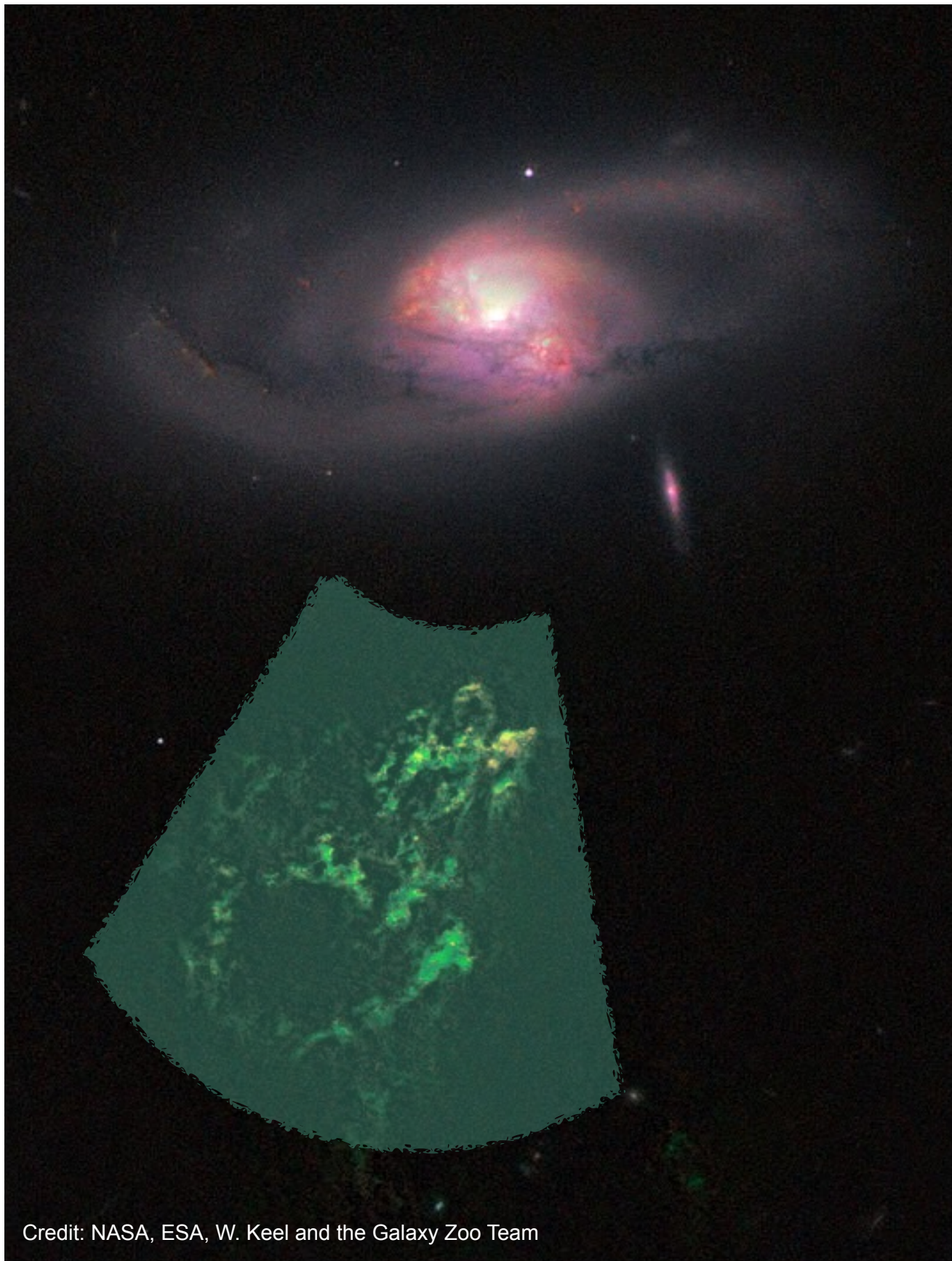
Credit: NASA, ESA, W. Keel and the Galaxy Zoo Team

Possible explanations:

> **obscured** AGN

Józsa+2009, Rampadarath+2010





Possible explanations:

> **obscured** AGN

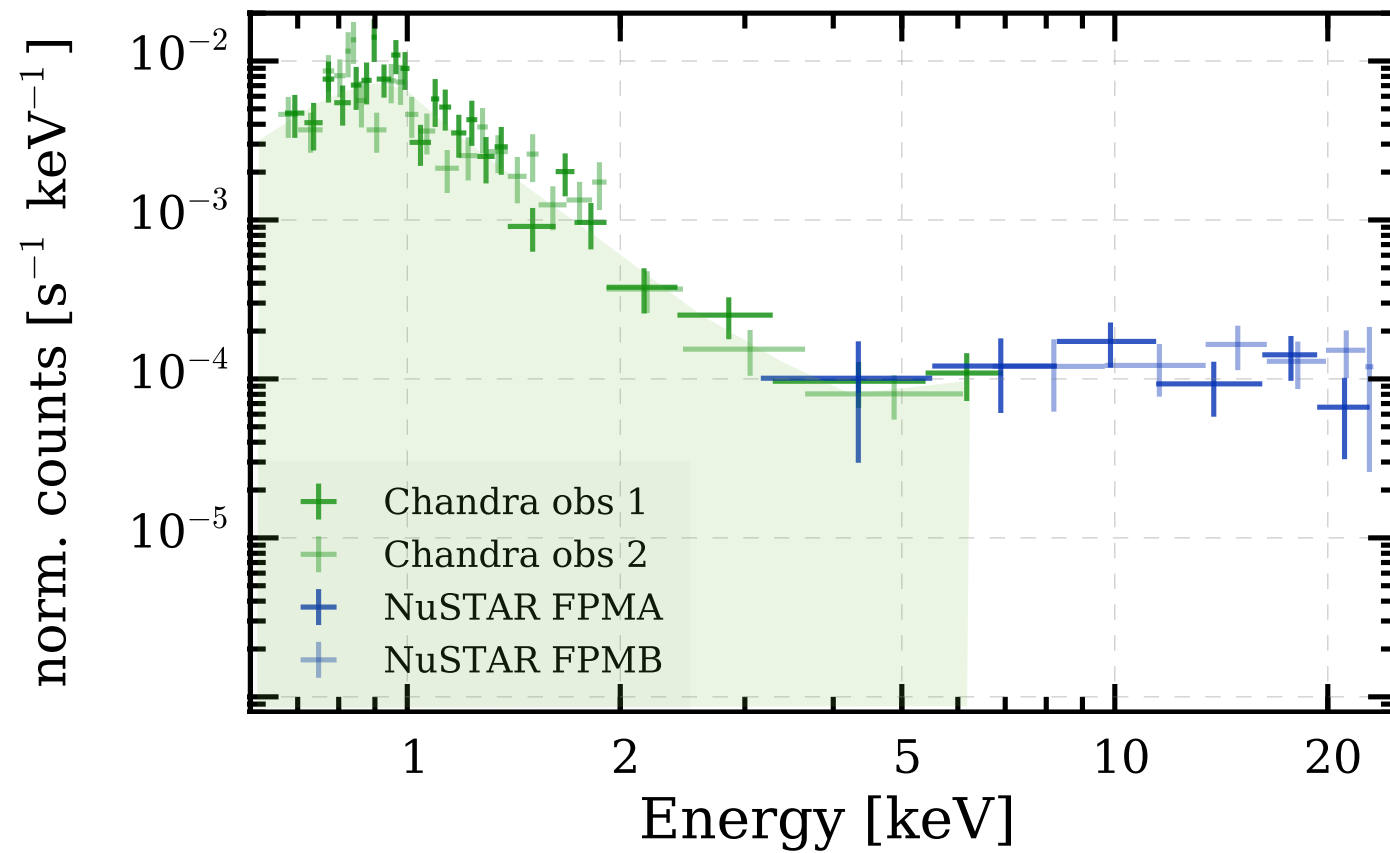
Józsa+2009, Rampadarath+2010

> **faded** AGN

Lintott+2009, Schawinski+2010, Keel+2012

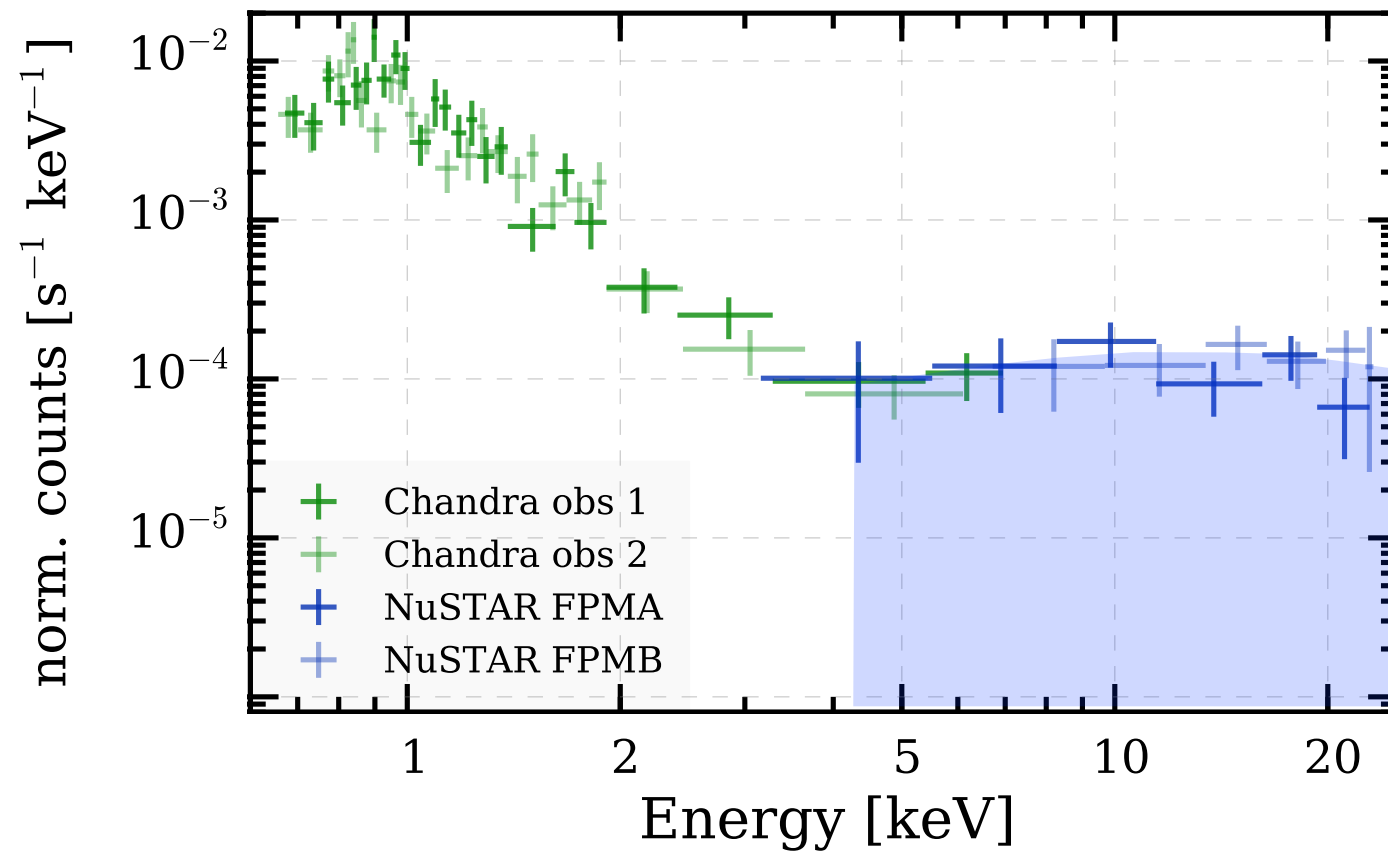
Chandra + NuSTAR analysis of IC 2497

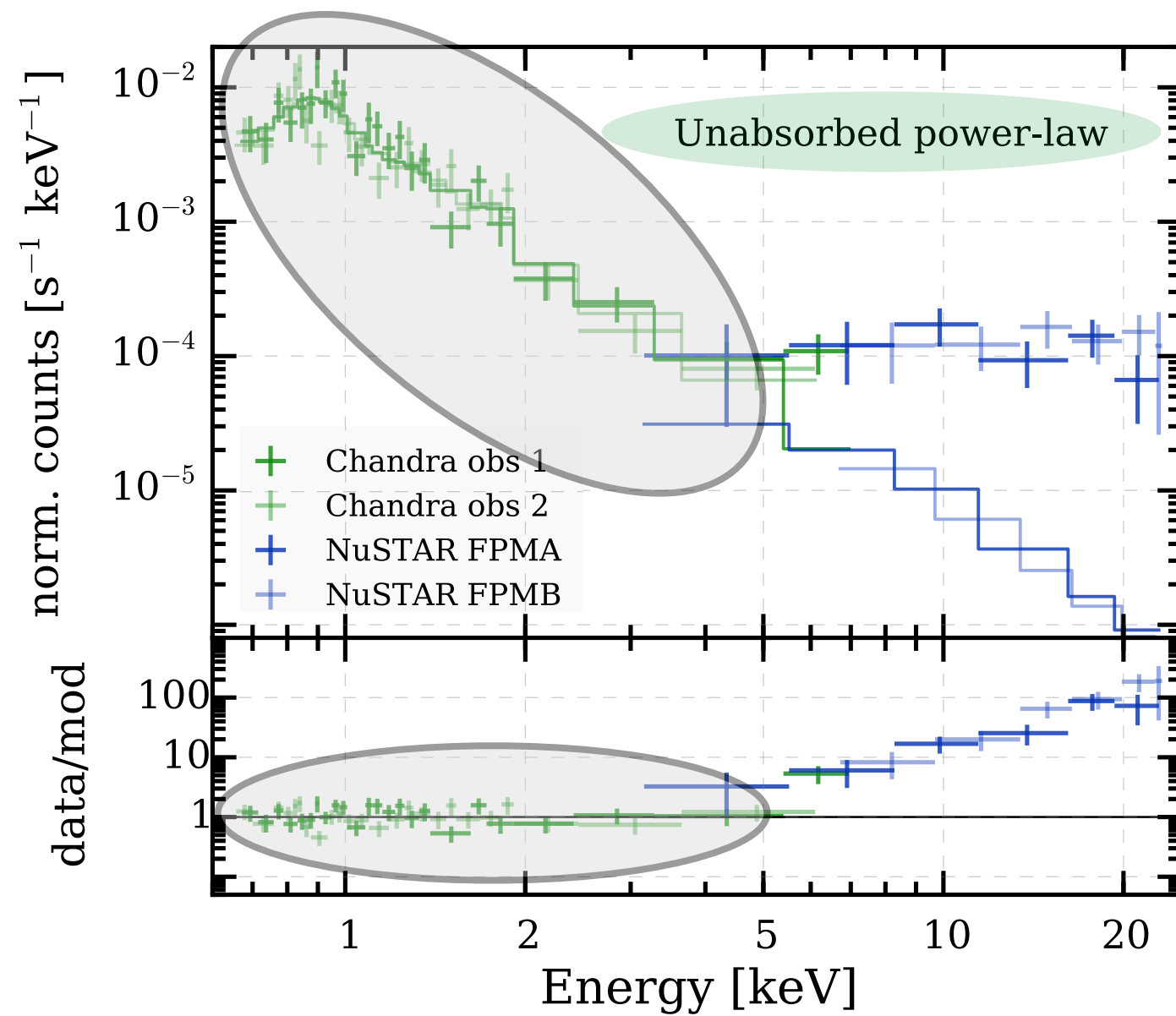
Sartori + 2017 submitted

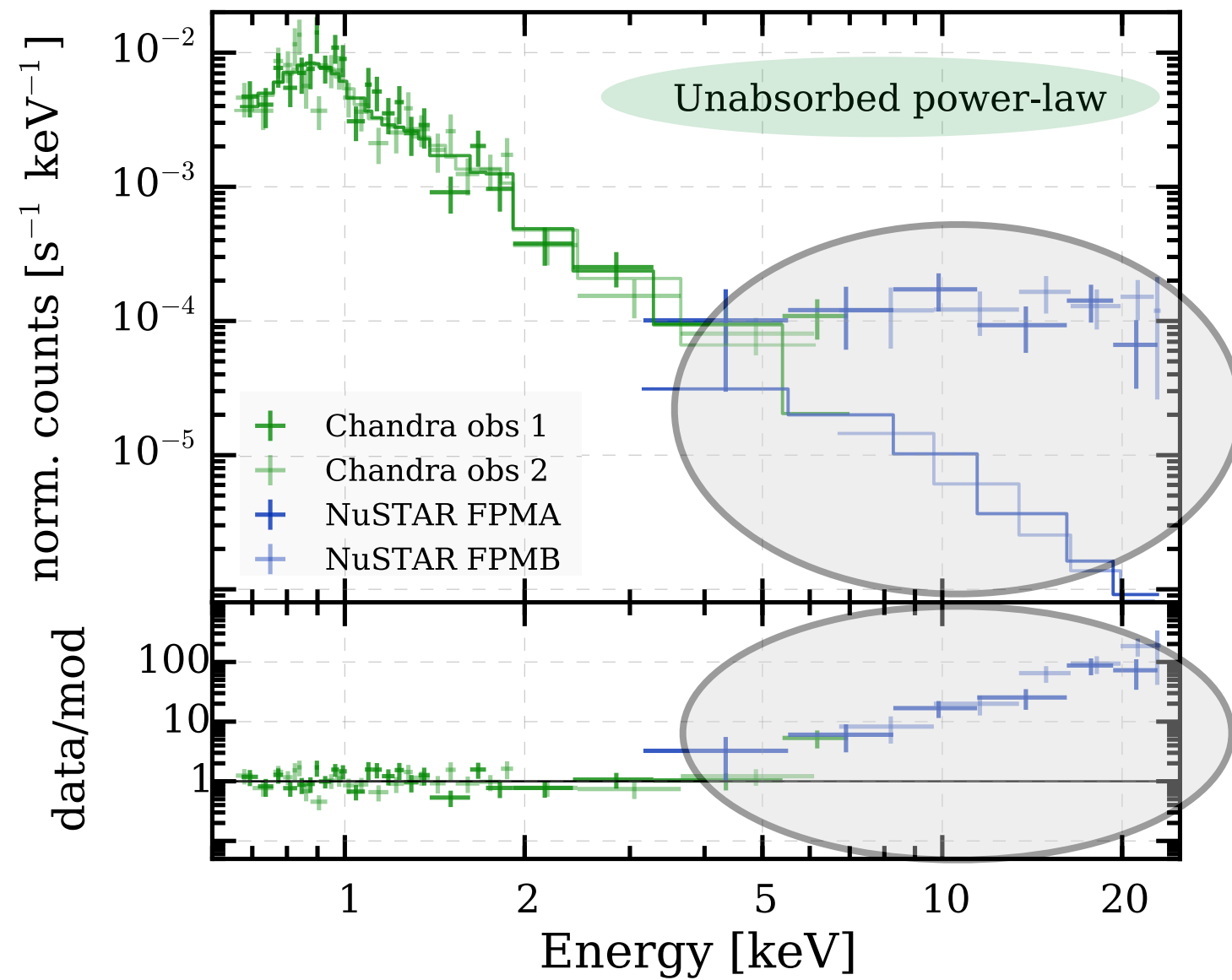


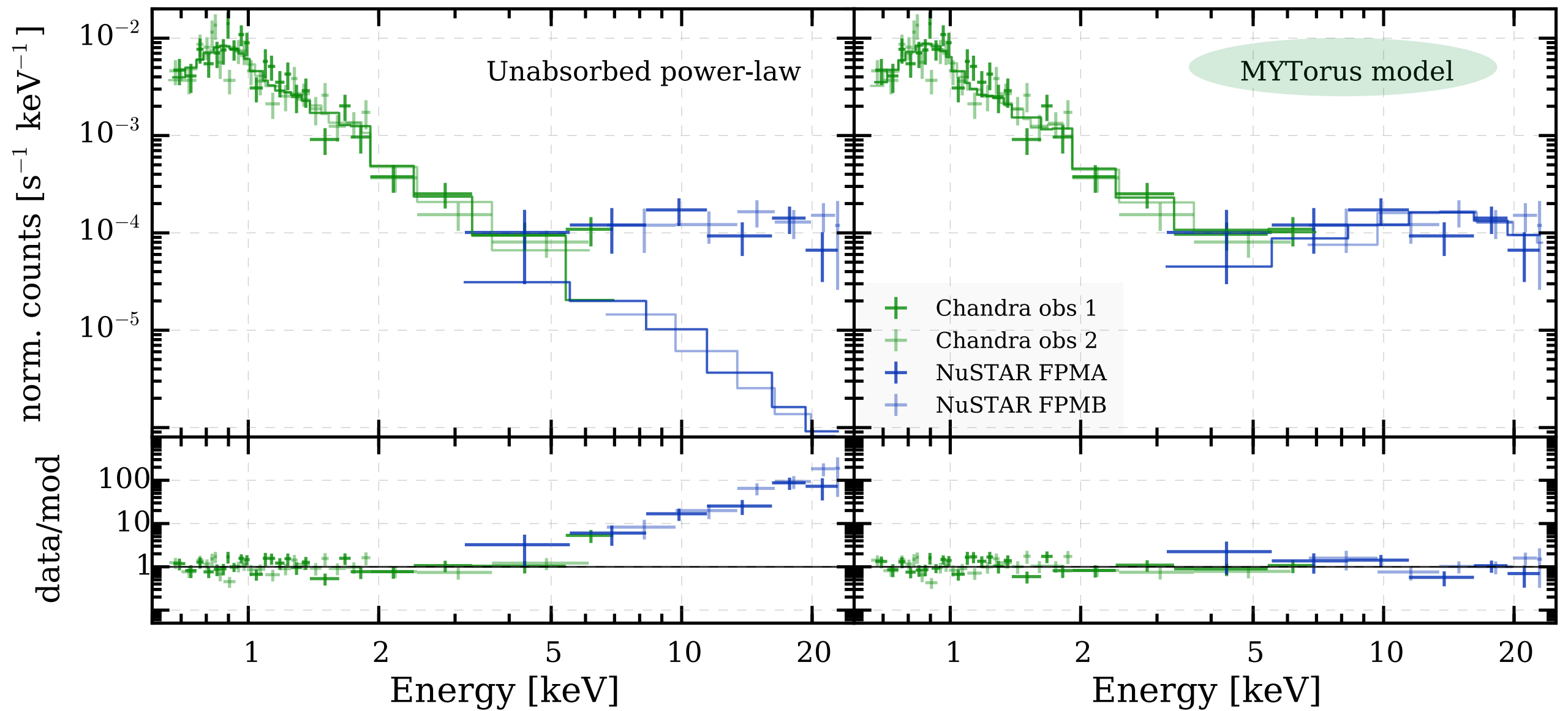
Chandra + NuSTAR analysis of IC 2497

Sartori + 2017 submitted









obscured AND faded AGN

$$n_{\text{H}} \sim 2 \times 10^{24} \text{ cm}^{-2}$$
$$L_{\text{bol}} \sim 2\text{-}5 \times 10^{44} \text{ erg/s}$$

Galaxy

> *present* AGN state

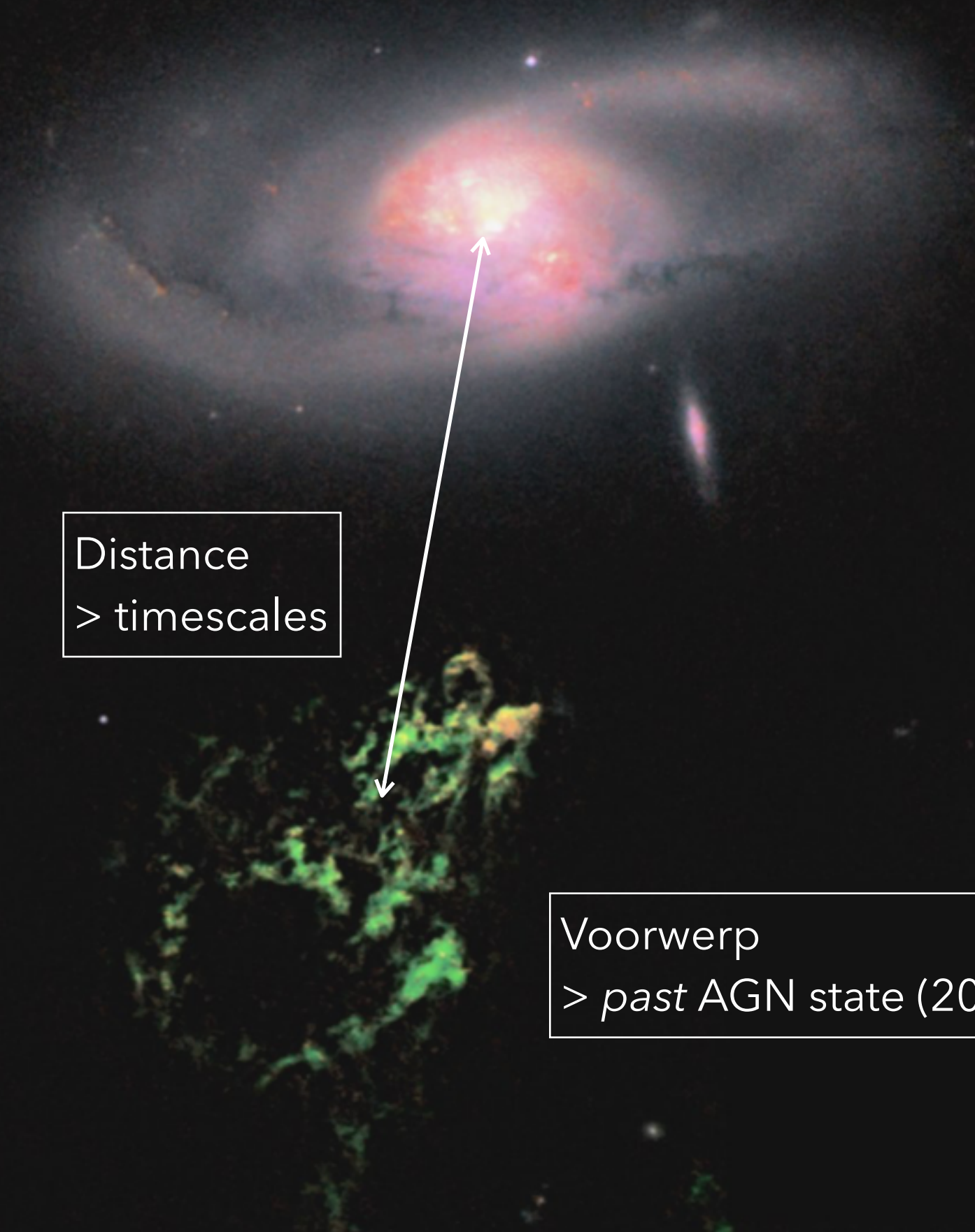
> AGN - host galaxy
interaction

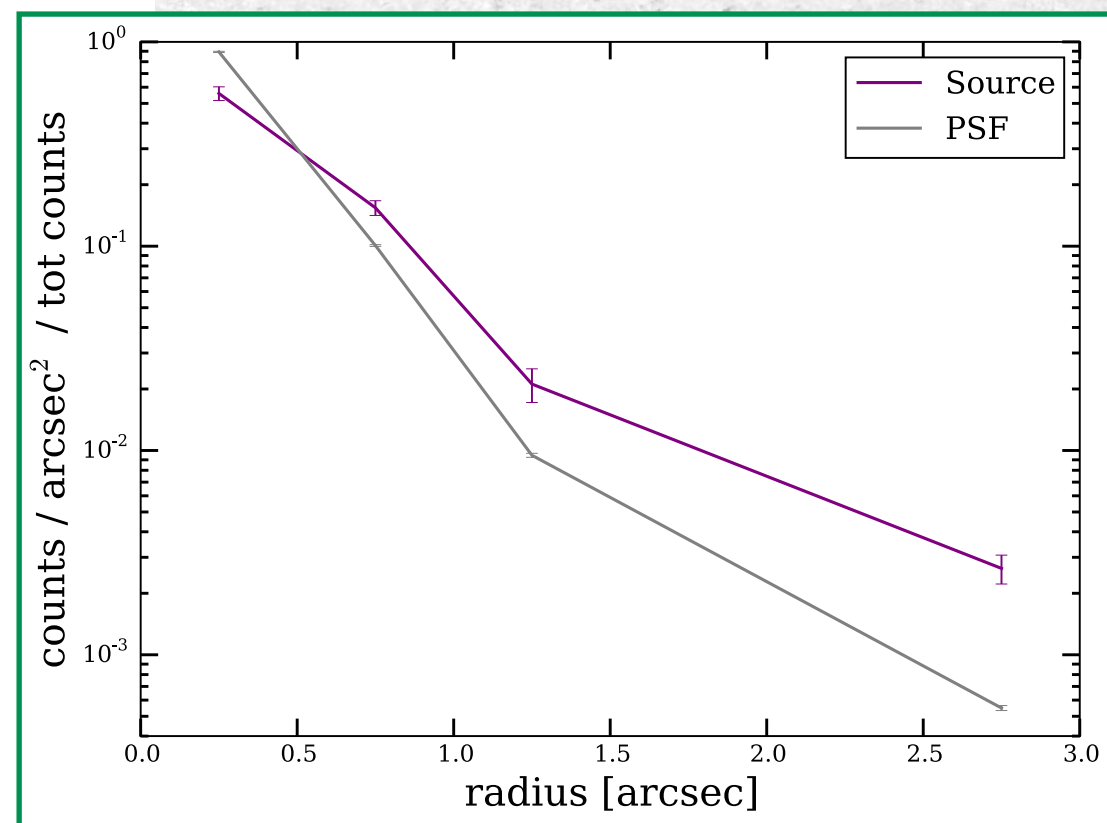
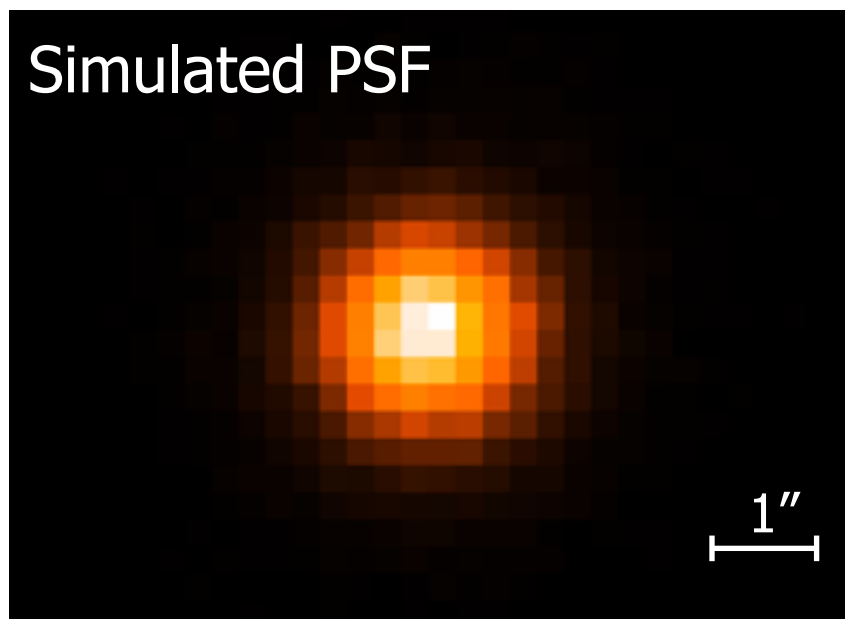
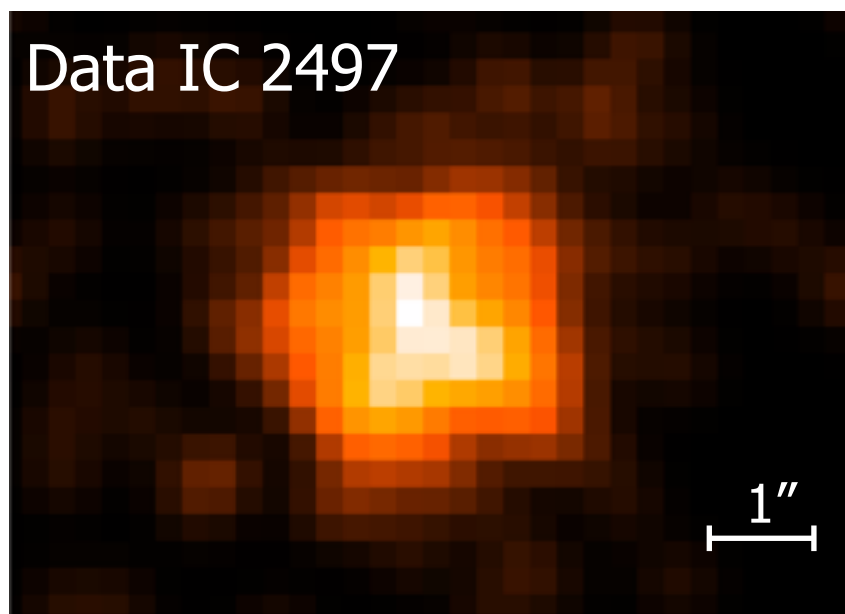
Distance
> timescales

10 kpc $\sim 3 \times 10^4$ yr

Voorwerp

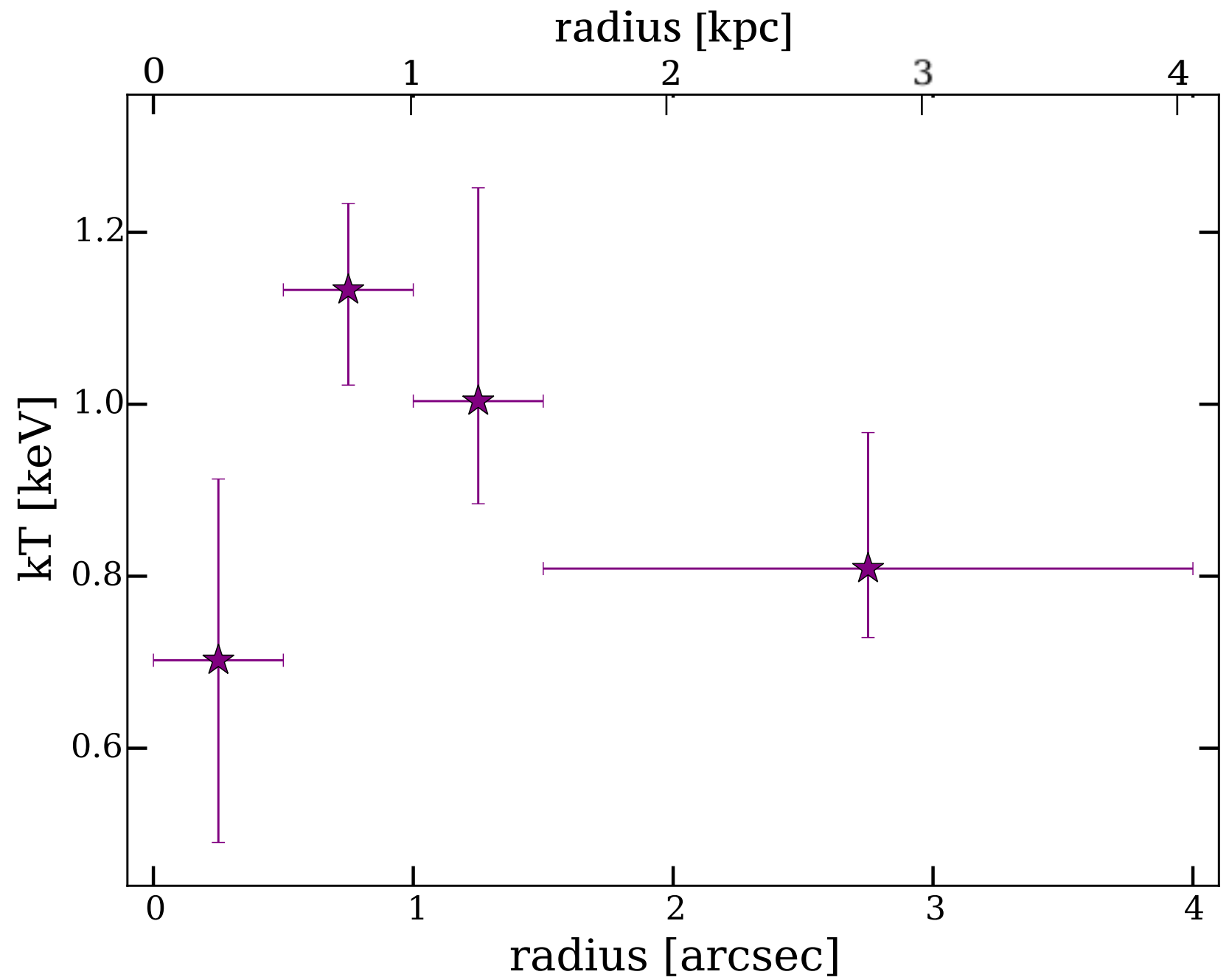
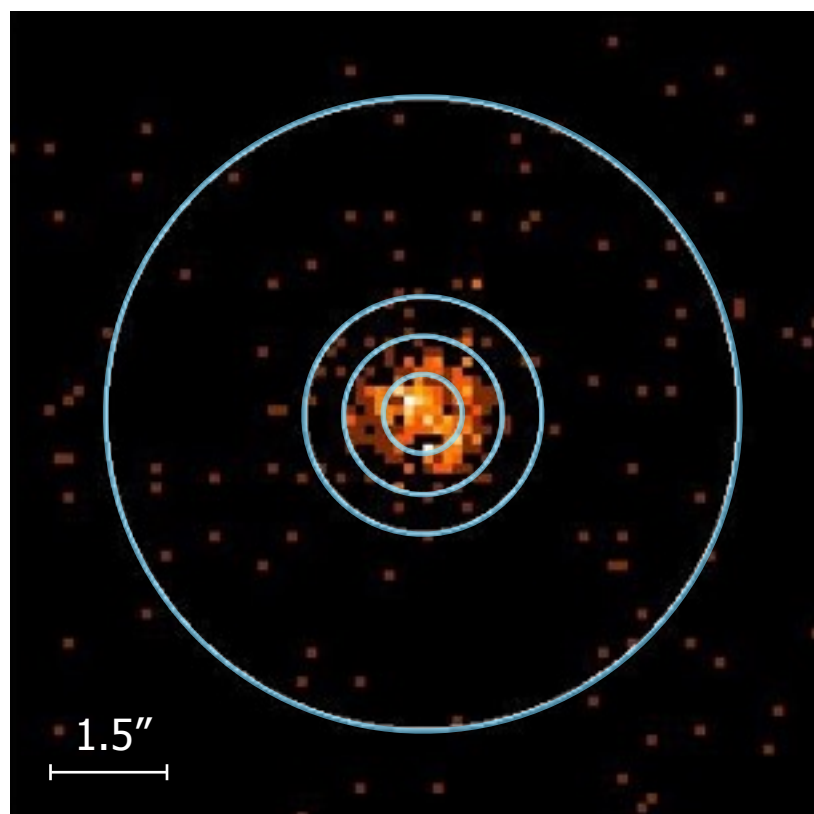
> *past* AGN state (200 kyr ago)





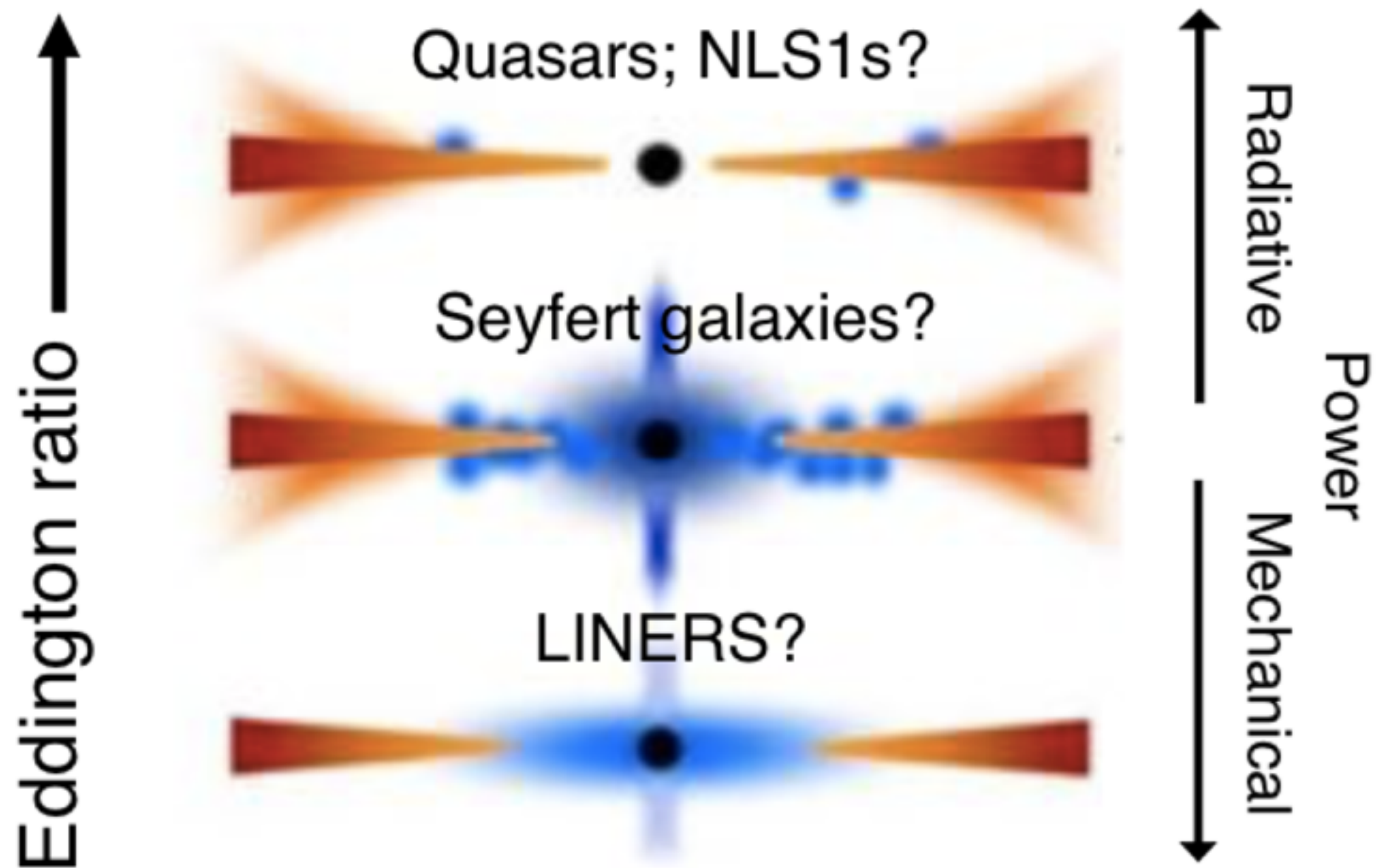
AGN - host galaxy interaction

Sartori + 2016



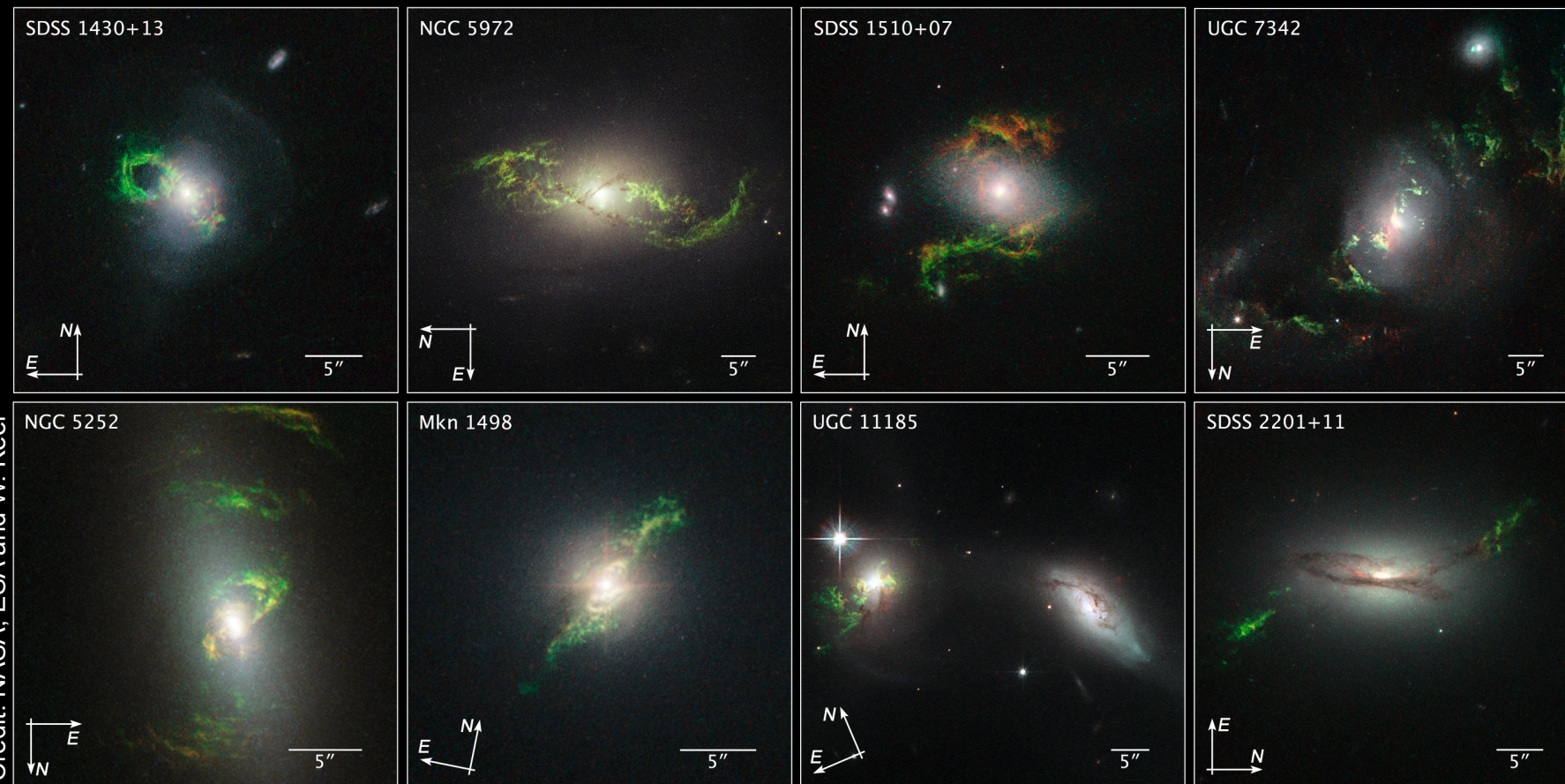
A bubble driven by an AGN in kinetic mode?

A bubble driven by an AGN in kinetic mode?



Is IC 2497 a peculiar galaxy?

Extended emission line regions



Voorwerpjes

Keel et al. 2012, 2015, 2017

Gagne et al. 2014

Harrison et al. 2014

Ramos Almeida et al. 2017

Lya blobs

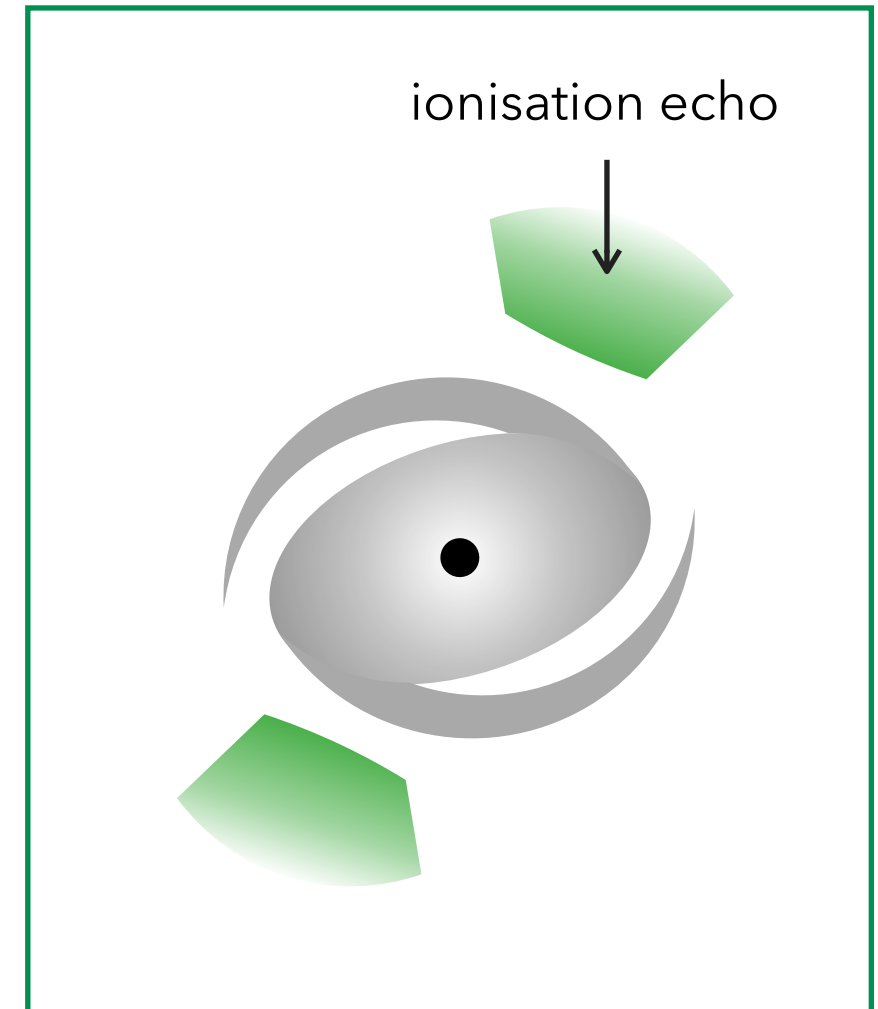
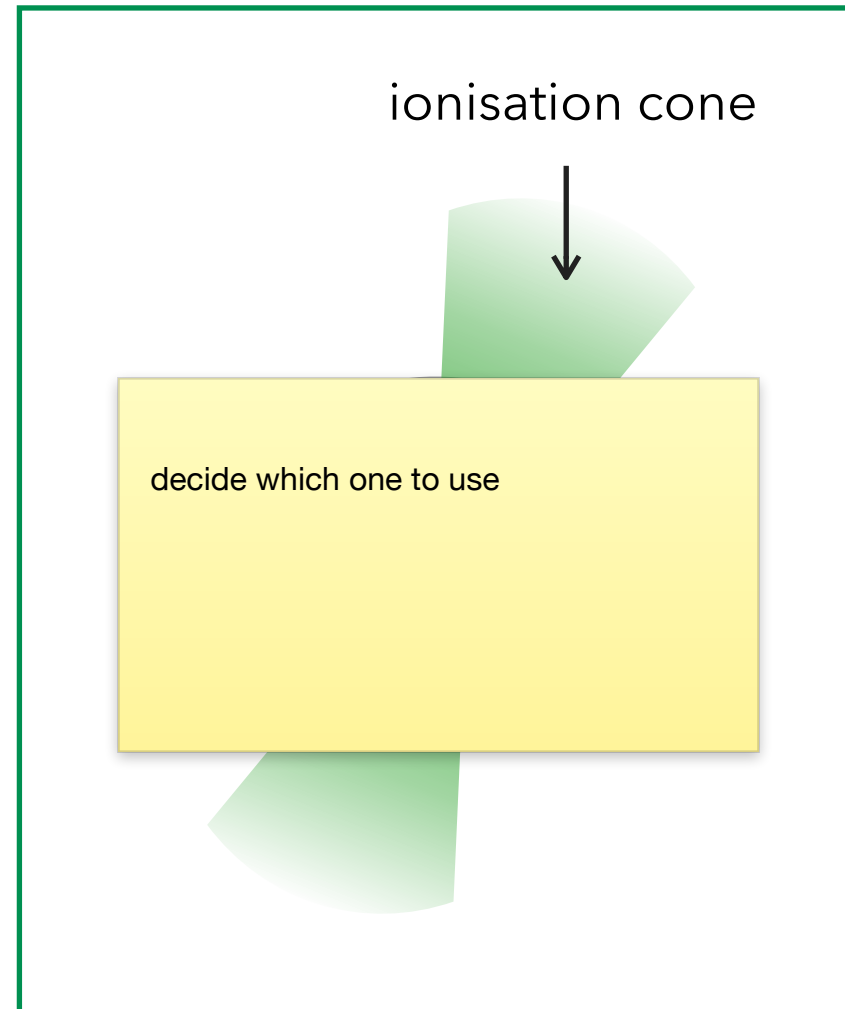
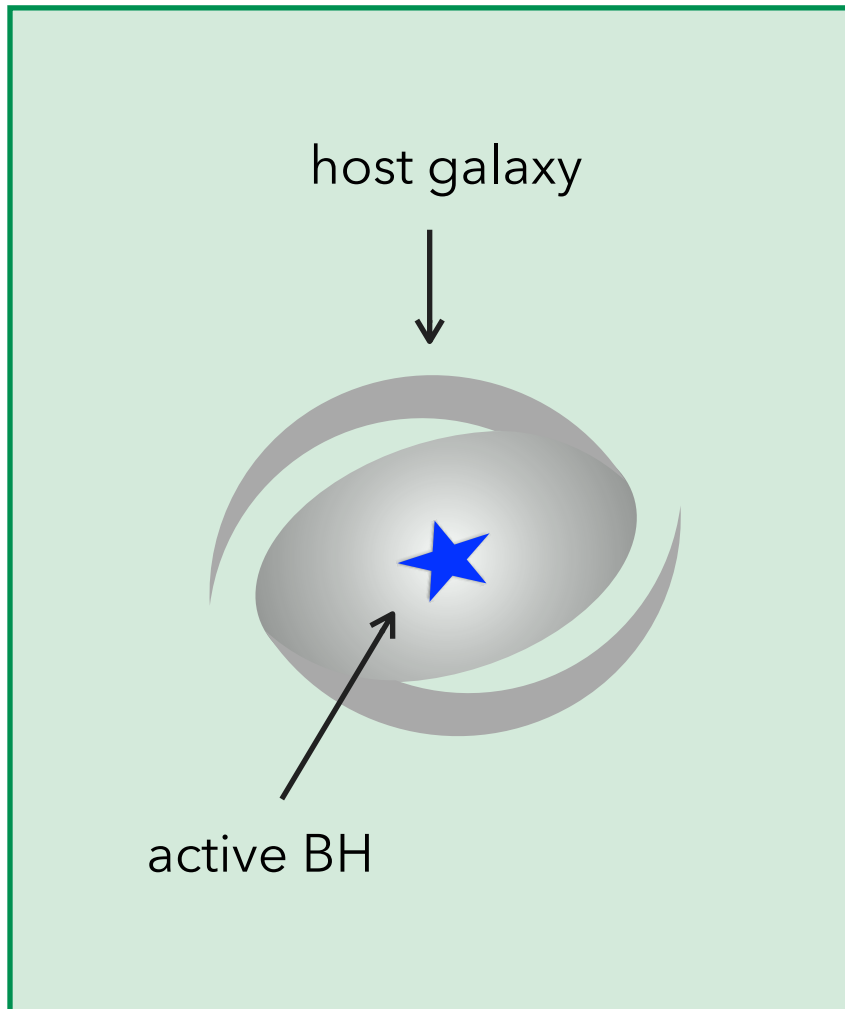
Schirmer et al. 2013, 2016



switch on

normal AGN

switch off



nuclear X-ray emission



extended optical line emission

BASS - BAT AGN Spectroscopic Survey

An all sky study of the brightest hard X-ray detected AGN

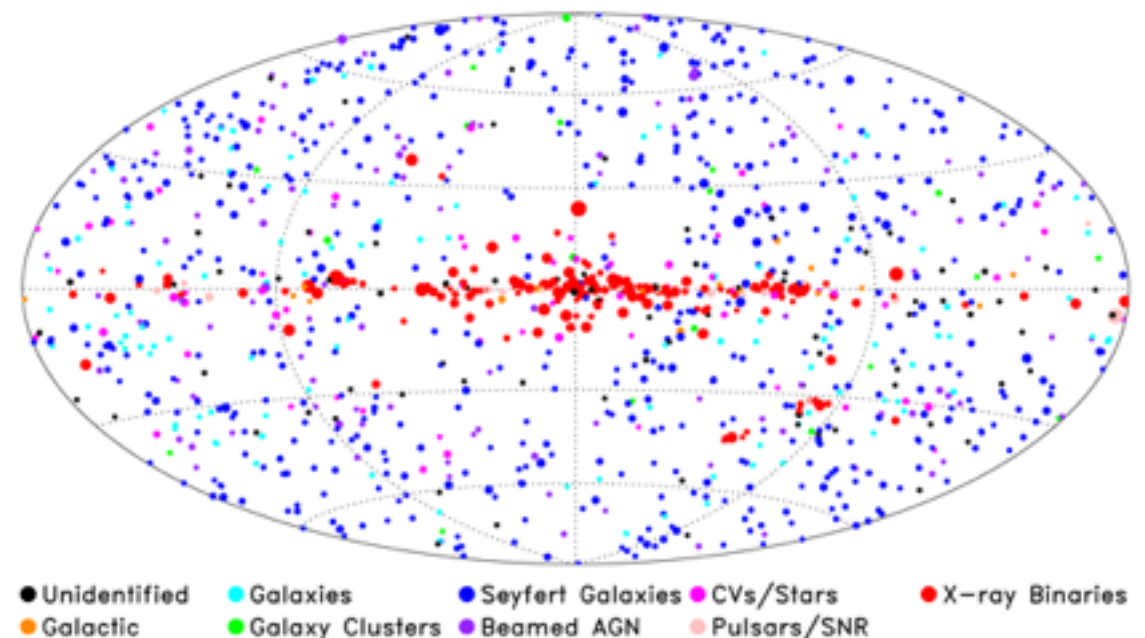
Papers

1. Initial Catalog, 650 AGN with BH masses (Koss submitted)
2. Large scatter with [OIII] (Berney 2016)
3. Accretion rates vs. Line Ratio (Oh 2017)
4. NIR Spectra/Coronal Lines (Lamperti 2017)
5. X-ray Catalog (Ricci submitted)
6. Gamma vs. L/L_{Edd} (Trakhtenbrot 2017)
7. Accretion Rate vs. X-ray Obscuration (Ricci submitted)

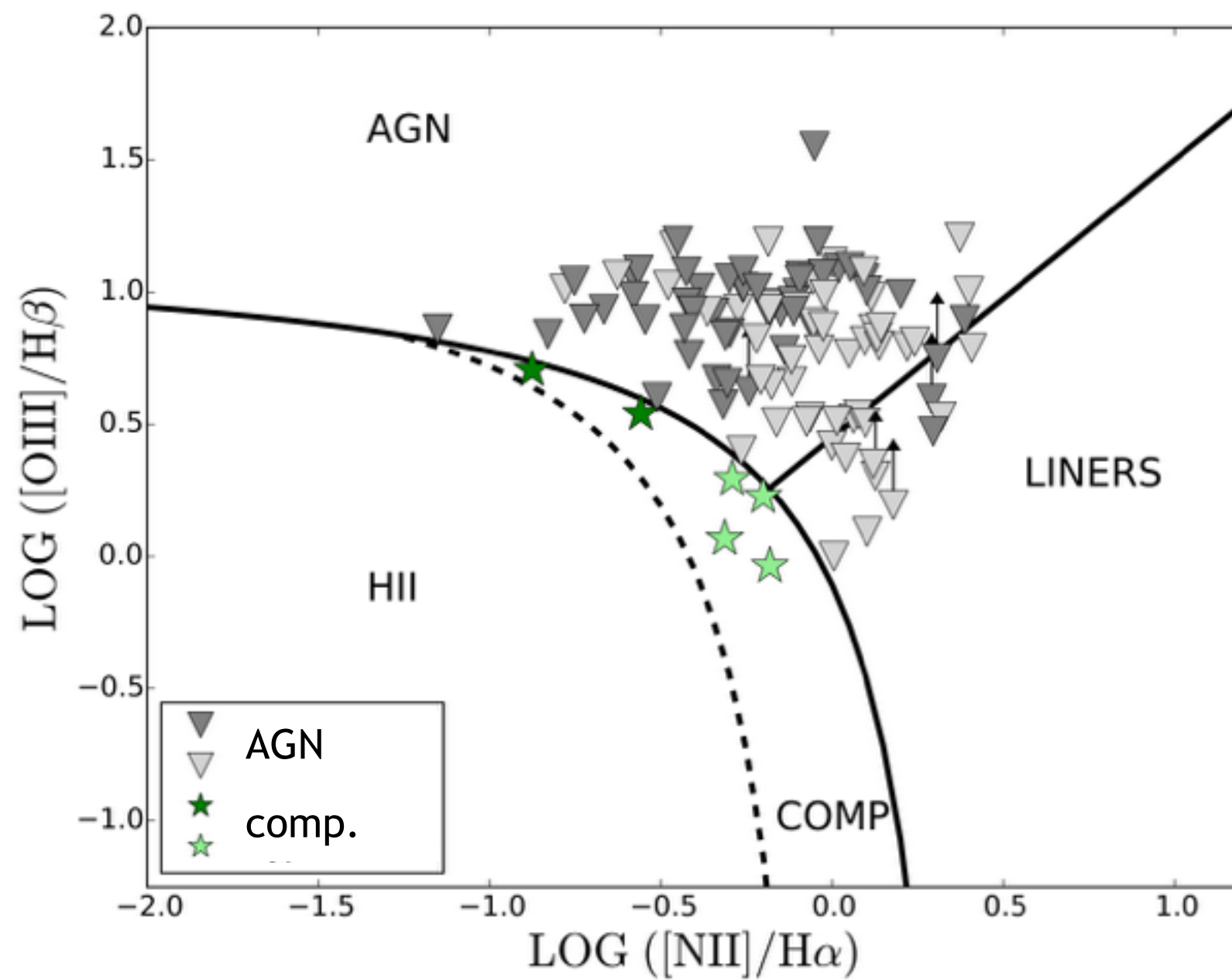
... and many more to come



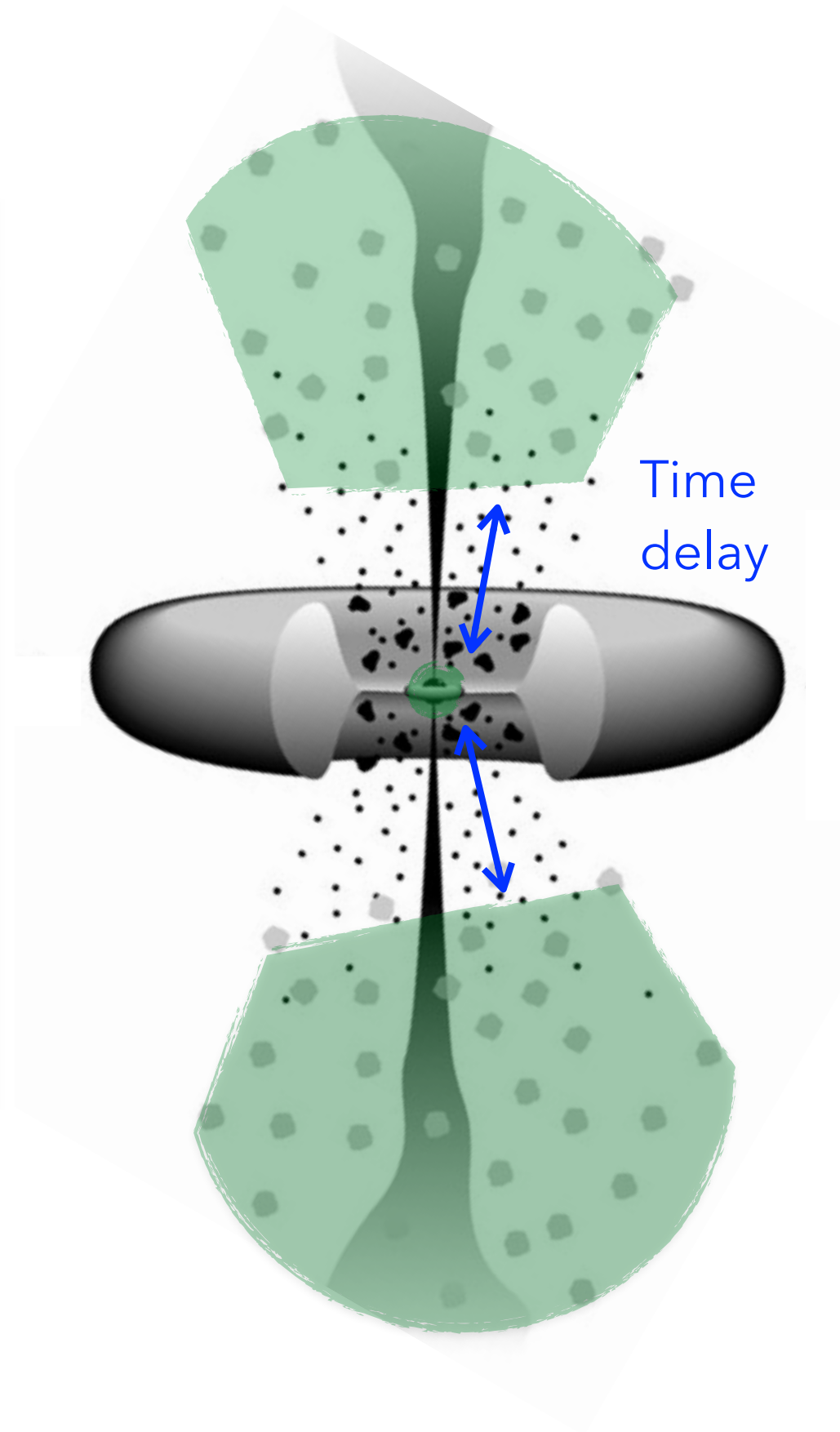
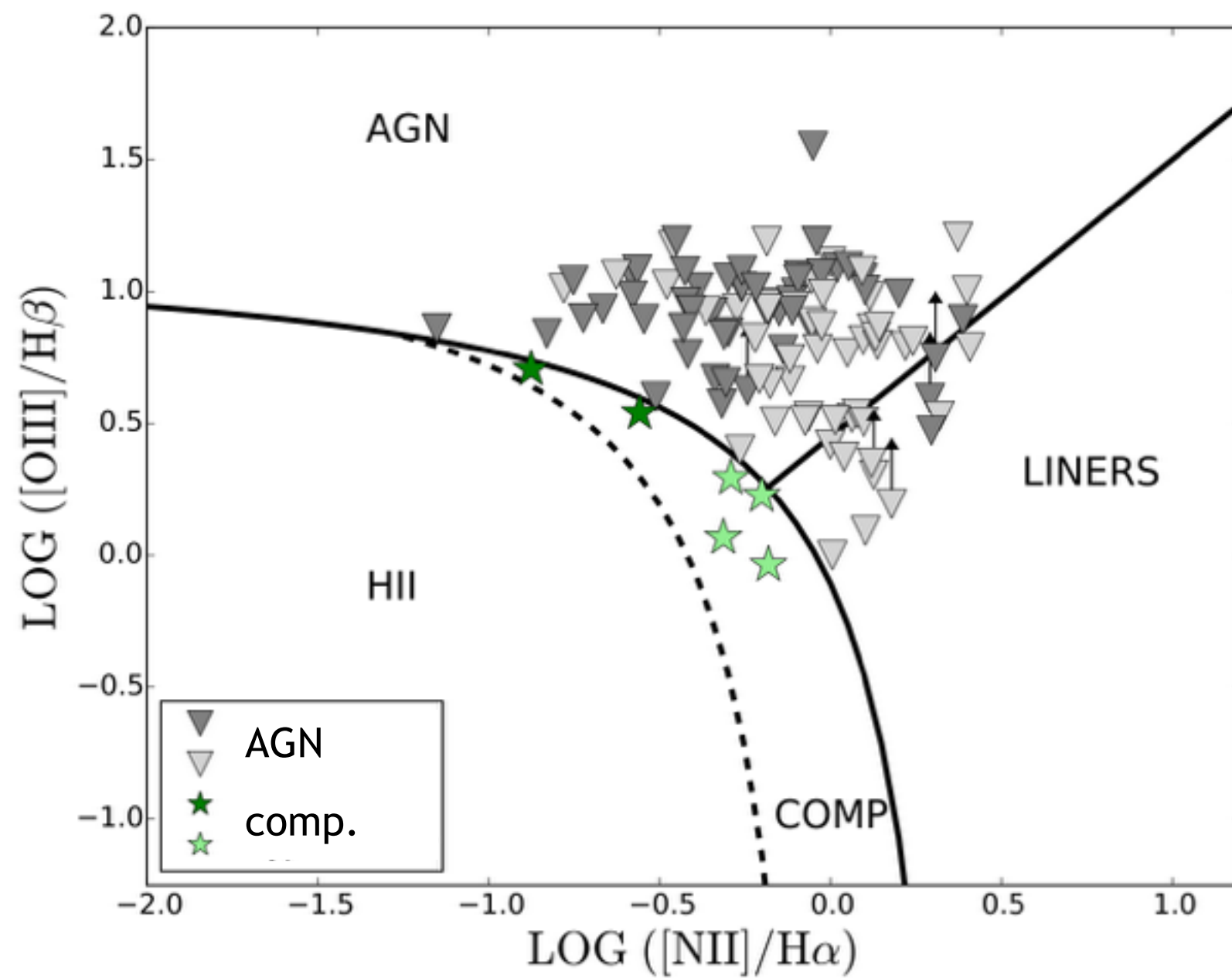
Swift BAT 70-Month hard X-ray Survey



The “switch on” phase



The “switch on” phase



AGN phase lifetime

$$t_{\text{AGN}} \sim \frac{\text{time to photoionise the host galaxy}}{\text{fraction of optically elusive AGN}}$$

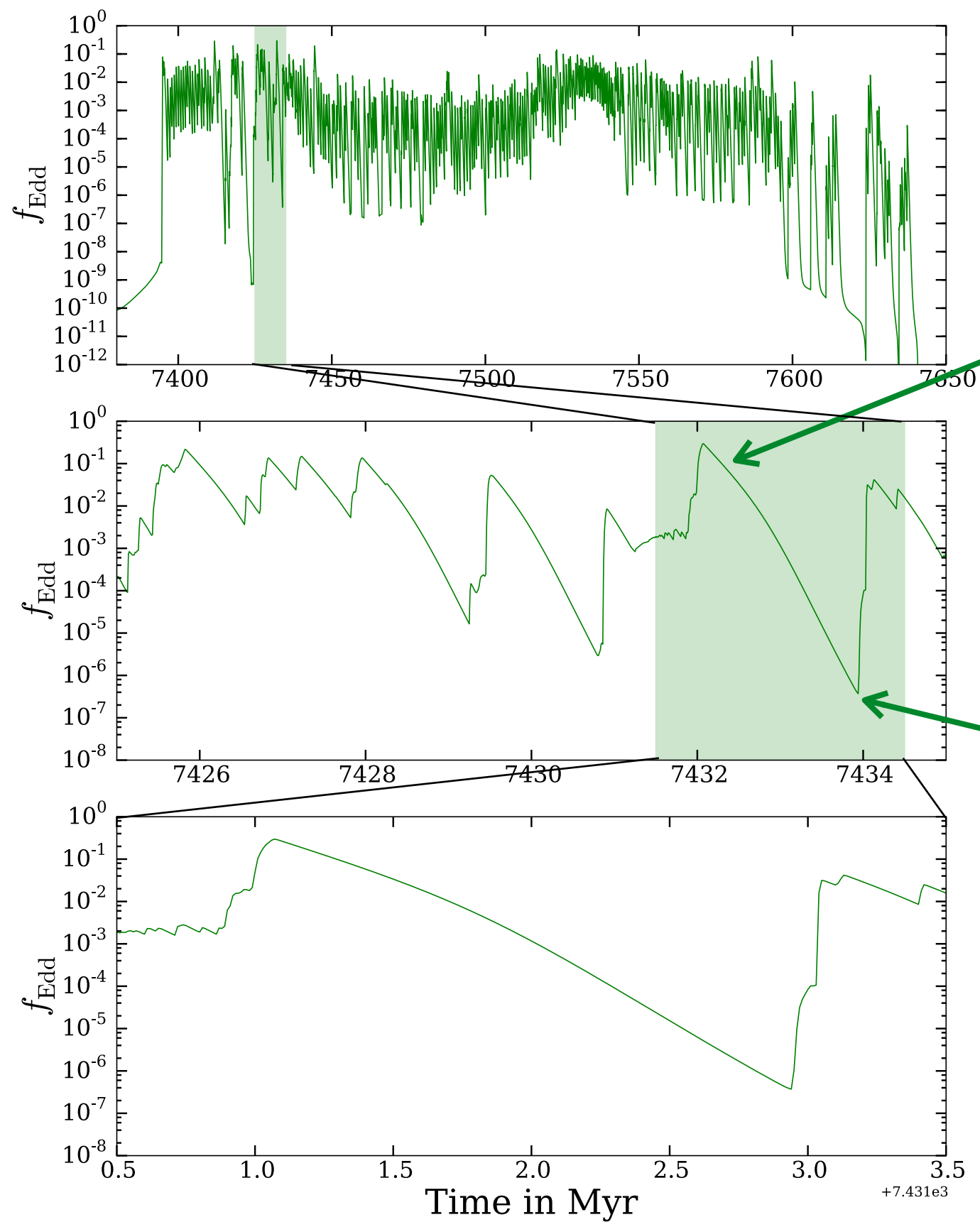
$$t_{\text{AGN}} \sim \frac{10'000 \text{ years}}{5 \%} \sim 200'000 \text{ years}$$

NLR size: Schmitt+03; Keel+12; Hainline+13

Optically elusive AGN fraction: La Franca+02; Hornscheneier+05; Smith+14

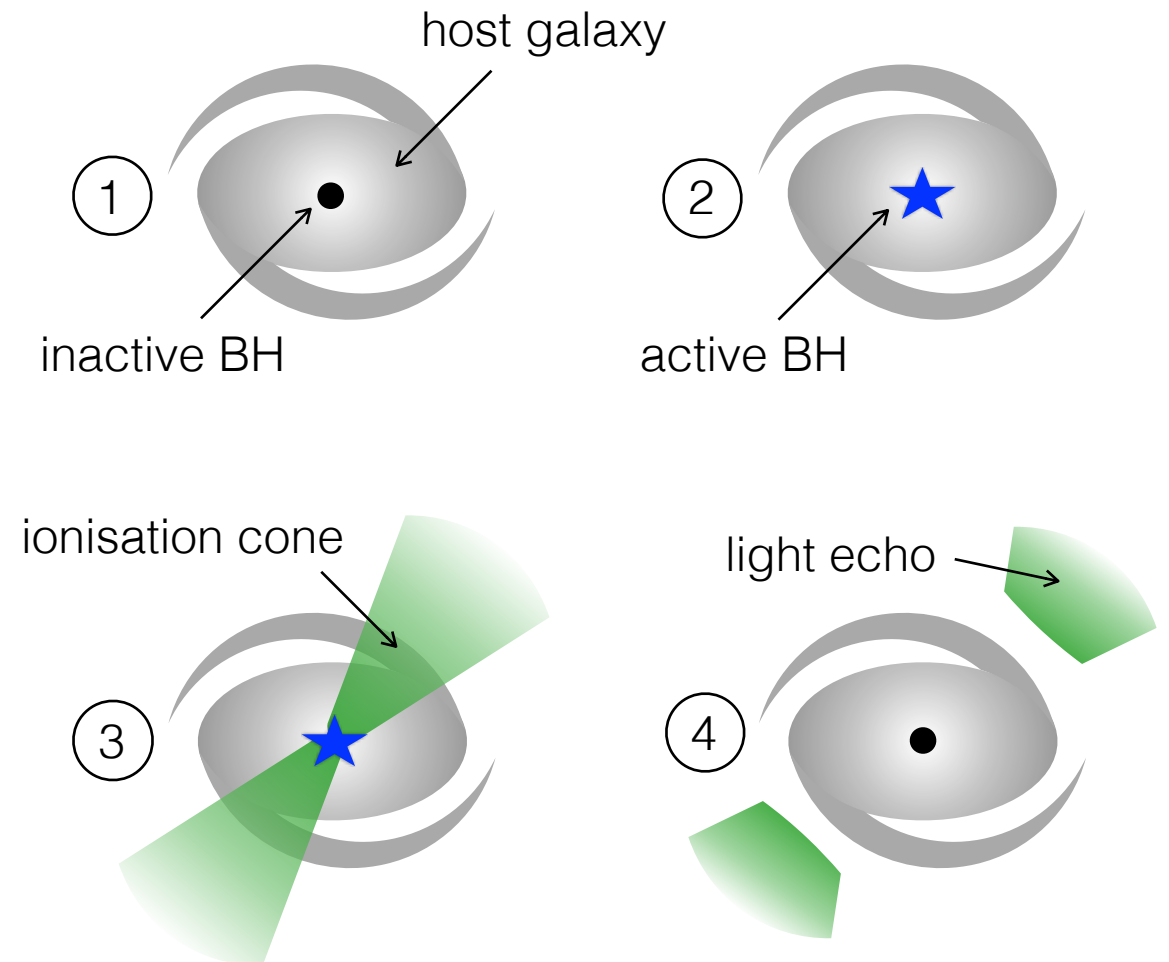
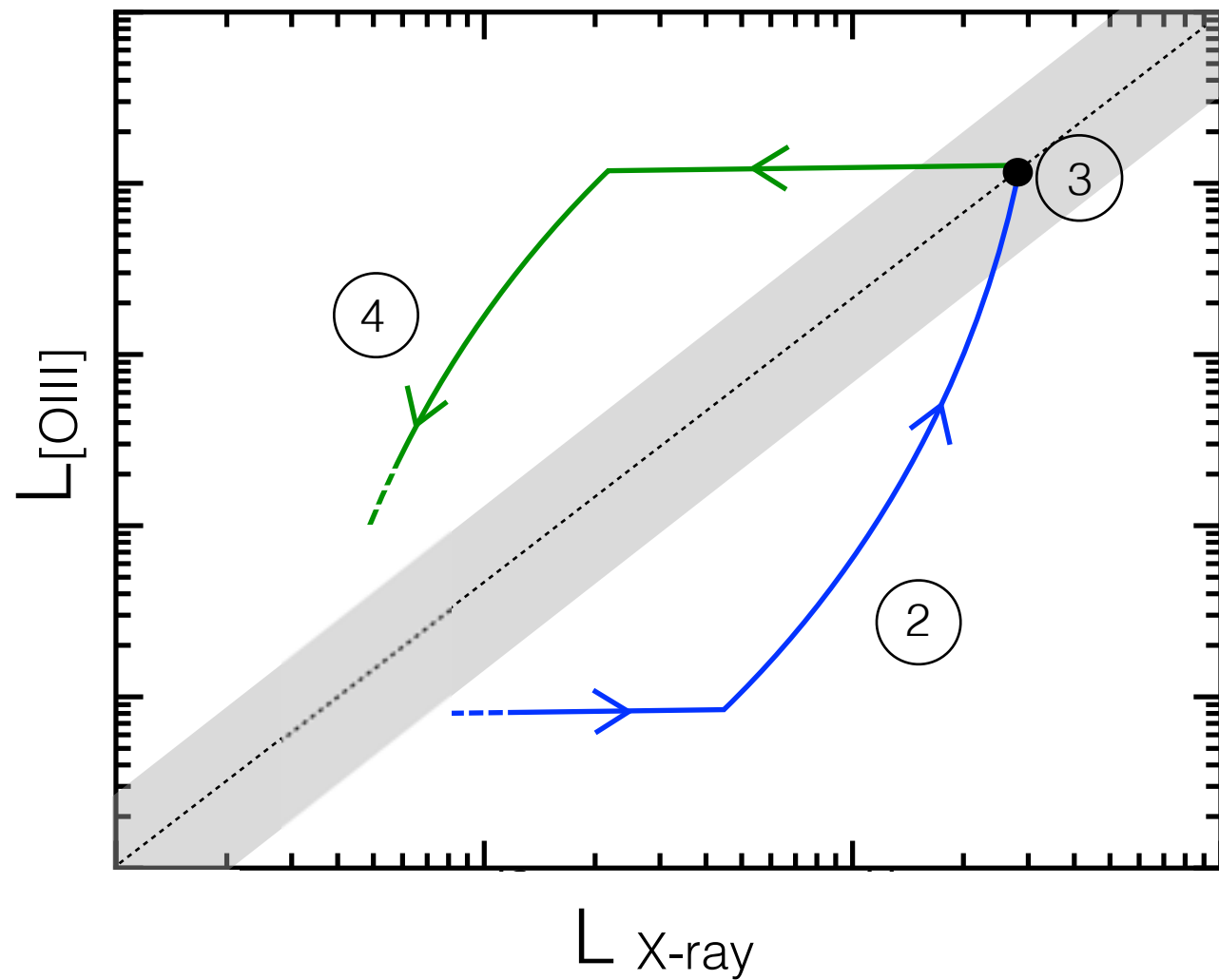
→ AGN flickering

AGN flickering



Novak+2011, Hickox+2014,
Schawinski...**Sartori** et al. 2015

The cycle of BH accretion phases

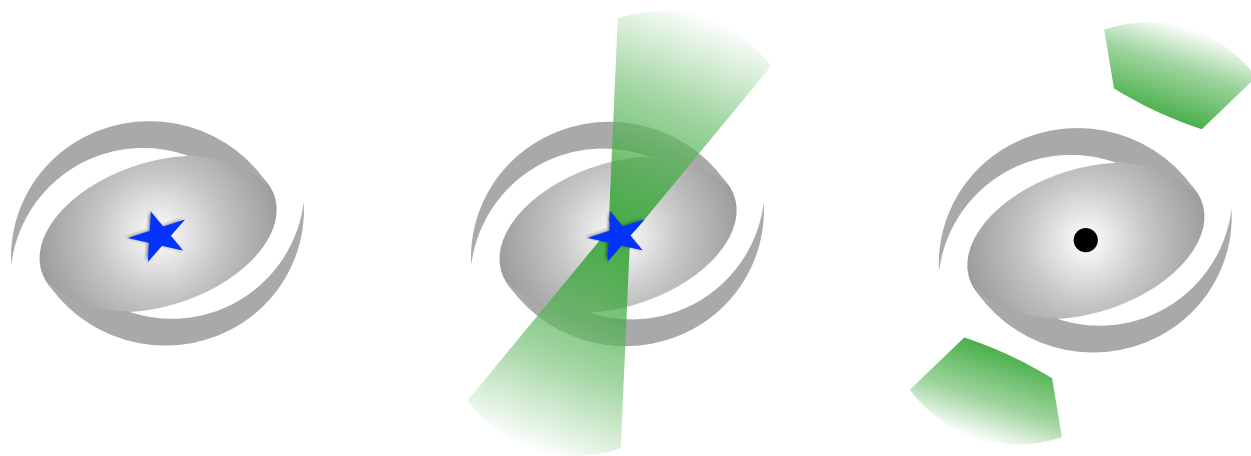


Schawinski...**Sartori** +2015

Berney et al. 2016, Lamperti et al. 2017

Summary

- > Extended emission line regions probe AGN variability on super-human timescales
- > Voorwerpjes: info about “switch off” phase
- > optically elusive AGN : info about “switch on” phase
- > estimated AGN phase lifetime $\sim 10^5$ yr
 - AGN flickering
 - implications for AGN - host galaxy relations

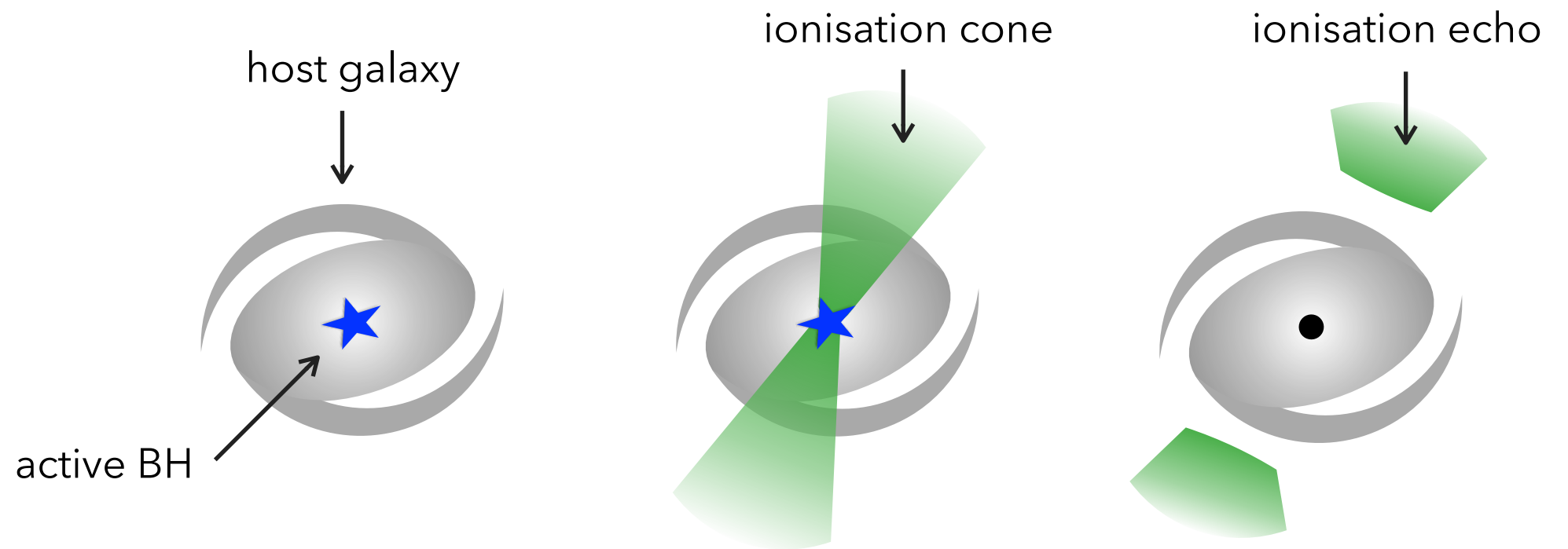


Schawinski...Sartori et al. 2015, arXiv:1501.06733

Sartori et al. 2016, arXiv:1601.07550

Sartori et al. 2017 submitted

Summary



Nuclear X-ray emission	on	on	off
Extended optical line emission (photoion. regions)	not yet generated	on	still visible
Classification	optically elusive AGN	normal AGN	ionisation echo / Voorwerp