

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

Lia F. Sartori

ETH Zürich

with Kevin Schawinski (ETHZ), Benny Trakhtenbrot (ETHZ), Michael Koss (Eureka Scientific), Ezequiel Treister (PUC),
Peter Maksym (CfA), William Keel (University of Alabama), Meg Urry (Yale), Daniel Stern (JPL/Caltech), Claudio Ricci (PUC)



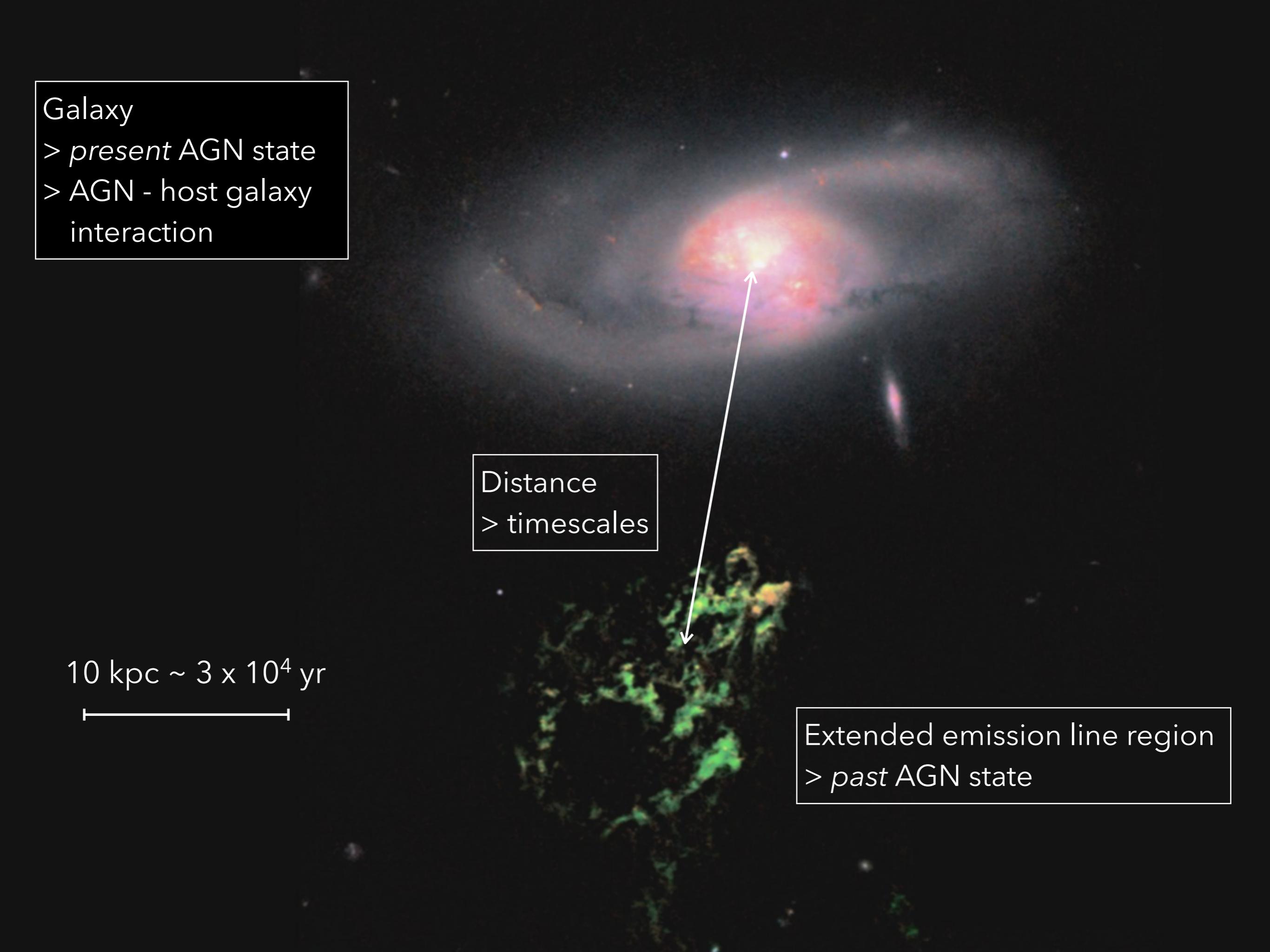
@liafsartori





$10 \text{ kpc} \sim 3 \times 10^4 \text{ yr}$

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



Galaxy

- > present AGN state
- > AGN - host galaxy interaction

Distance
> timescales

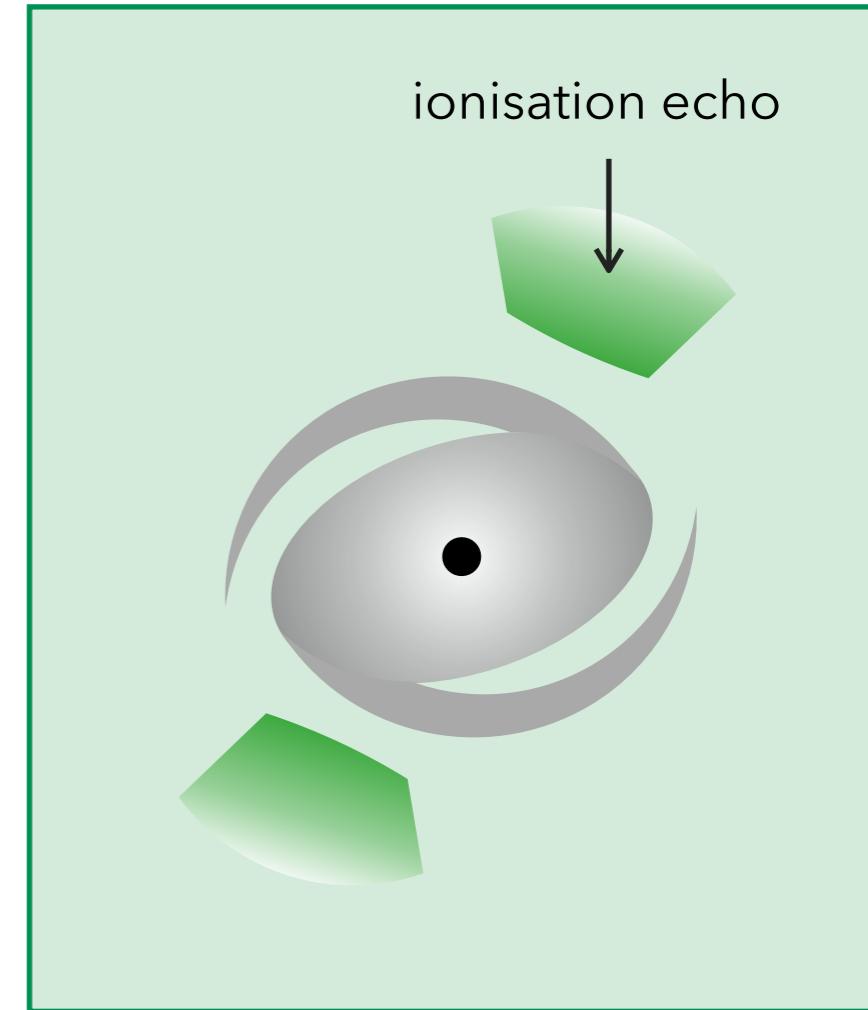
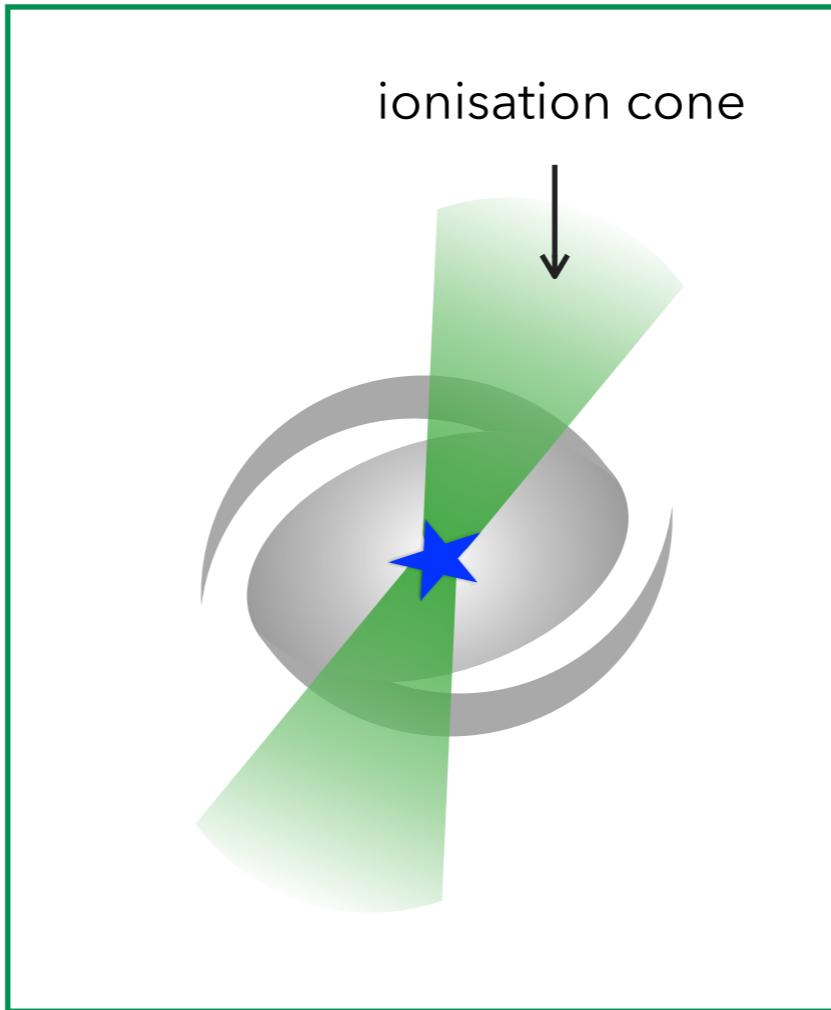
10 kpc $\sim 3 \times 10^4$ yr

Extended emission line region
> past AGN state

switch on

normal AGN

switch off

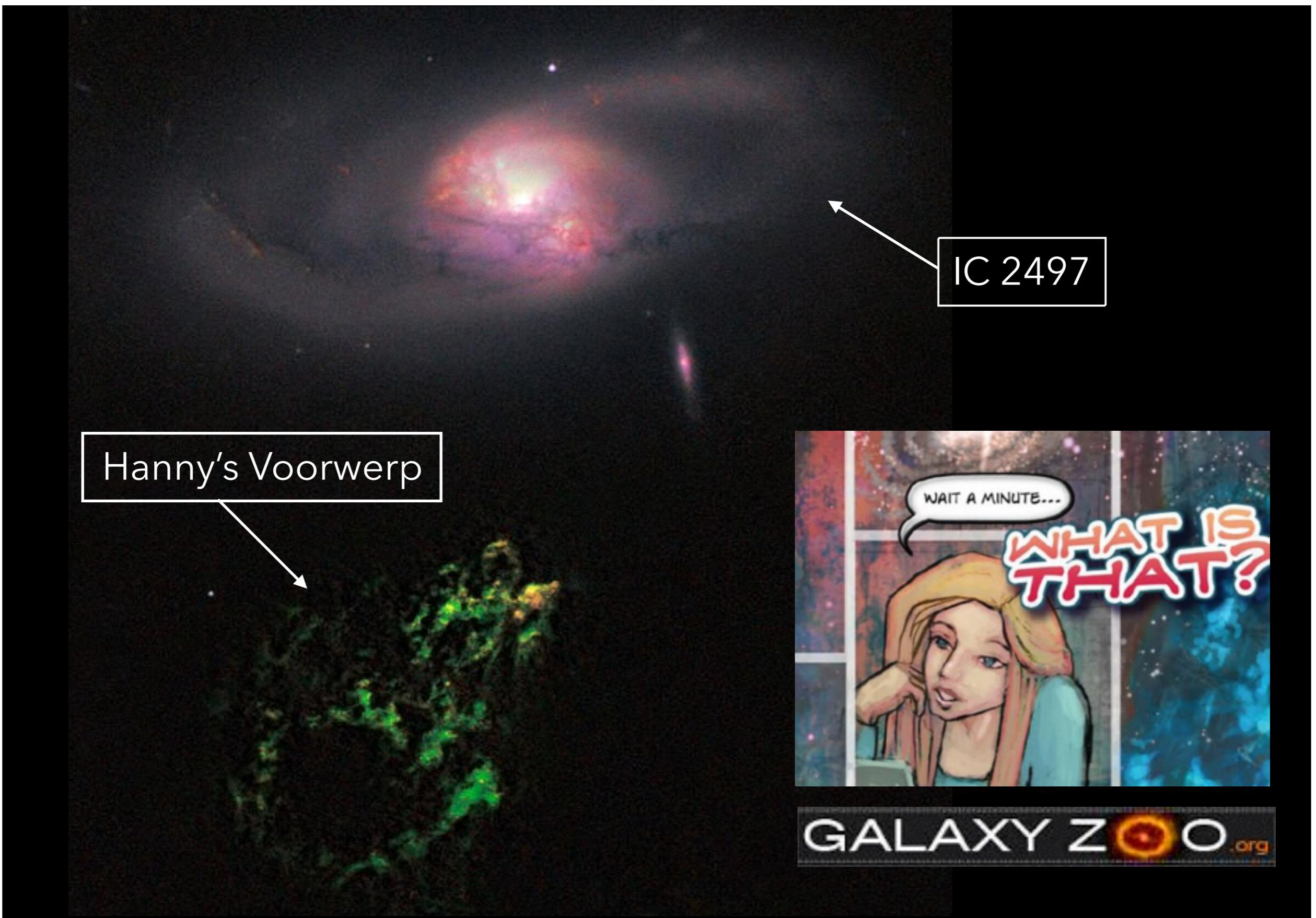


nuclear X-ray emission

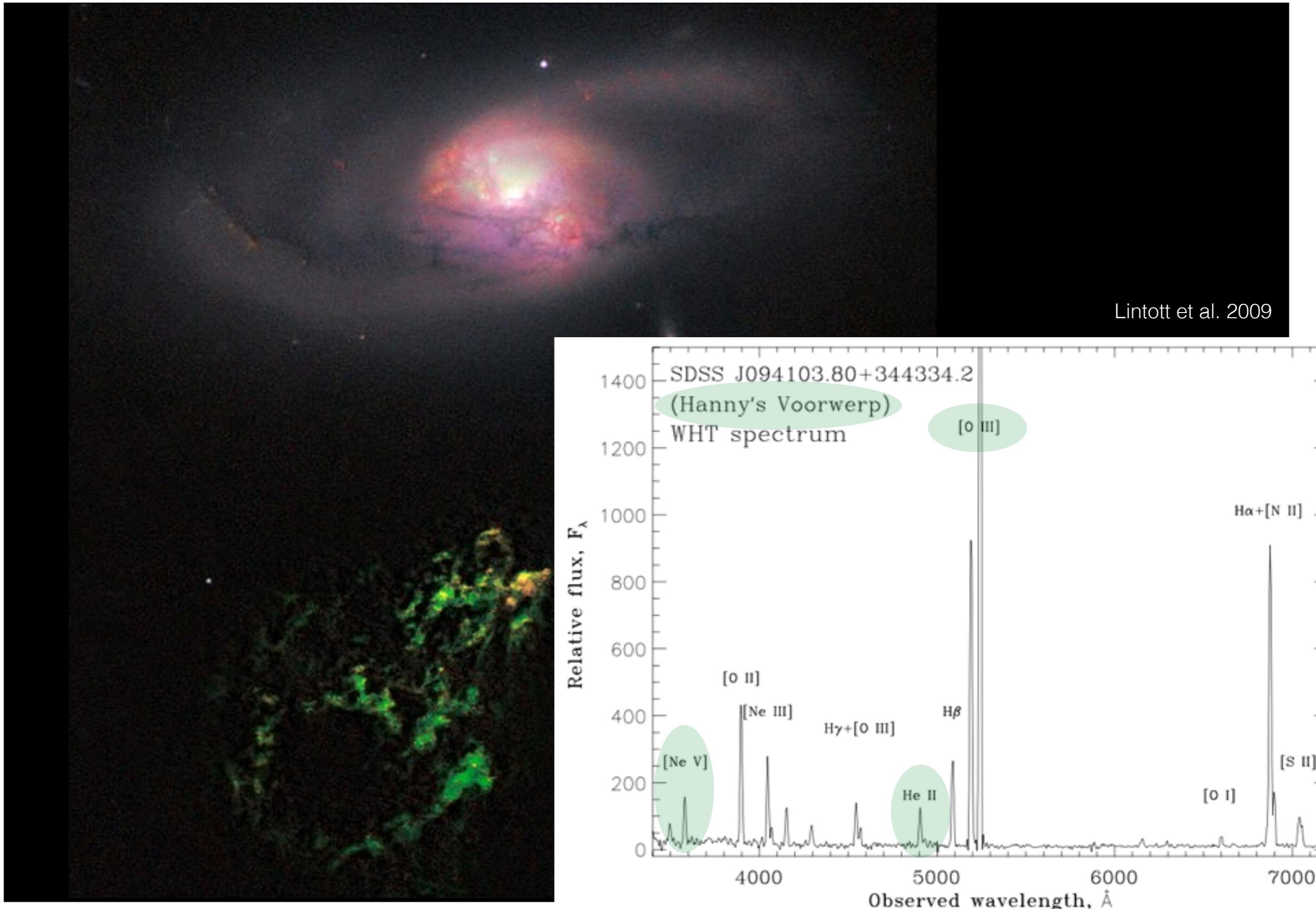


extended optical line emission

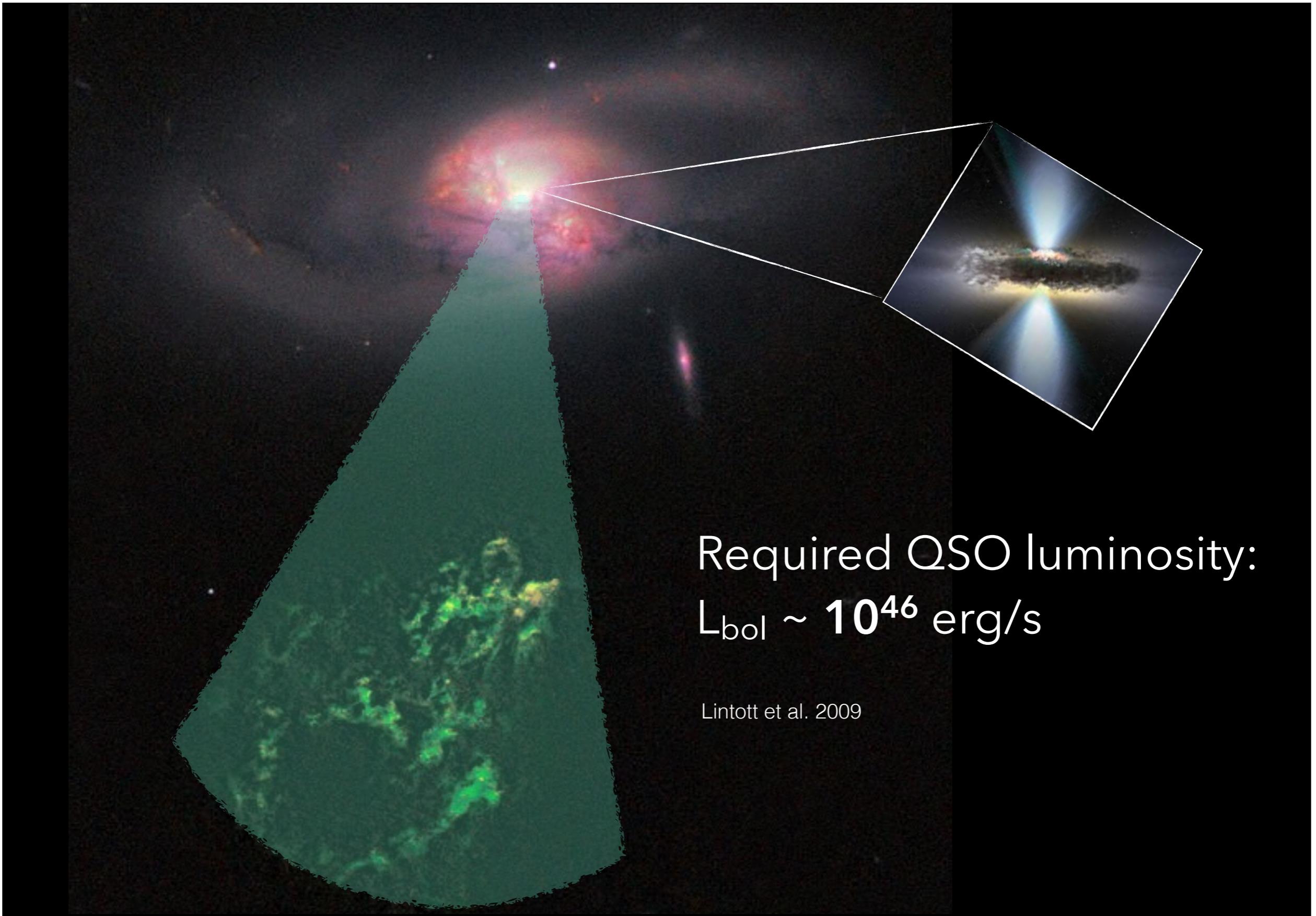
Hanny's Voorwerp



Hanny's Voorwerp



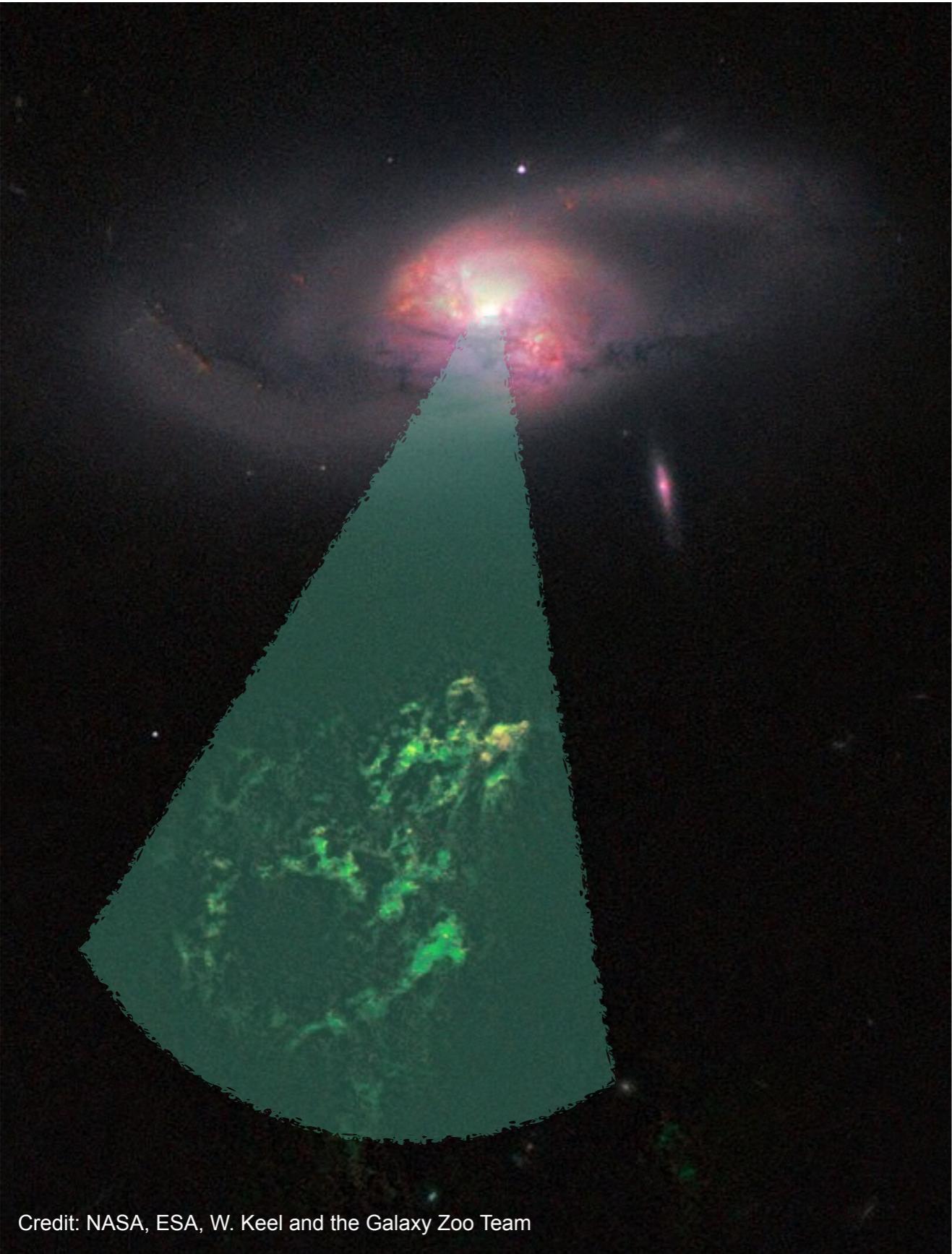
Hanny's Voorwerp



Required QSO luminosity:
 $L_{\text{bol}} \sim 10^{46} \text{ erg/s}$

Lintott et al. 2009

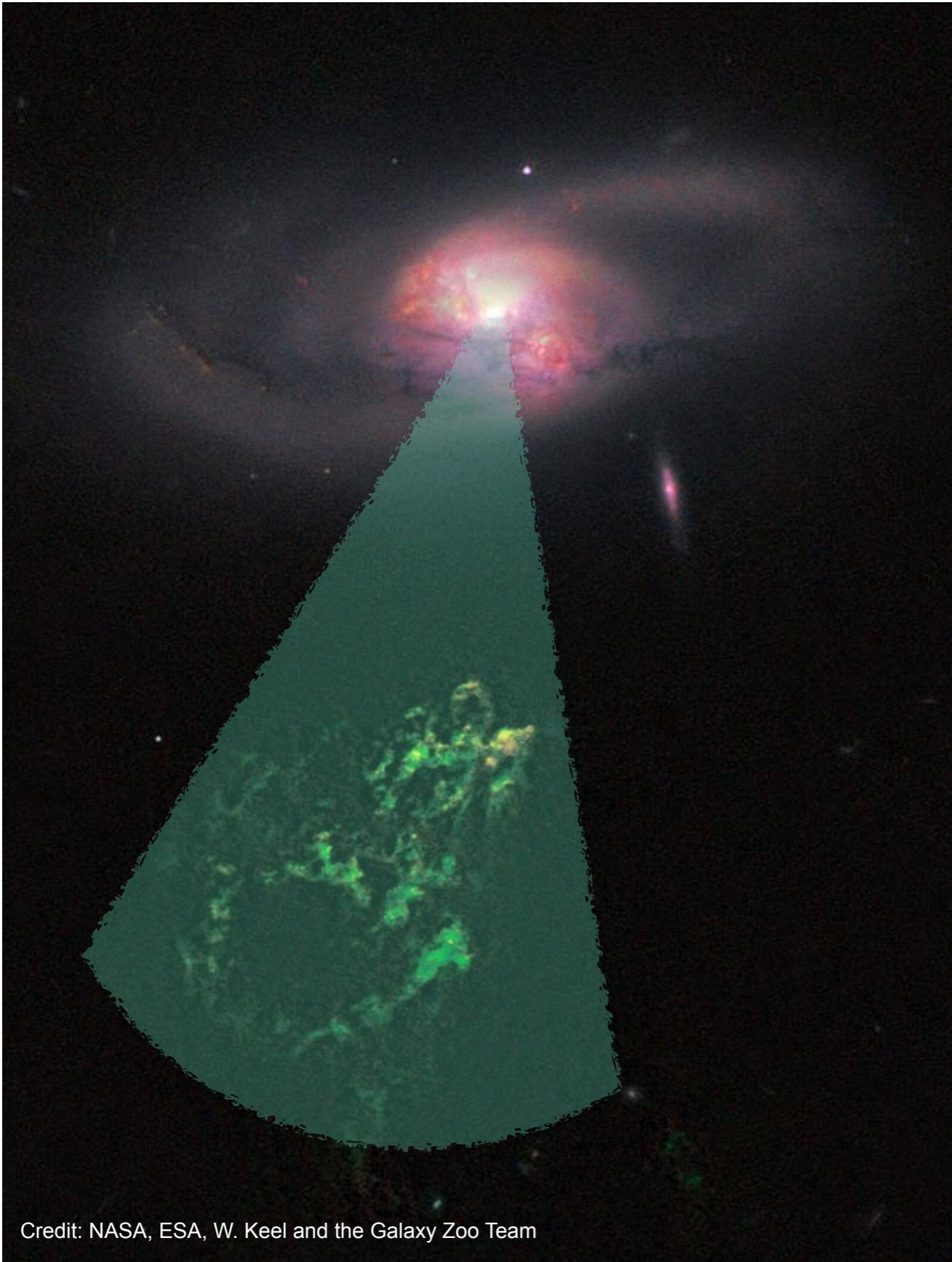
Hanny's Voorwerp



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

Possible explanations:

Hanny's Voorwerp

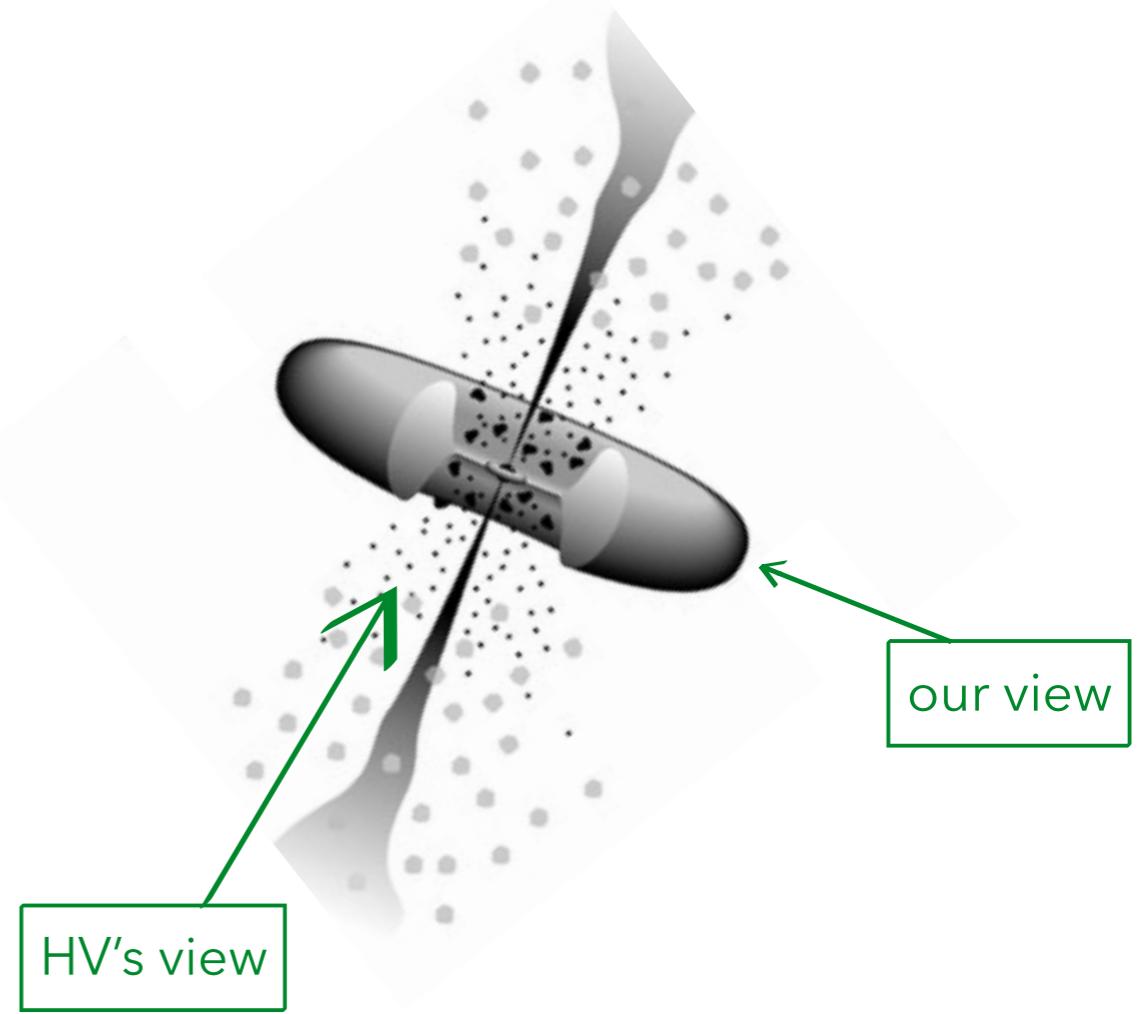


Credit: NASA, ESA, W. Keel and the Galaxy Zoo Team

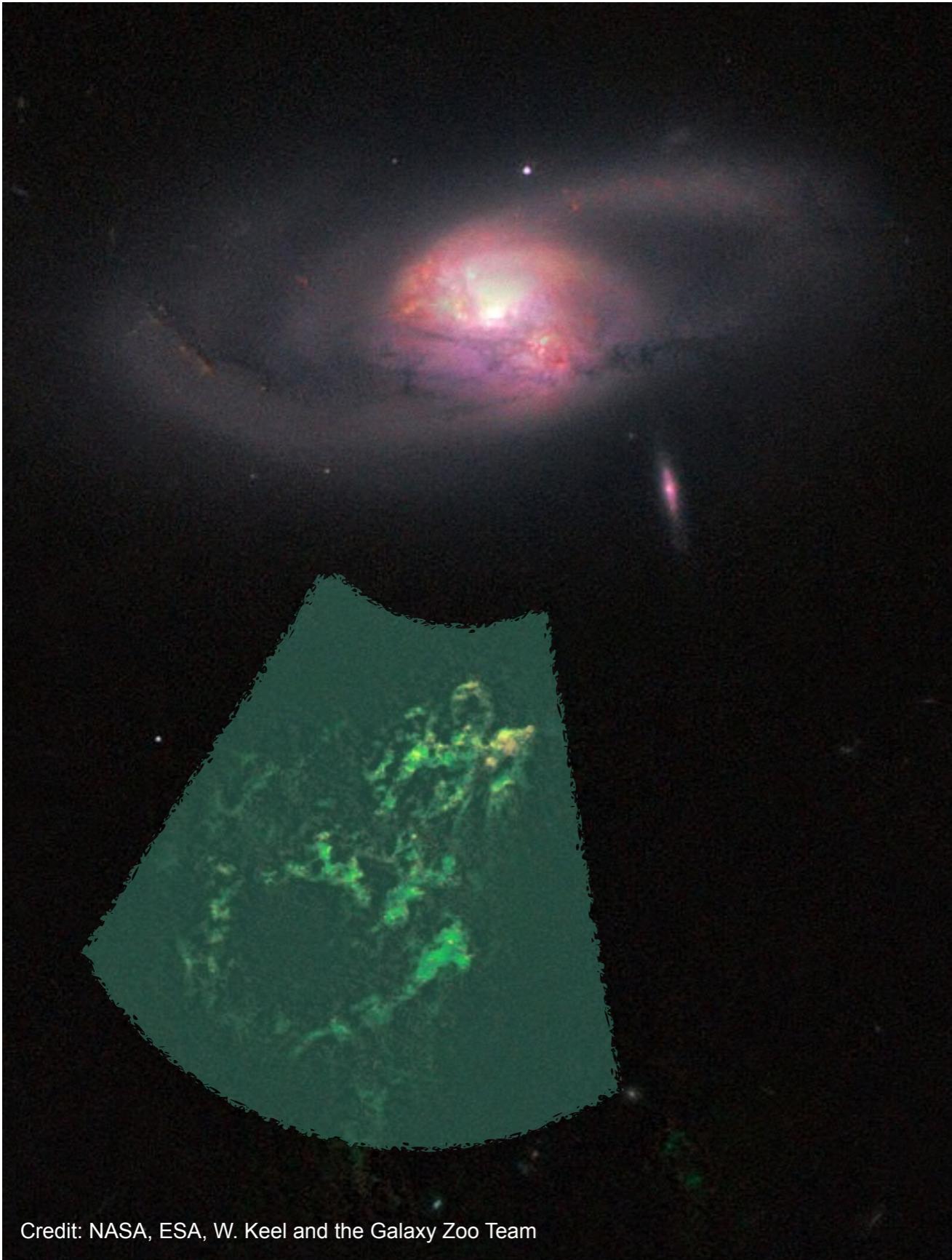
Possible explanations:

> **obscured AGN**

Józsa+2009, Rampadarath+2010



Hanny's Voorwerp



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

Possible explanations:

> **obscured AGN**

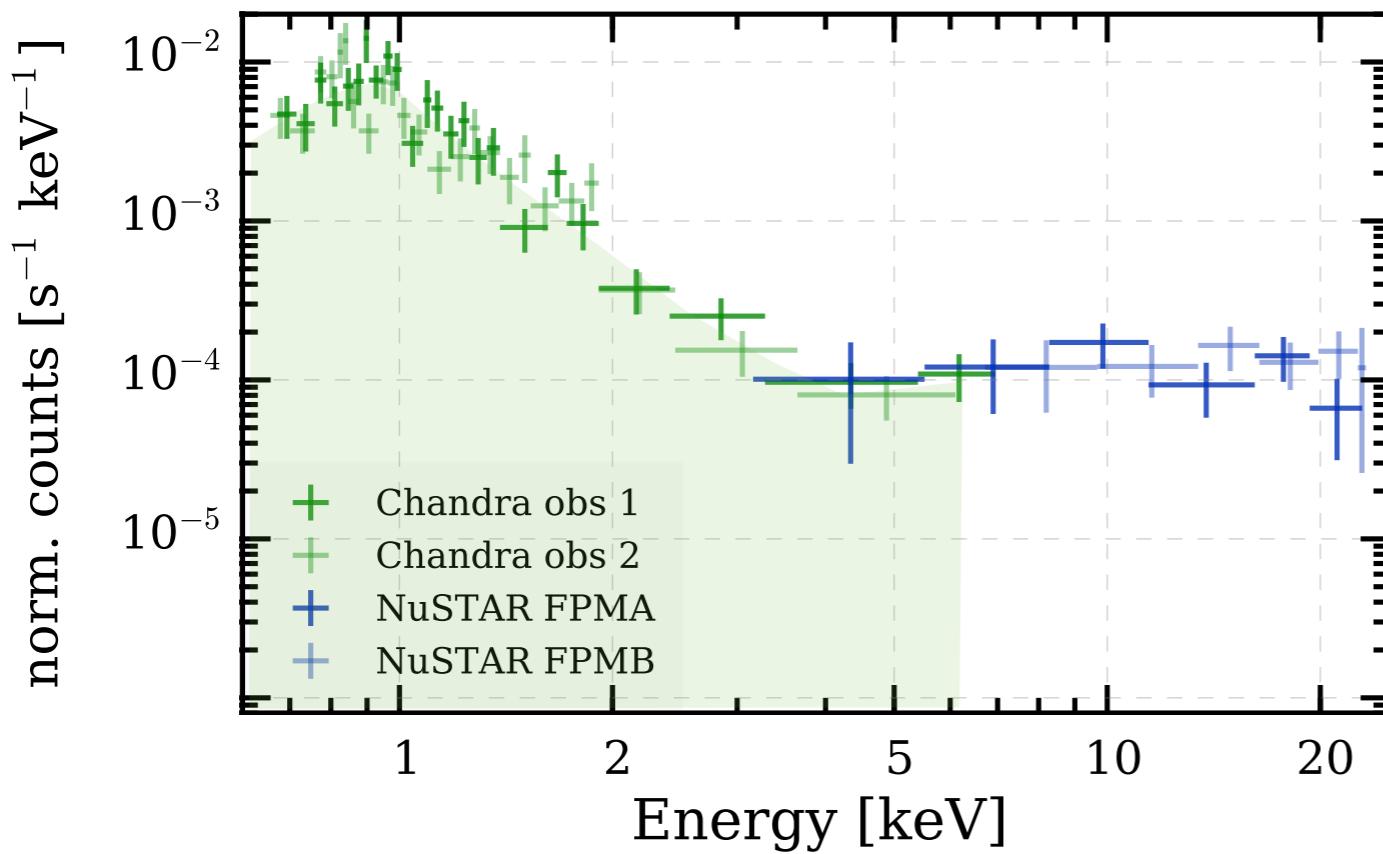
Józsa+2009, Rampadarath+2010

> **faded AGN**

Lintott+2009, Schawinski+2010, Keel+2012

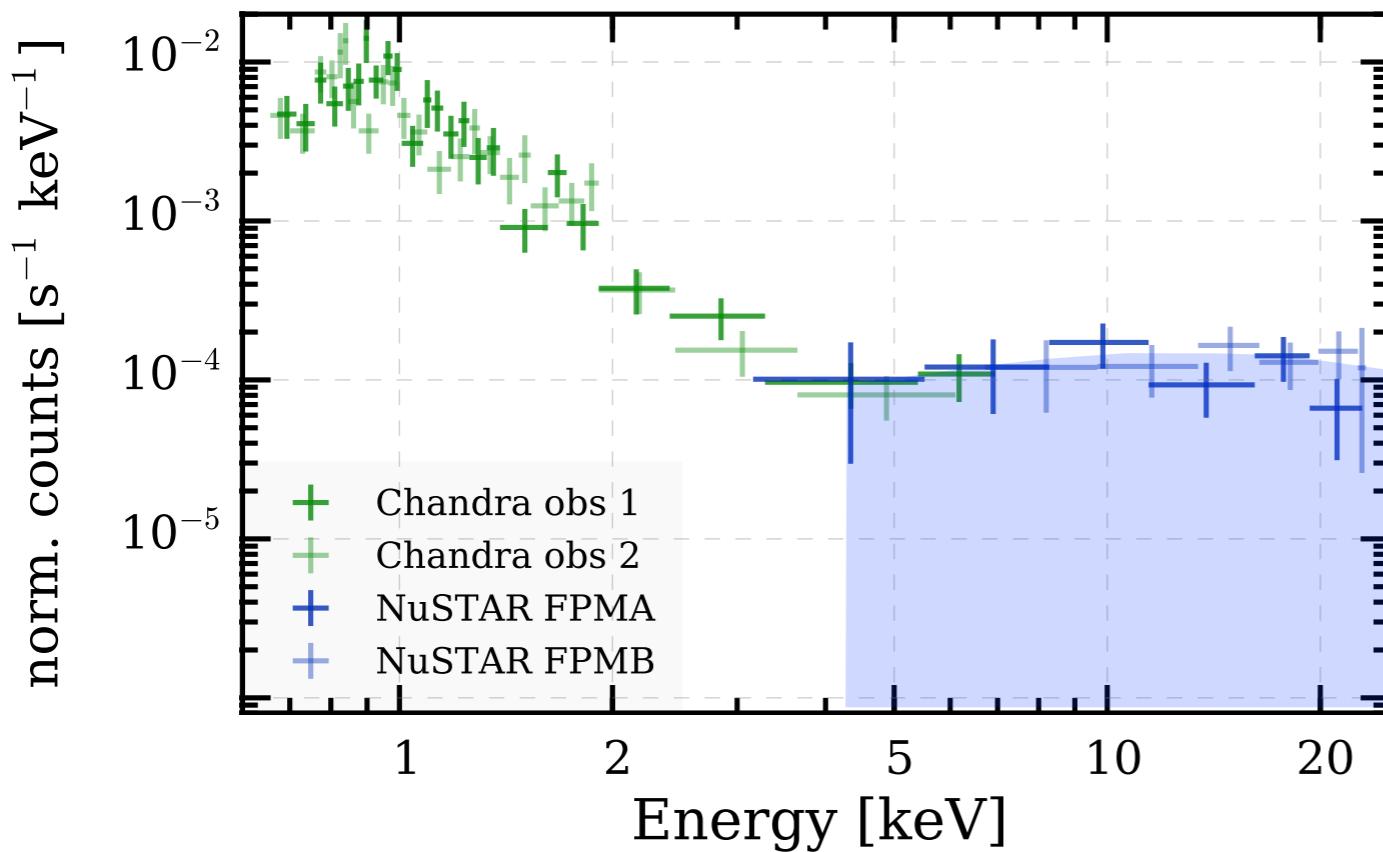
Chandra + NuSTAR analysis of IC 2497

Sartori + 2017 submitted



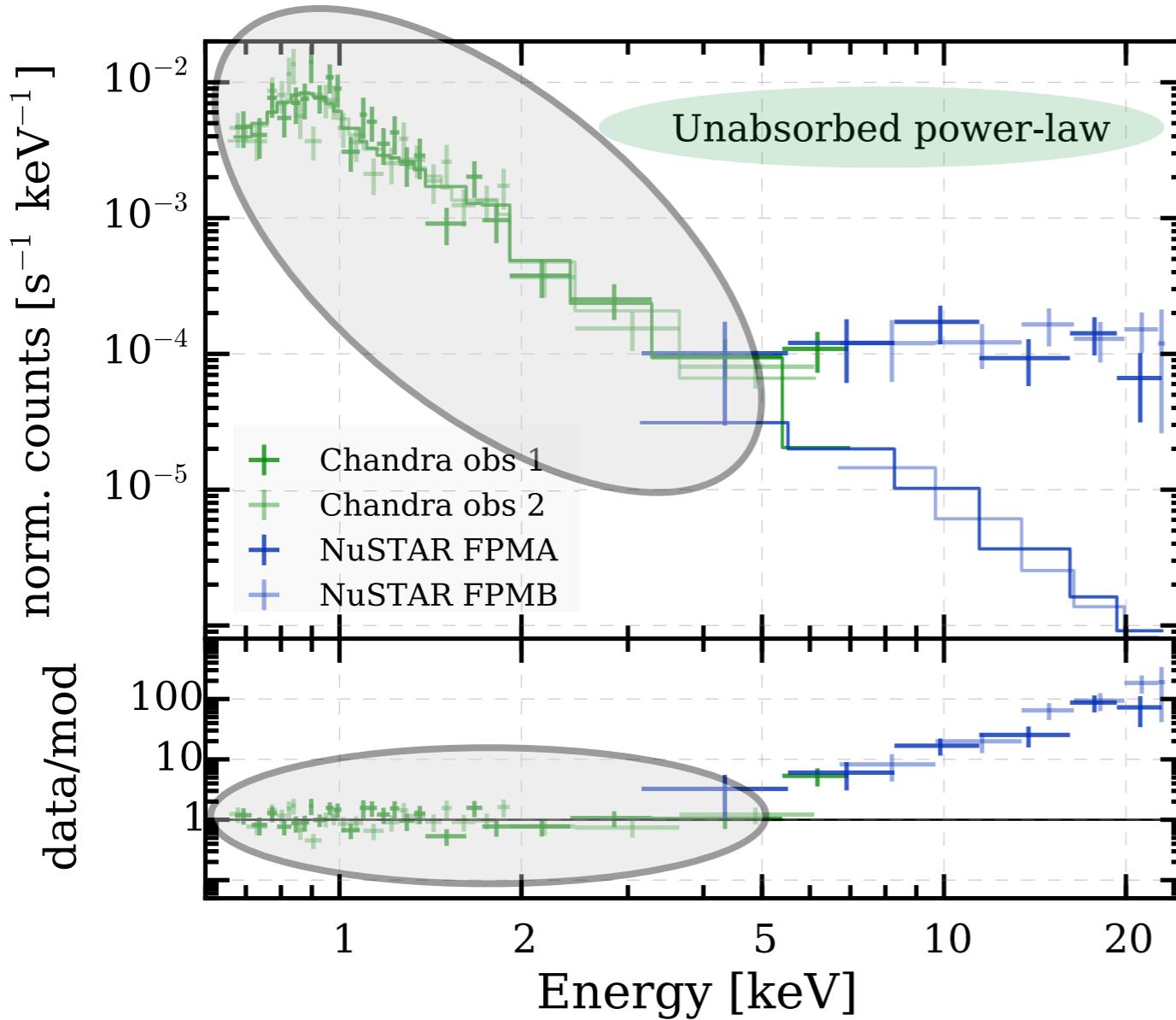
Chandra + NuSTAR analysis of IC 2497

Sartori + 2017 submitted



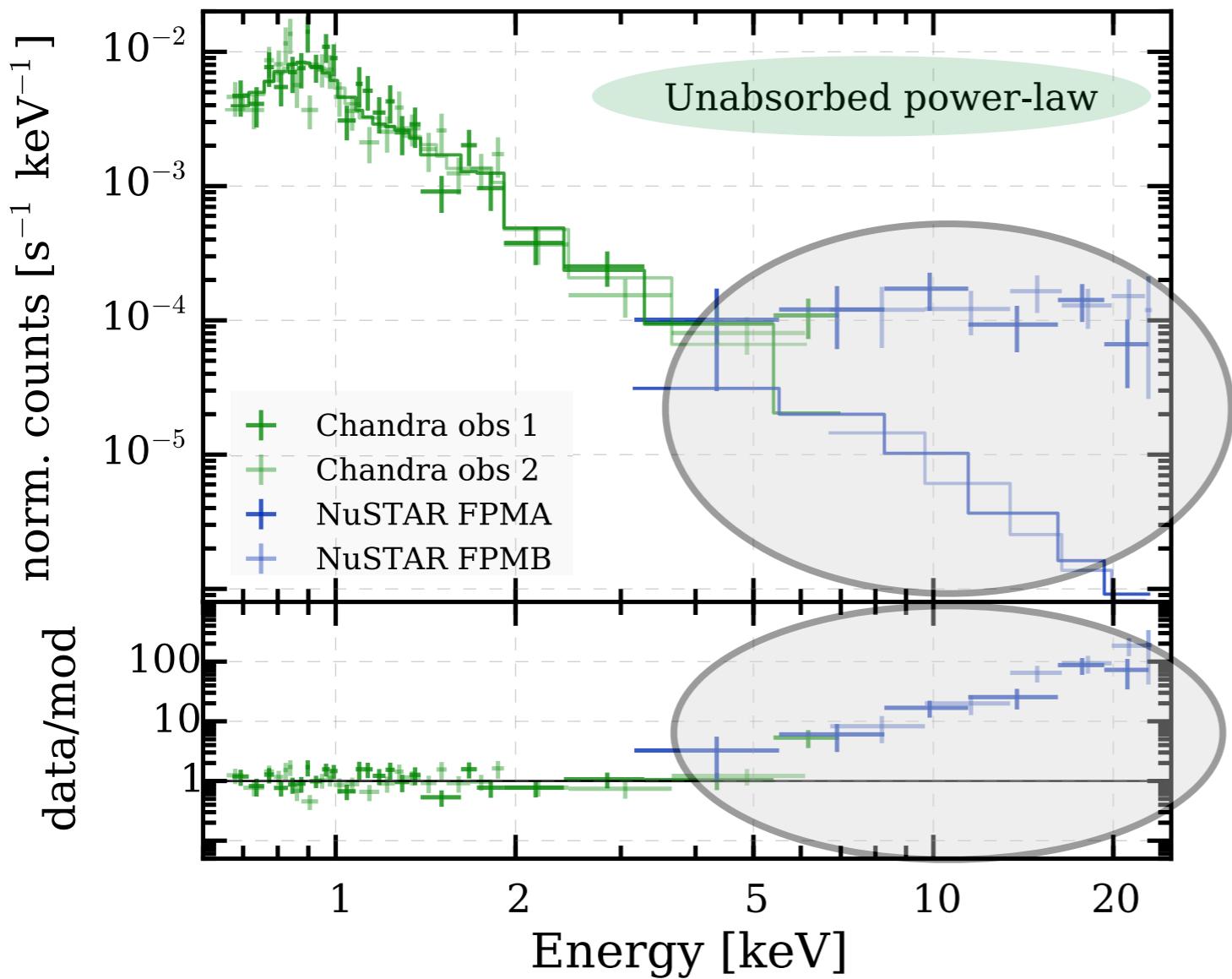
Chandra + NuSTAR analysis of IC 2497

Sartori + 2017 submitted



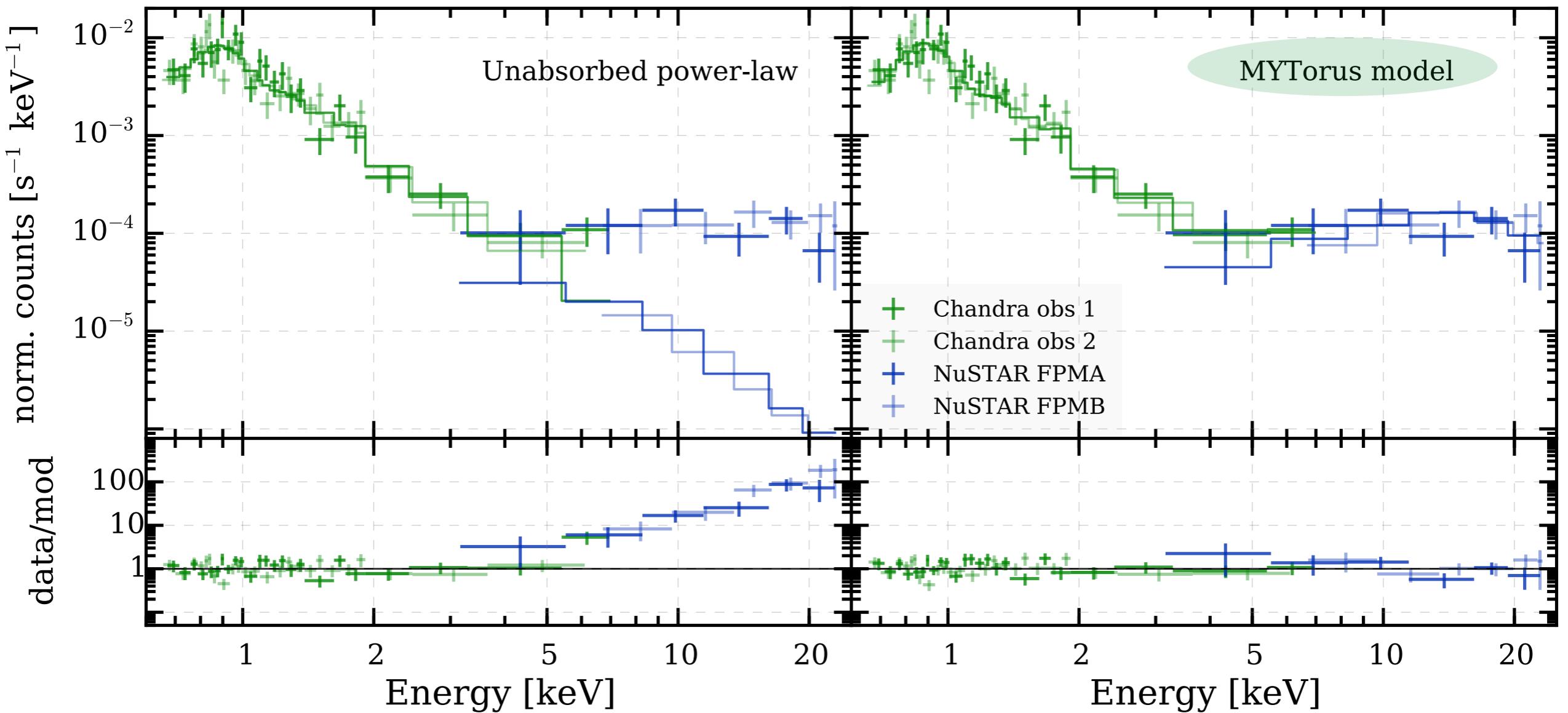
Chandra + NuSTAR analysis of IC 2497

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obscured AND faded AGN

$$n\text{H} \sim 2 \times 10^{24} \text{ cm}^{-2}$$

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

Galaxy

- > present AGN state
- > AGN - host galaxy interaction

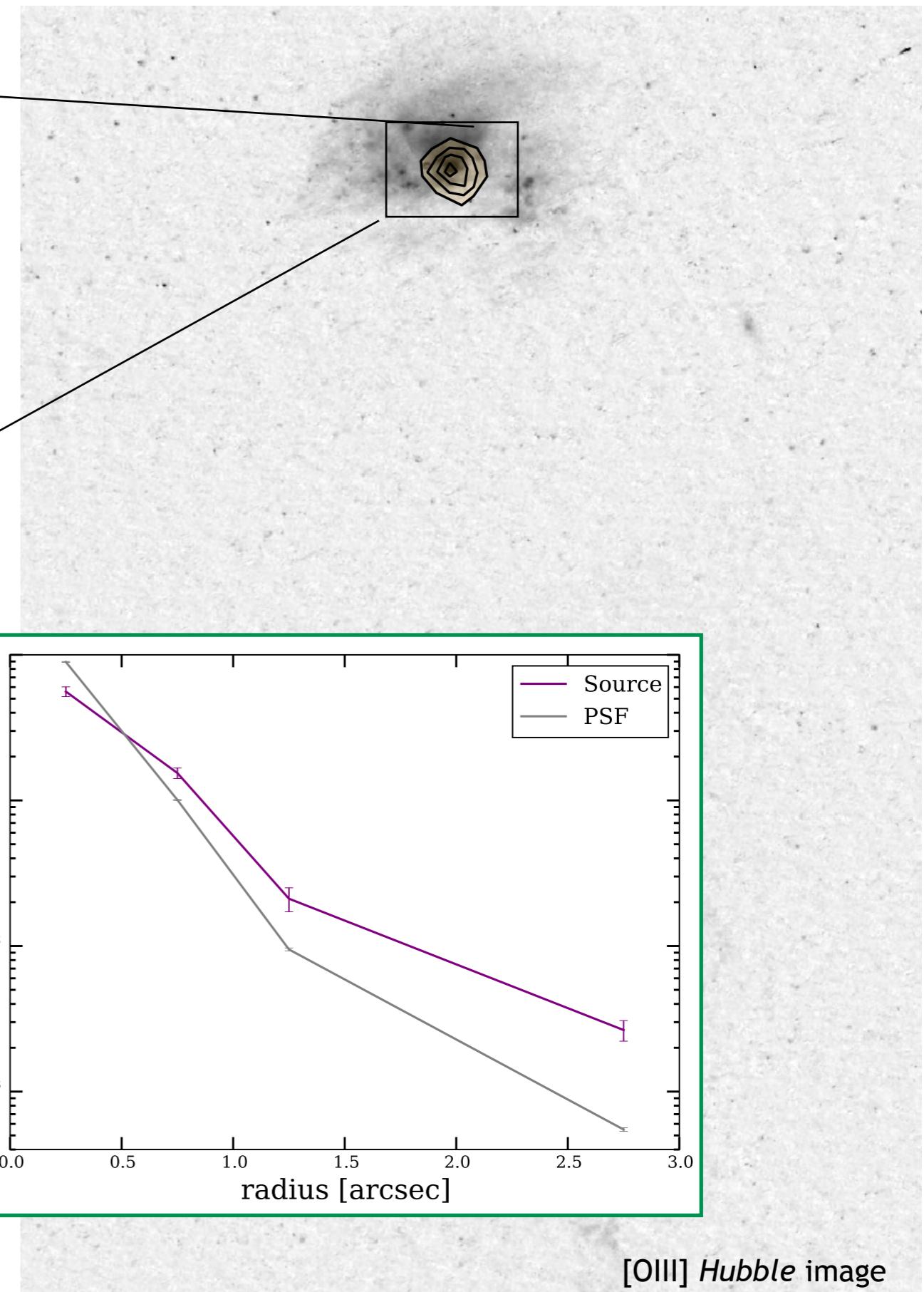
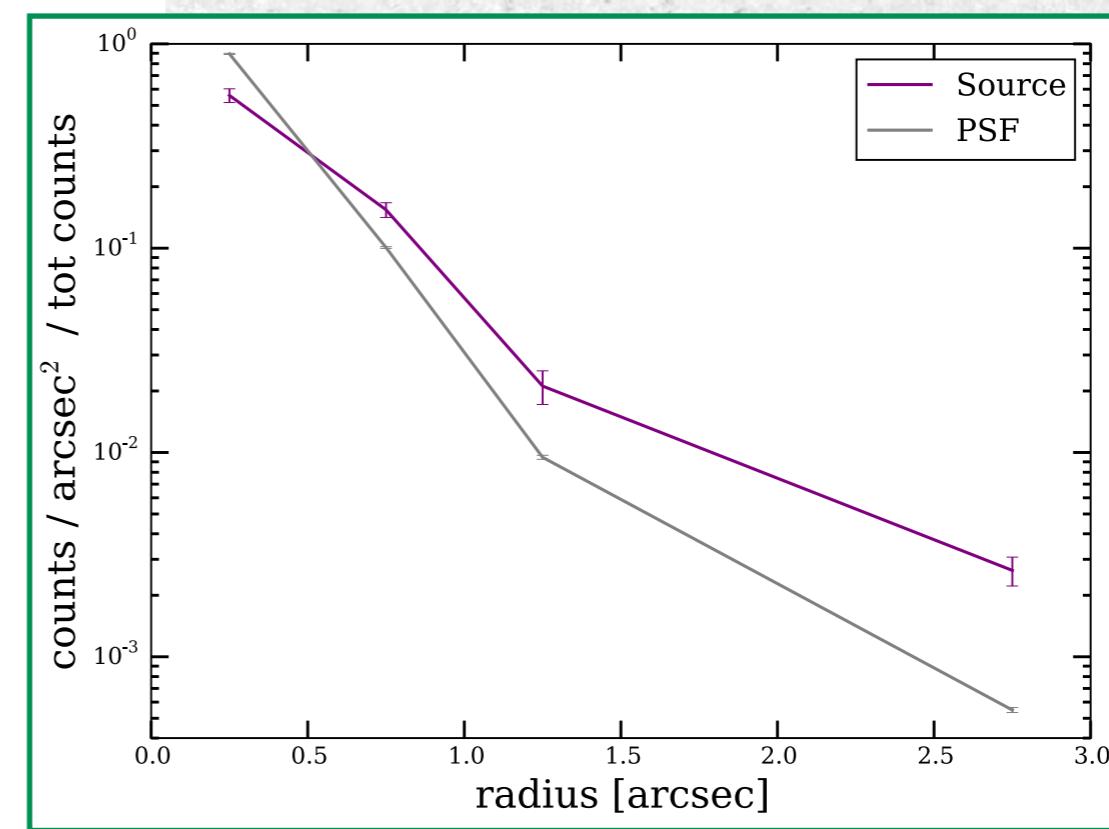
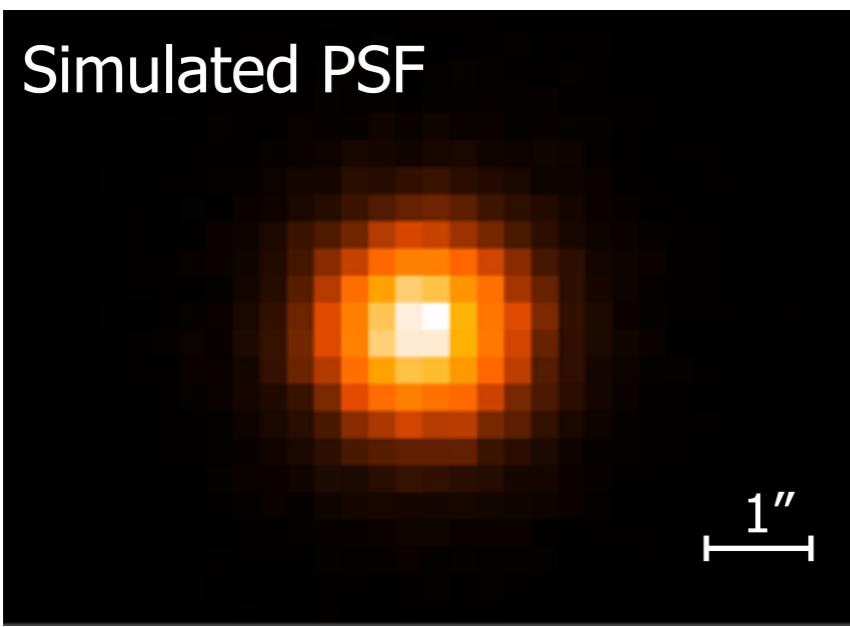
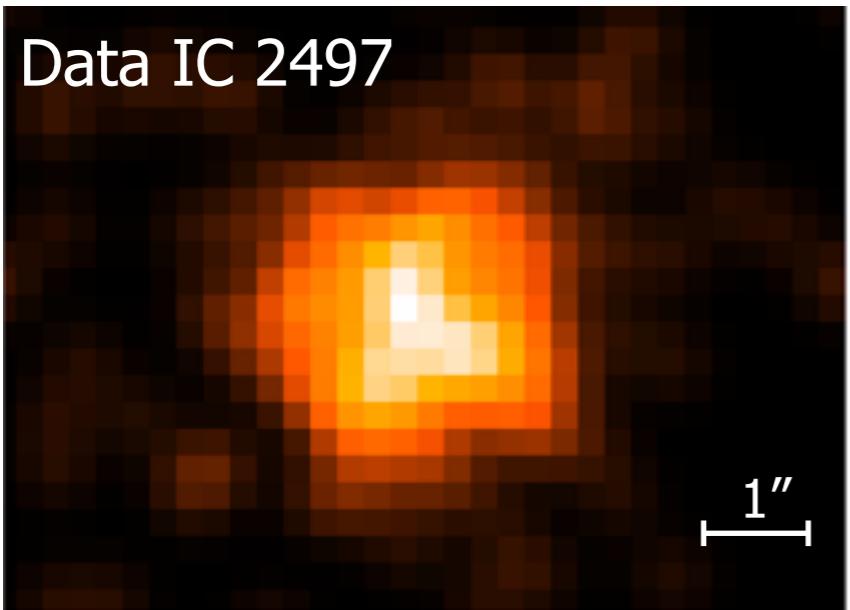
Distance
> timescales

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

Voorwerp
> past AGN state (200 kyr ago)

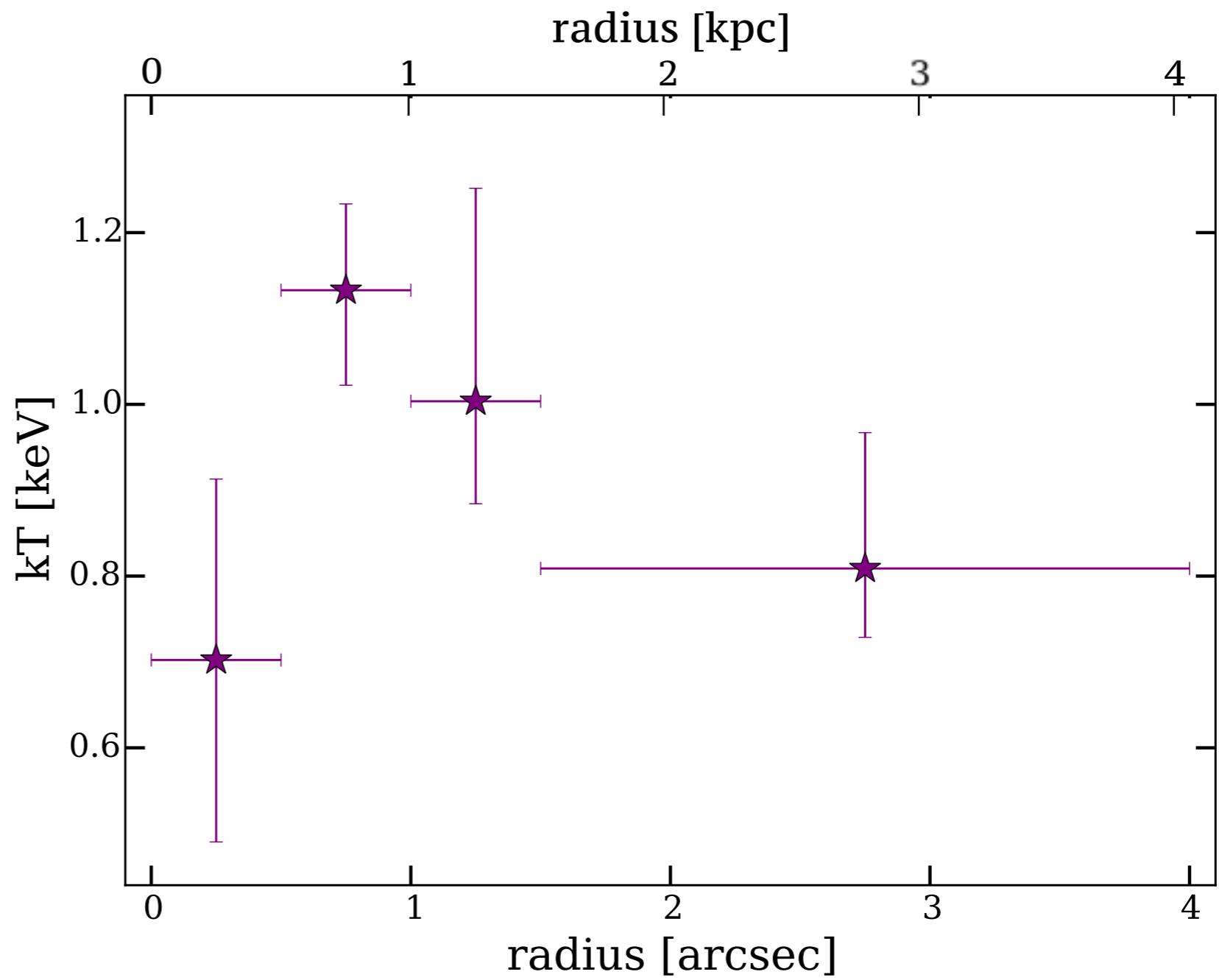
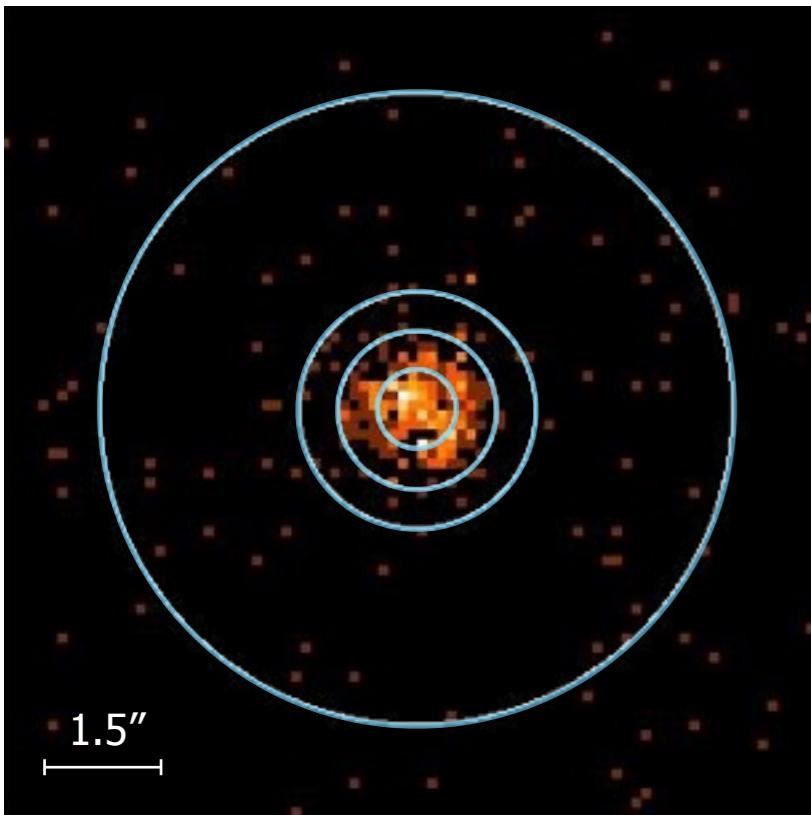
Chandra analysis of IC 2497

Sartori + 2016



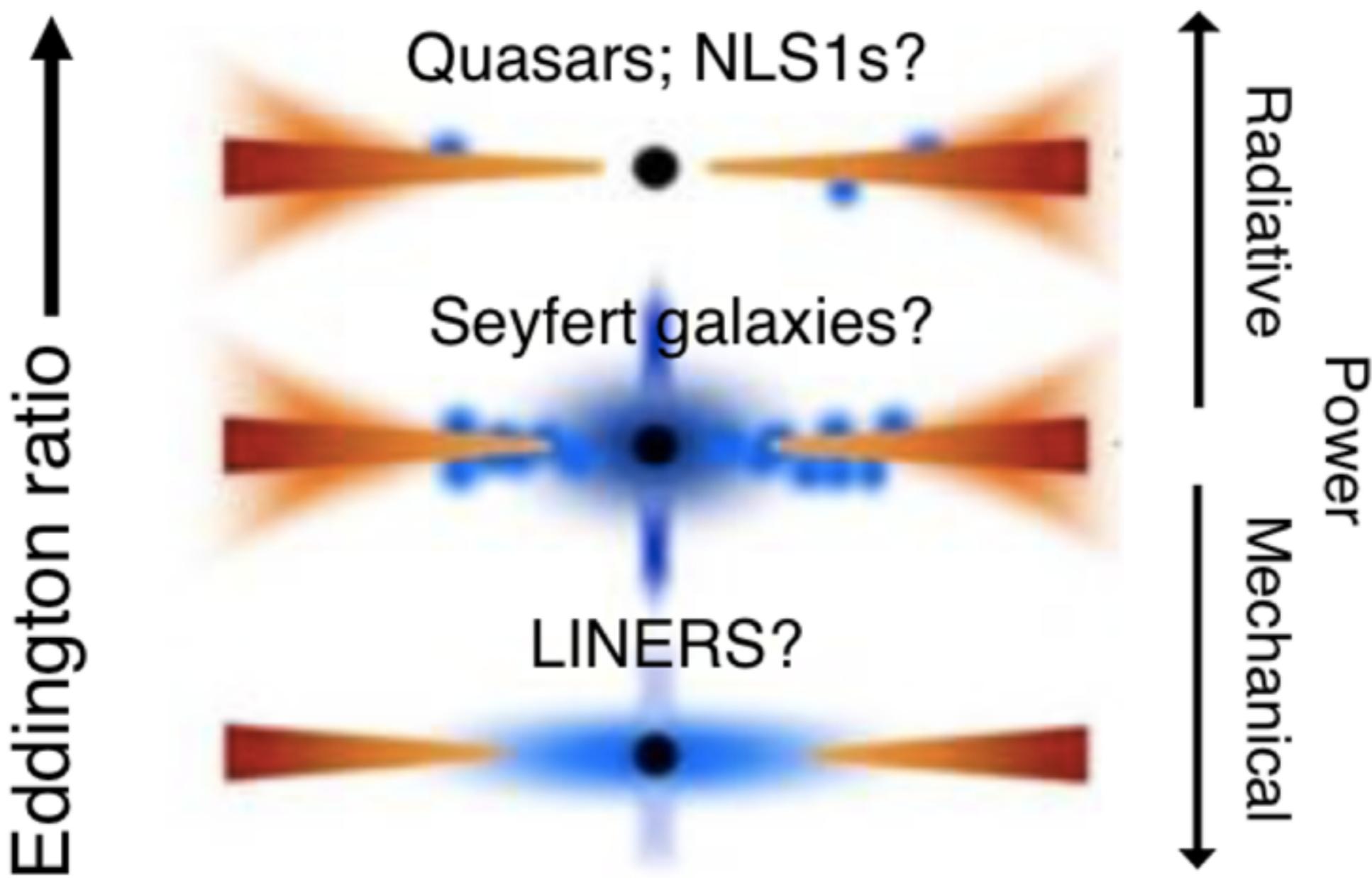
AGN - host galaxy interaction

Sartori + 2016



A bubble driven by an AGN in kinetic mode?

A bubble driven by an AGN in kinetic mode?

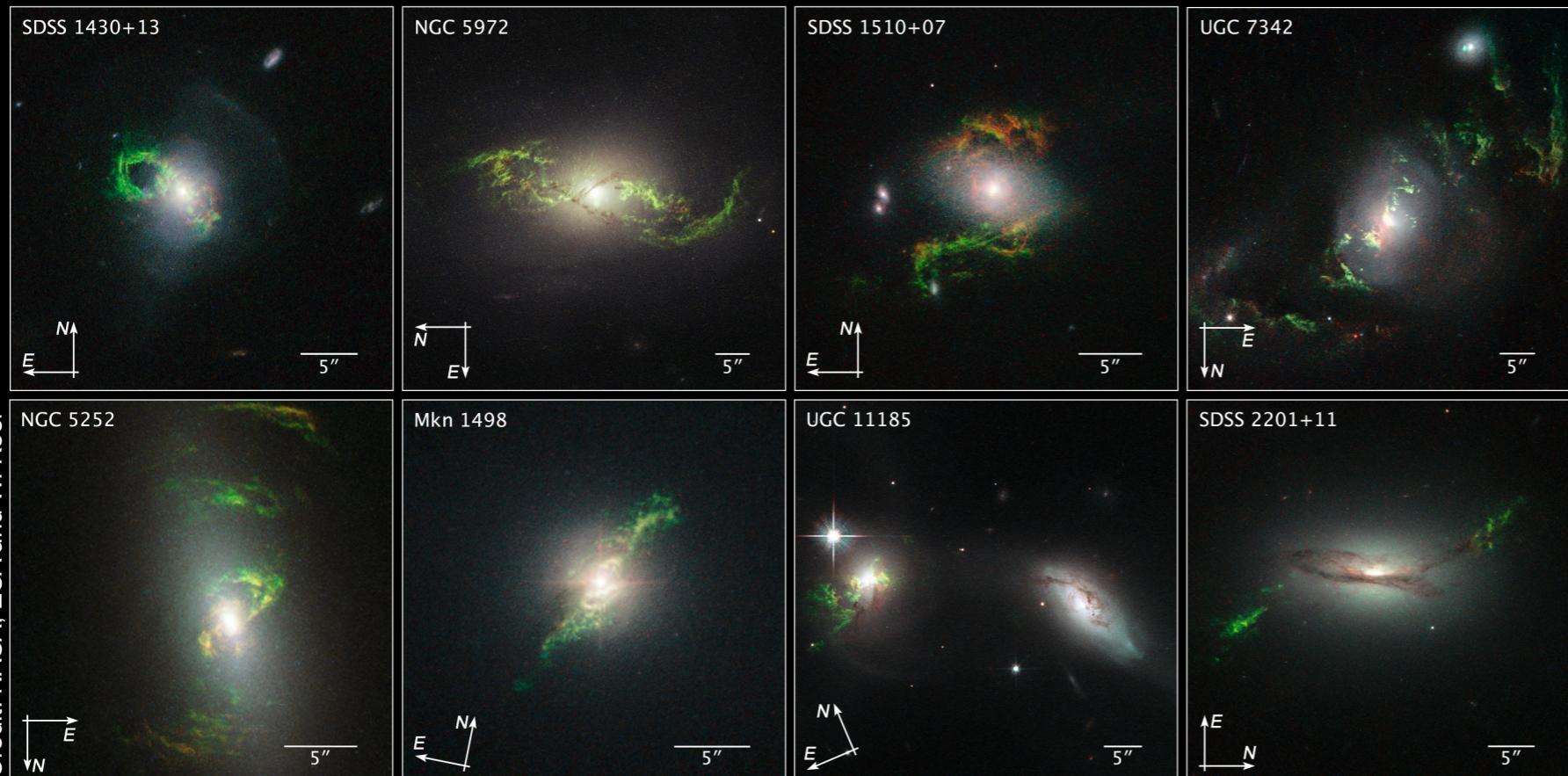


Done+2007, Alexander & Hickox 2012

Is IC 2497 a peculiar galaxy?

Extended emission line regions

Credit: NASA, ESA and W. Keel



Voorwerpjes

Keel et al. 2012, 2015, 2017

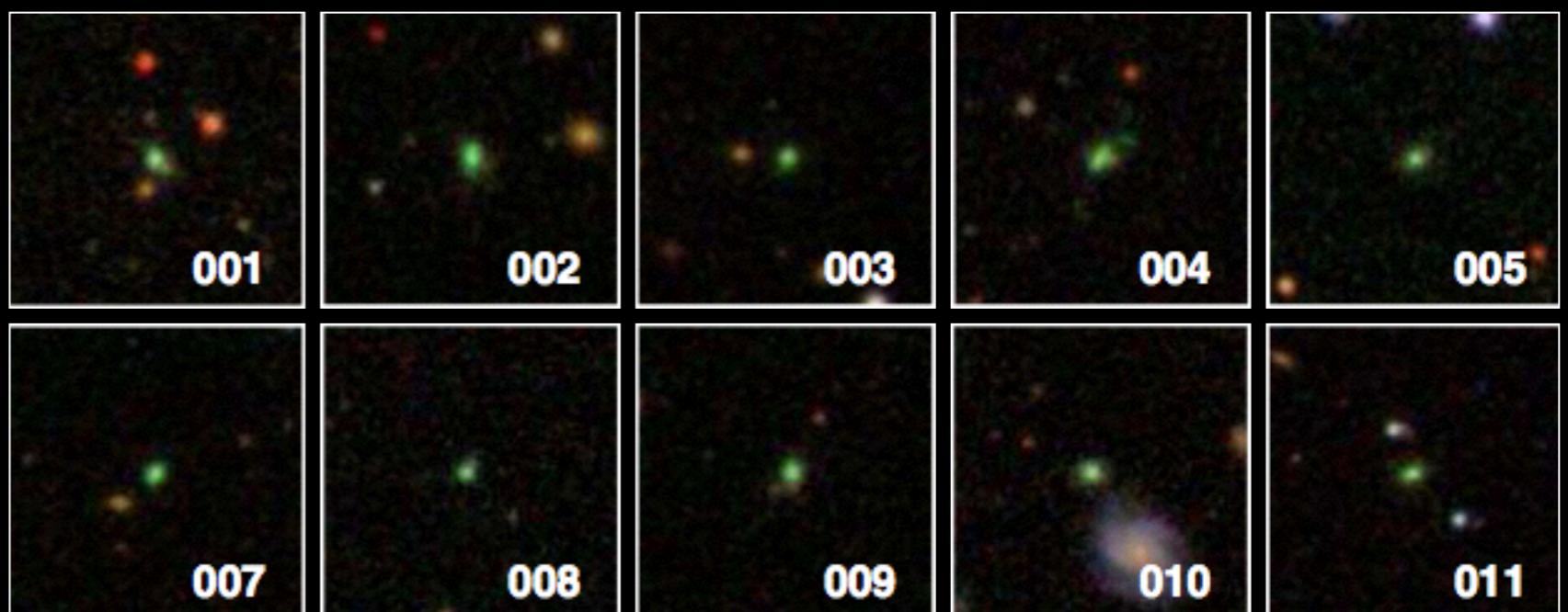
Gagne et al. 2014

Harrison et al. 2014

Ramos Almeida et al. 2017

Lya blobs

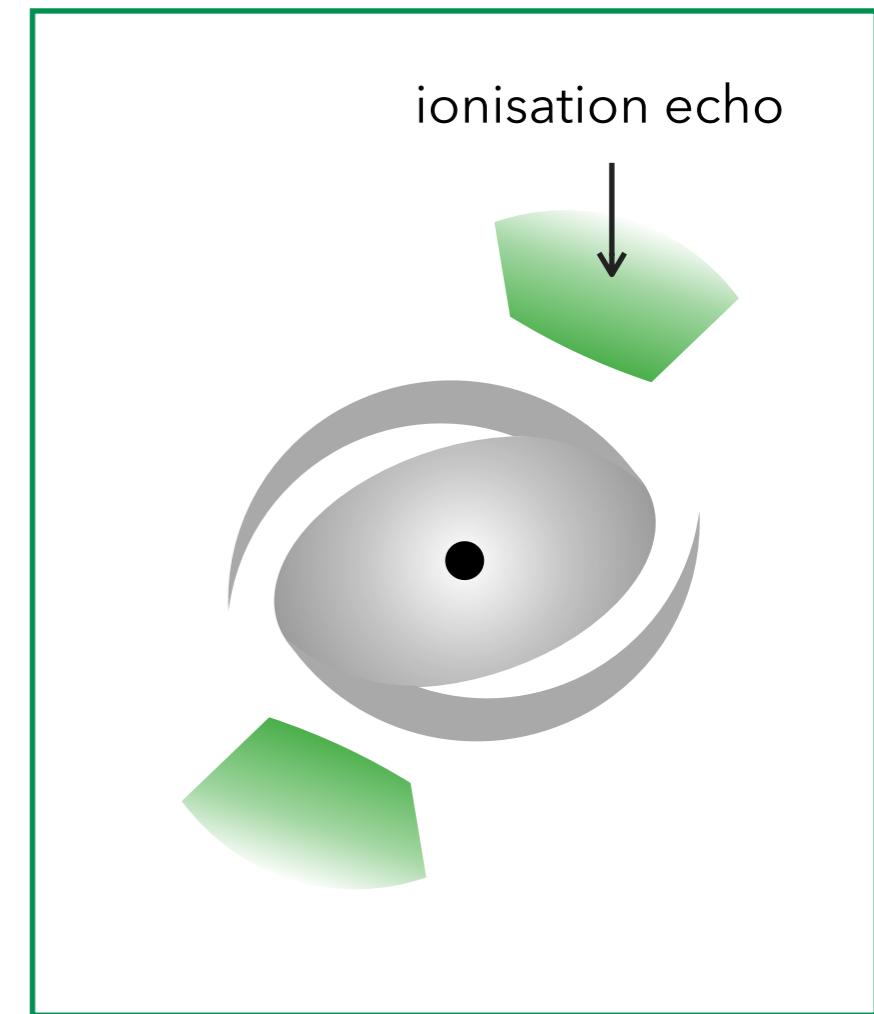
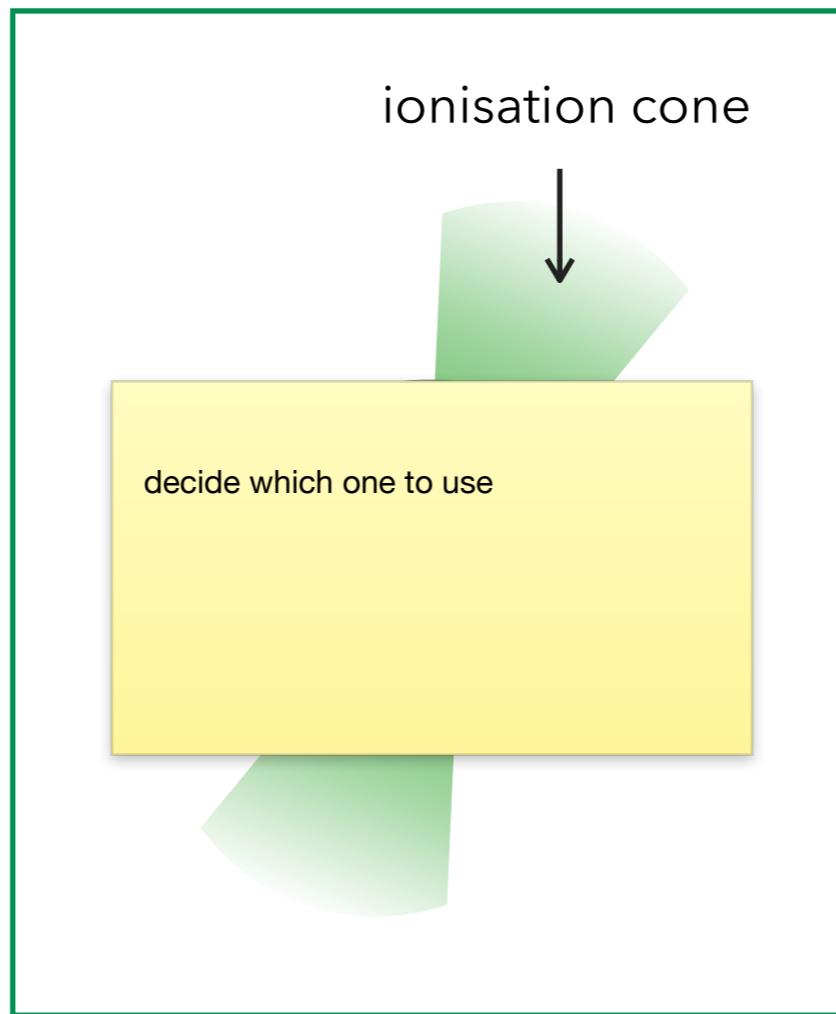
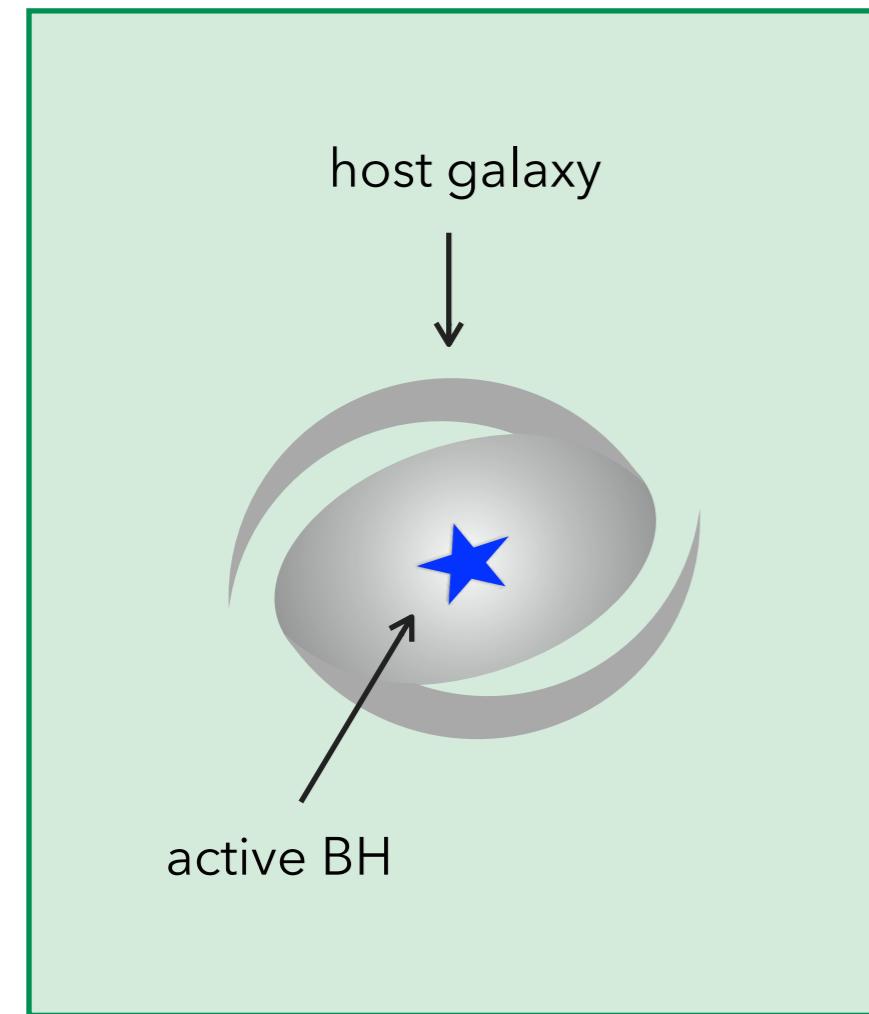
Schirmer et al. 2013, 2016



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

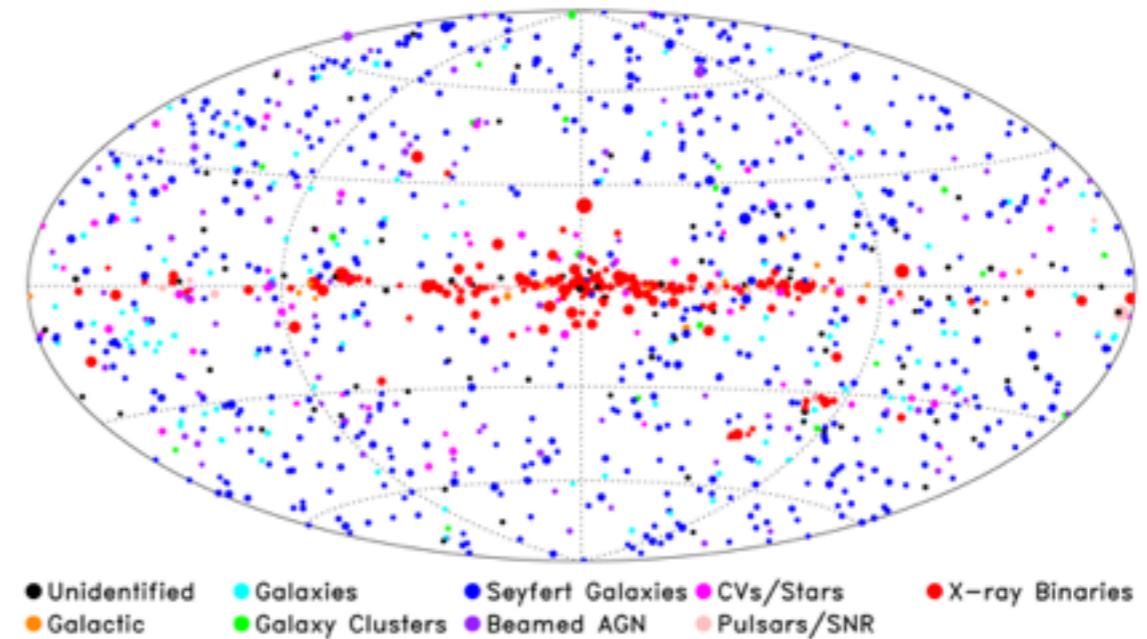
Papers

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)

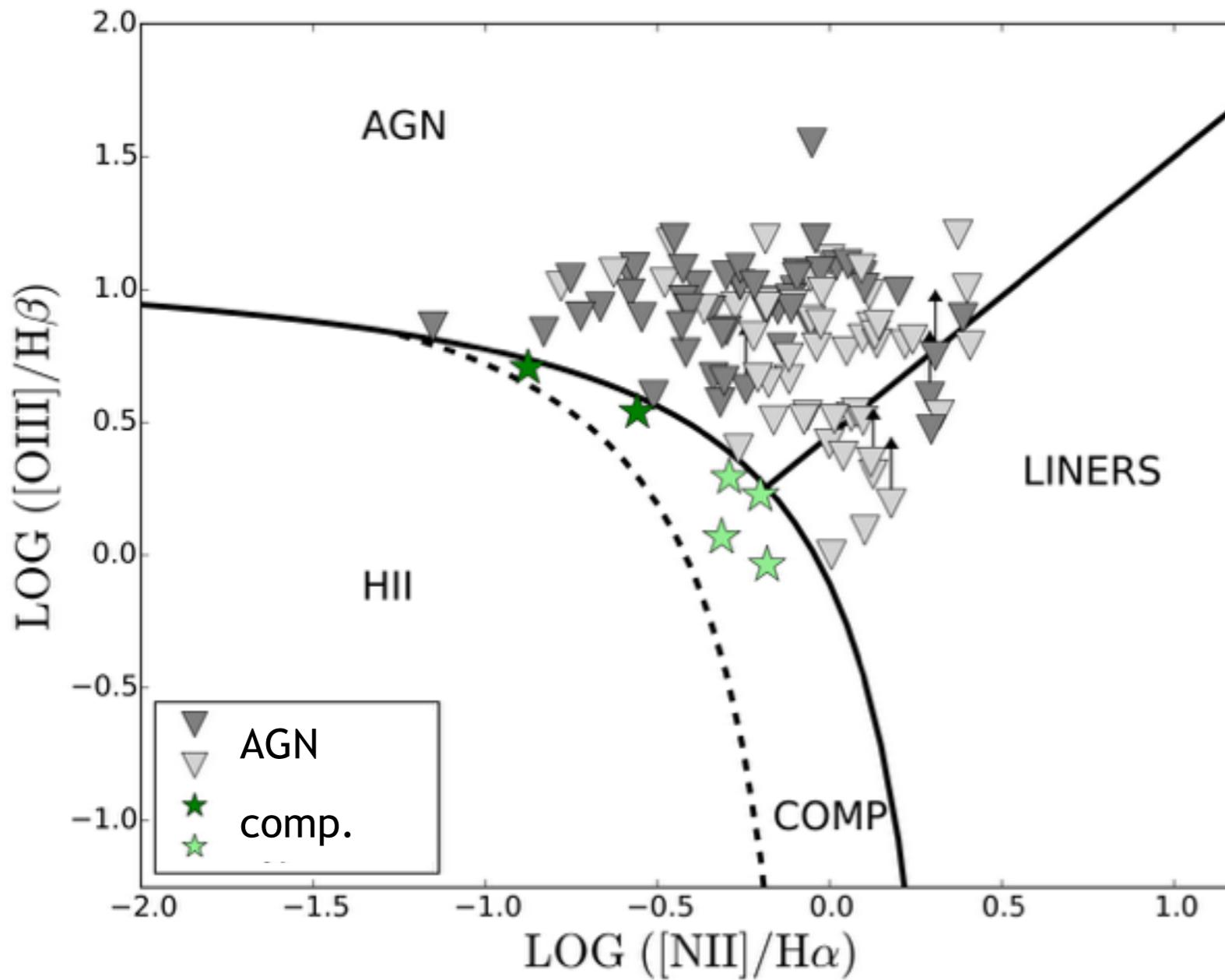
... and many more to come



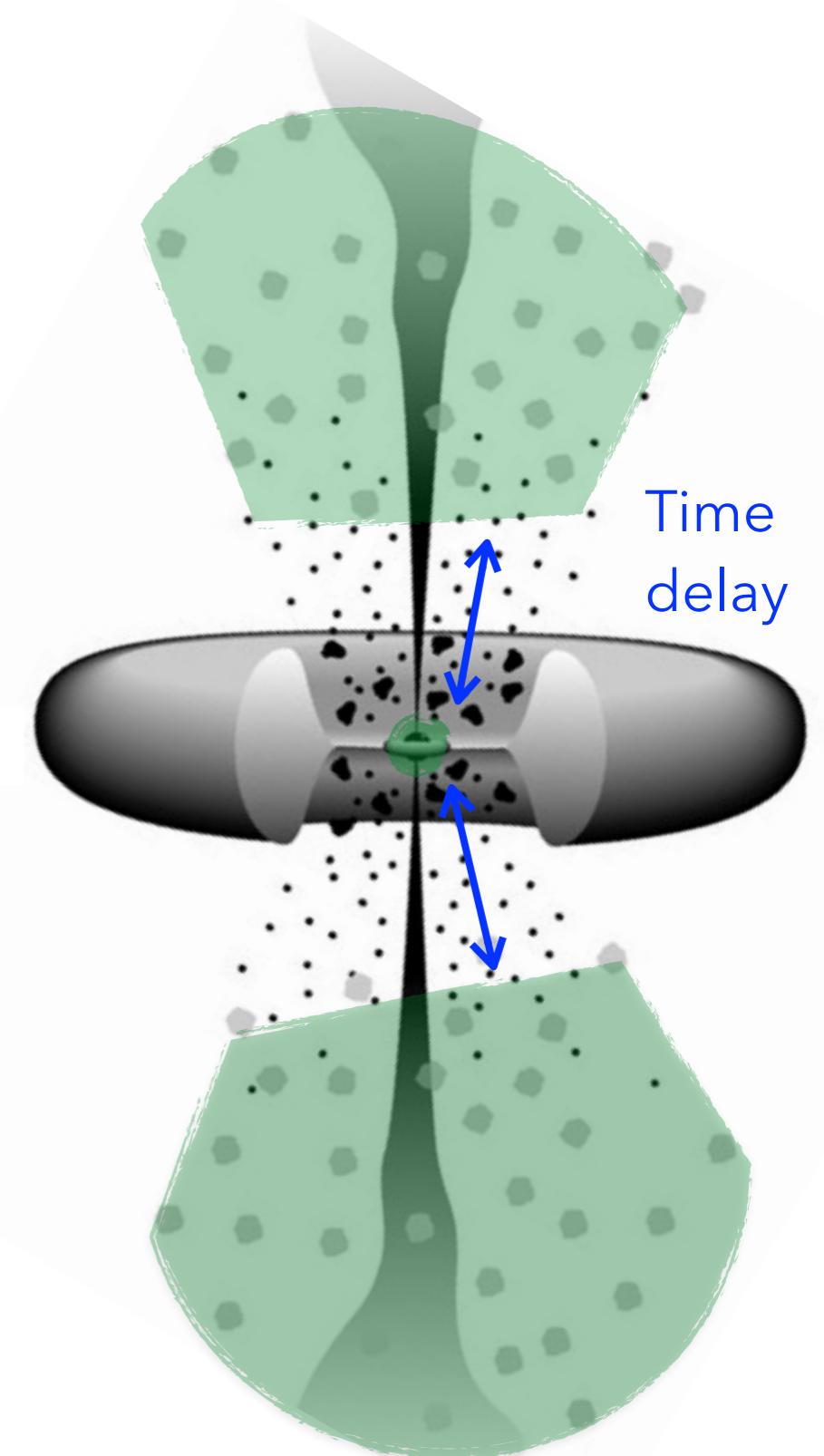
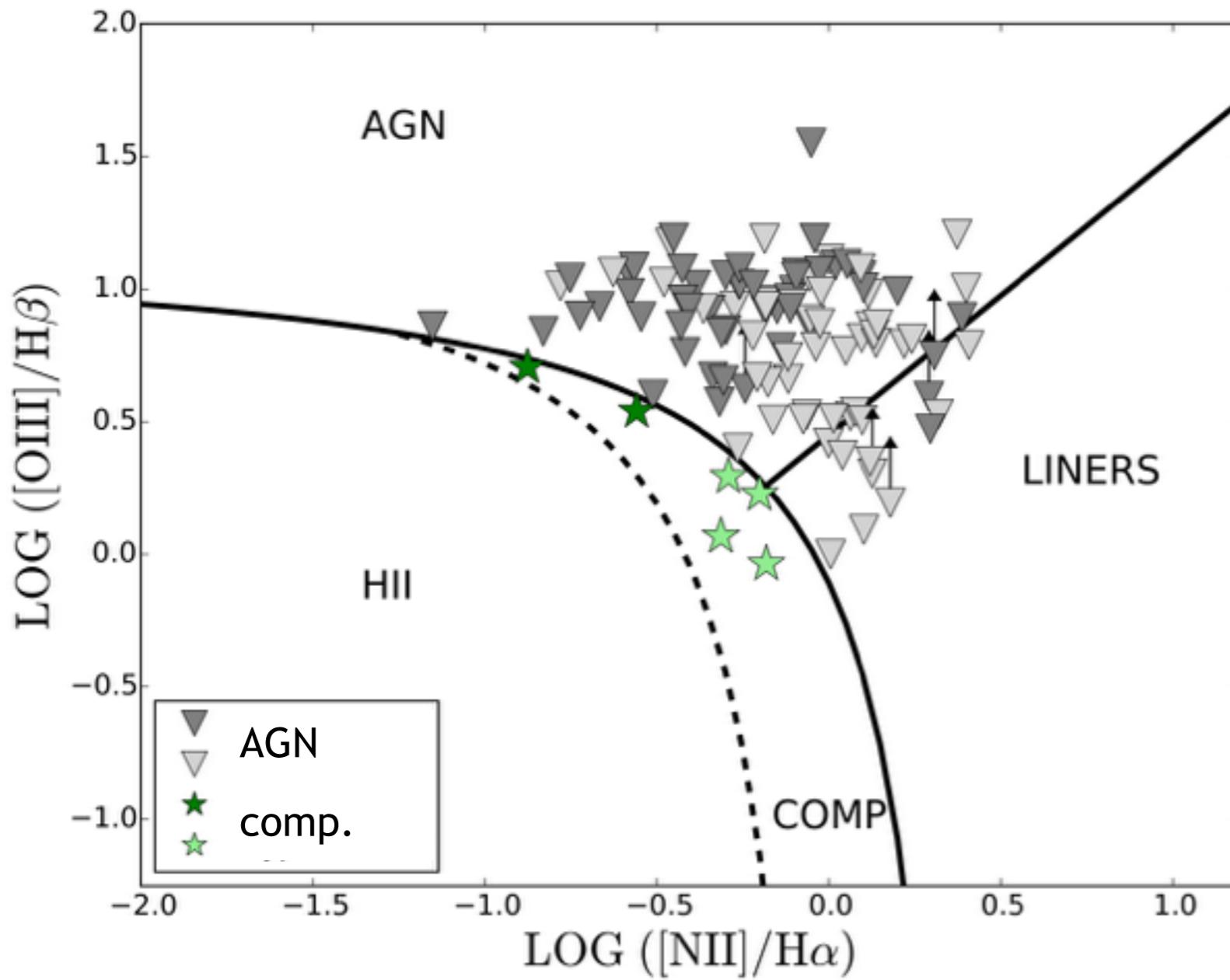
Swift BAT 70-Month hard X-ray Survey



The “switch on” phase



The “switch on” phase



AGN phase lifetime

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

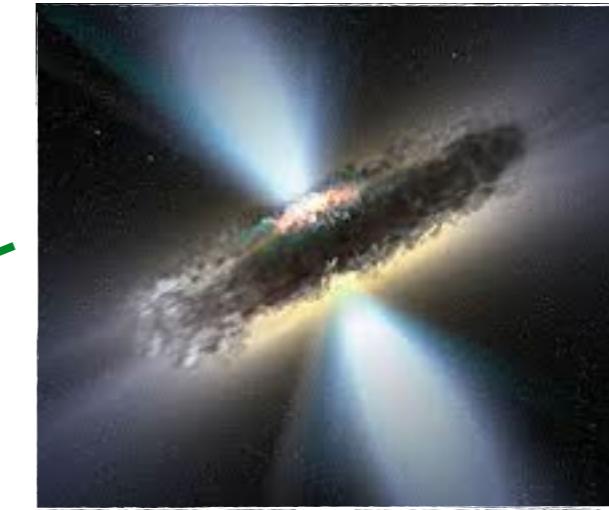
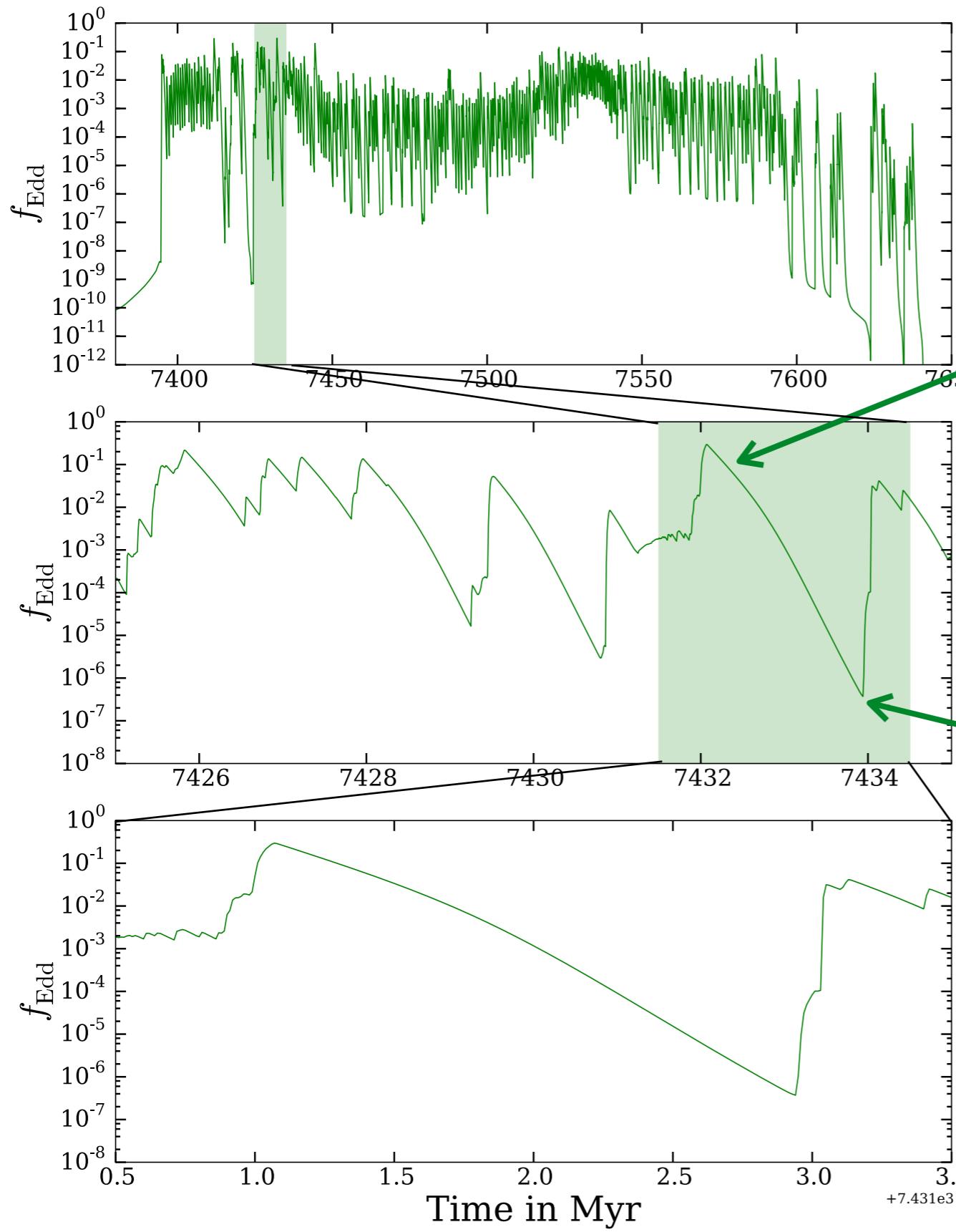
$$t_{\text{AGN}} \sim \frac{10'000 \text{ years}}{5 \%} \sim 200'000 \text{ years}$$

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

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

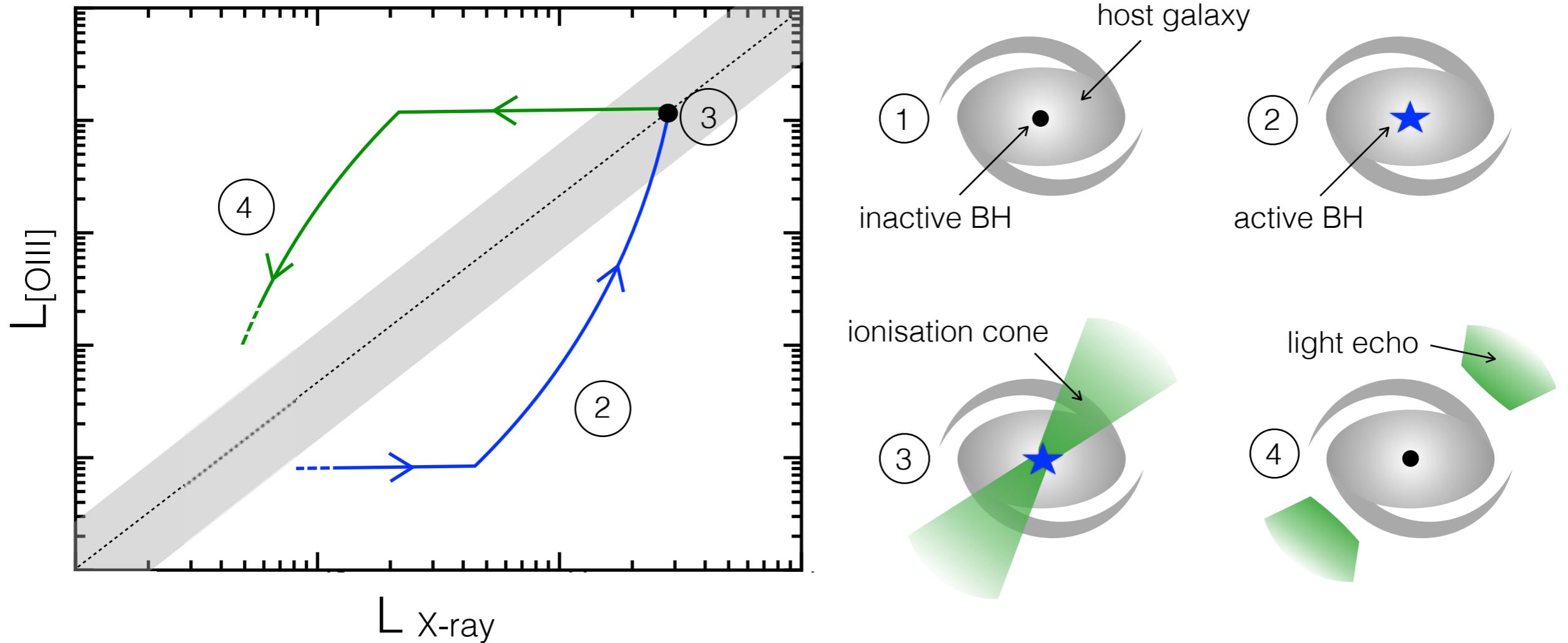
→ AGN flickering

AGN flickering



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

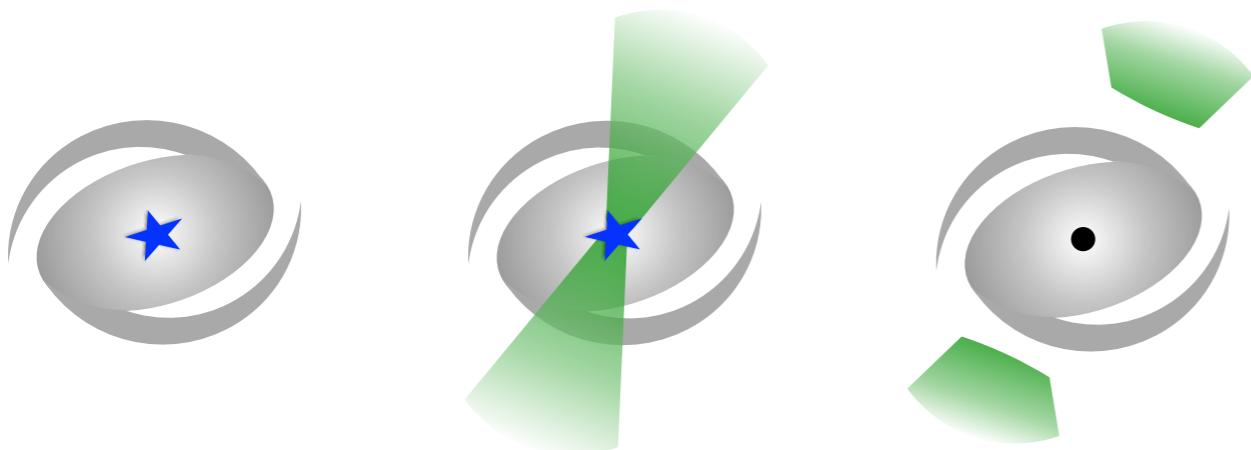
The cycle of BH accretion phases



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

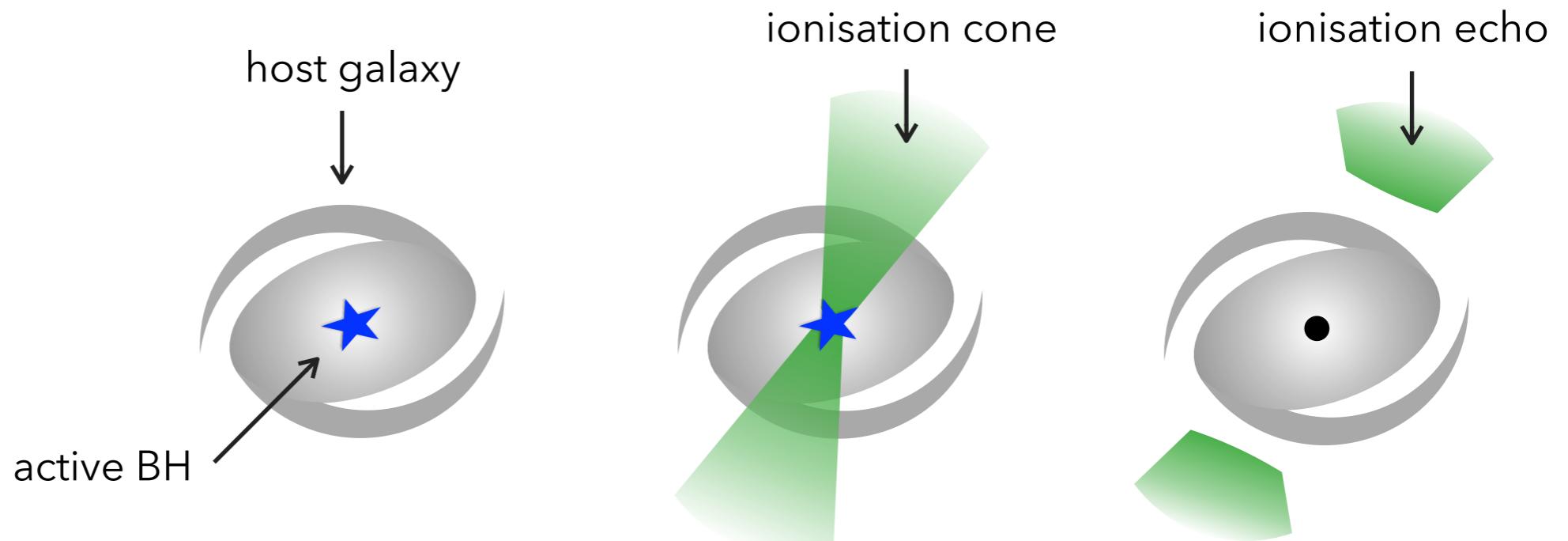


Schawinski...Sartori et al. 2015, arXiv:1501.06733

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