

# Is the BLR always there?

or *How small can the BLR get?*

(answer: really small)

**Stefano Bianchi, Robert Antonucci, Alessandro Capetti, Marco Chiaberge, Loredana Bassani, Francisco J. Carrera, Fabio La Franca, Andrea Marinucci, Giorgio Matt, Riccardo Middei, Francesca Panessa**

Bianchi et al. (2019)

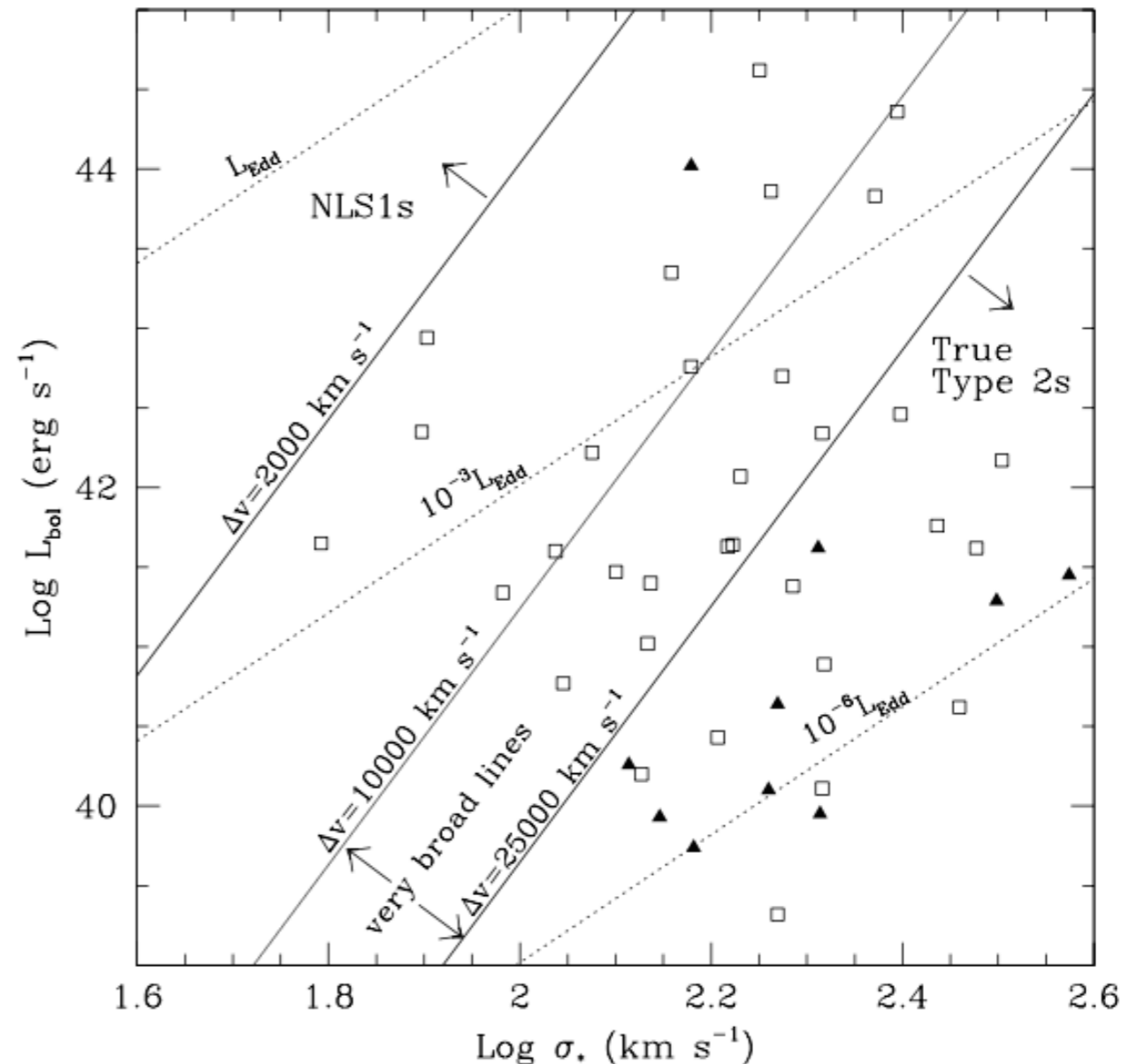
# or Are there true type 2 AGN?

= unobscured type 2 AGN

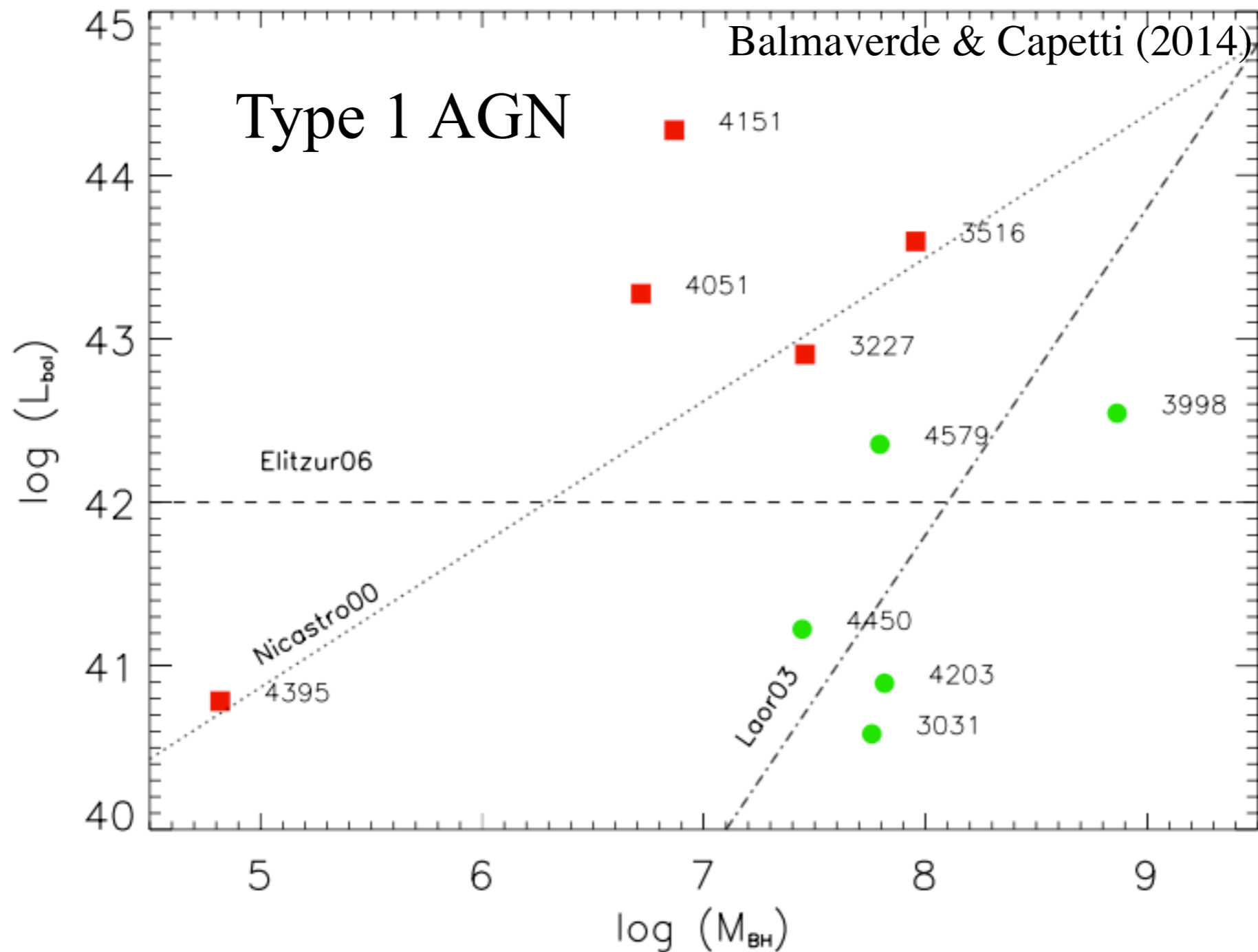
= NLR + unabsorbed and rapidly variable X-rays

The BLR gets smaller with decreasing luminosity  
—> LLAGN should have very broad lines

A physical limits on the maximal possible FWHM?  
Or, maybe a detection limit?

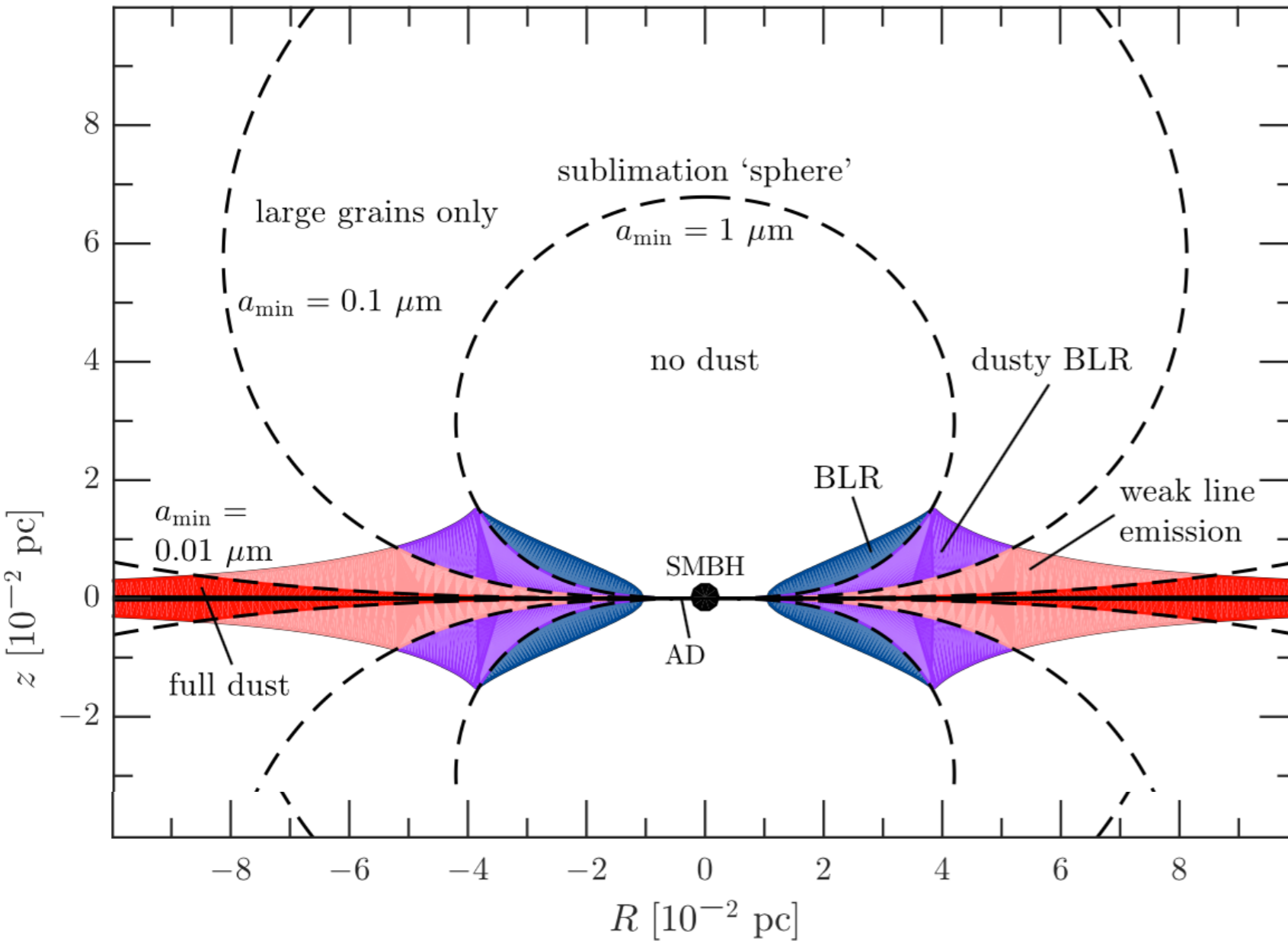


# Other suggestions + Observations



# Dust inflated accretion disc as the origin of the broad line region in active galactic nuclei

Alexei Baskin<sup>★†</sup> and Ari Laor<sup>★</sup> (2018)



$$R_{\max} \propto L^{0.59} M_{\text{BH}}^{0.075} (Z/Z_{\odot})^{0.26} \epsilon^{-0.33}$$

$$\text{CF} \propto L^{0.18} M_{\text{BH}}^{0.15} (Z/Z_{\odot})^{0.51} \epsilon^{-0.67}$$

$$\dot{m} < 0.0065 (Z/Z_{\odot})^{-1}$$

# The best True Type 2 candidate

## NGC 3147: a ‘true’ type 2 Seyfert galaxy without the broad-line region

Mon. Not. R. Astron. Soc. **385**, 195–199 (2008)

S. Bianchi,<sup>1★</sup> A. Corral,<sup>2</sup> F. Panessa,<sup>2</sup> X. Barcons,<sup>2</sup> G. Matt,<sup>1</sup> L. Bassani,<sup>3</sup> F. J. Carrera<sup>4</sup>  
and E. Jiménez-Bailón<sup>4,5</sup>

## The *Suzaku* X-ray spectrum of NGC 3147

A&A 540, A111 (2012)

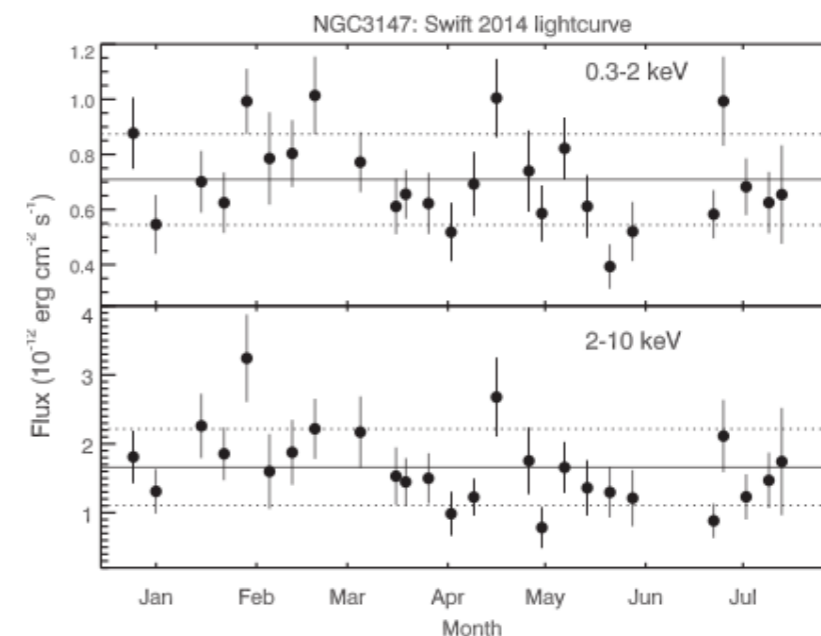
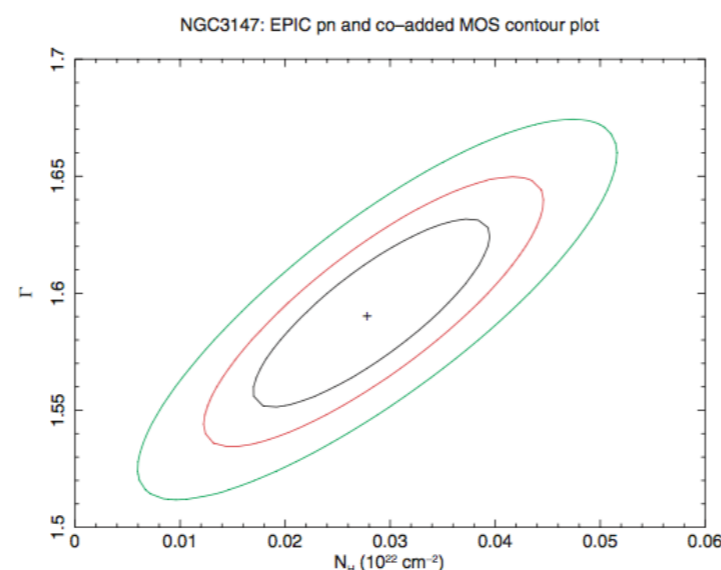
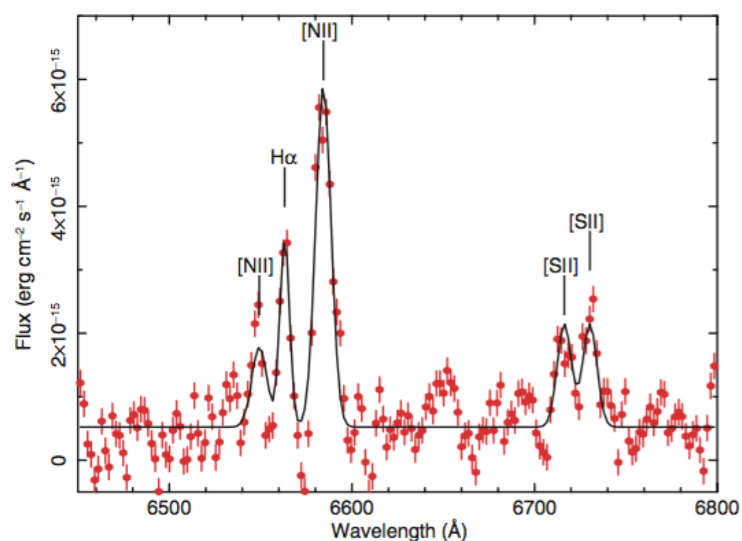
## Further insights on the best “true” Seyfert 2 galaxy candidate

G. Matt<sup>1</sup>, S. Bianchi<sup>1</sup>, M. Guainazzi<sup>2</sup>, X. Barcons<sup>3</sup>, and F. Panessa<sup>4</sup>

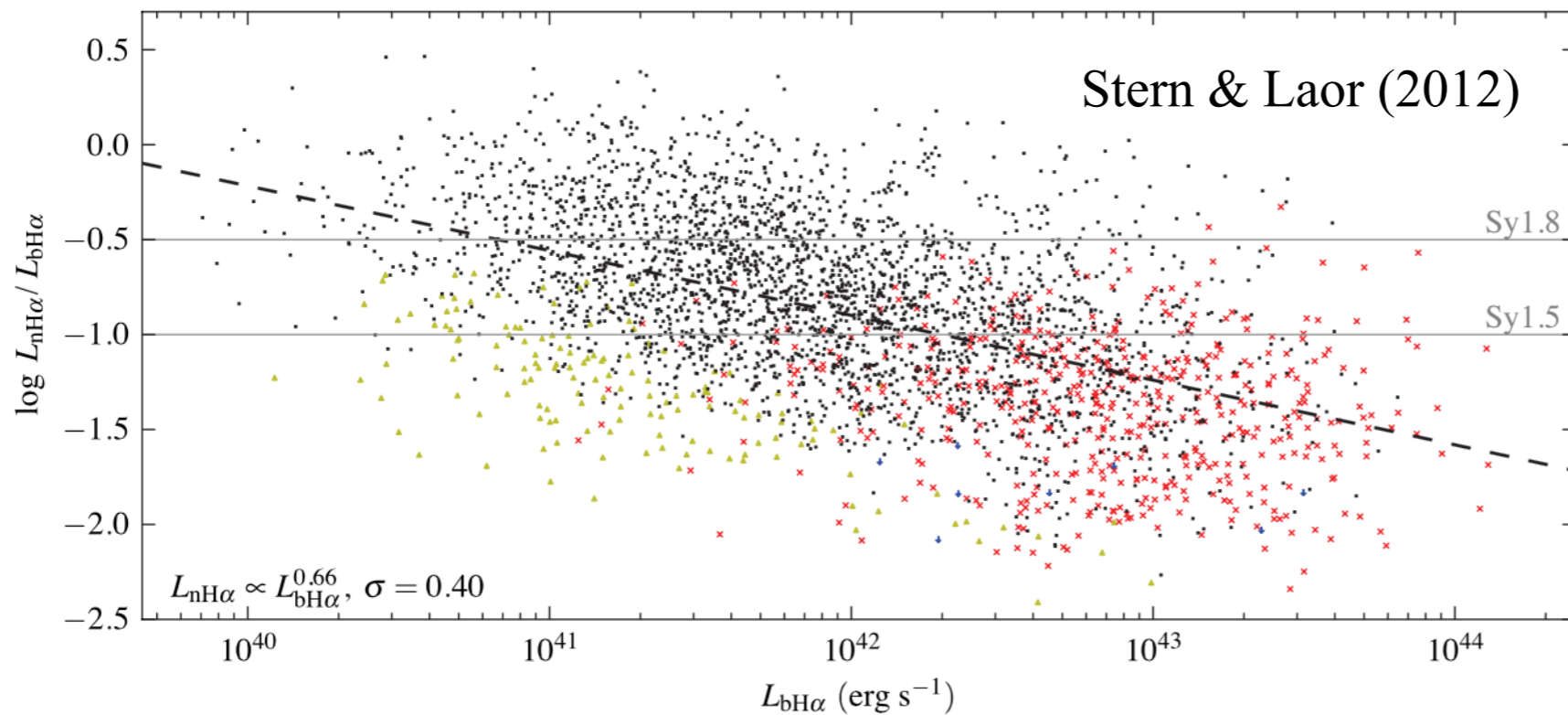
## The *NuSTAR* view of the true type 2 Seyfert NGC 3147

MNRAS **468**, 2740–2744 (2017)

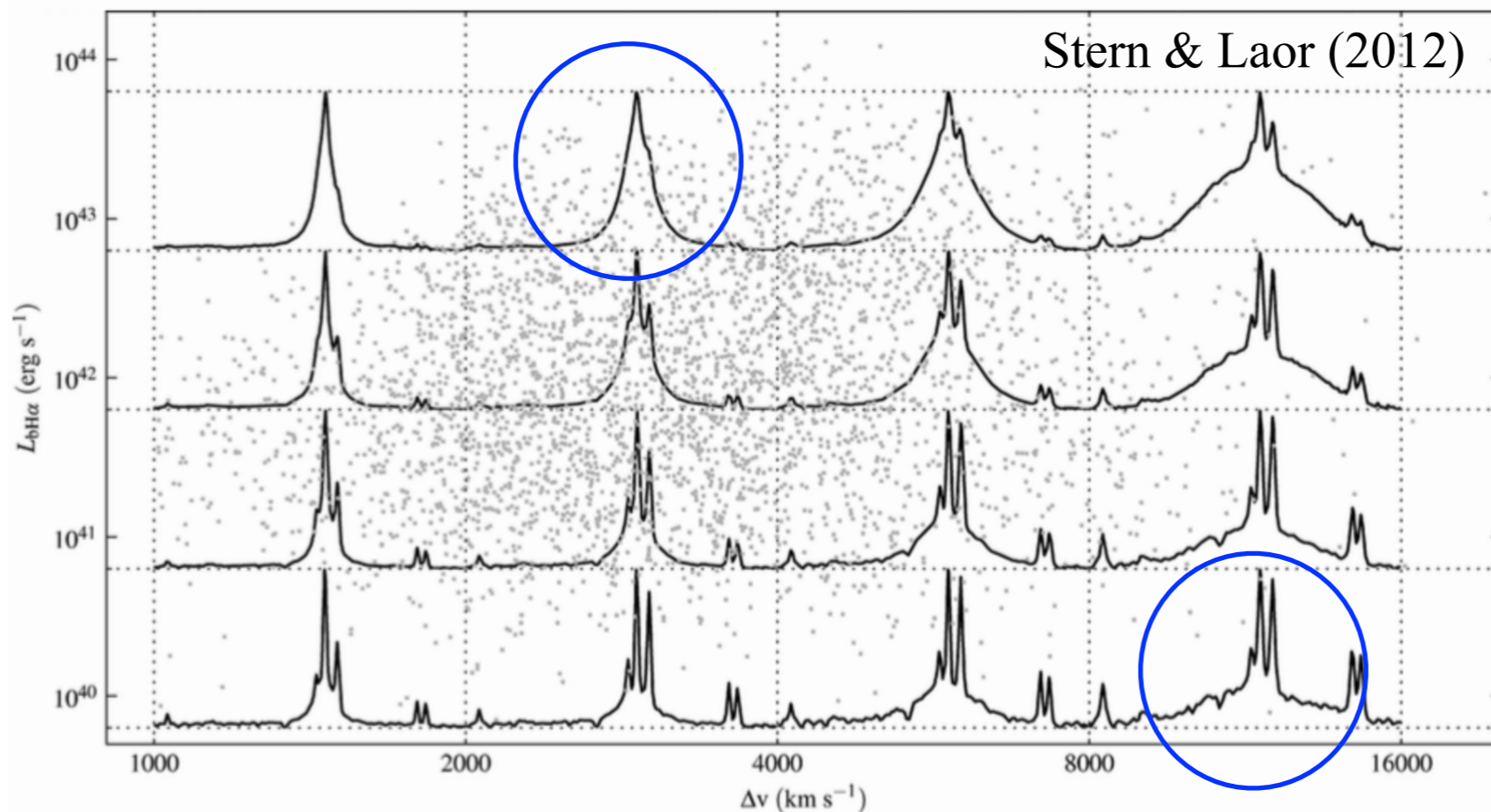
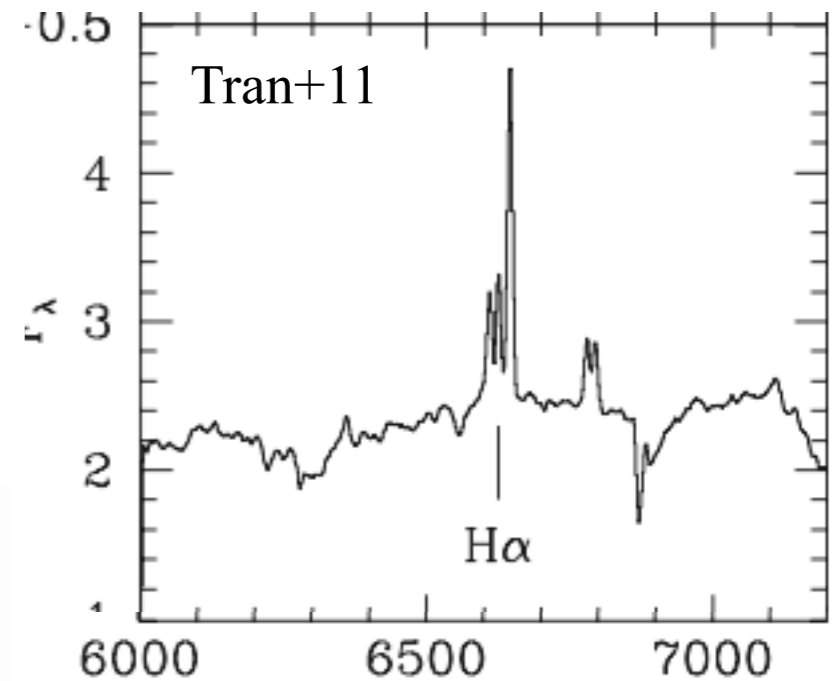
Stefano Bianchi,<sup>1★</sup> Andrea Marinucci,<sup>1</sup> Giorgio Matt,<sup>1</sup> Riccardo Middei,<sup>1</sup>  
Xavier Barcons,<sup>2</sup> Loredana Bassani,<sup>3</sup> Francisco J. Carrera,<sup>2</sup> Fabio La Franca<sup>1</sup>  
and Francesca Panessa<sup>4</sup>



# But...



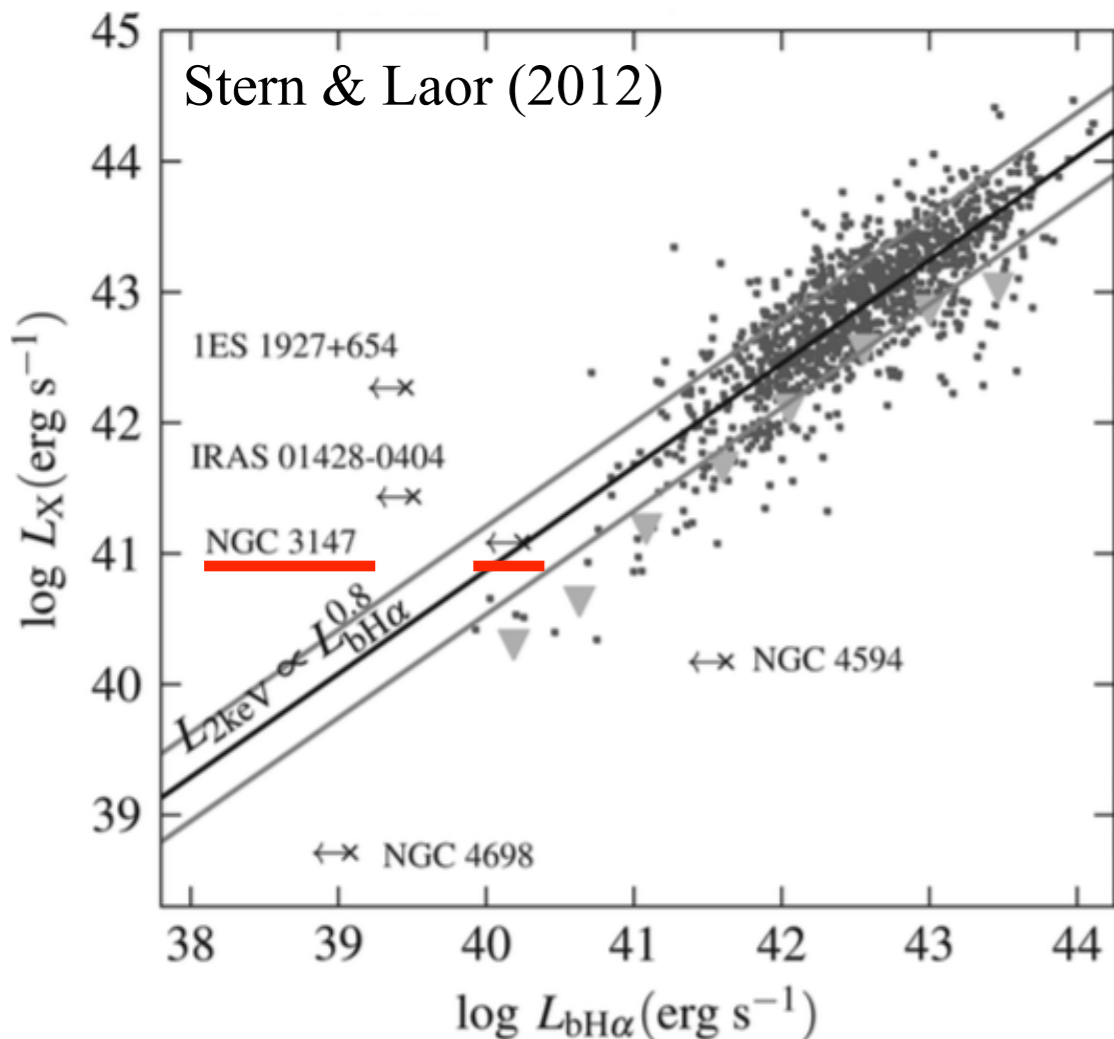
## NGC 3147



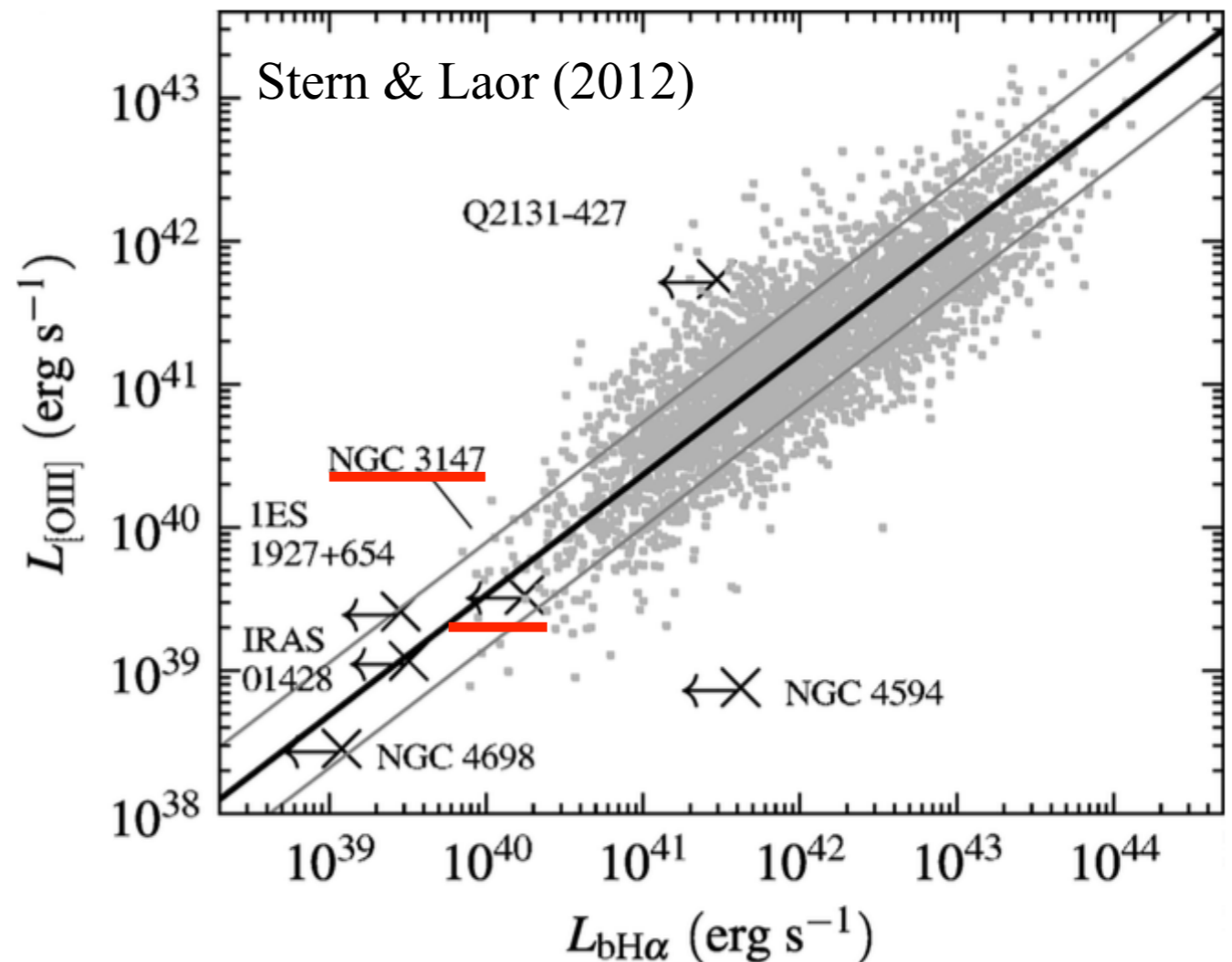
—> BLR becomes shallow and weak in **Type 1** LLAGN

(+ host dilution)

and indeed...



$$\rightarrow \log L_{bH\alpha} = 40.5 \pm 0.5$$



$$\rightarrow \log L_{bH\alpha} = 40.6 \pm 0.5$$

The predicted  $L_{bH\alpha}$  based on  $L_x$  and  $L[O III]$  is not excluded

*Is NGC 3147 a type 1 or a true type 2 AGN? [Ski]*



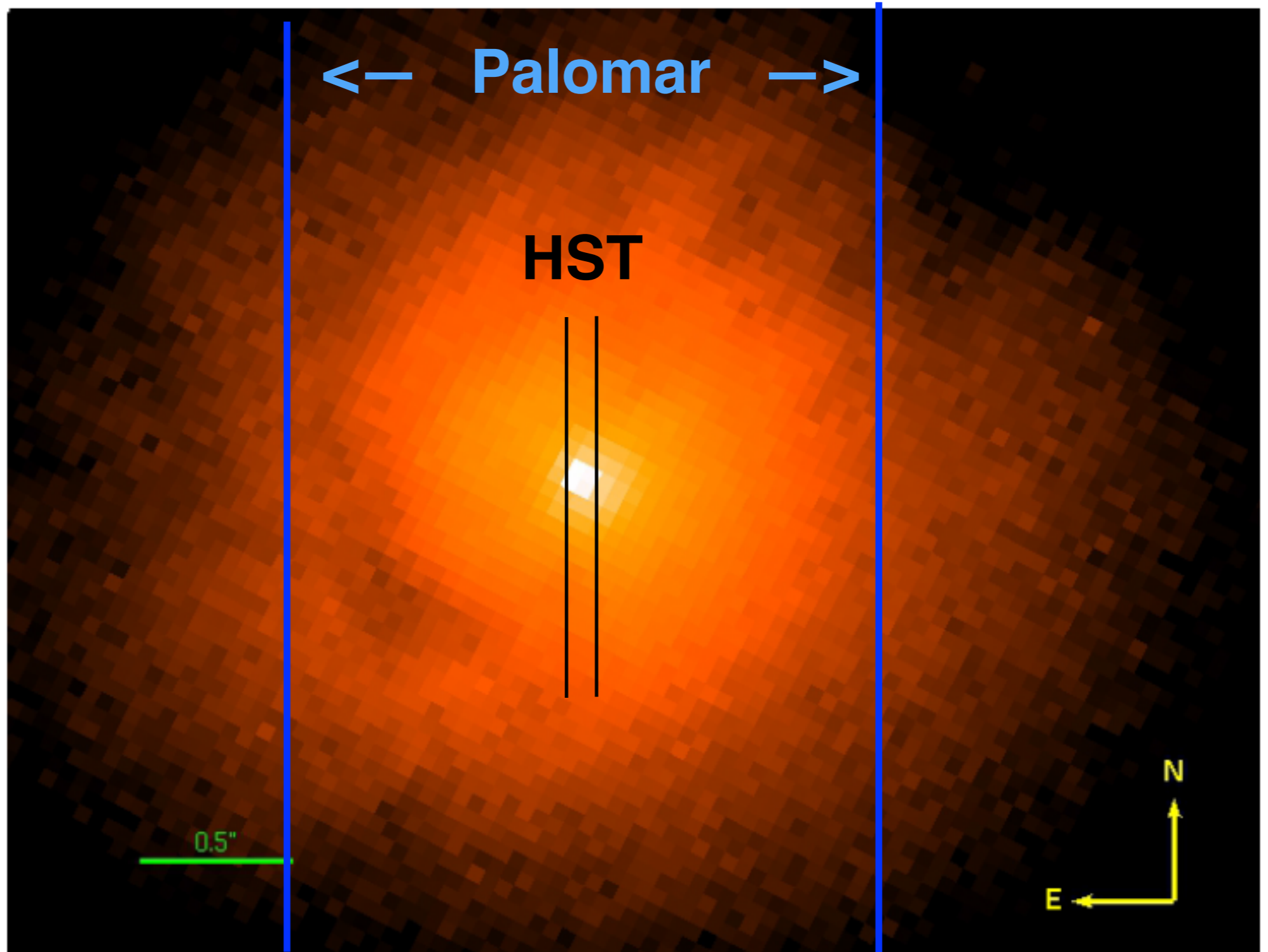


# How can we find out?

Need to exclude the host light,  
and get the net AGN emission

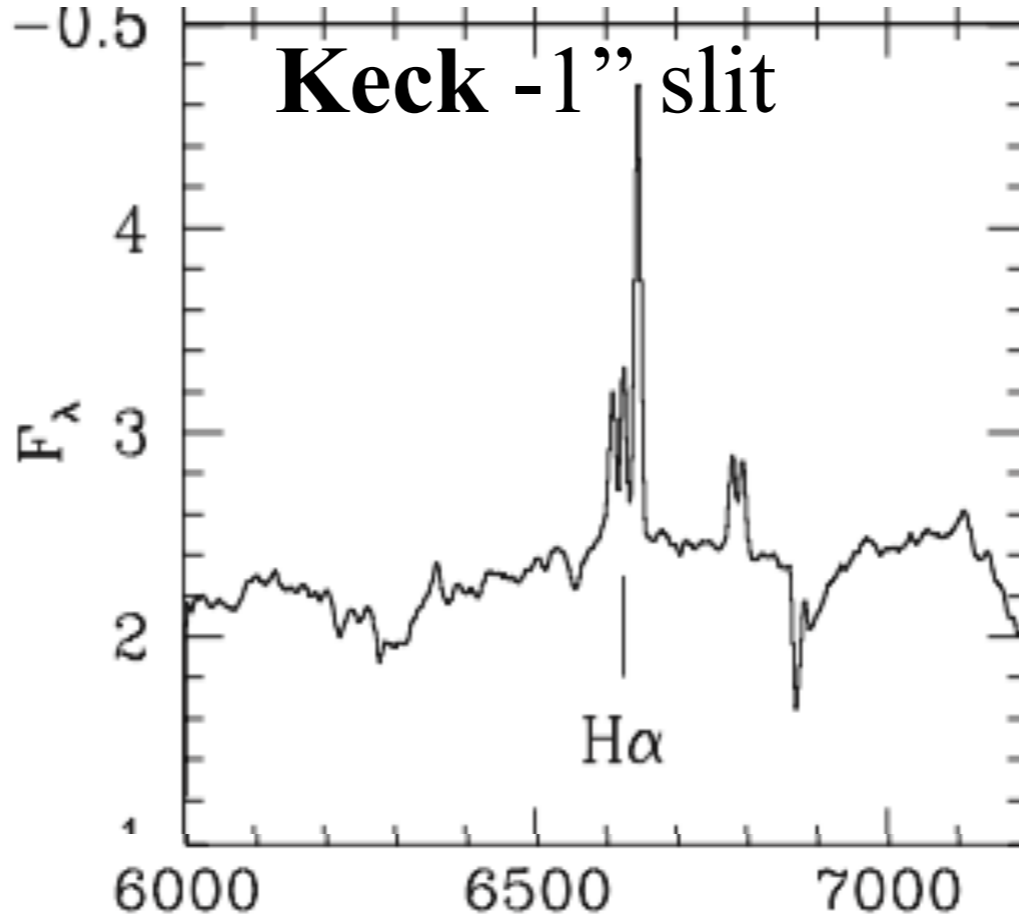
188 pc/arcsec

—> HST



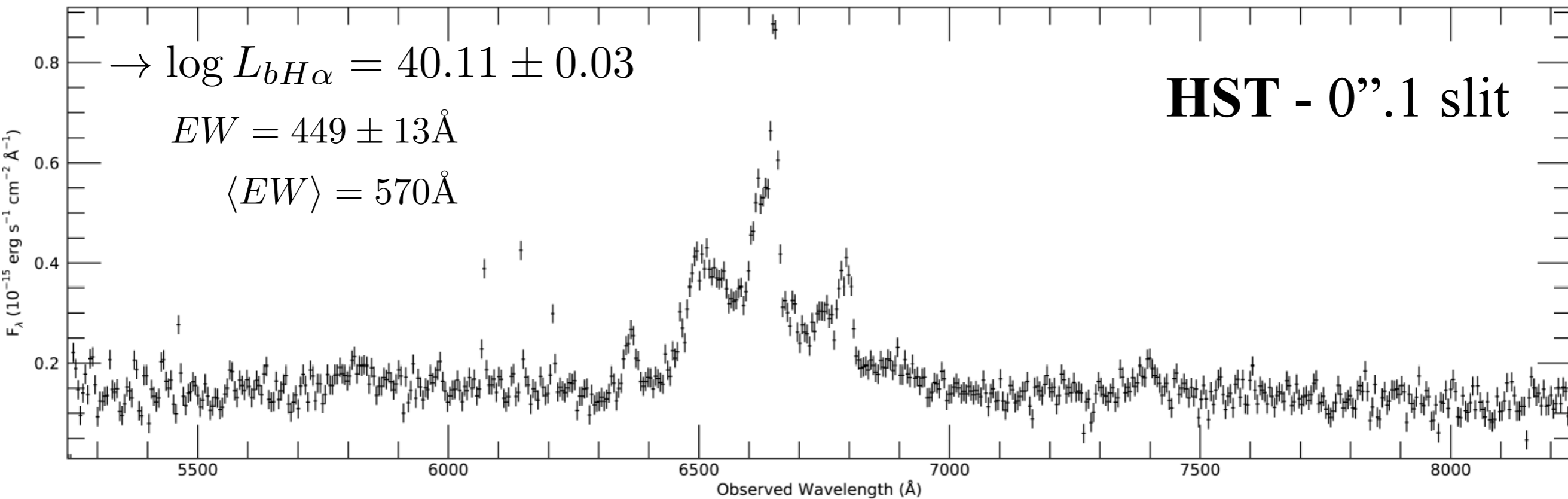
*So ??*

# Surprise #1



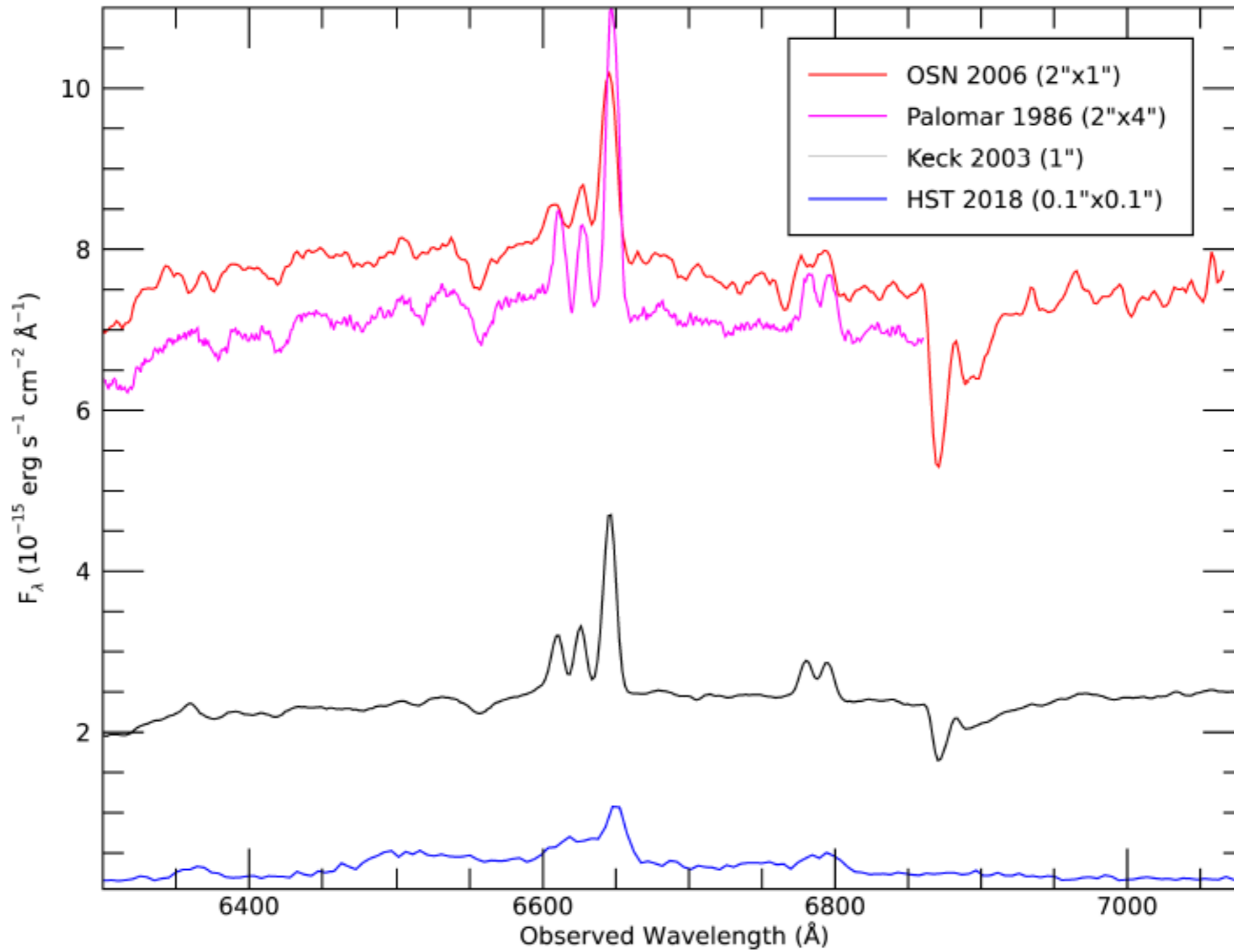
*The BLR is there!*

NGC3147 - HST STIS G750L

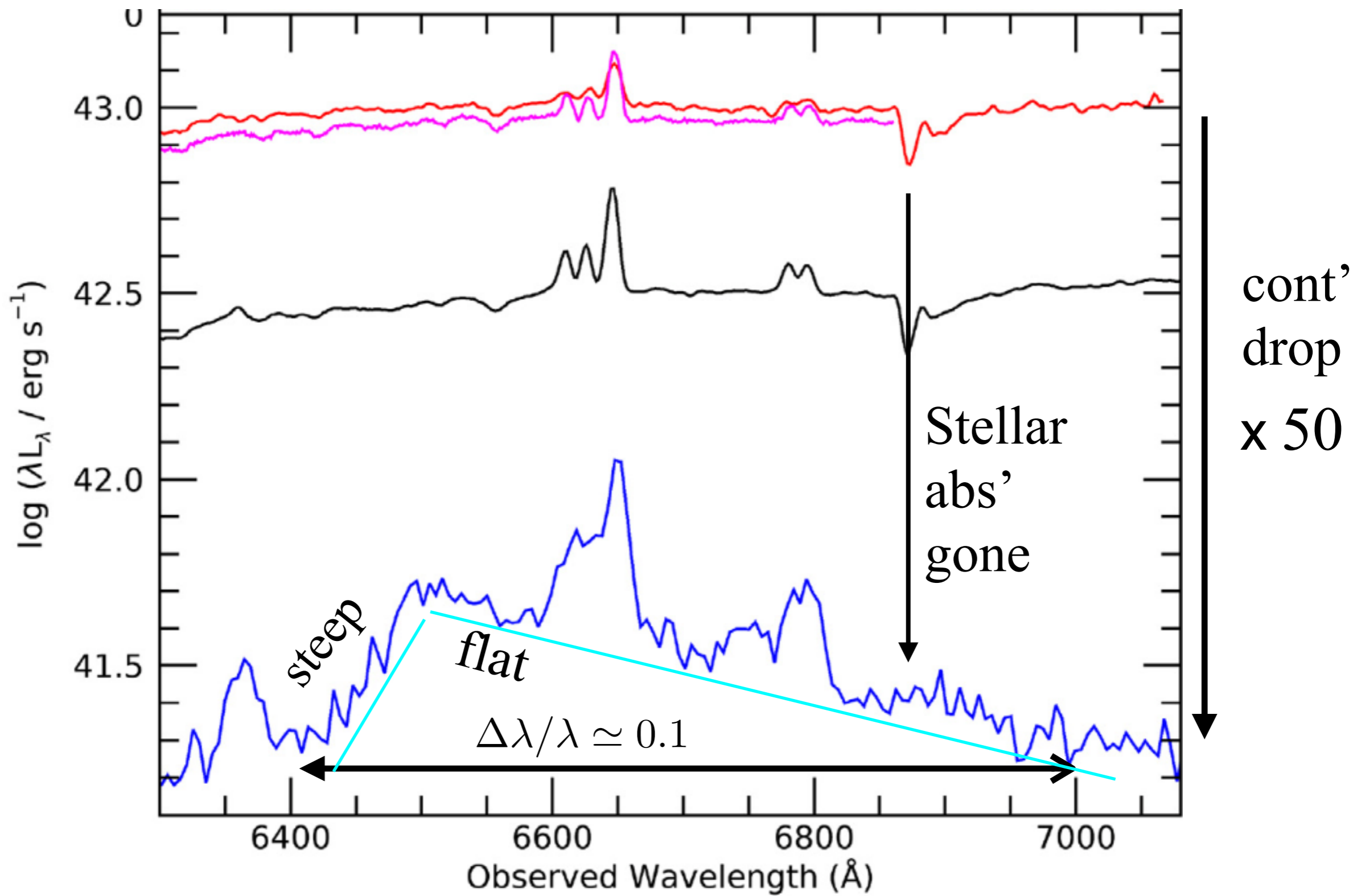


At the expected luminosity, with a typical EW

# NGC3147

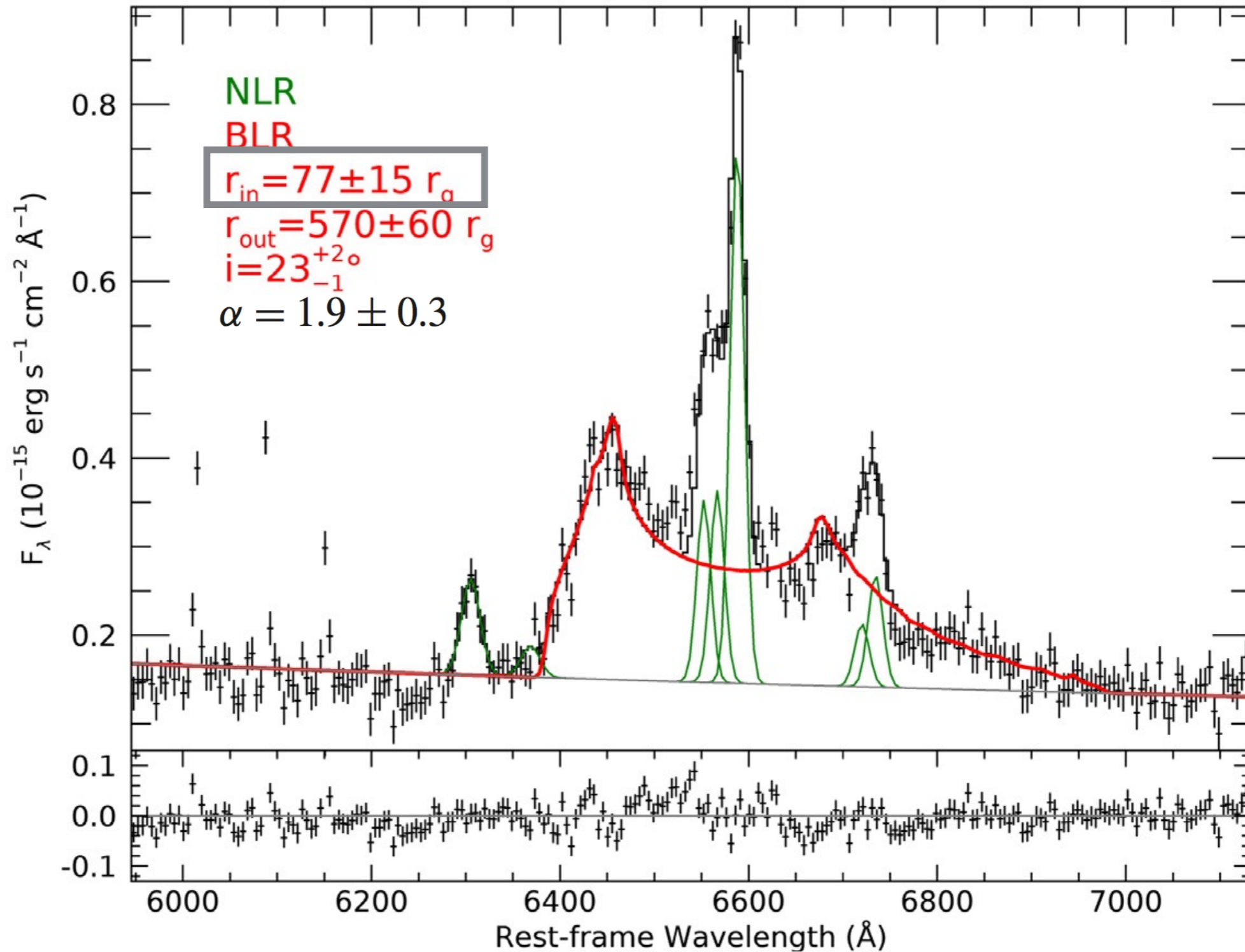


The AGN is simply swamped by the host light



# Surprise #2

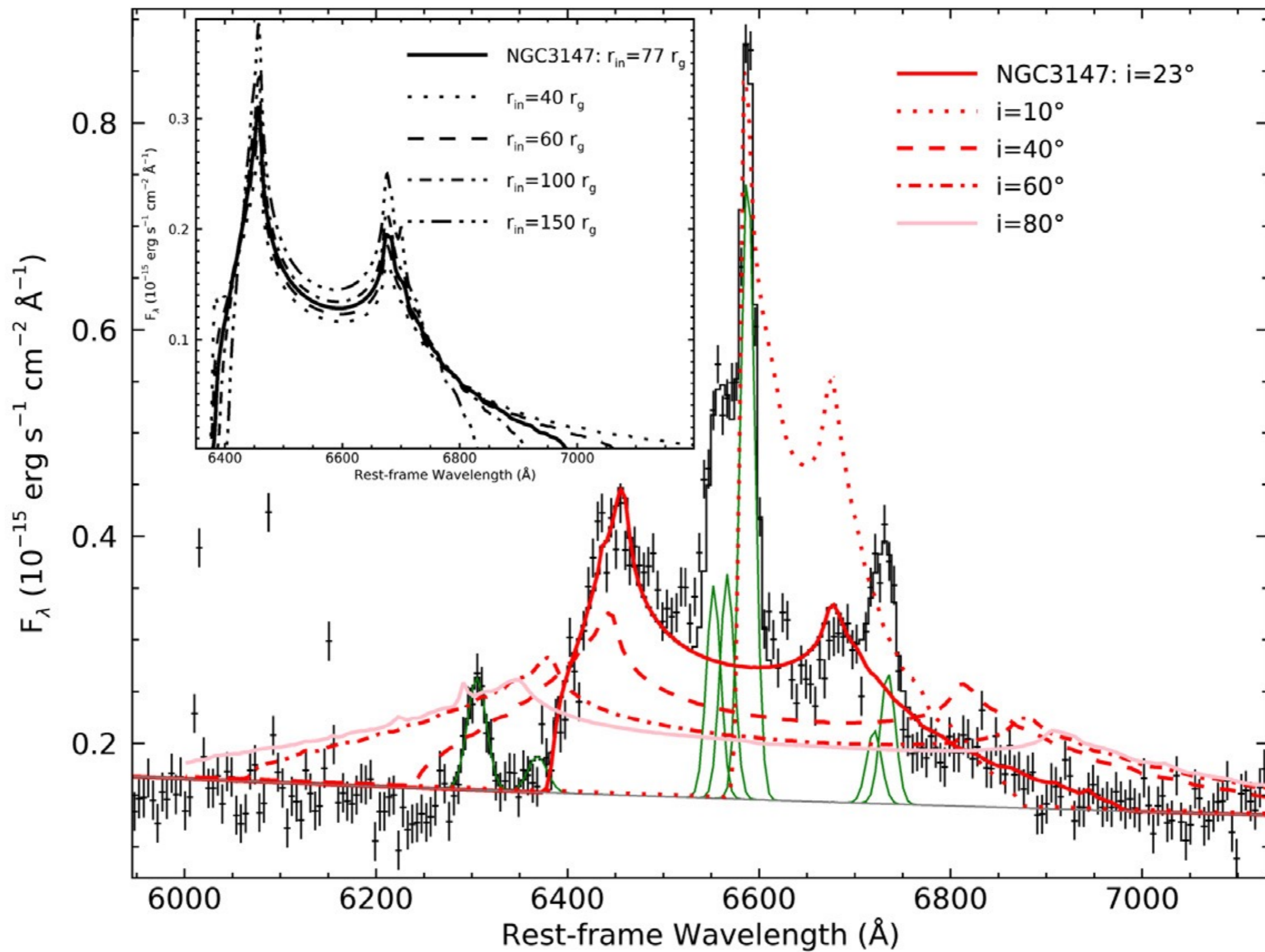
NGC3147 - HST STIS G750L



A thin accretion disk line profile

# Line parameters constraint

NGC3147 - HST STIS G750L



## Surprise #3

The line profile fit gives:  $r_{\text{in}}/r_g = 77 \pm 15$   
 $r_{\text{out}}/r_g = 570 \pm 60$

*what is the predicted BLR size?*

$$\log L_{\text{bH}\alpha}/\text{erg s}^{-1} = 40.11 \rightarrow R_{\text{BLR}} = 2.8 \pm 0.2 \times 10^{15} \text{ cm}$$

Greene & Ho (2005)

$$\sigma_* = 233 \pm 8 \text{ km s}^{-1} \rightarrow \log M_{\text{BH}}/M_{\odot} = 8.49 \pm 0.11$$

$$r_g = GM_{\text{BH}}/c^2 = 4.5 \times 10^{13} \text{ cm}$$

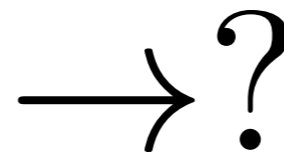
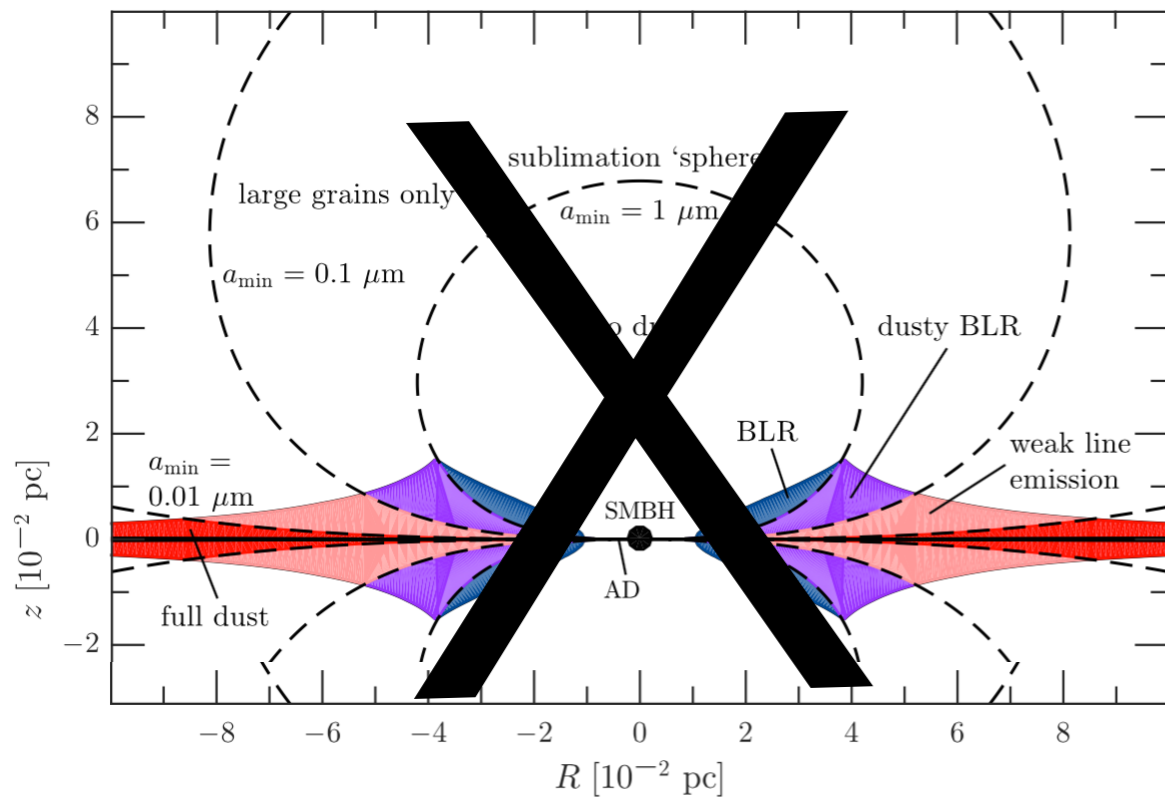
$$\rightarrow R_{\text{BLR}} = 62_{-14}^{+18} r_g$$

*The BLR radius-luminosity holds for  $r < 100 r_g$  (??)*

# Surprise #4

# A thin disk BLR?

In NGC 3147  $L_{\text{bol}}/L_{\text{Edd}} = 1.0 \pm 0.4 \times 10^{-4}$



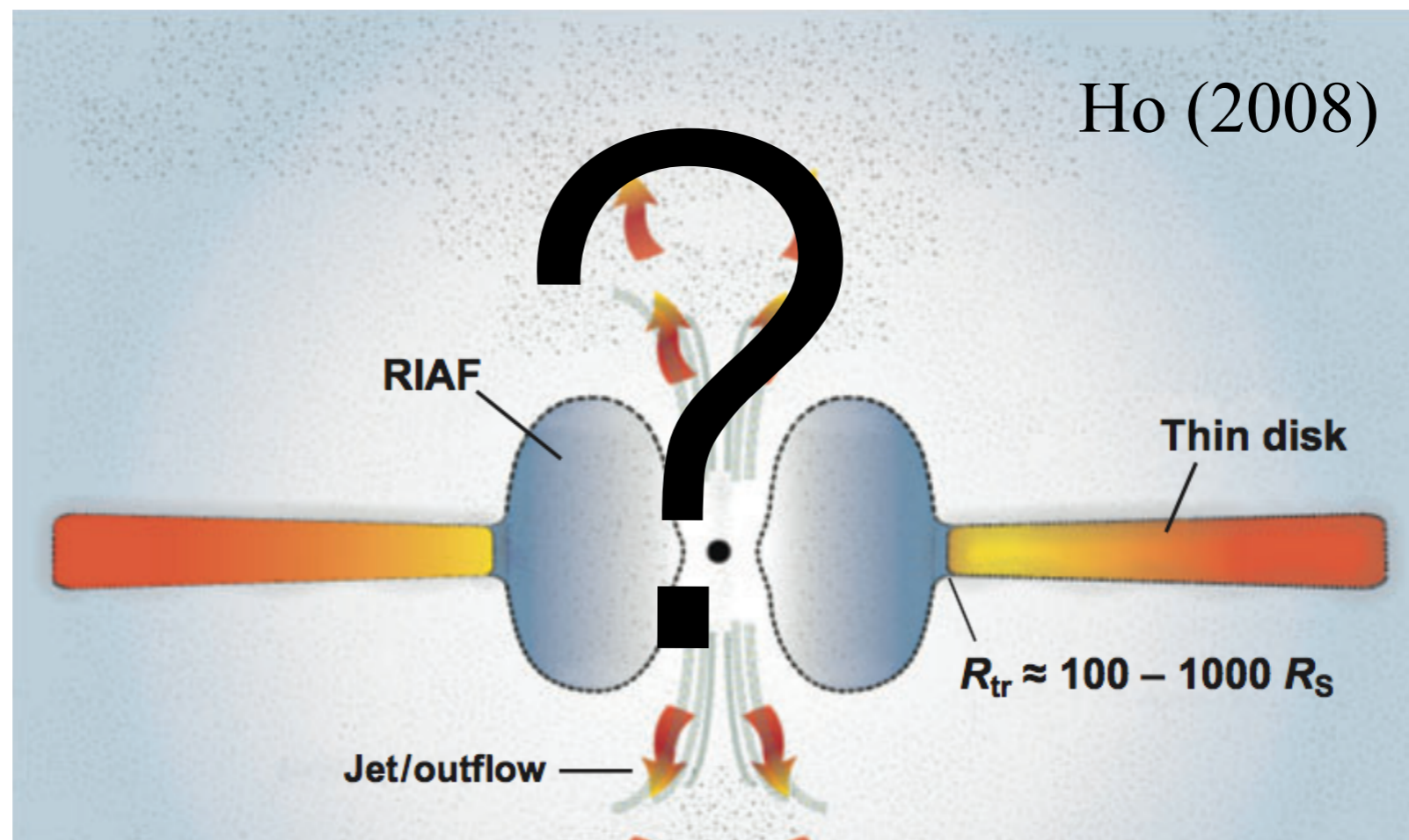
*The BLR comes from an illuminated thin disk?*



# ADAF Excluded?

No ADAF transition, at least down to  $77R_g$ ,  
a thin AD all the way in?

See also the ALMA discovery of a disk down to  $2 \times 10^4 R_g$   
at the Galactic centre, where  $L/L_{\text{Edd}} = 10^{-8}$   
Murchikova, Phinney, Pancoast, & Blandford (2019)



# Why is NGC 3147 different?

1. Optical double peaked Balmer lines are known.

*But, they come from  $M_{\text{BH}} \sim 10^9$ ,  $L/L_{\text{Edd}} \sim 10^{-3}$  from a thick structure, and from larger  $R/R_g$*

2. HST detected broad Balmer lines are known.

*But, they also do not show a simple thin disk line profile*

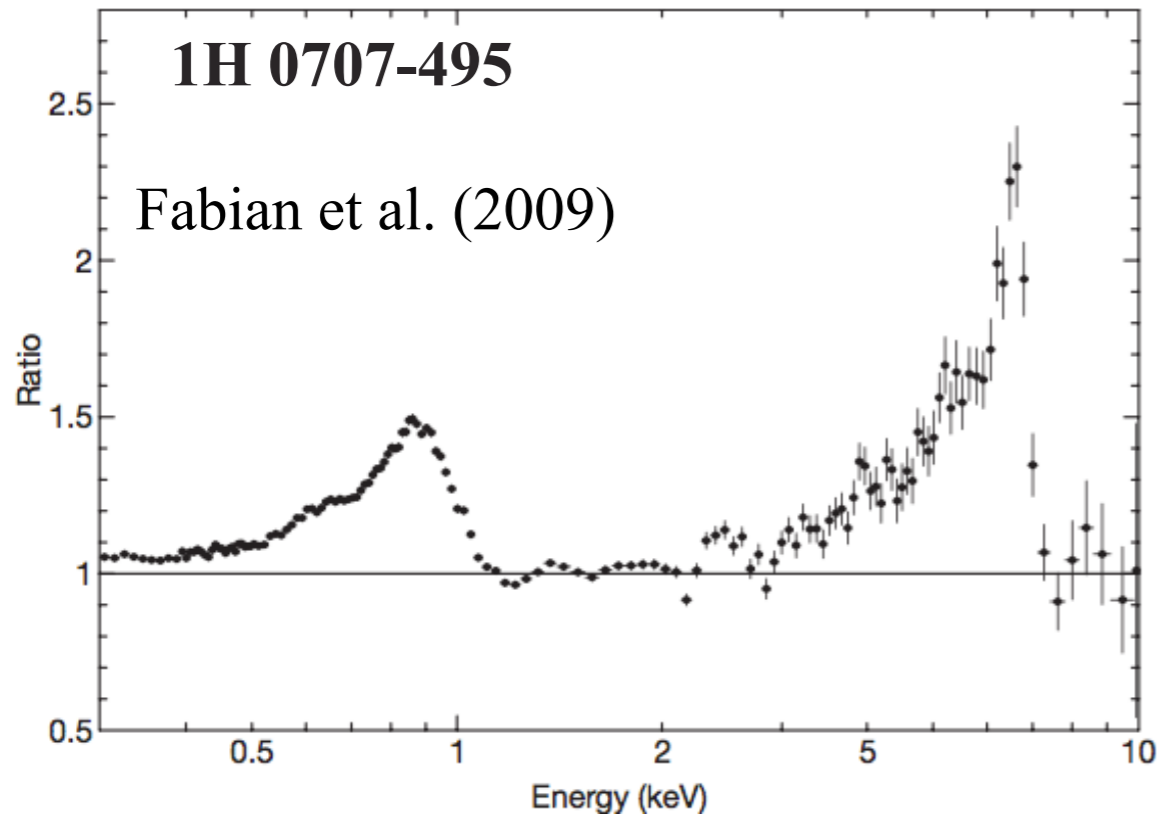
(and also the very broad line were predicted!)

**Are there more such object?**

**Can we find objects which go down further in  $R_{\text{BLR}}/R_g$ ?**

# The enormous diagnostic power of **optical** line profiles

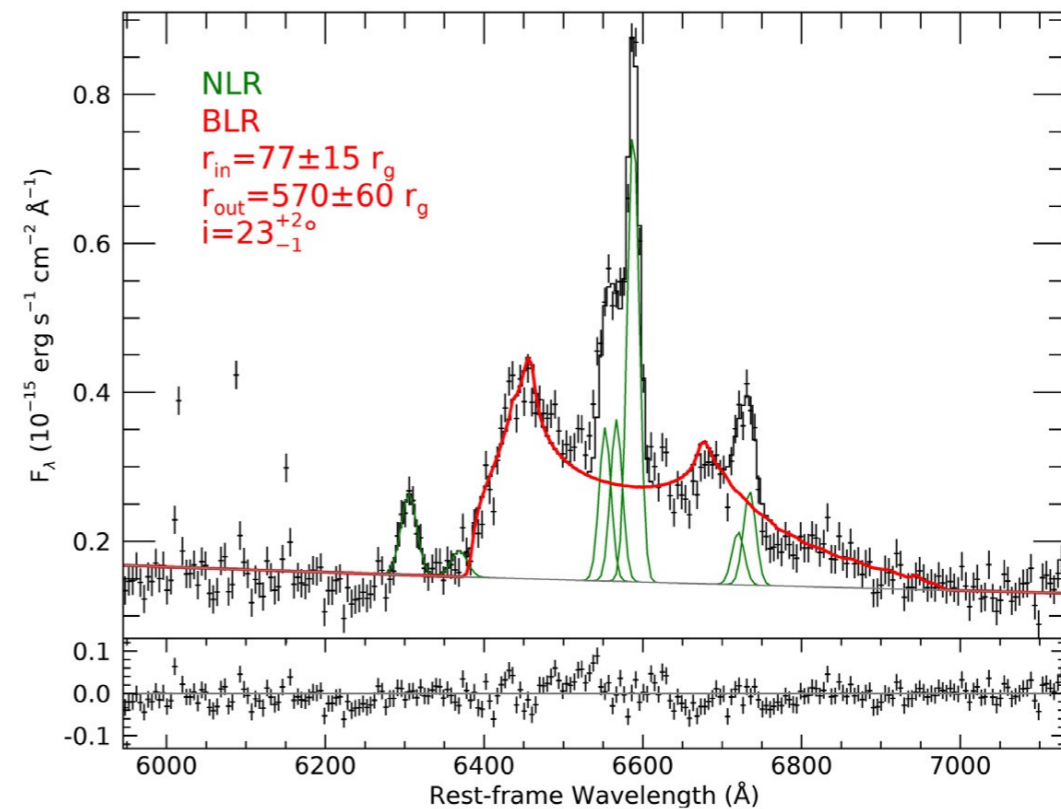
## X-rays



Among the best X-ray spectra

$$\frac{n_{\gamma}(\text{optical})}{n_{\gamma}(\text{X-ray})} \sim 10 \times 1000 \times 100 = 10^6$$

NGC3147 - HST STIS G750L



A lousy optical spectrum.

(500 s, very faint source, small telescope)

*Can we find an **optical** relativistic line profile?*

## New open questions

Do true type 2 AGN really exist?  
*or is it always just host dilution?* [yes, ~50%]

Is there a transition to ADAF at  $L/L_{\text{Edd}} < 0.01$ ?  
*or is a thin disk always there?* [yes, ~90%]  
*(see Galactic centre, and SS73)*

Can the BLR extend down to a few  $R_g$ ?  
*If yes, can we get the inner disk structure,*  
*and even the BH spin?* [yes, ~10%, but game changer]