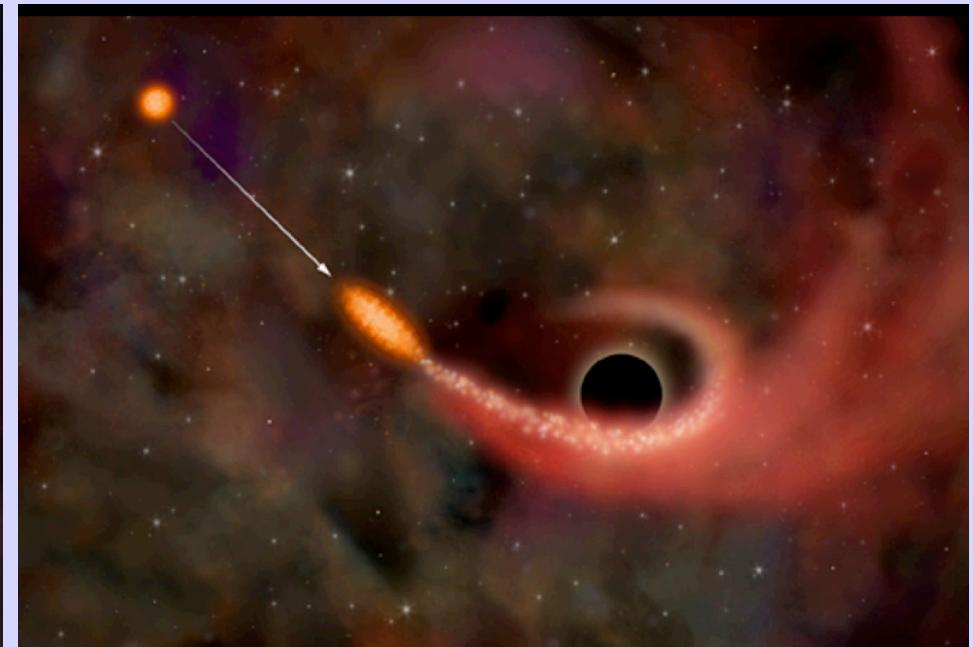


# Quasars from the inside out

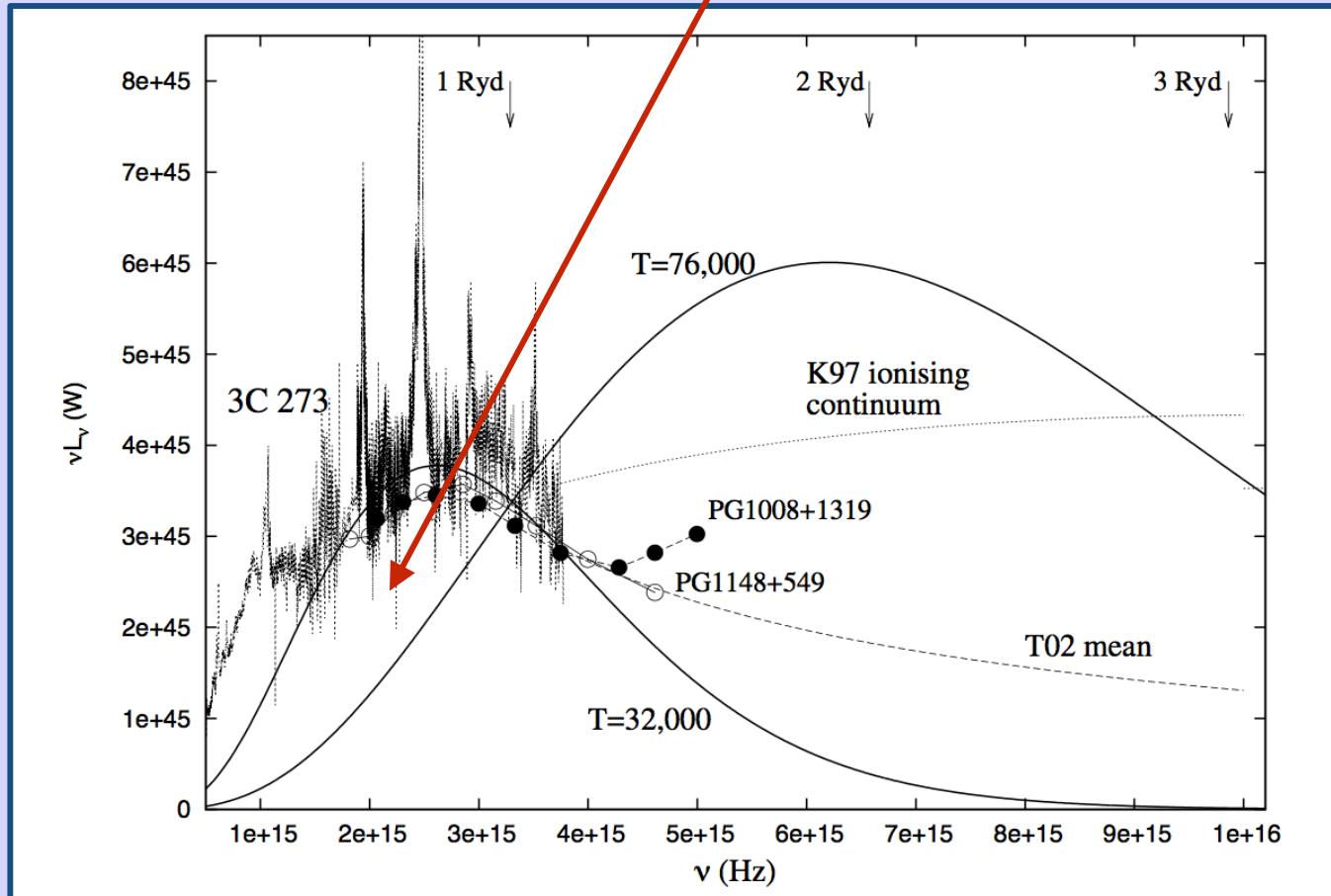


Andy Lawrence  
Edinburgh Aug 2019

*possibly  
all reprocessed*

All the  
action is in  
the EUV

Lawrence 2012



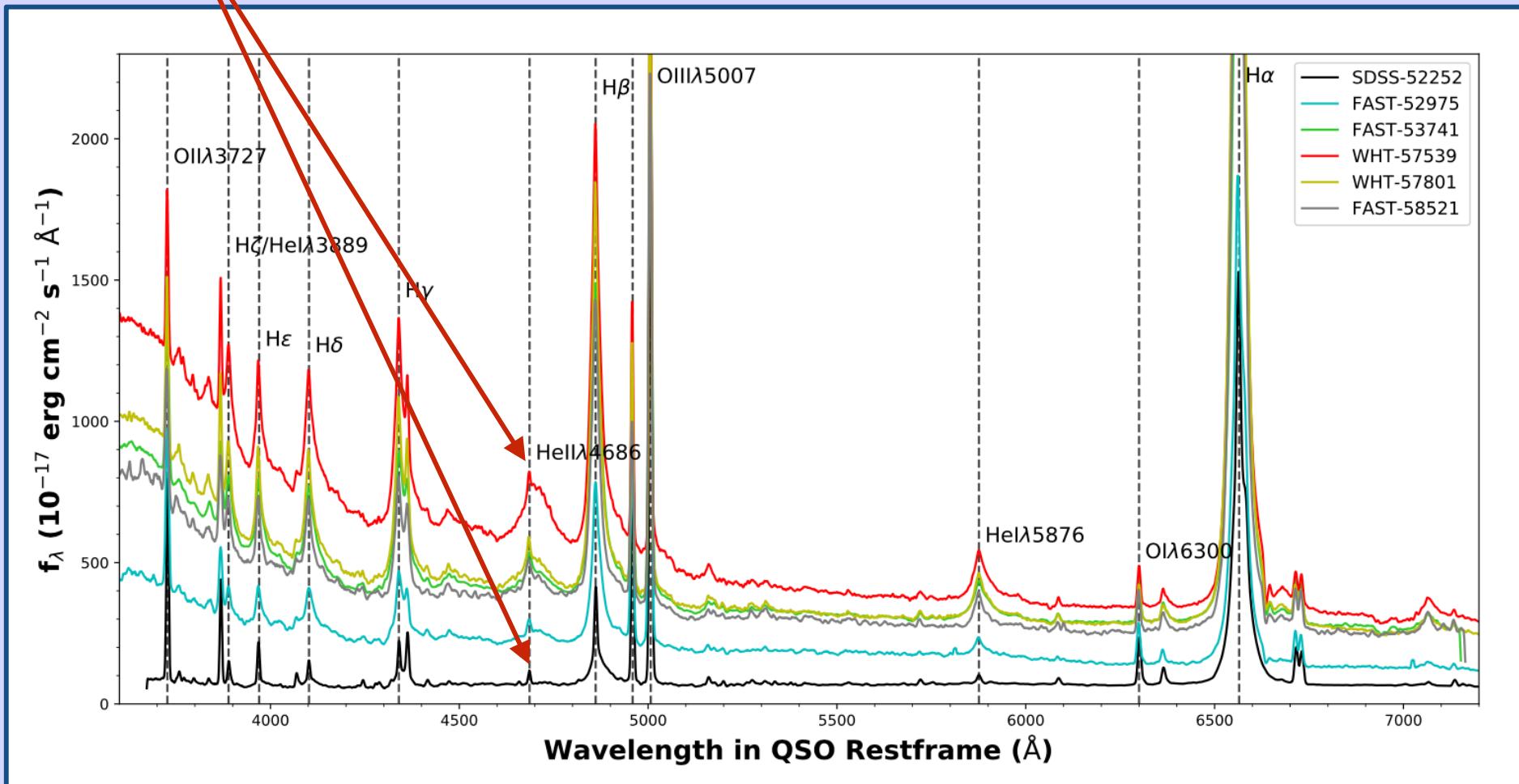
continuum  
we see  
 $T \sim 32,000$

continuum  
lines see  
 $T \sim 100,000$

# HUGE He II variability

# Thirty years of MKN 110

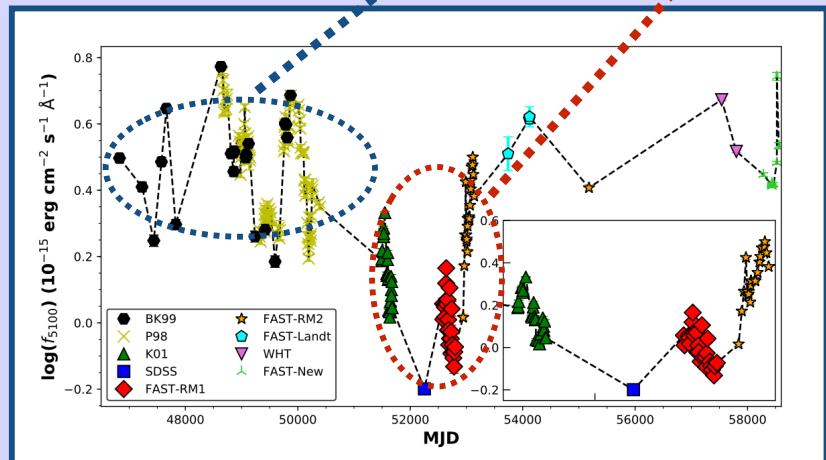
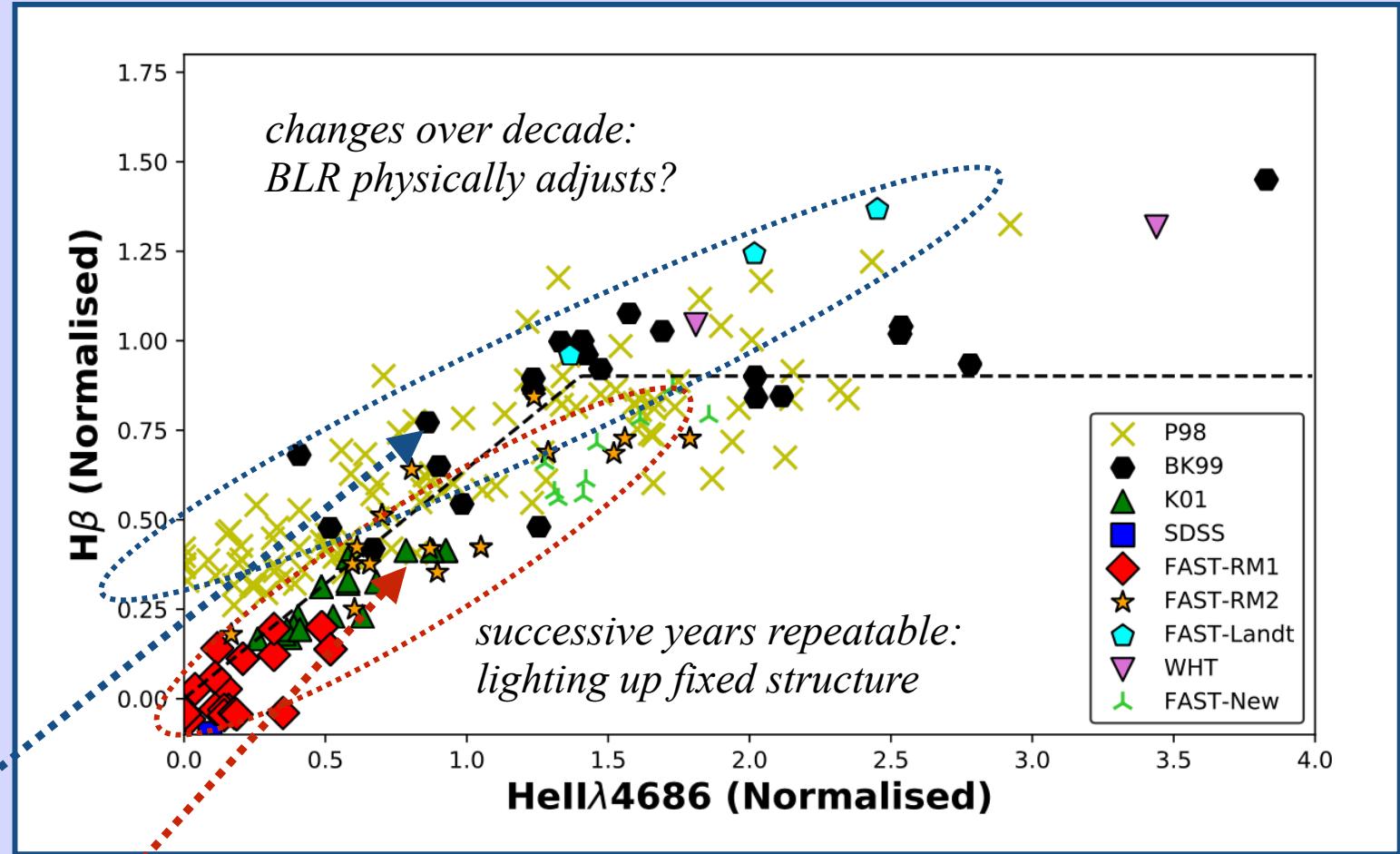
Homan et al in prep



CLQ not a distinct class  
really examples of *extreme variability*

# The BLR adjusts

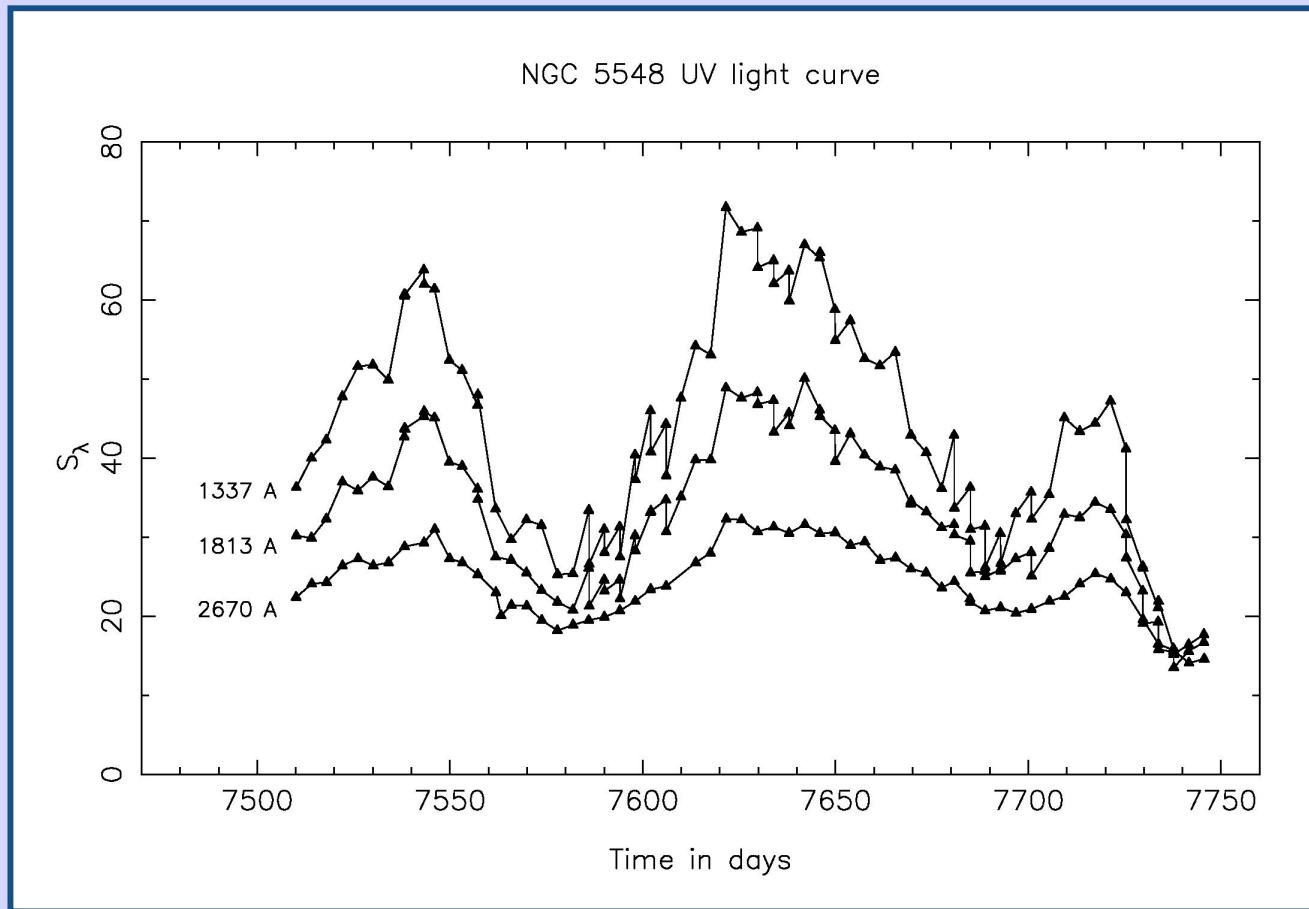
$M = 1.8 \times 10^7 M_{\odot}$   
 $\text{lag} = 24 \text{ l.d.}$   
 $R/R_S = 11,800$



$$t_{\text{dyn}} = 10.2 \text{ years}$$

Extreme reprocessing

Clavel et al 1991 via Lawrence 2018

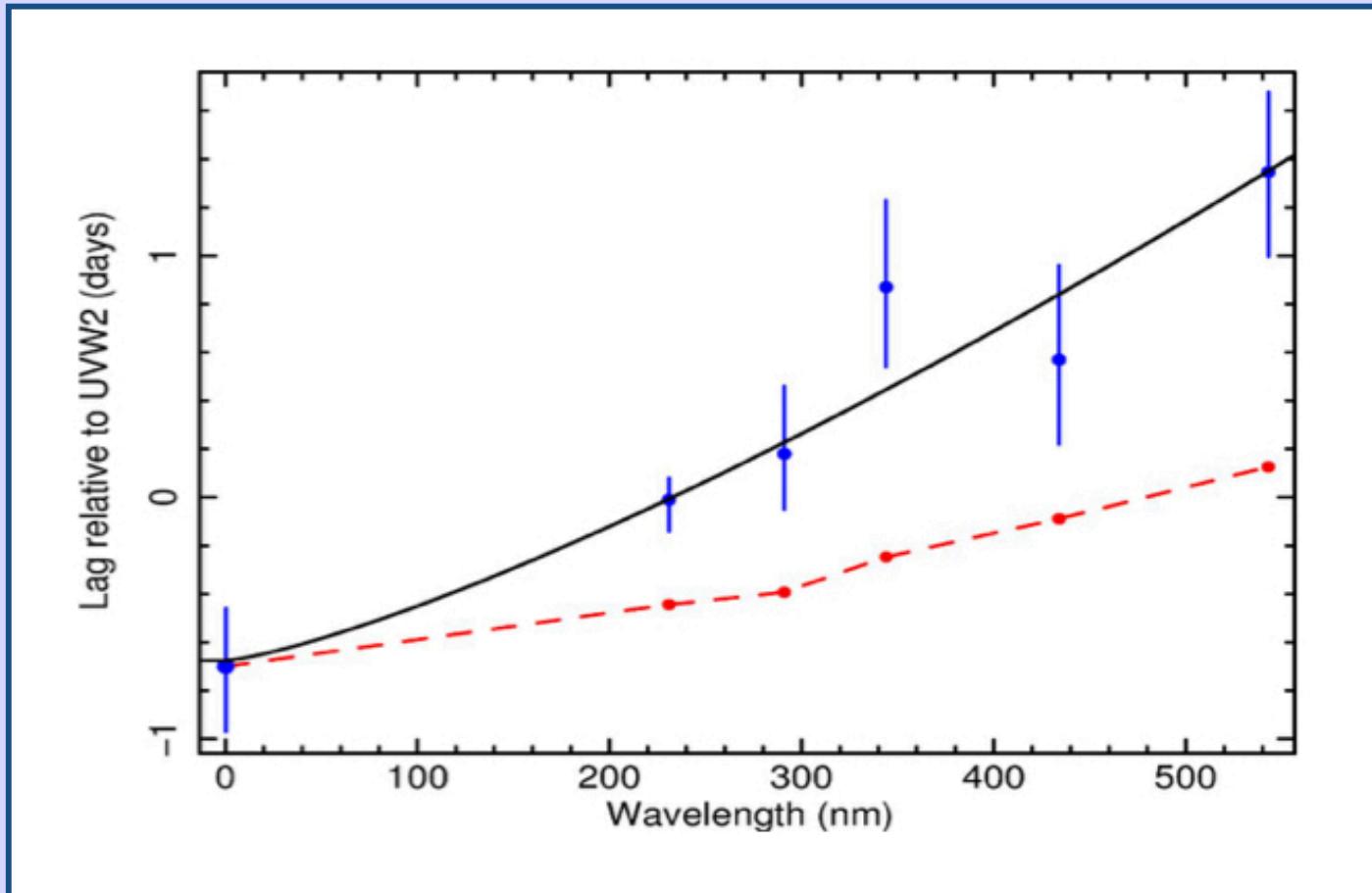


## NGC 5548 1991

variations fast  
and simultaneous

==> reprocessing  
(Clavel et al 1992)

- .... mixture of grav. and rad. heating?
- ... prime driver unclear
- ... geometry of illumination a problem

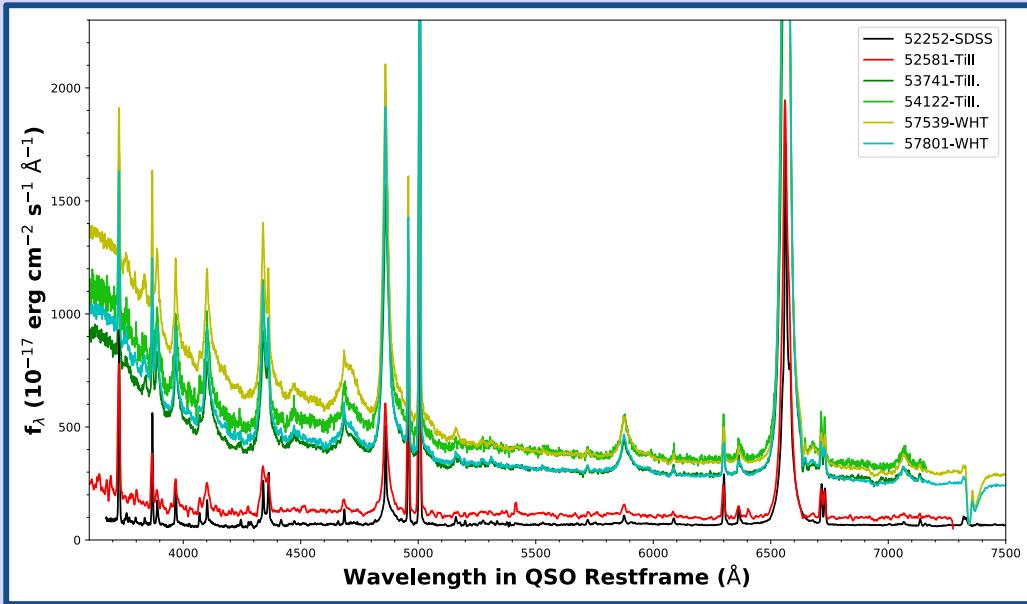


**NGC 5548 2014**

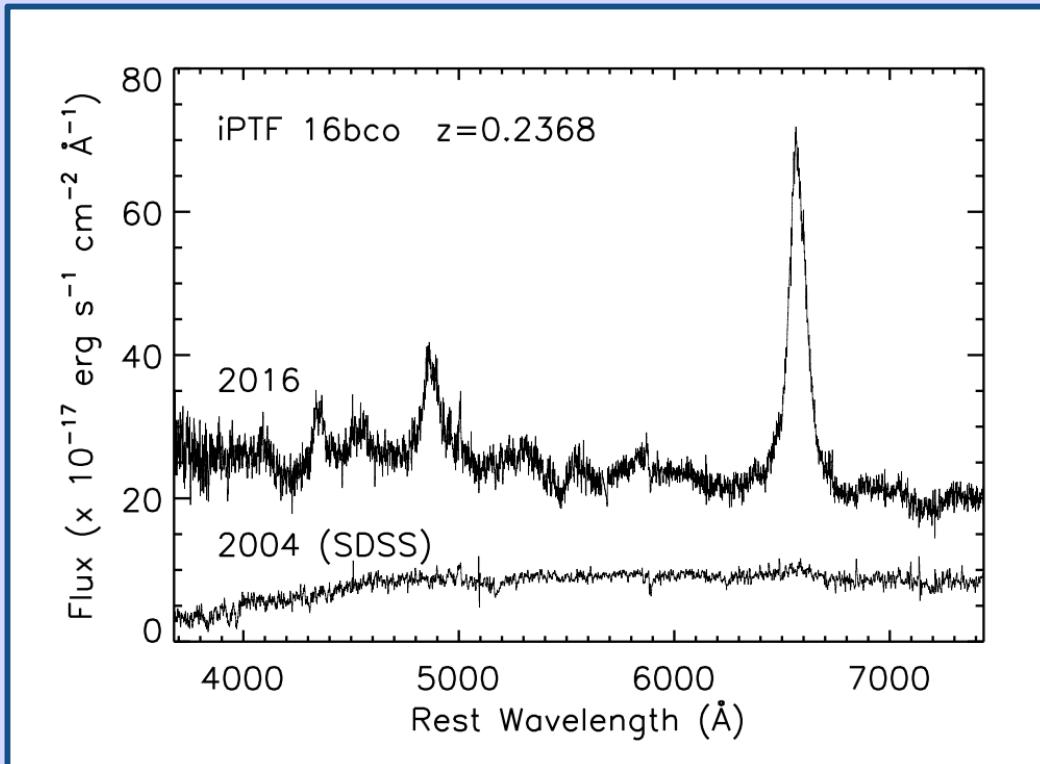
detected light  
travel delays?

but too large  
for disc models

*surface brightness problem*  
==> clumps?



Gezari et al 2017



large optical changes  
are a big extra problem

10% change  
can be  
inner disc

large change  
must involve  
hundreds of  $R/R_s$

timescale  
v.v.long

so:

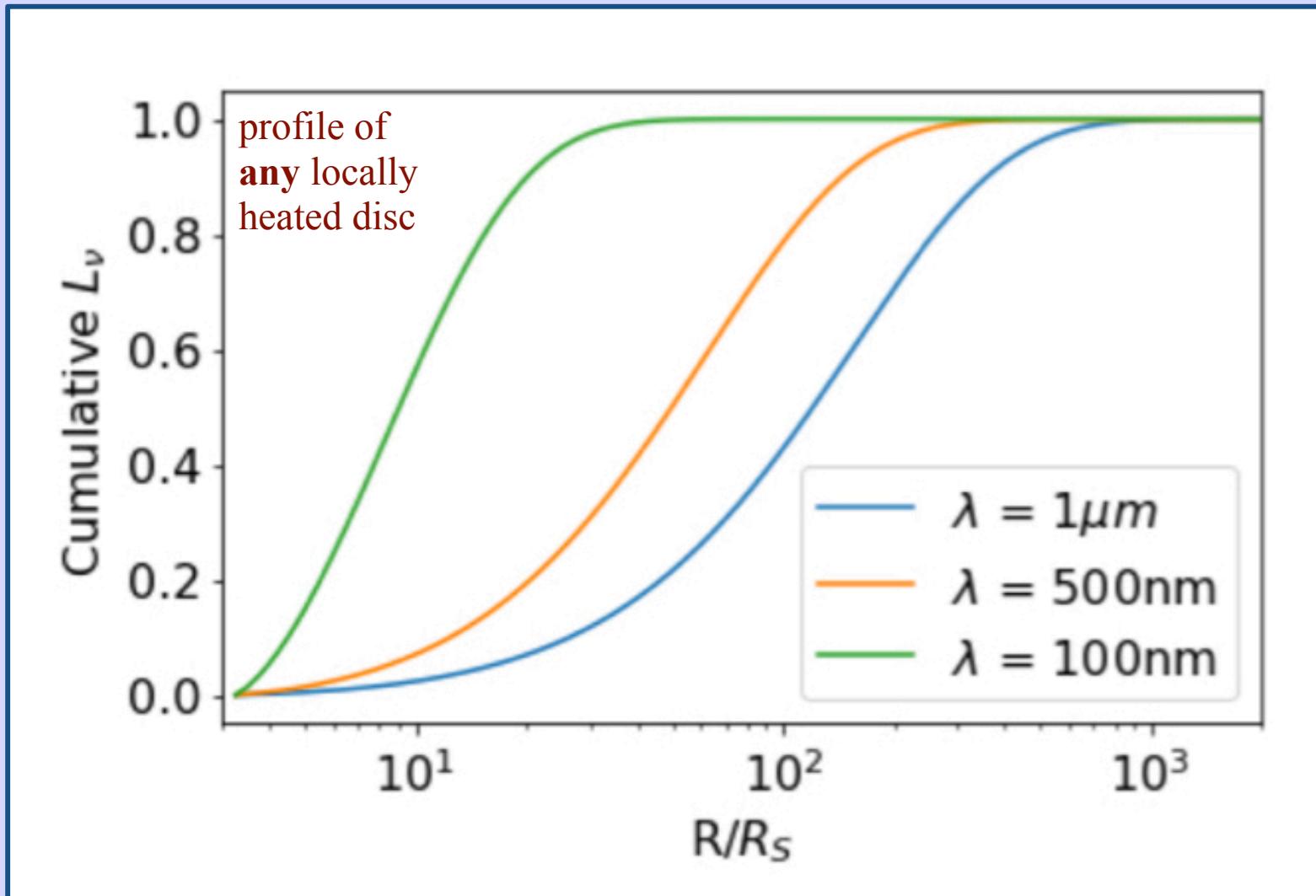
low state =  
max grav.part  
of high state

small

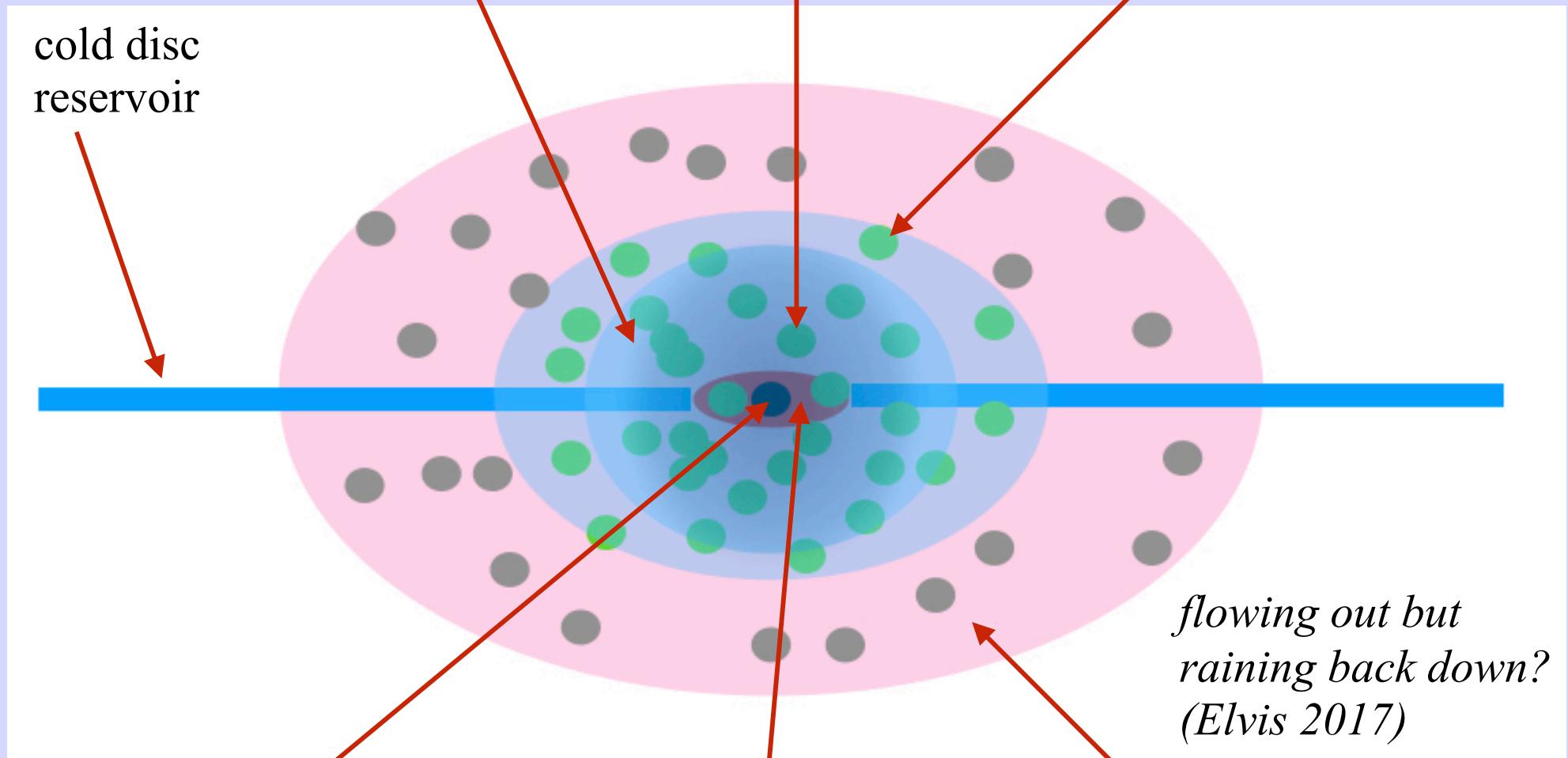
**most**  
of high state  
is reprocessed

or

torque is  
**very**  
non-local



# My cartoon



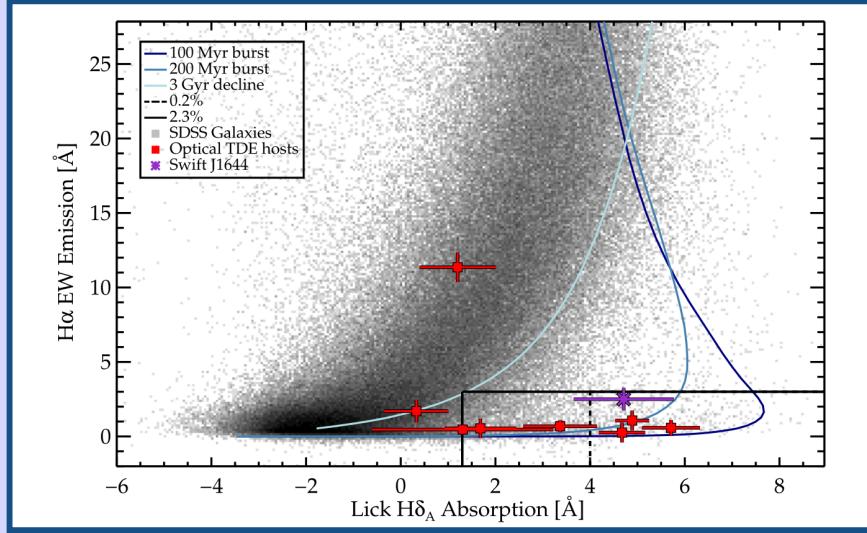
black  
hole

compact  
central engine  
~ $10^9$  K

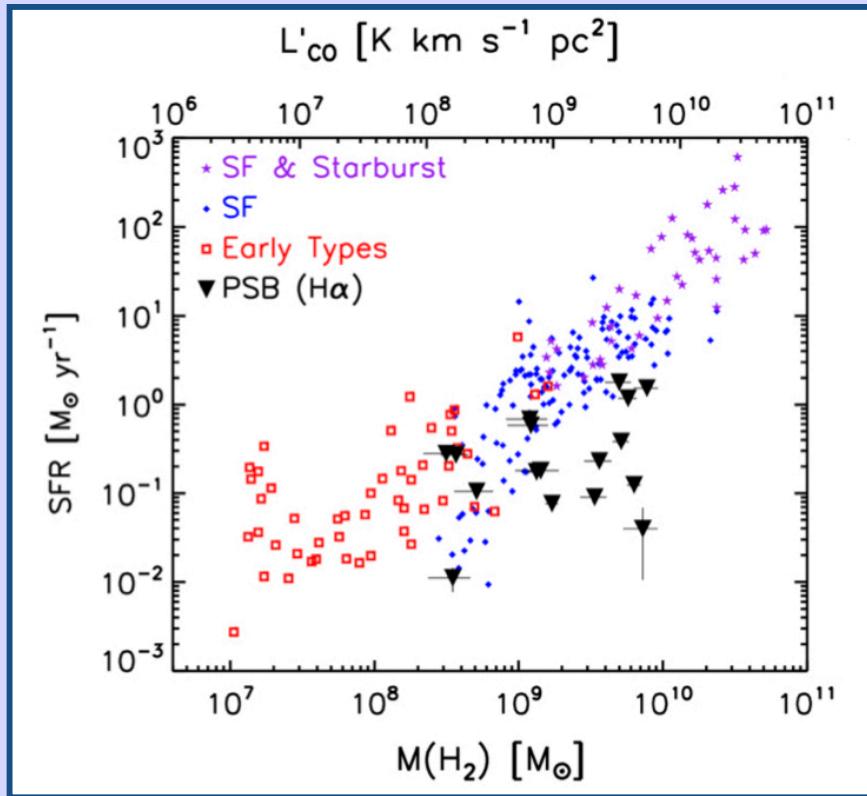
*flowing out but  
raining back down?  
(Elvis 2017)*

n~ $10^{10}$  clouds  
BLR lines

Dormant cold discs  
and nuclear transients

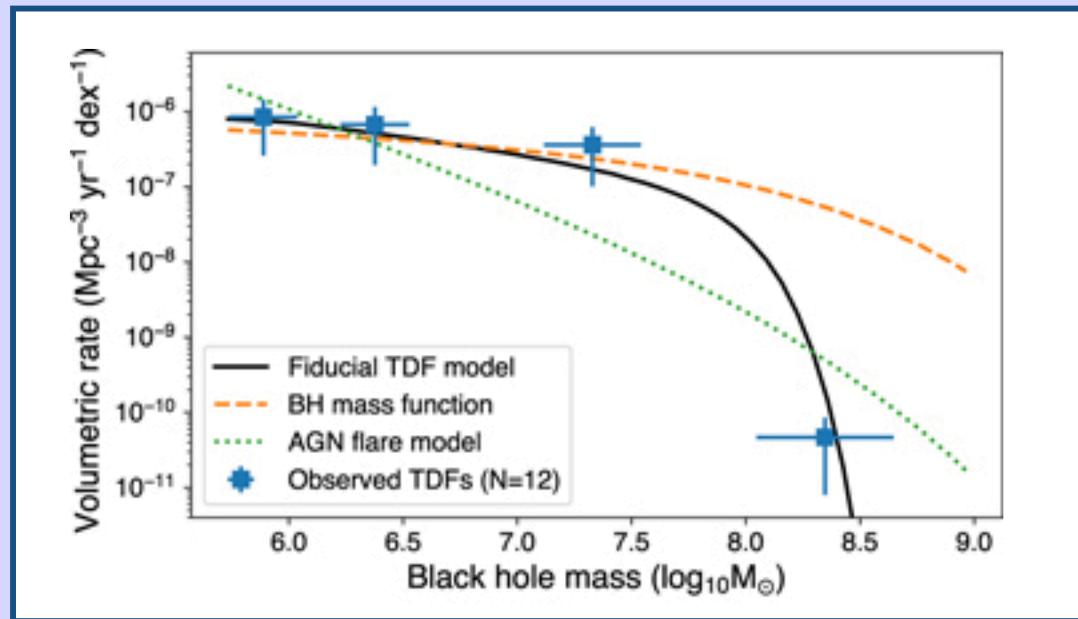


TDEs live  
in post-starburst  
galaxies

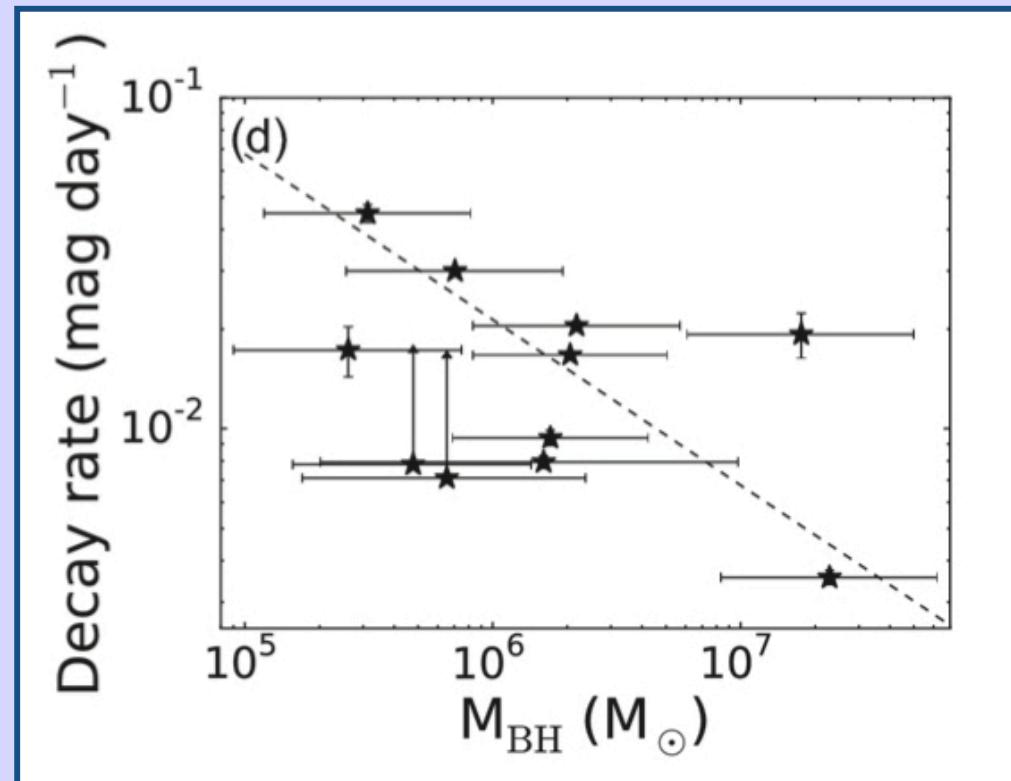


PSBs have large  
molec mass  
but little SF

*maybe “TDEs” have massive  
cold discs that re-awaken*

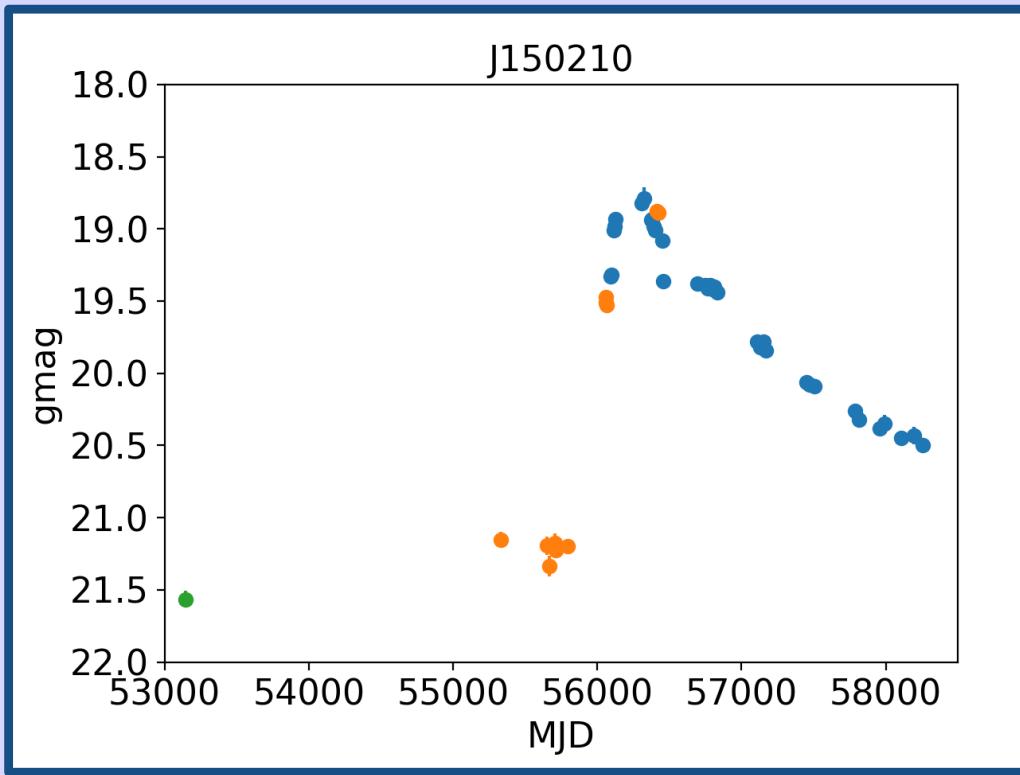


TDEs tend to have  
small masses  
... as expected?



but smaller masses  
evolve faster  
... classification bias?

*are there big slow  
outbursts  
we haven't been  
classifying as TDEs?*



$z=0.63$

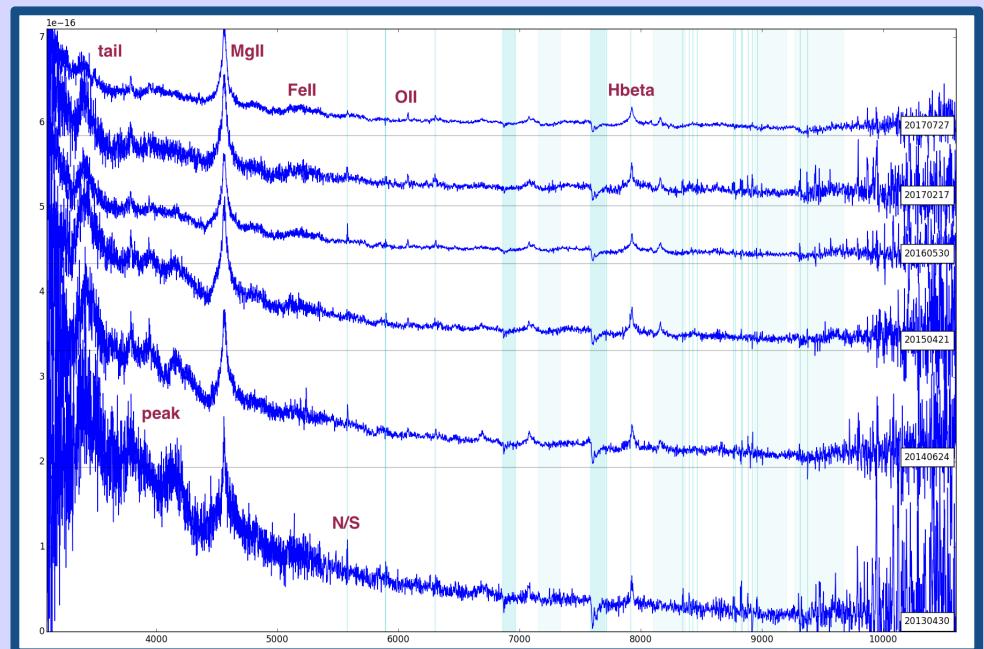
$E = 7 \times 10^{52}$  ( $\sim 0.4 M_{\text{sun}}$ )

broad MgII?? AGN

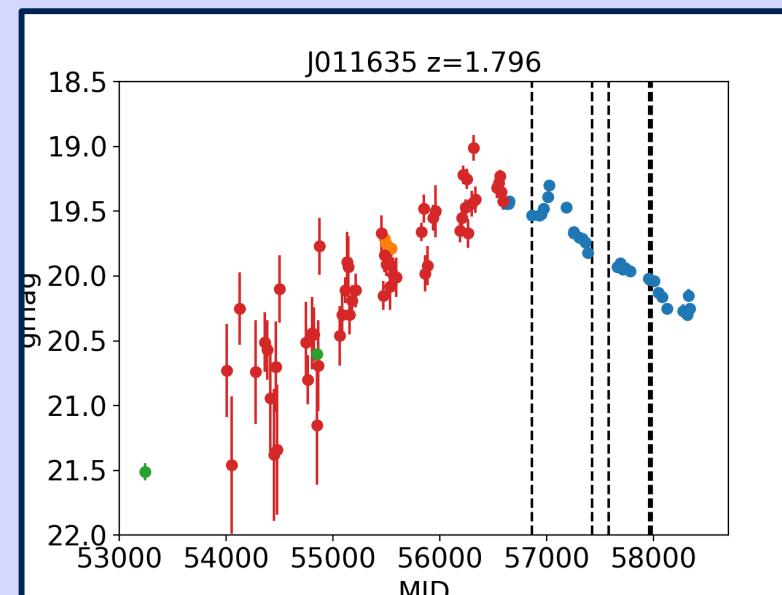
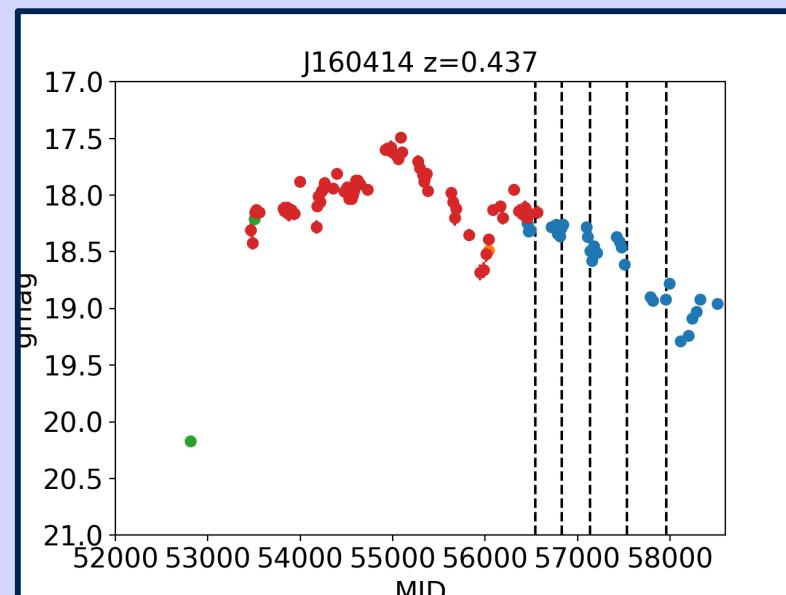
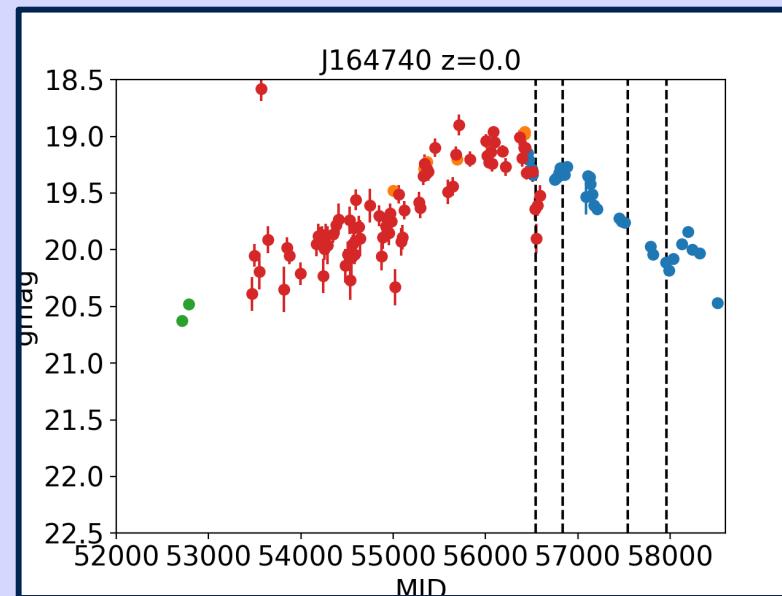
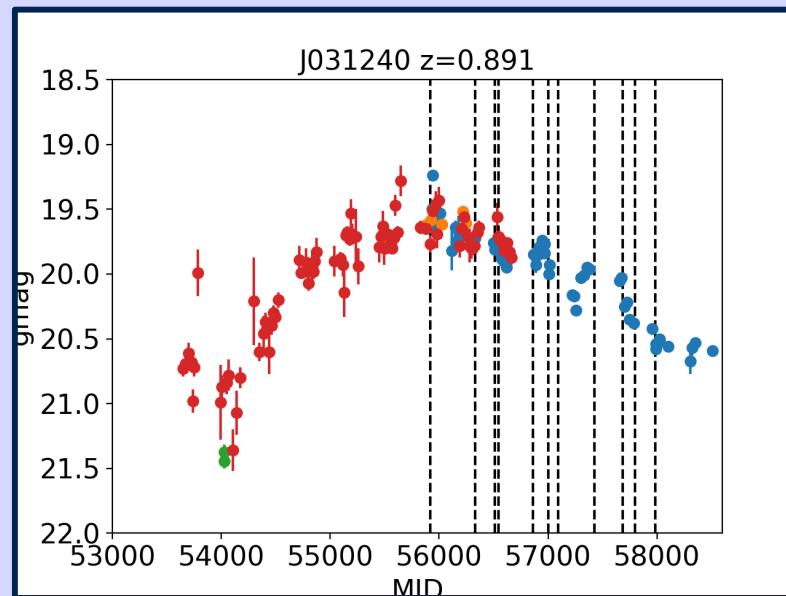
MgII >> H $\beta$ ?? nope

YES

big slow burst



more slow bursts

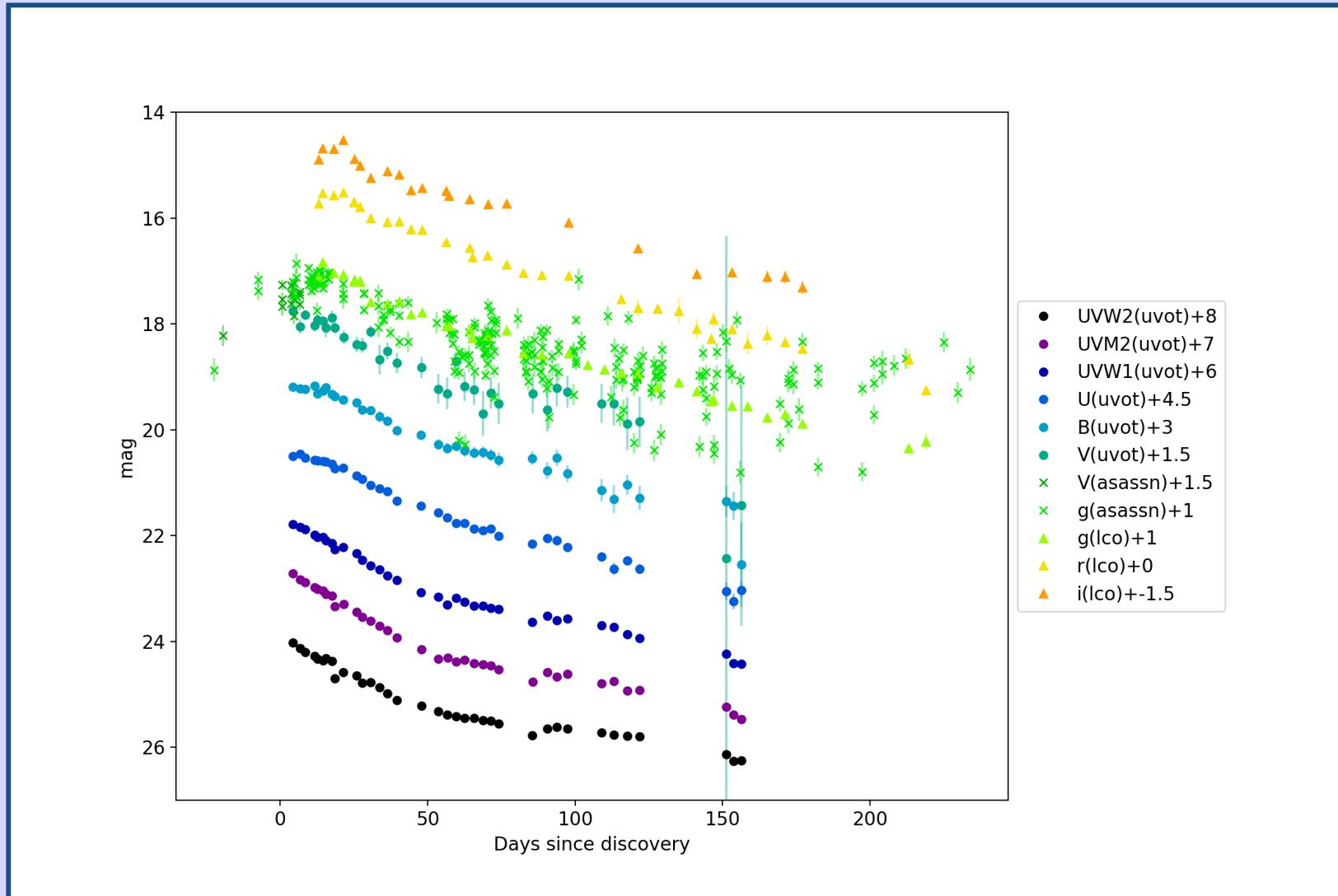


all anonymous  
galaxies before  
outburst

but look like  
AGN now

*(some may be microlensing)*

Evolving lines in AT2018hyz



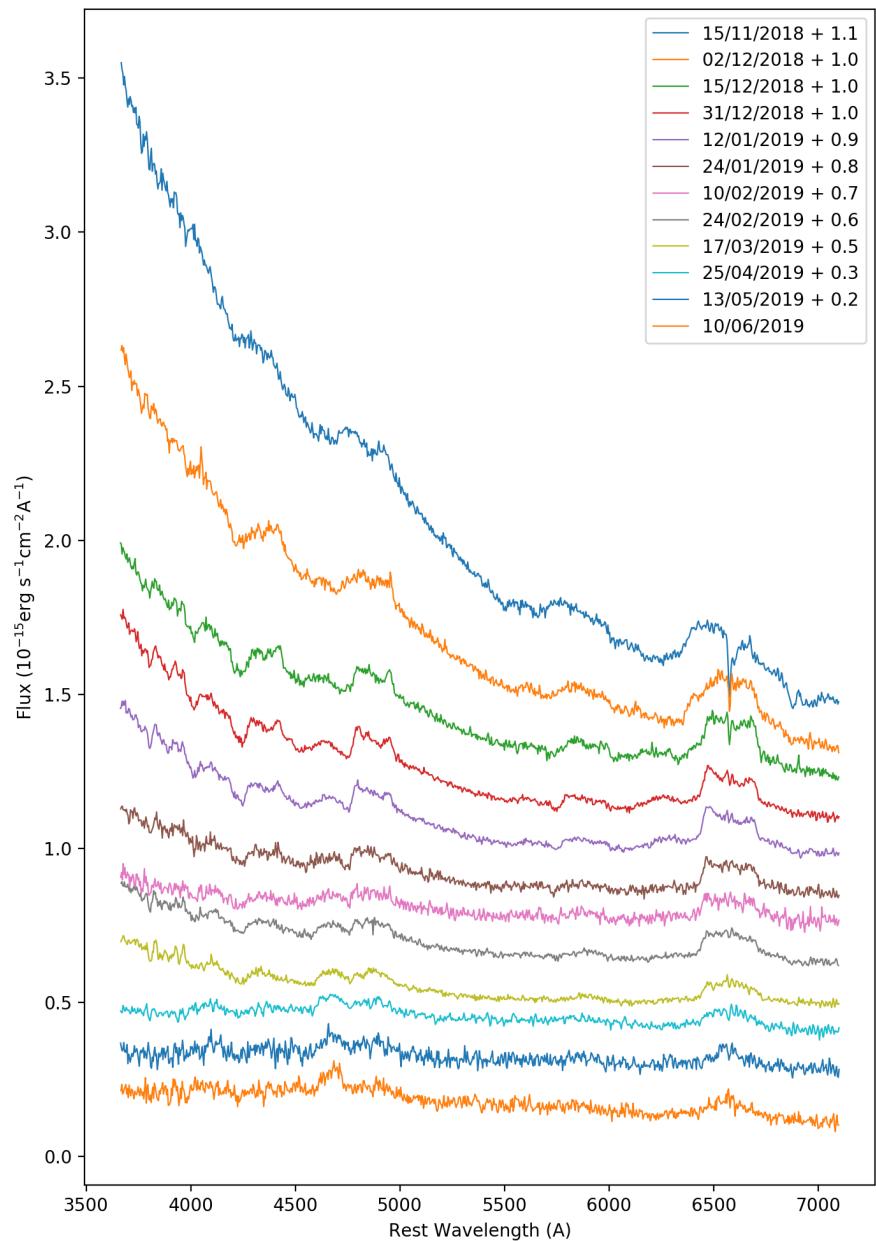
Colour  
~constant

Temp  
~ 15-20K

MOSFIT  
 $M \sim 4 \times 10^6$

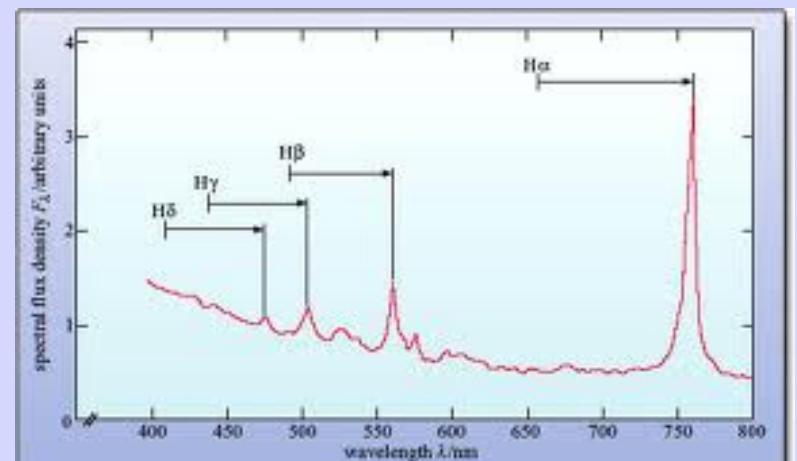
$L_{\text{pk}} \sim 1 \times 10^{44}$   
 $\sim 0.2 L_{\text{Edd}}$

$E_{\text{tot}} \sim 9 \times 10^{50}$   
 $m \sim 0.005 M_{\text{sun}}$



very weak  
very broad  
lines

*cf typical quasar*

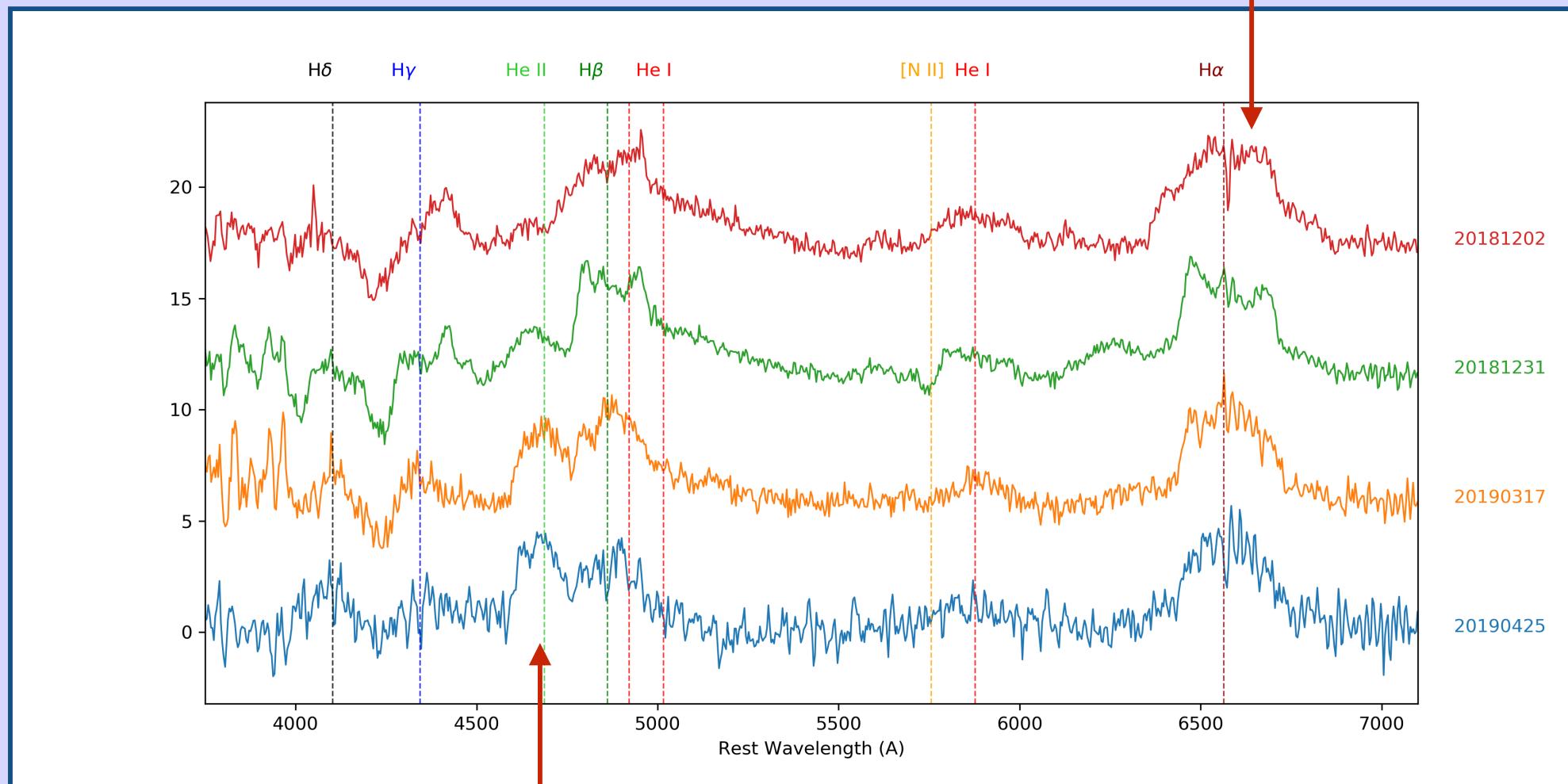


*continuum  
subtracted*

Short et al in prep

boxy/dble horned

$\Delta v \sim 12,000$  km/s     $R/R_S \sim 1250$



HeII emerges  
over  $\sim 100$  days

flat Balmer decrement  
==> collisional:  $T \sim 4000$

*cf*  $T_{disc} \sim 3,000$   
 $T_{cloud} \sim 15,000$

**dynamical times:**  $M=4 \times 10^6$   
 $= emergence\ time\ after\ outburst?$

building  
an AGN  
from the  
inside out

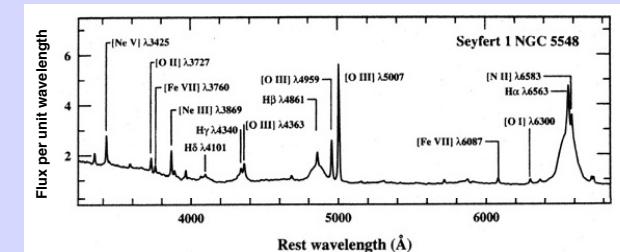
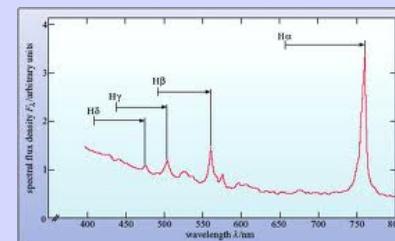
$$X=R/R_S$$

|                       |                   |            |
|-----------------------|-------------------|------------|
| quasi-continuum       | X=30              | 3 hrs      |
| collisional lines     | X=1,000           | 20 days    |
| BLR HeII              | X=2,000           | 60 days    |
| BLR H <sub>beta</sub> | X=10,000          | 1.8 years  |
| torus?                | X~10 <sup>5</sup> | 60 years   |
| NLR?                  | X~10 <sup>6</sup> | 1800 years |

TDE never  
gets here

NLR encodes  
the past

*variety comes from history*



**FIN**