

Coronal Line Reverberation and the AGN SED

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Accretion characteristic temperature

$$T_{ch} \approx 123,000 \left(\frac{L}{L_E} \right)^{1/4} \left(\frac{M}{10^9 M_\odot} \right)^{-1/4} \left(\frac{R}{3R_S} \right)^{-1/2}$$

quasar

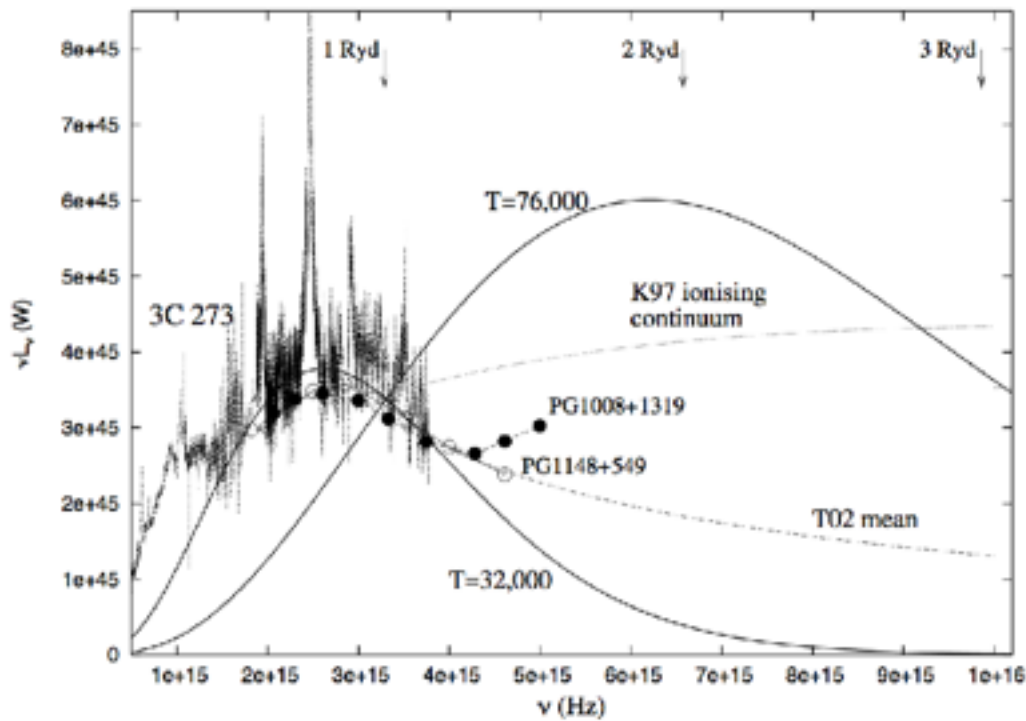
$$M = 10^9 \rightarrow E_{pk} \sim 67eV$$

TDE

$$M = 10^6 \rightarrow E_{pk} \sim 375eV$$

quasars:
 $T \sim 30,000$

(but BLR models imply
harder ionising
continuum)

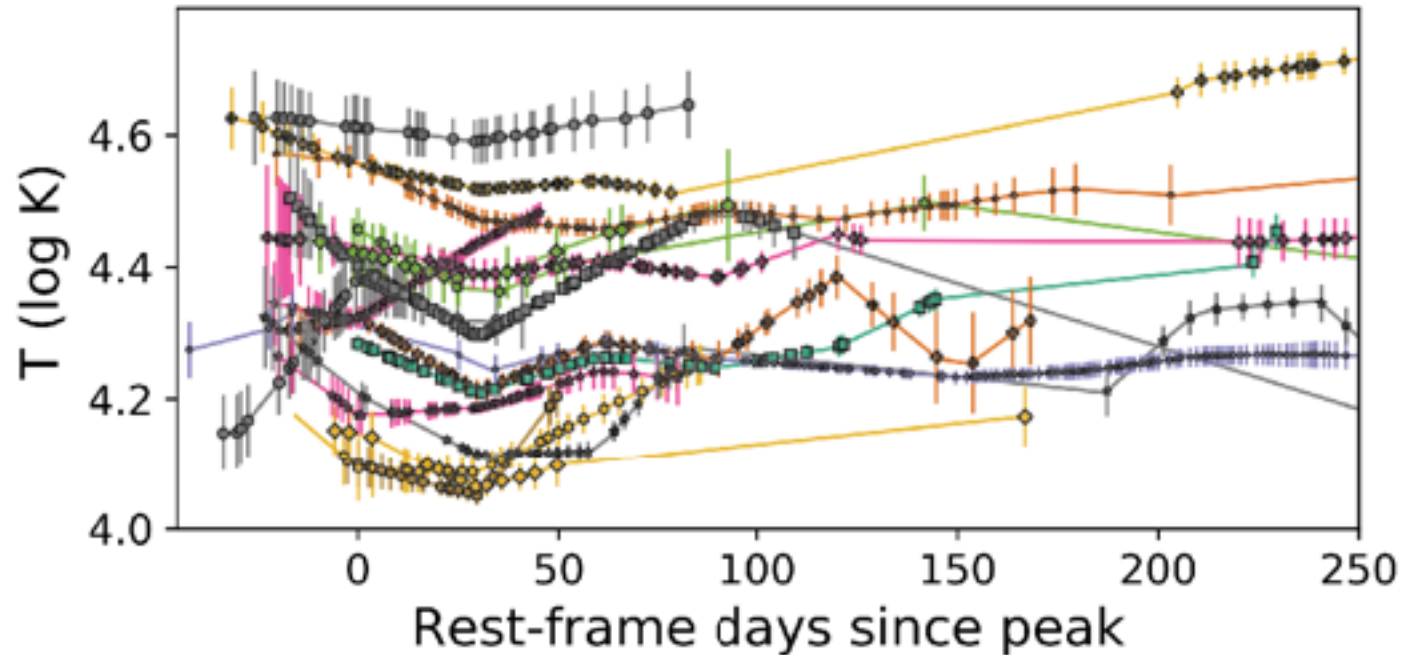


Lawrence 2012

Van Velzen et al 2021

TDEs: similar

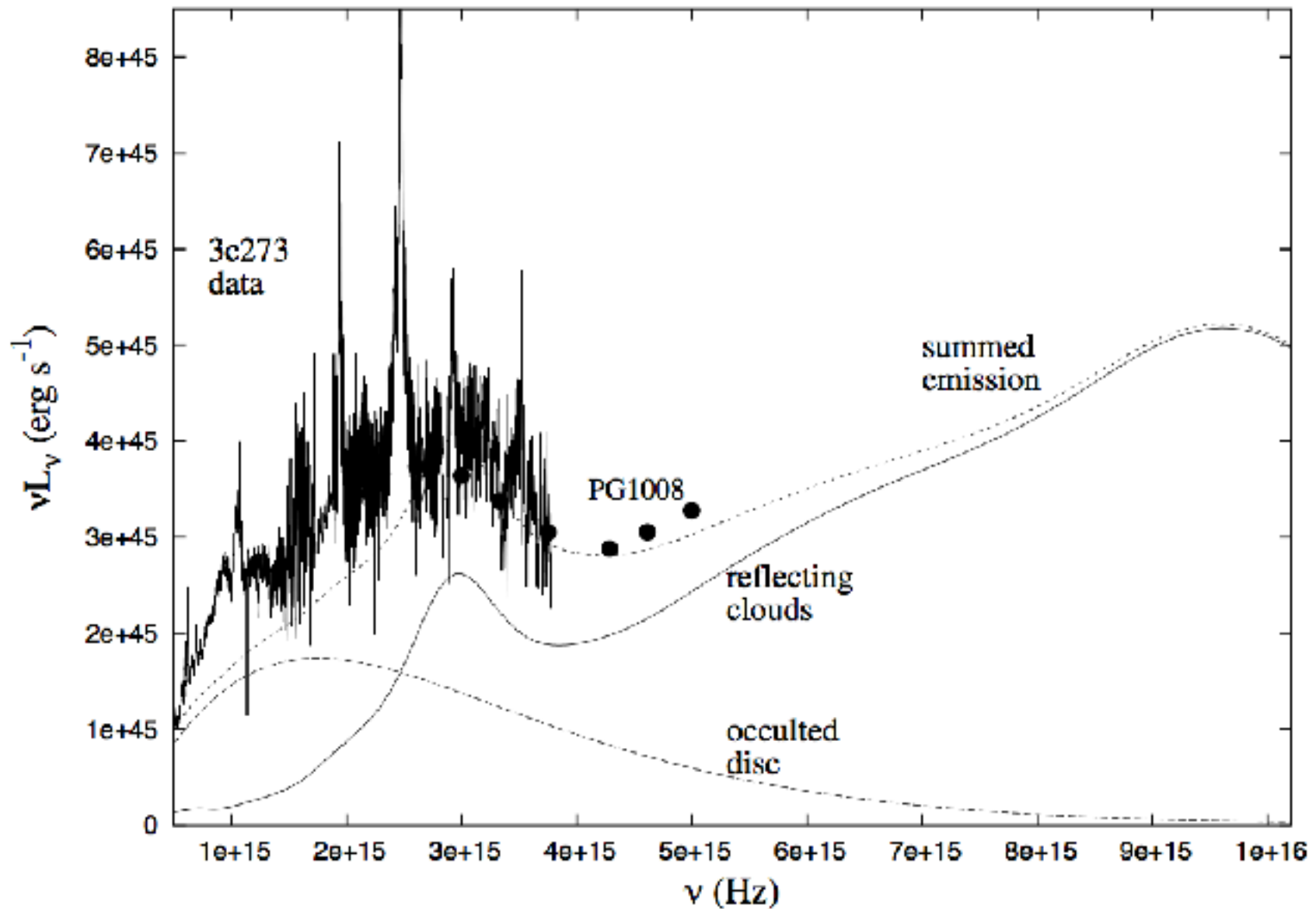
(and do not cool!)



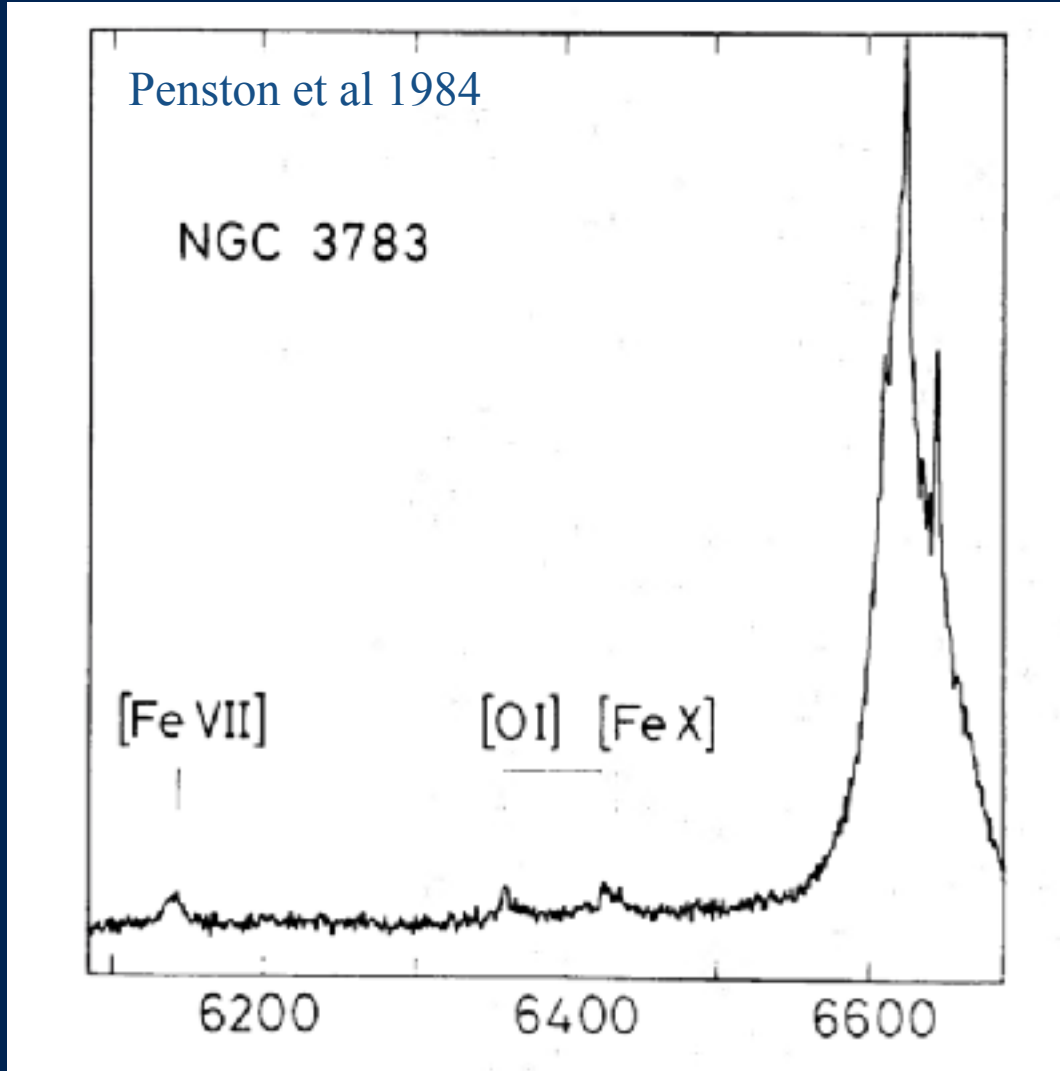
NUV
is reprocessed
fake peak?

Lawrence 2012

the real disc
is over here!



Coronal Lines



	IP	λ
[FeVII]	99eV	6087Å
[FeX]	233eV	6373Å
[SiVI]	165eV	1.96 μ m
[SiX]	378eV	1.43 μ m

typical FWHM~600 km/s
cf BLR~5000 km/s
cf NLR ~ 300 km/s

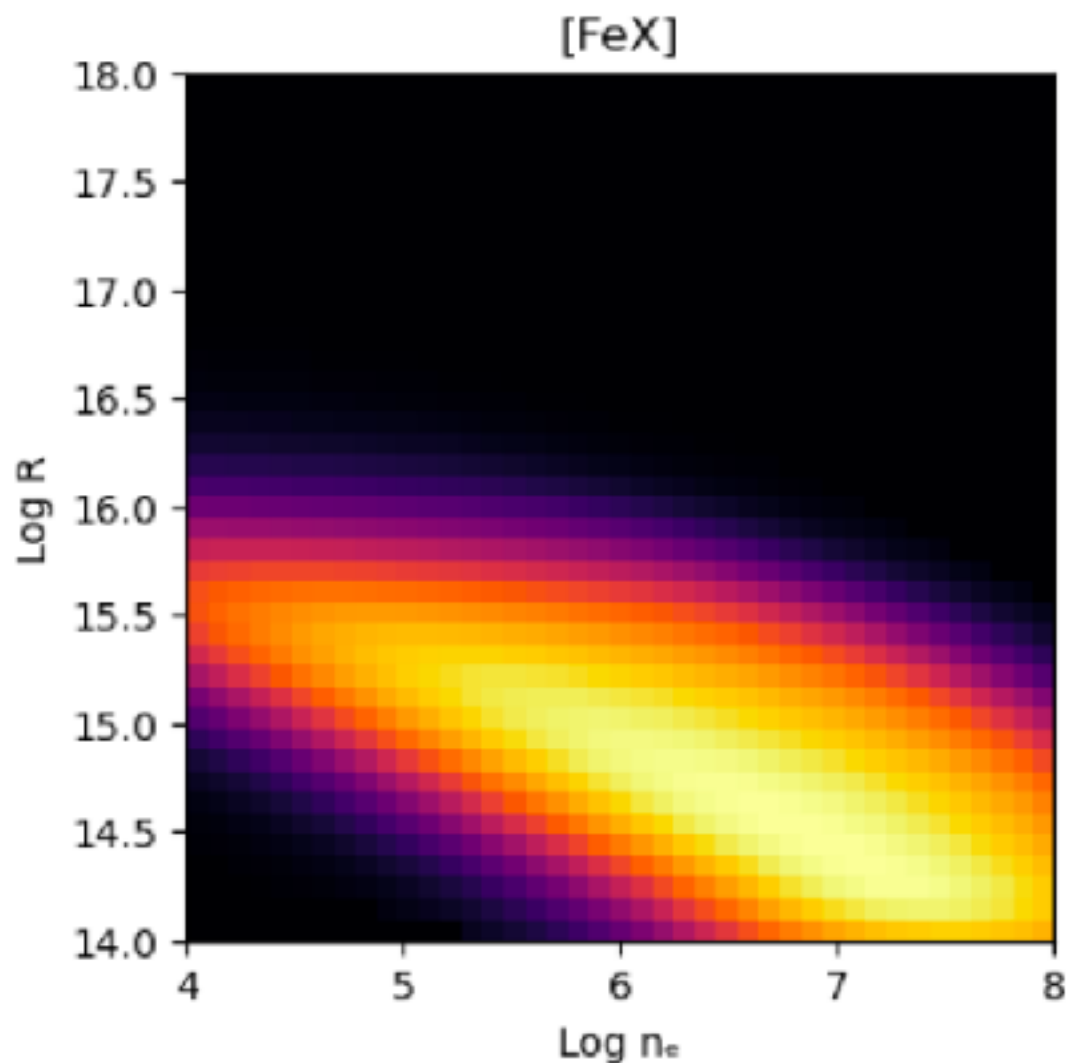
==> Intermediate Line
Region (CLR=ILR)

→ $R \sim 1\text{pc} (M/10^8)$

but some resolved?

Circinus ~10pc (Oliva et al 1994)

T0109-383 ~200pc (Muryama et al 1998)



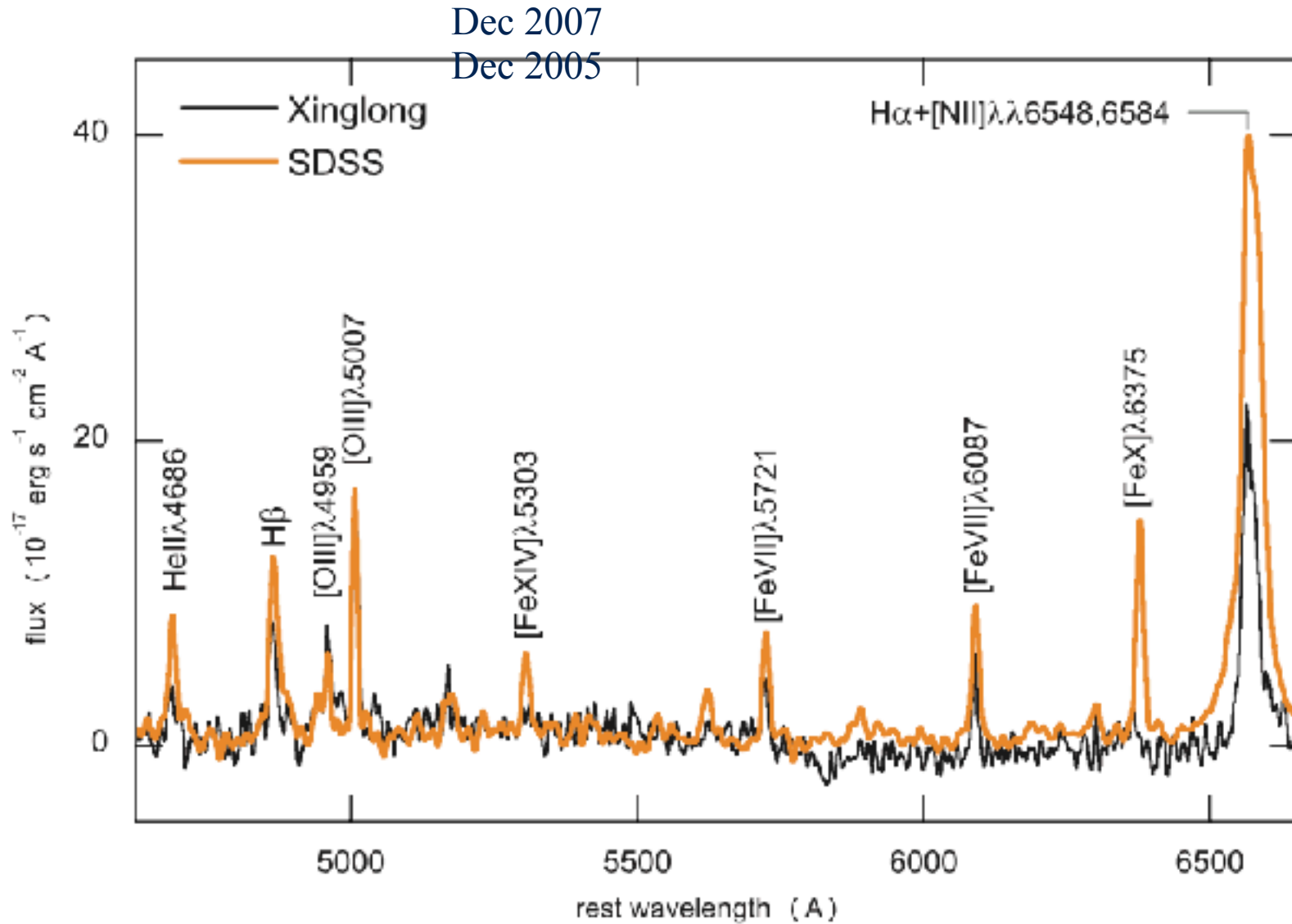
location of strip depends on SED

Line return max
wherever $U \sim 0.1$

could come from
almost anywhere?

outflow?
ISM gas?
Torus Wall?
(Muruyama et al 1998)

Need structure model
and/or
measurement of location



Dec 2007
Dec 2005

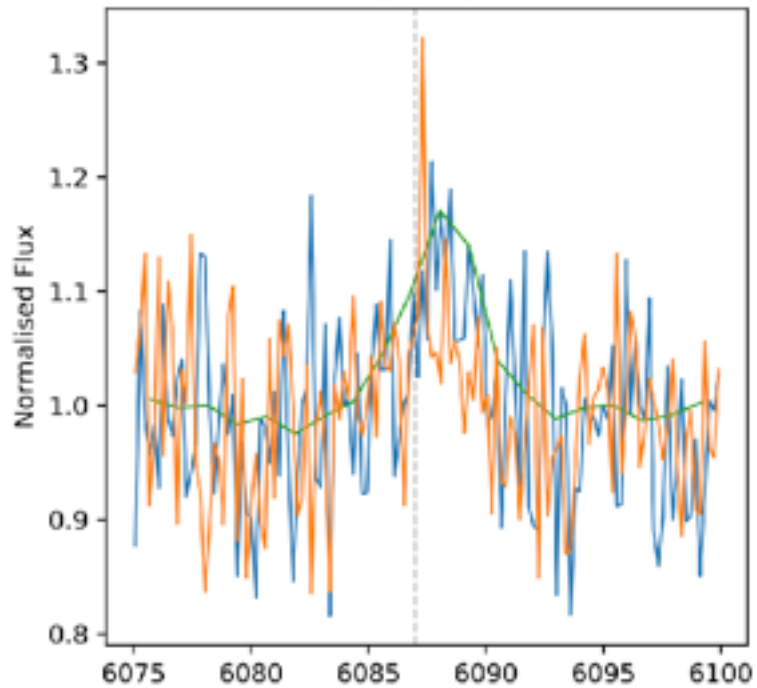
evolving coronal lines in
non-AGN galaxies

proposed to be echoes
of past TDEs

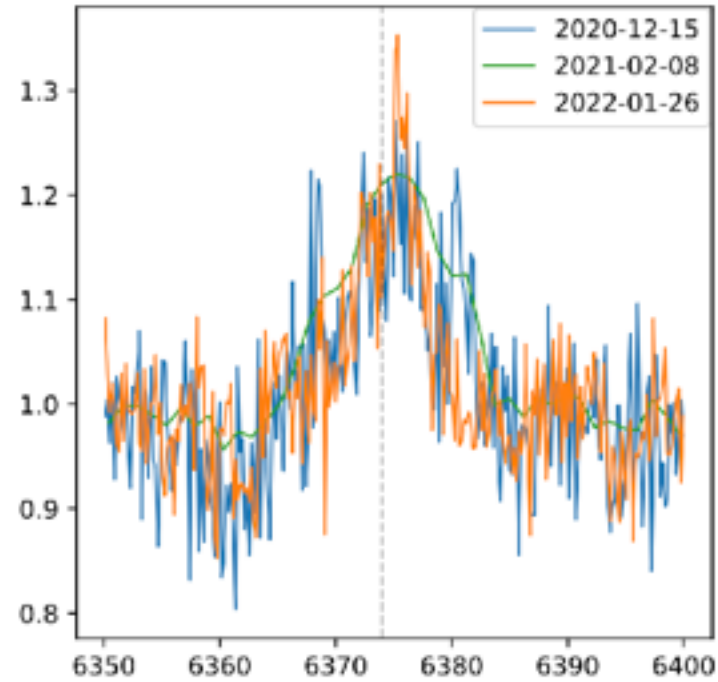
Short
et al 2022

AT2019qiz

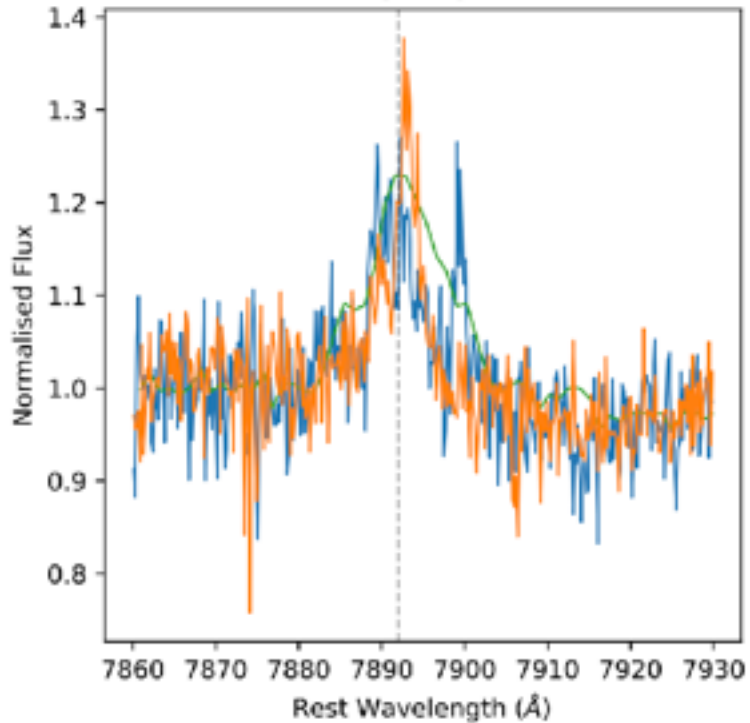
[FeVII]



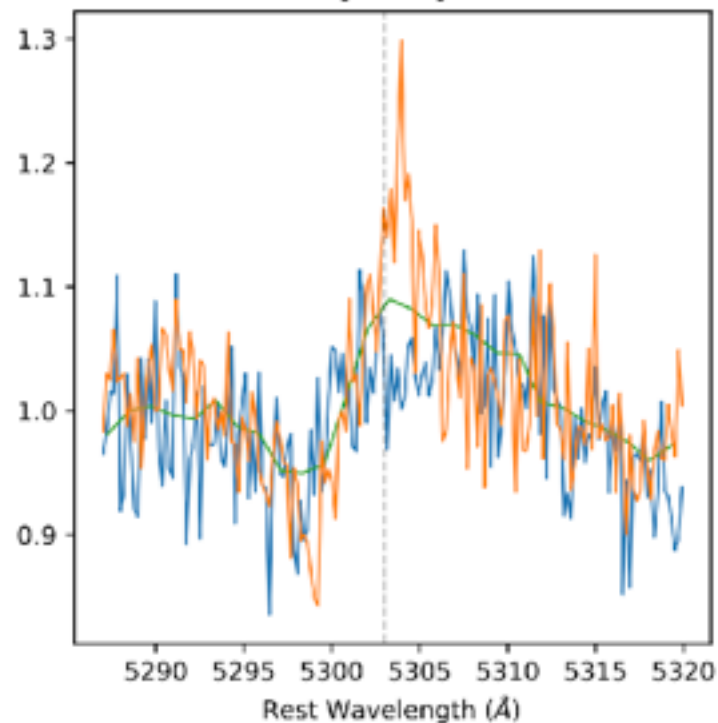
[FeX]



[FeXI]



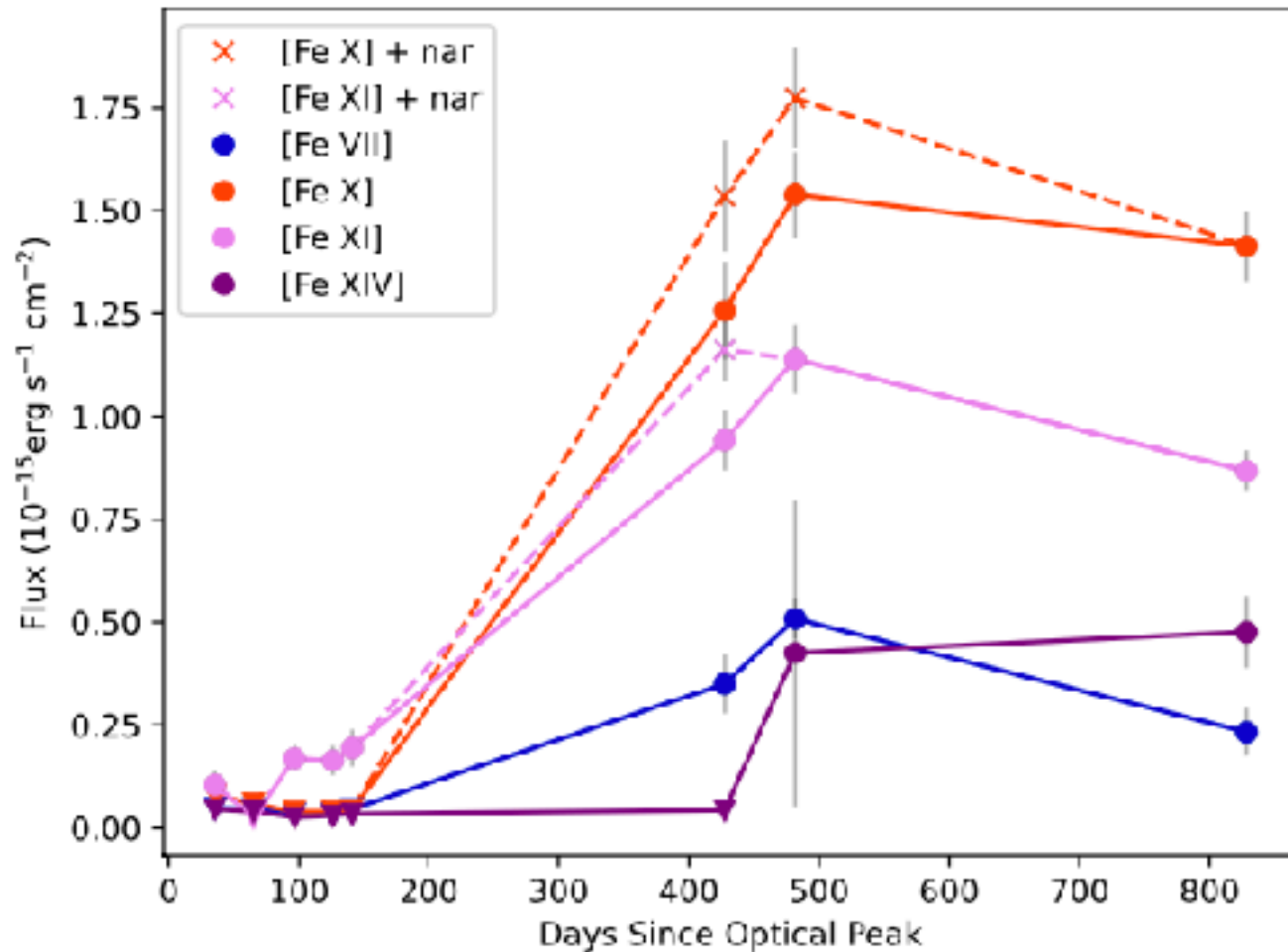
[FeXIV]



Coronal
lines
appear in
late time
spectra

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Fe Line Fluxes



Fe lines
peak at
 ~ 500 days

l.c. much broader
than TDE outburst

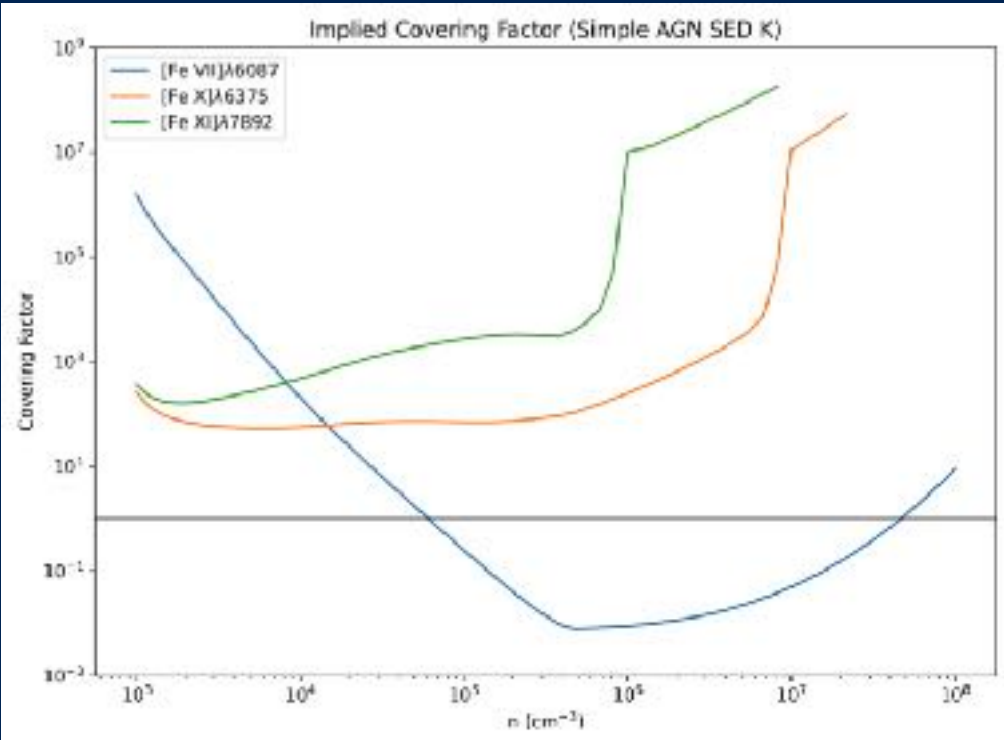
smearred by
similar amount

pre-existing material
outflow time ~ 5000 yrs

either: wide range of angles
or: wide range of distances

Cloudy modelling

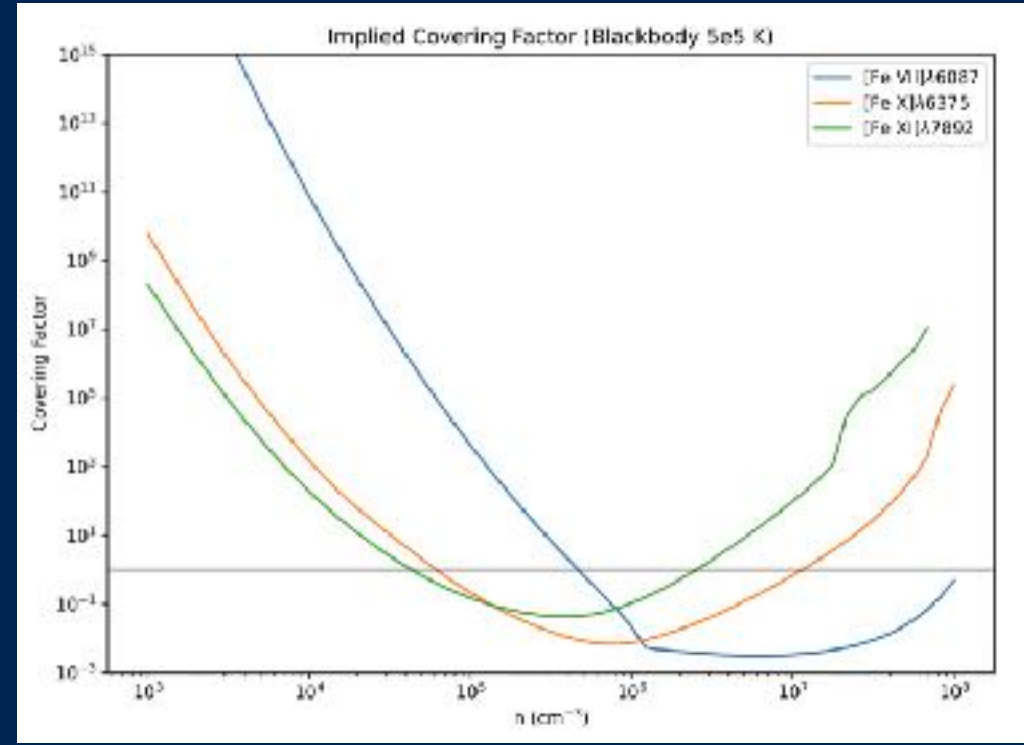
Yin et al
in preparation



standard AGN SED
cannot explain
strength of lines
with material at 500 l.d.

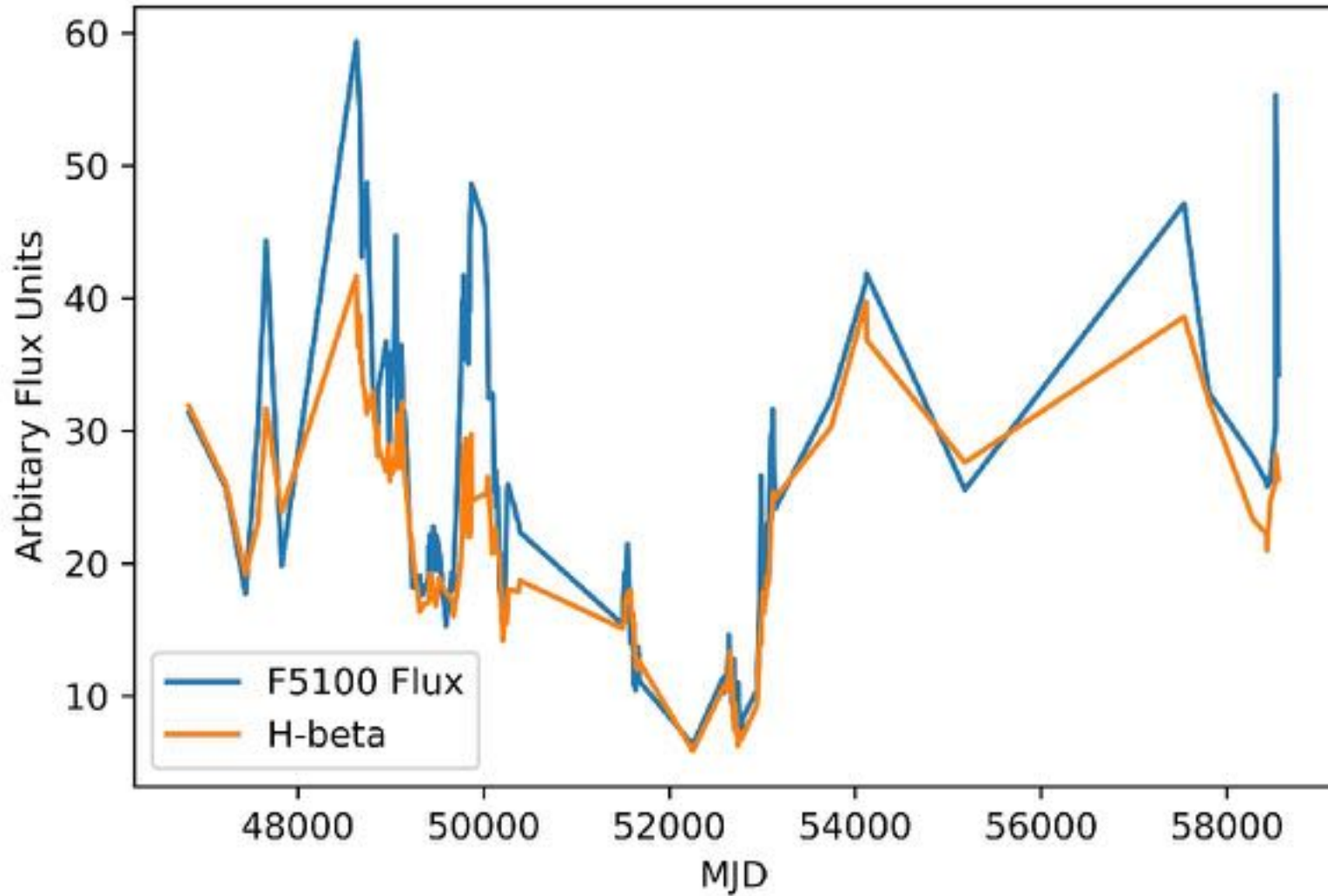
T=500,000 much better

$n \sim 10^6$ cm⁻³



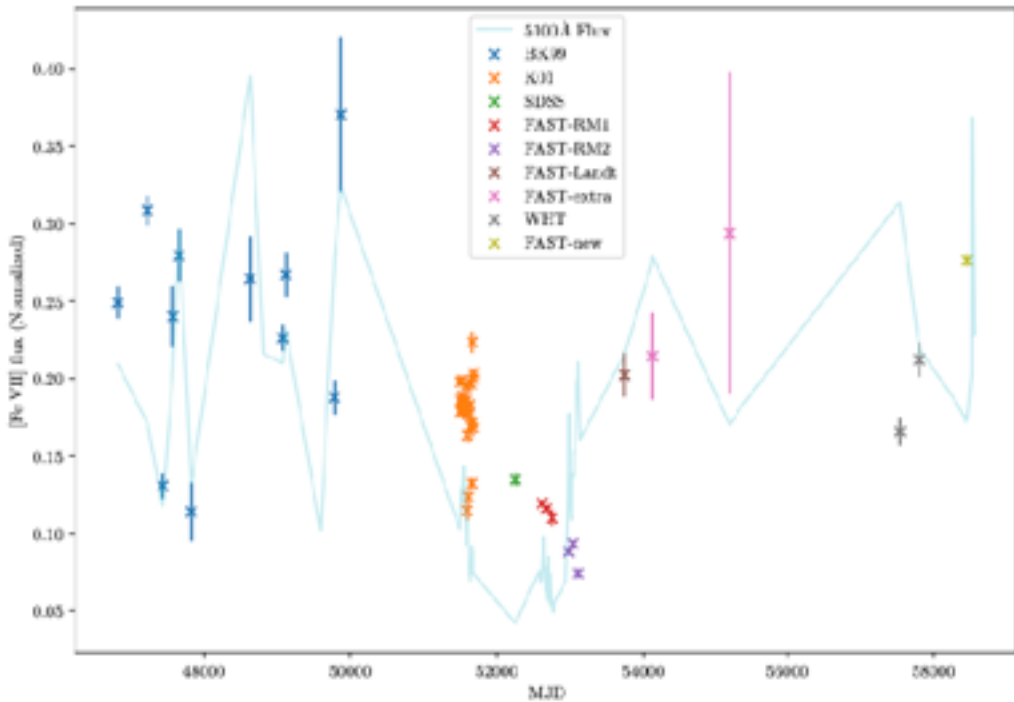
Thirty year light curve of MKN 110

Homan et al 2022



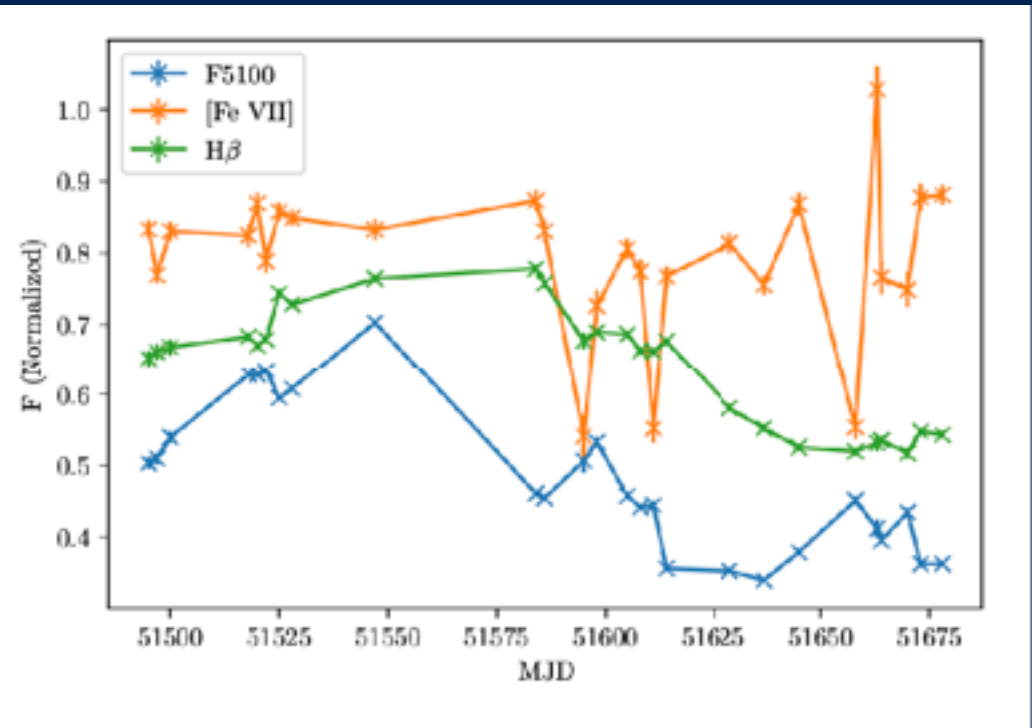
H β tracks continuum well

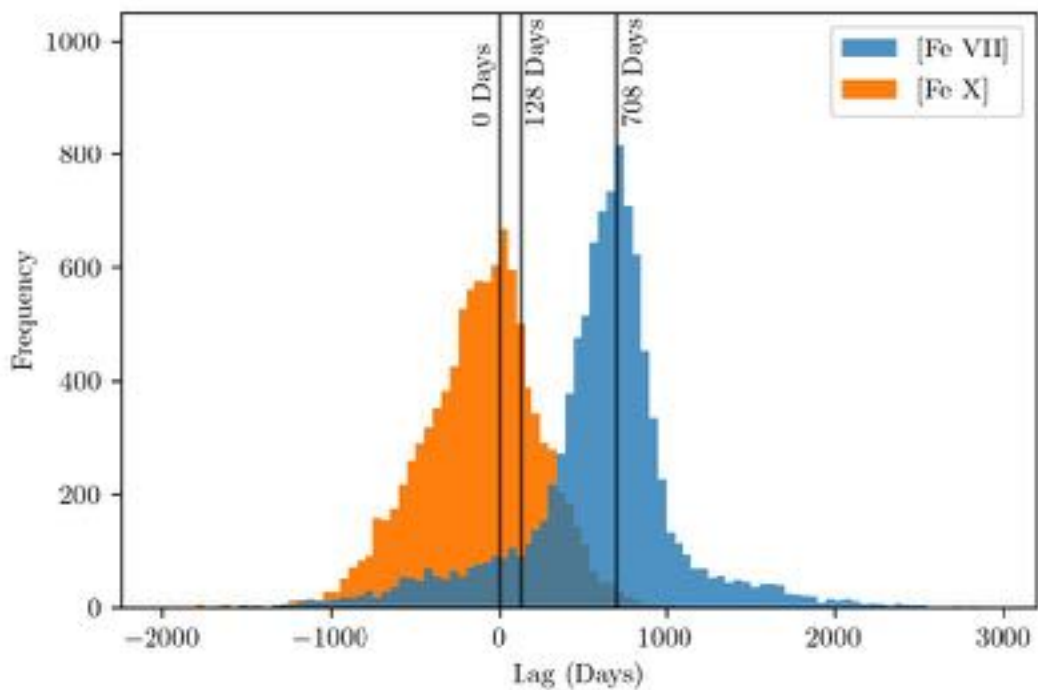
[FeVII] tracks continuum
on long timescales



Yin
et al in
preparation

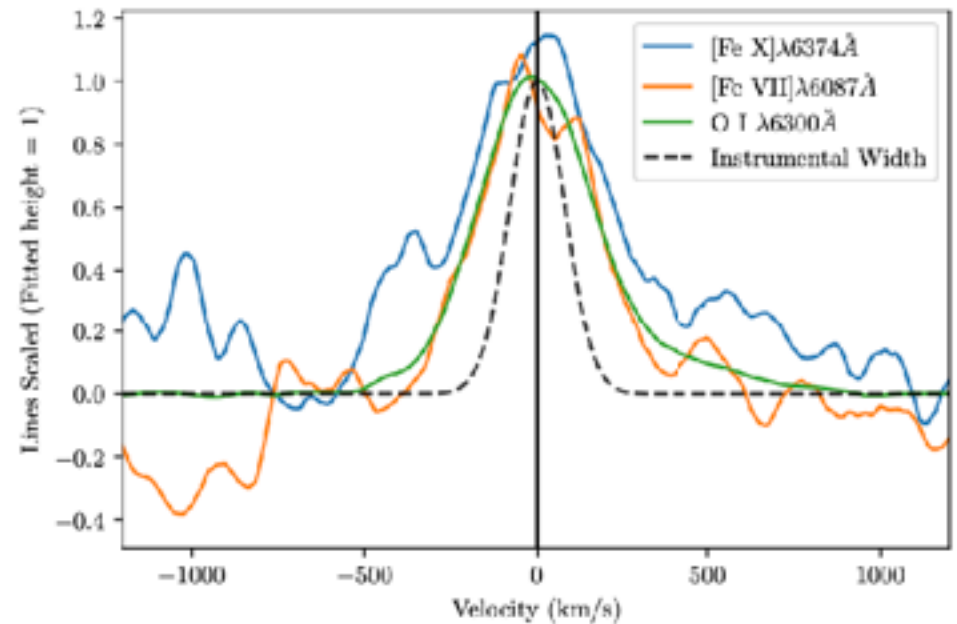
but not on
short timescales





[FeVII] lag 708 ± 100 d

[FeX] lag < 205 d (2σ)



[FeVII] FWHM = 330 km/s

[FeX] FWHM = 778 km/s

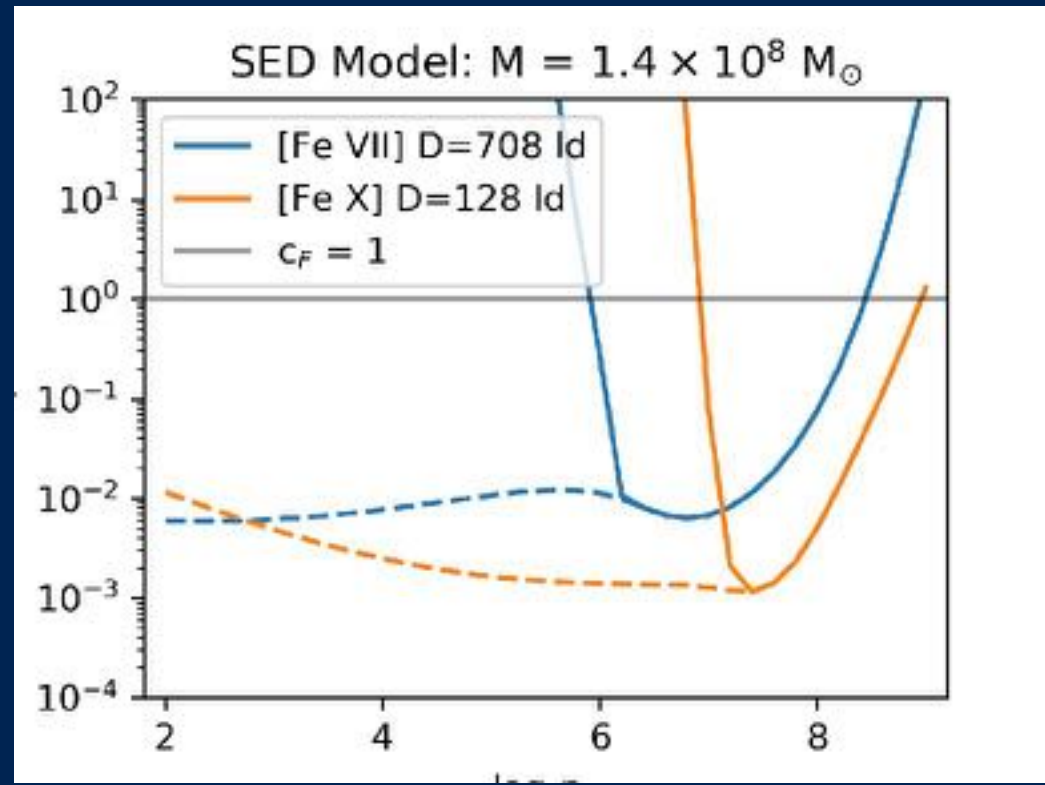
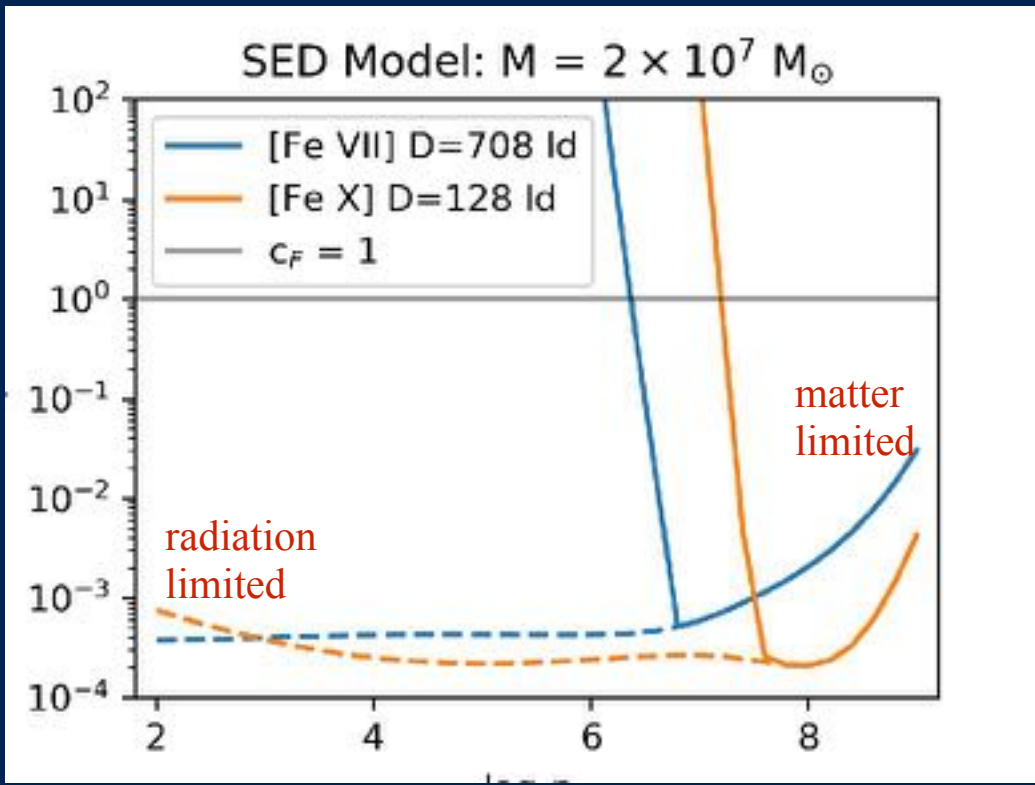
(predicts lag = 128d)

even the ILR is stratified

**structure and SED problems
still coupled...**

Cloudy two-cloud models vs SED and density

Yin et al in preparation



solutions depend on SED model
closer material is denser

if we make minimum covering factor assumption

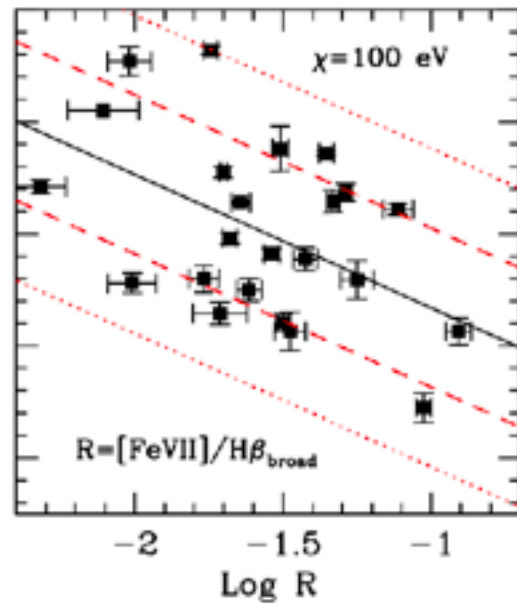
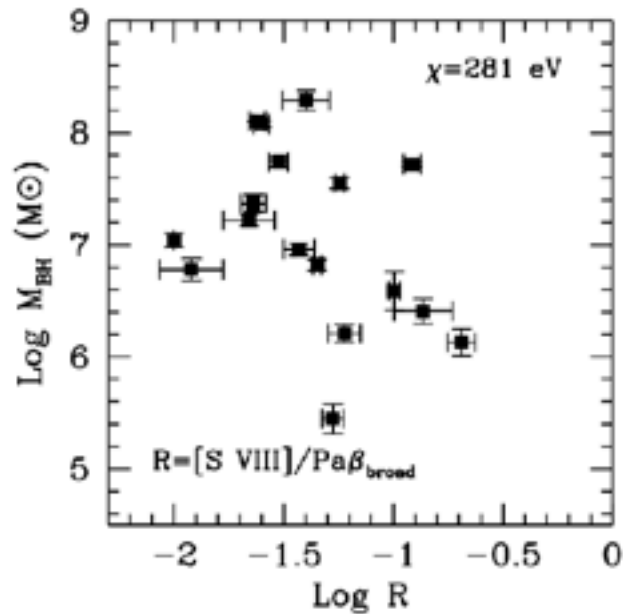
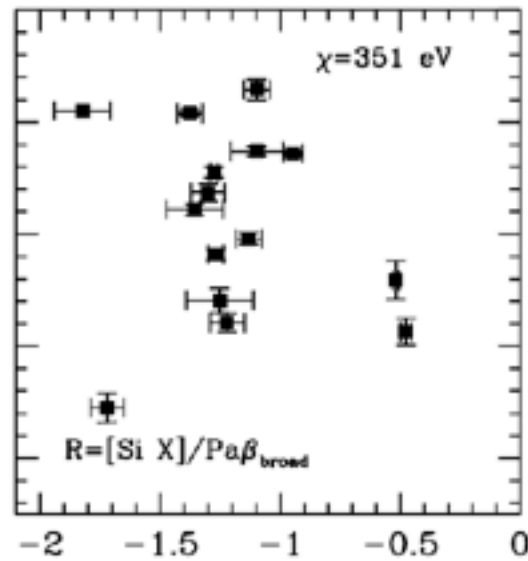
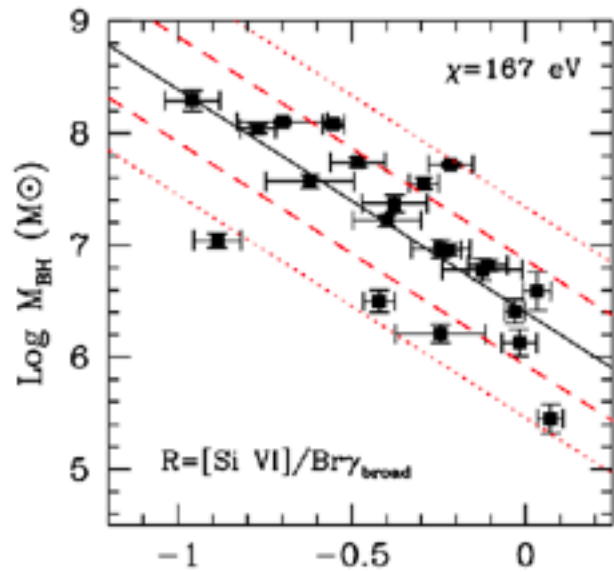
$$n_H \propto 1/D$$

Provisional conclusions

- optical-NUV is not the primary continuum
- coronal lines trace the real energy source
- TDEs are much hotter than luminous AGN
- Coronal lags: hundreds of light days
- Smearing: range of angles and/or distances
- ILR stratified: consistent with $n_H \propto 1/D$
- Structure and SED need to be solved at same time!

FIN

out takes



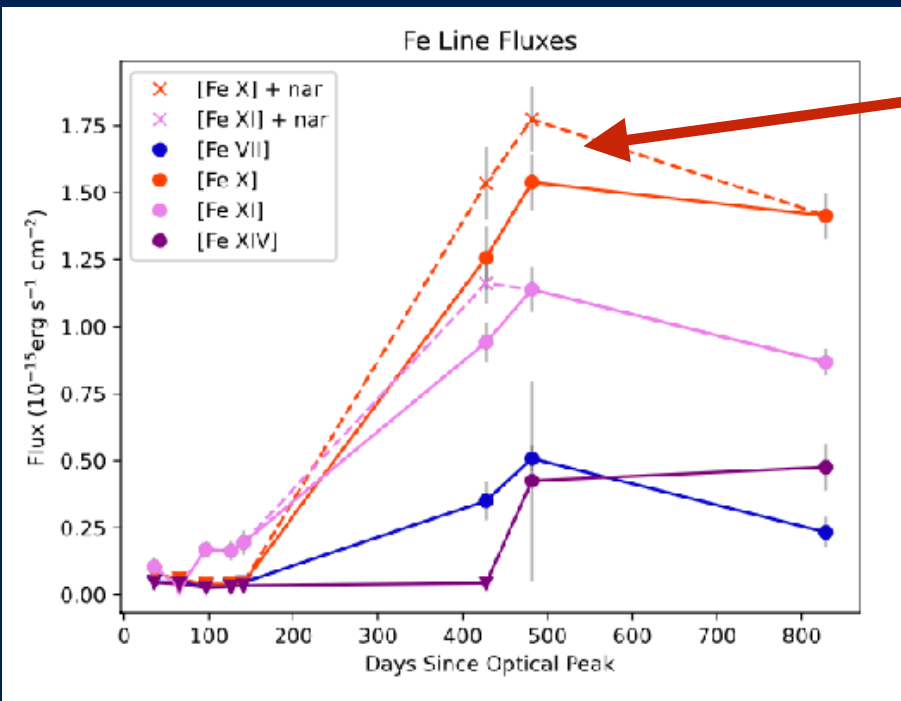
attempt to find
T vs M relation

promising
but confusing..

mixes ILR and BLR

outflow time
thousands of years

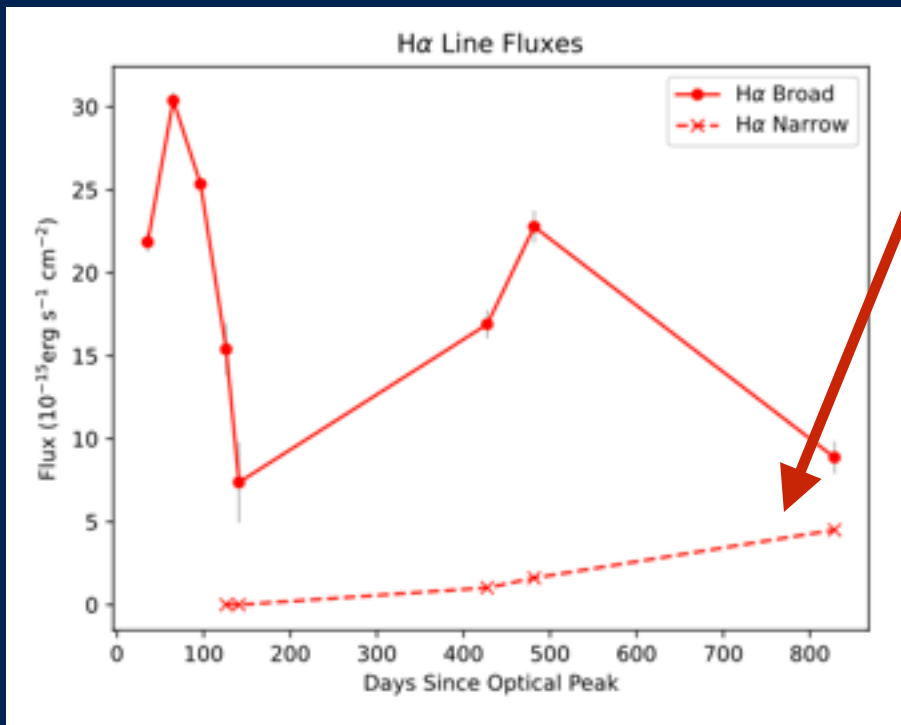
unknown differential
covering factor



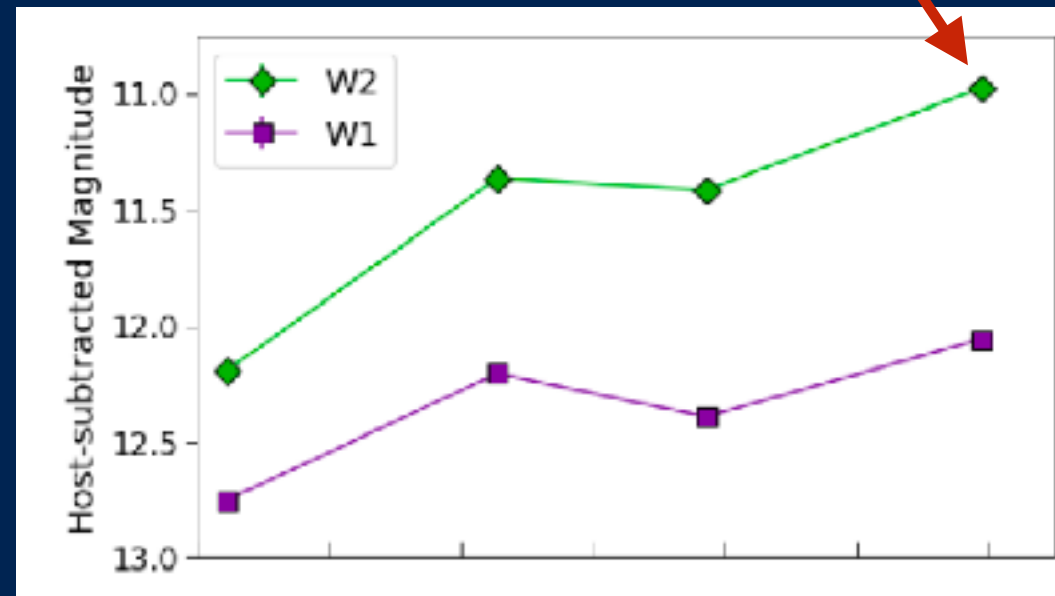
Fe lines
peak at
~ 500 days

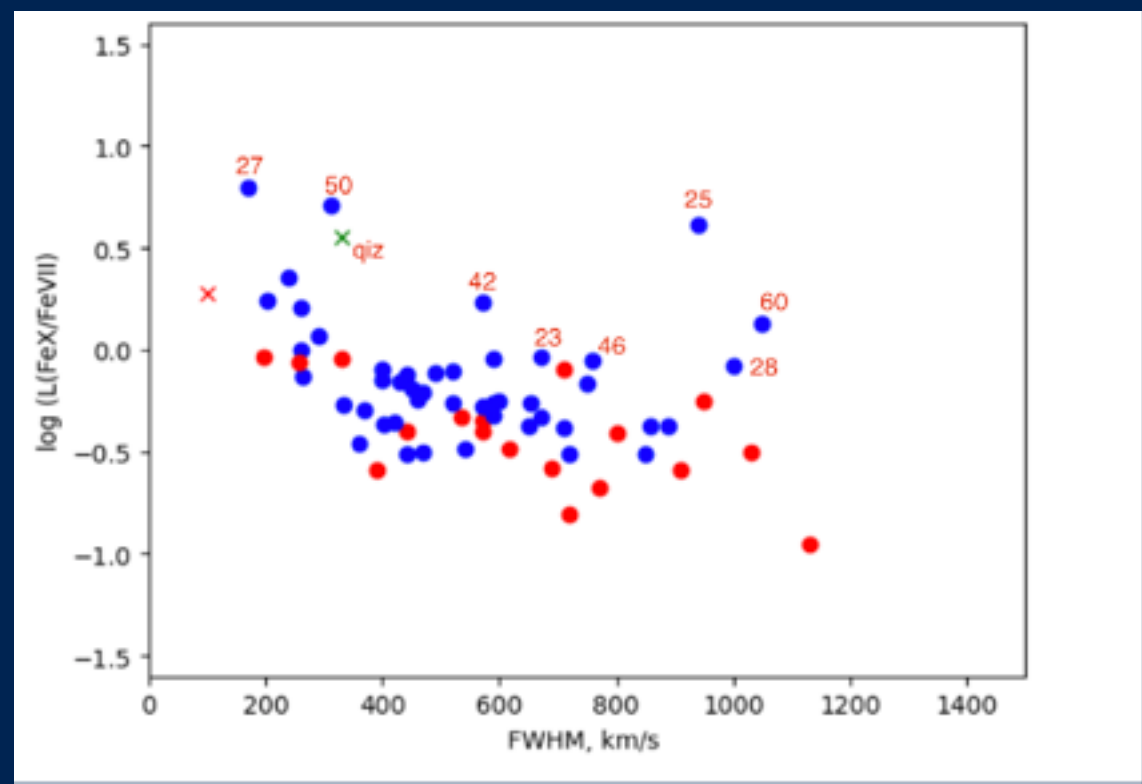
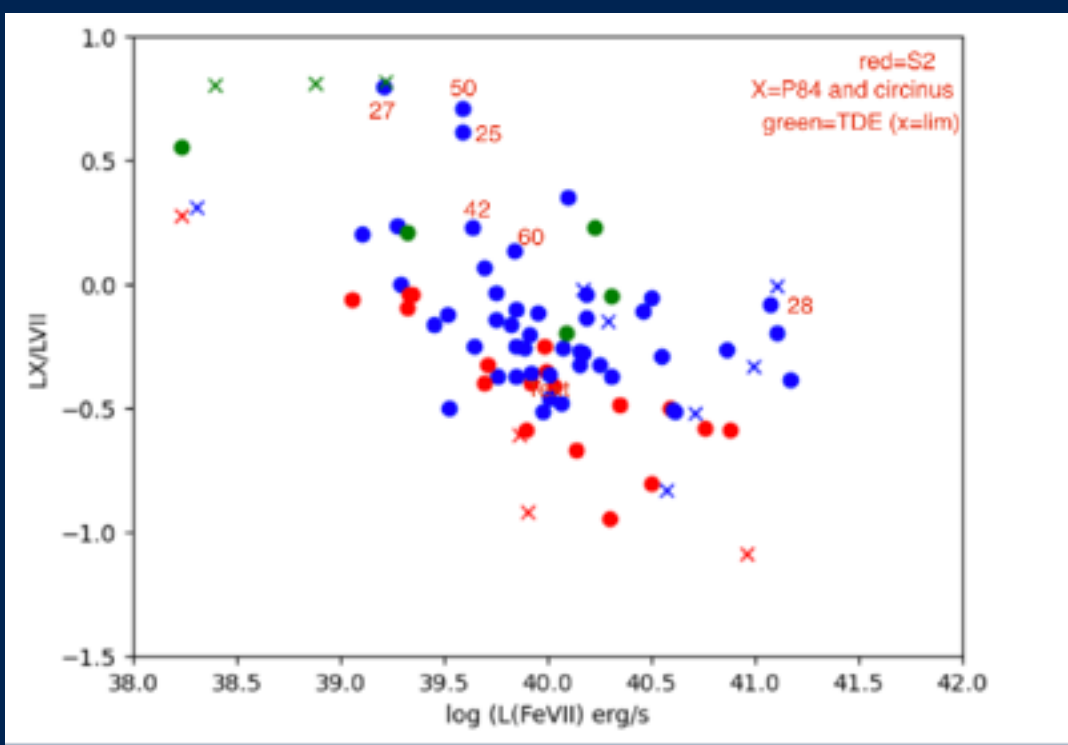
Narrow Halpha and Hbeta
still climbing at 800 days

MIR still climbing
at 800 days



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AT2019qiz Iron Coronal Lines

