

Coronal reverberation

Andy Lawrence
Torus 2022 Leiden
Dec 13-15 2022

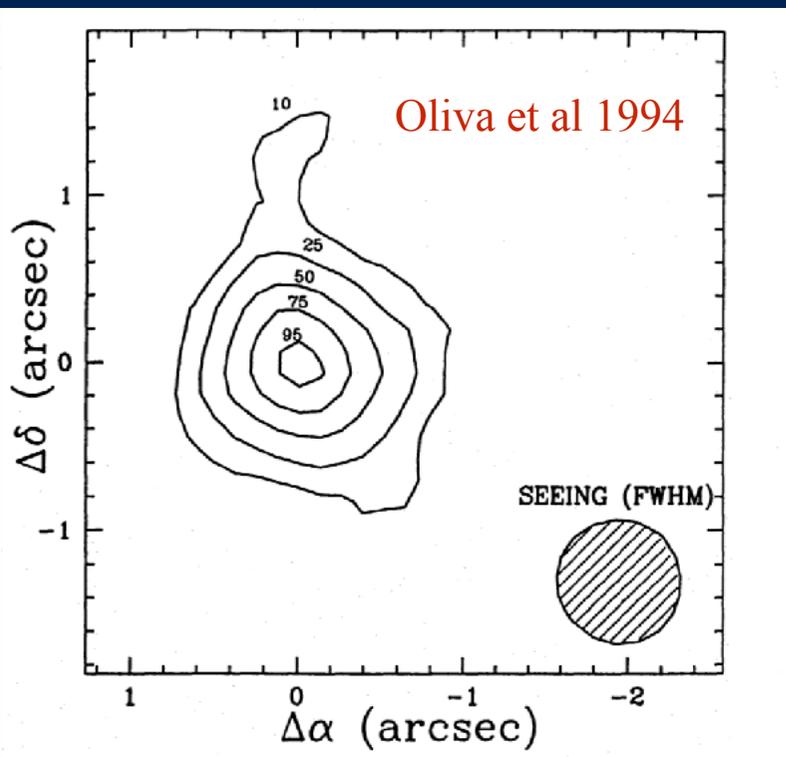
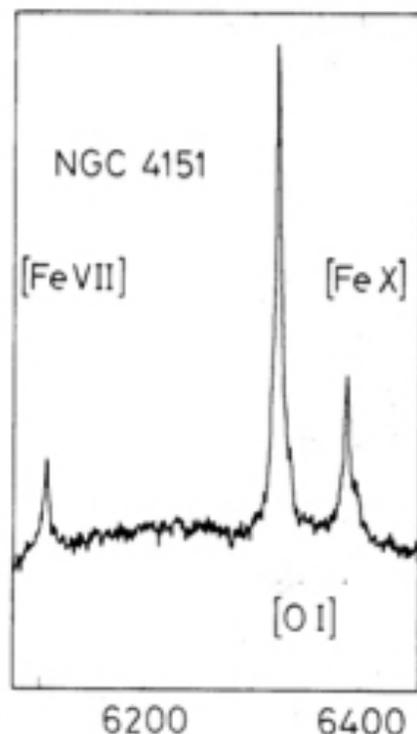
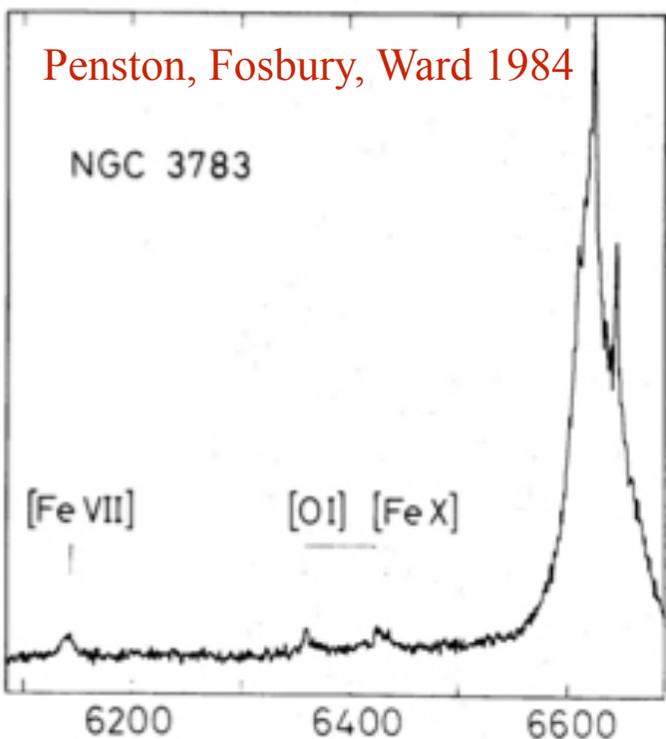
with Charles Yin, Phil Short, Matt Micholl, Martin Ward, and others

Coronal lines in AGN

photo-ionised

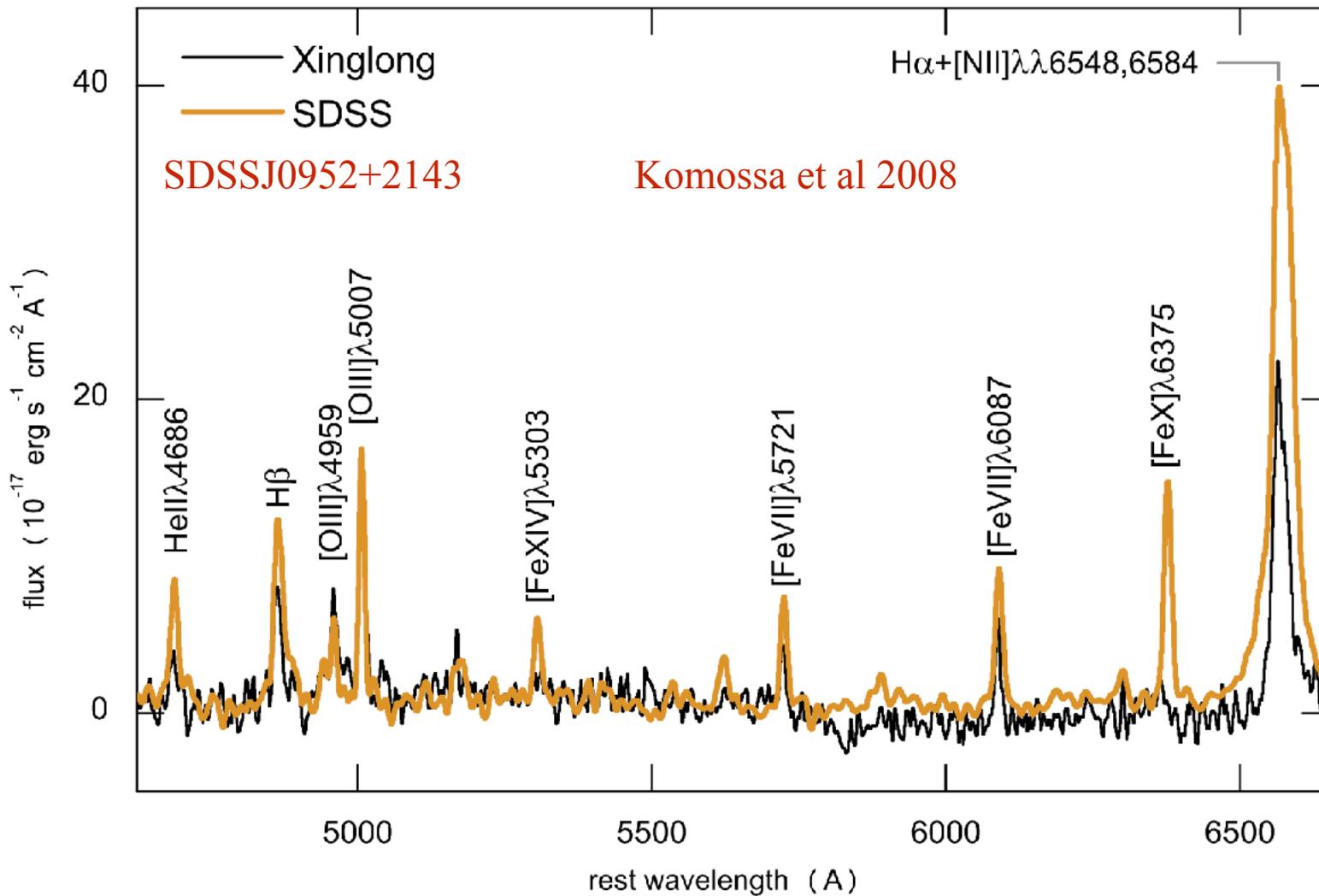
potentials 100-400eV

intermediate line width
==> intermediate distance?



Circinus: 4Mpc

resolved? ~ 10 pc



super strong
coronal lines
in non-AGN

“ECLE”

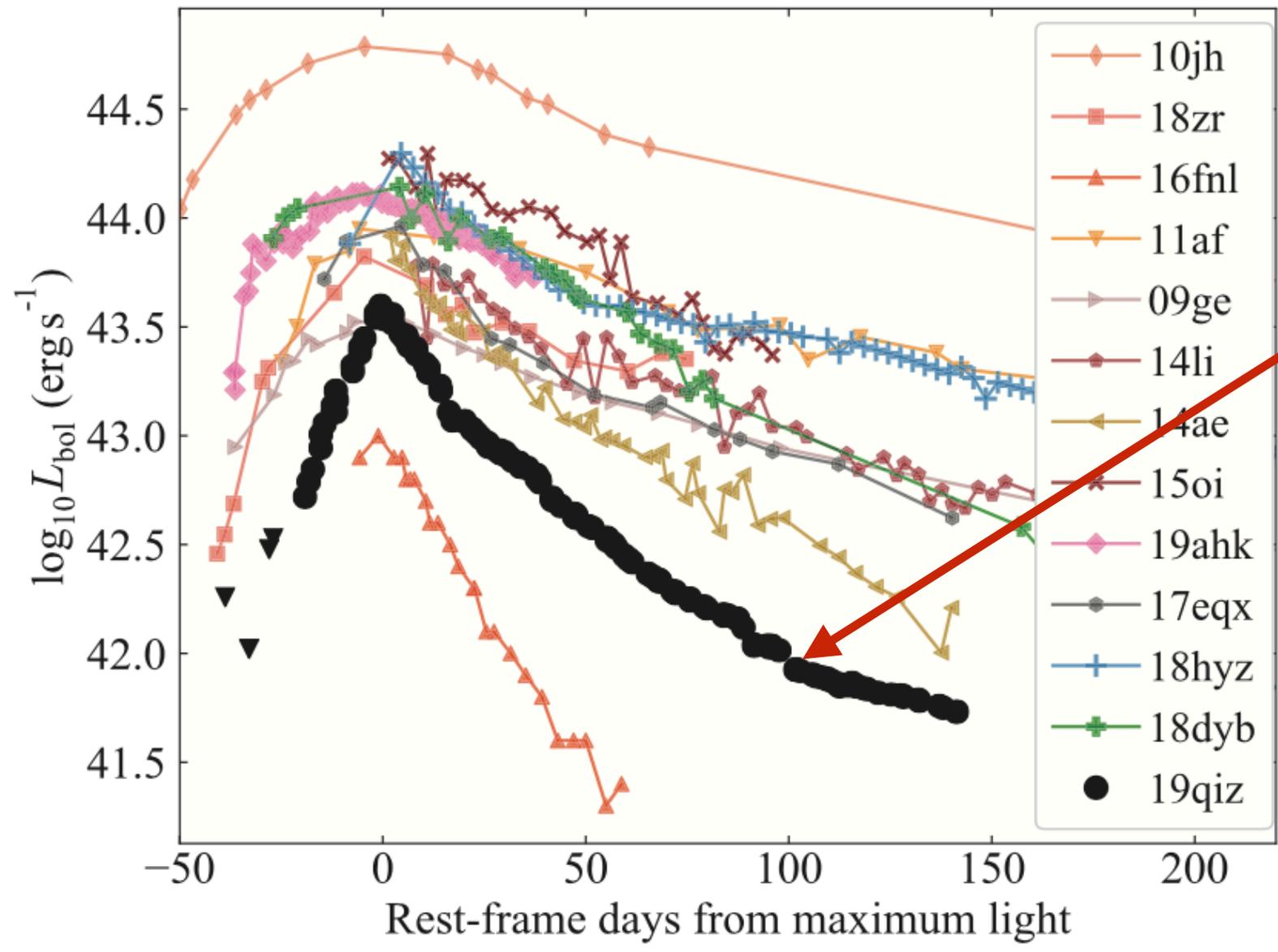
orange
Dec 2005

black
Dec 2007

fading with time!
echo of past event?

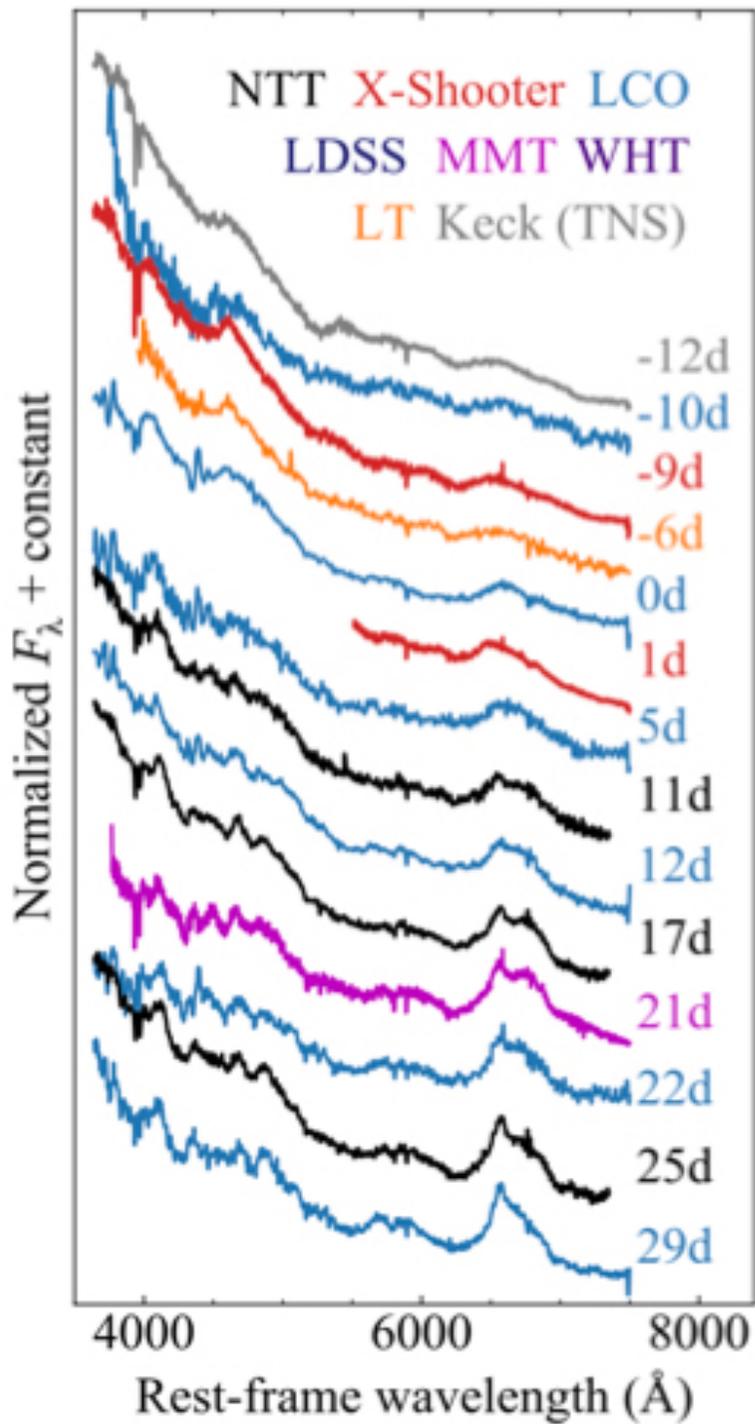
TDE??

TDE AT2019qiz



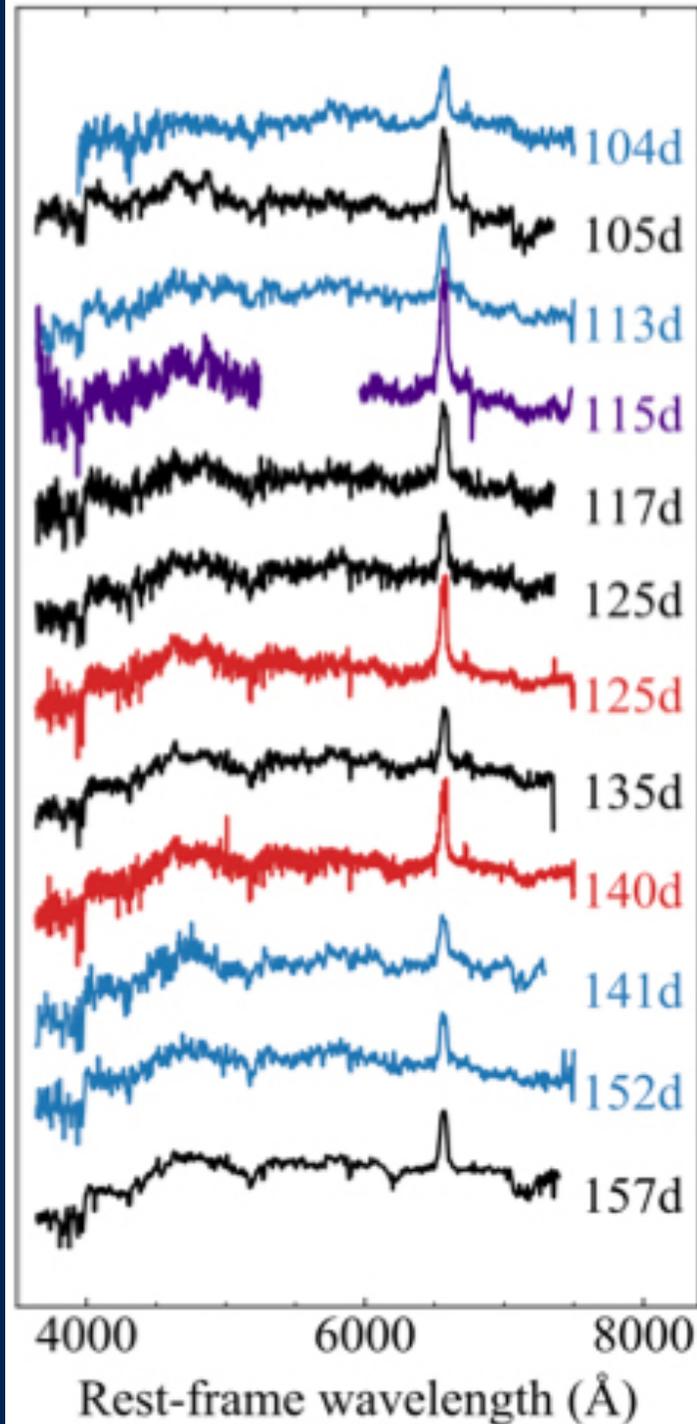
TDE AT2019qiz

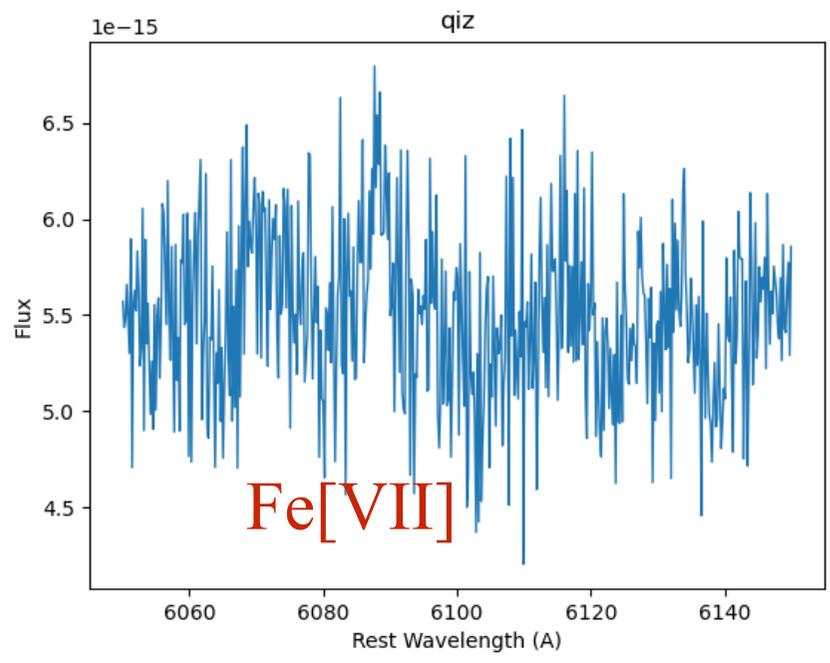
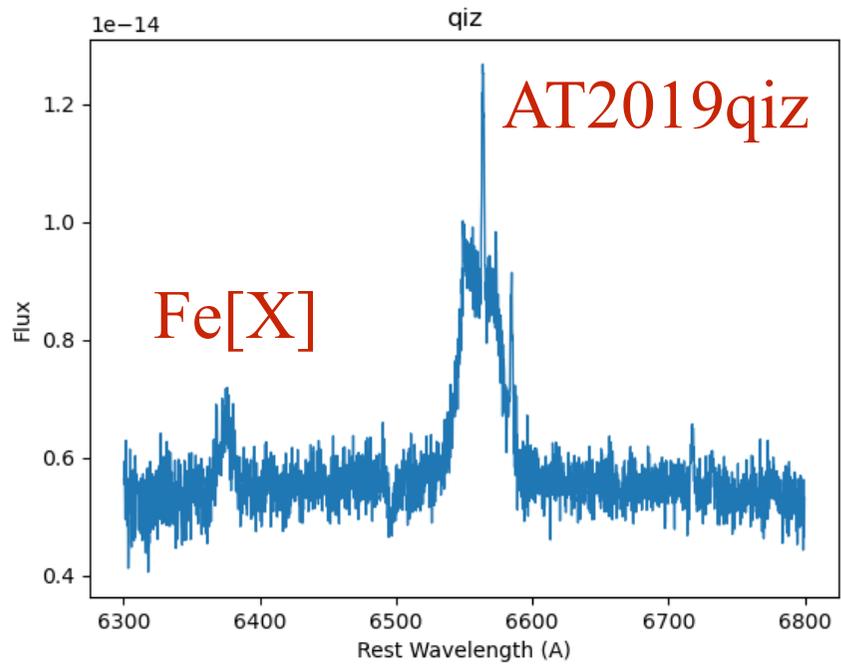
Nicholl et al 2020



weak
broad
lines

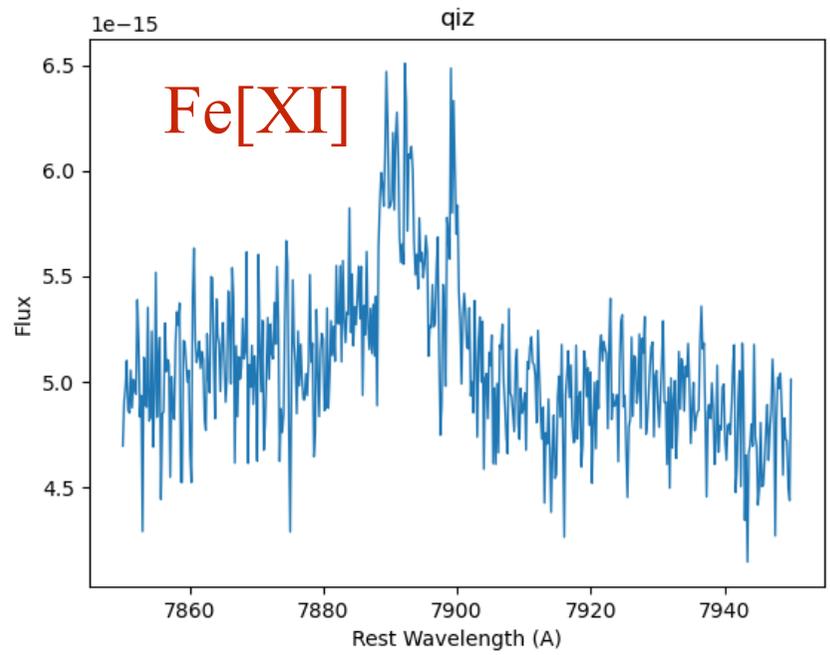
starlight
plus some
H α

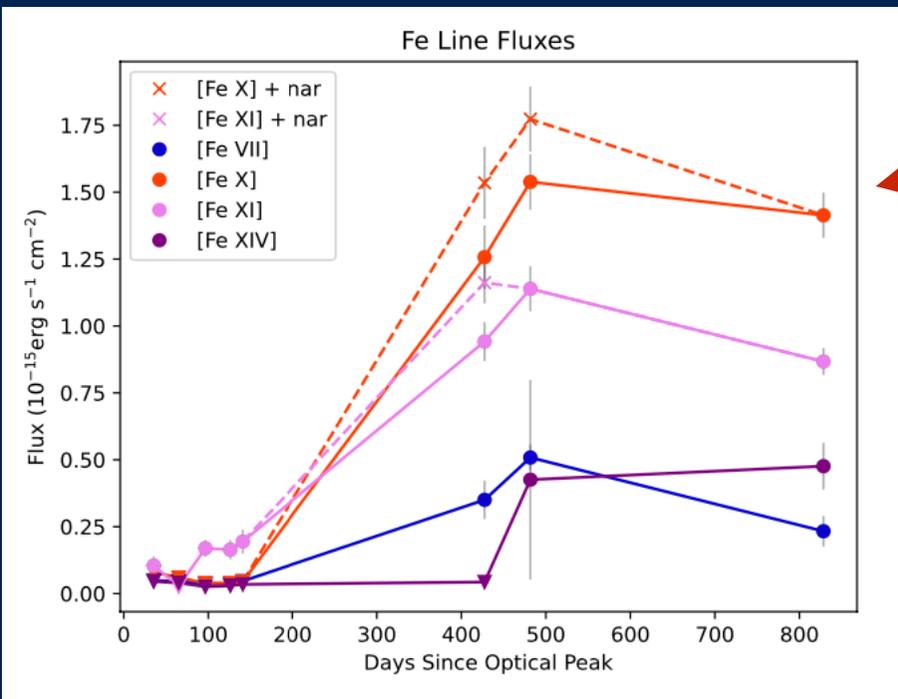




Short et al 2022

Coronal lines appear
after ~ 2 years

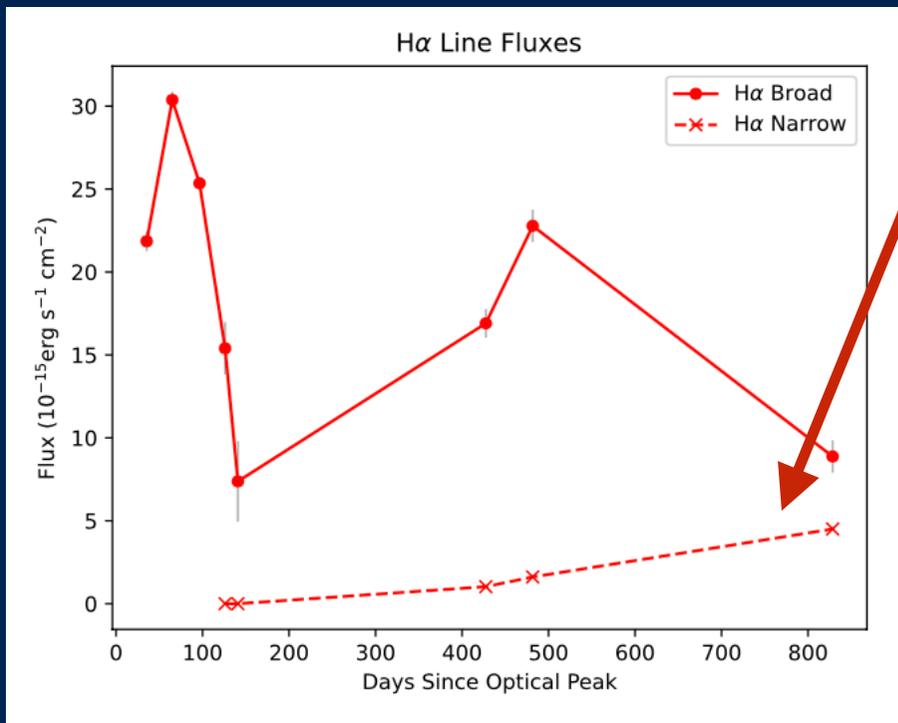




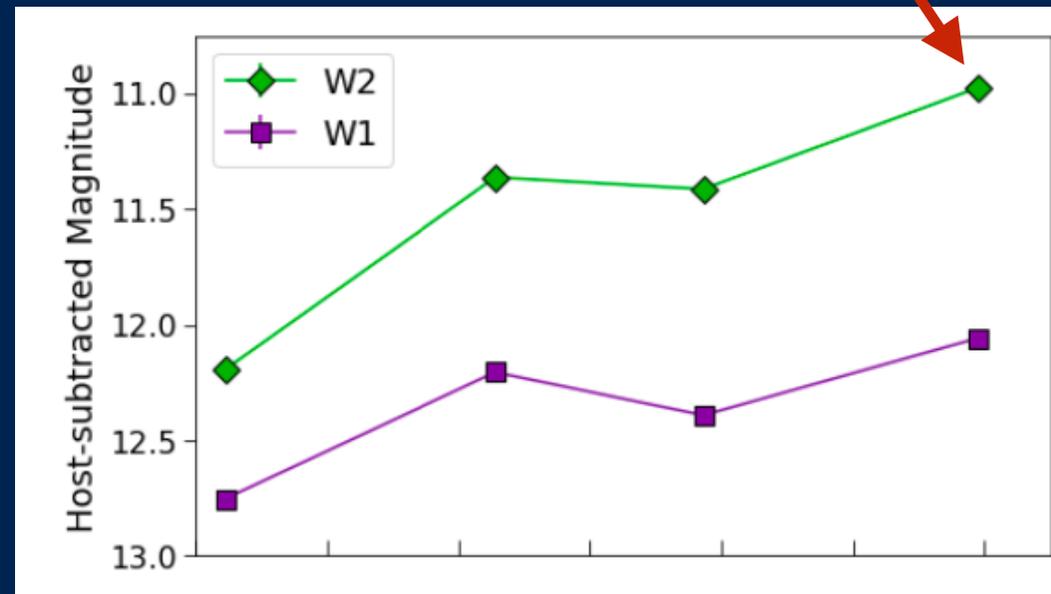
Fe lines peak at ~ 500 days

Narrow H α and H β still climbing at 800 days

MIR still climbing at 800 days



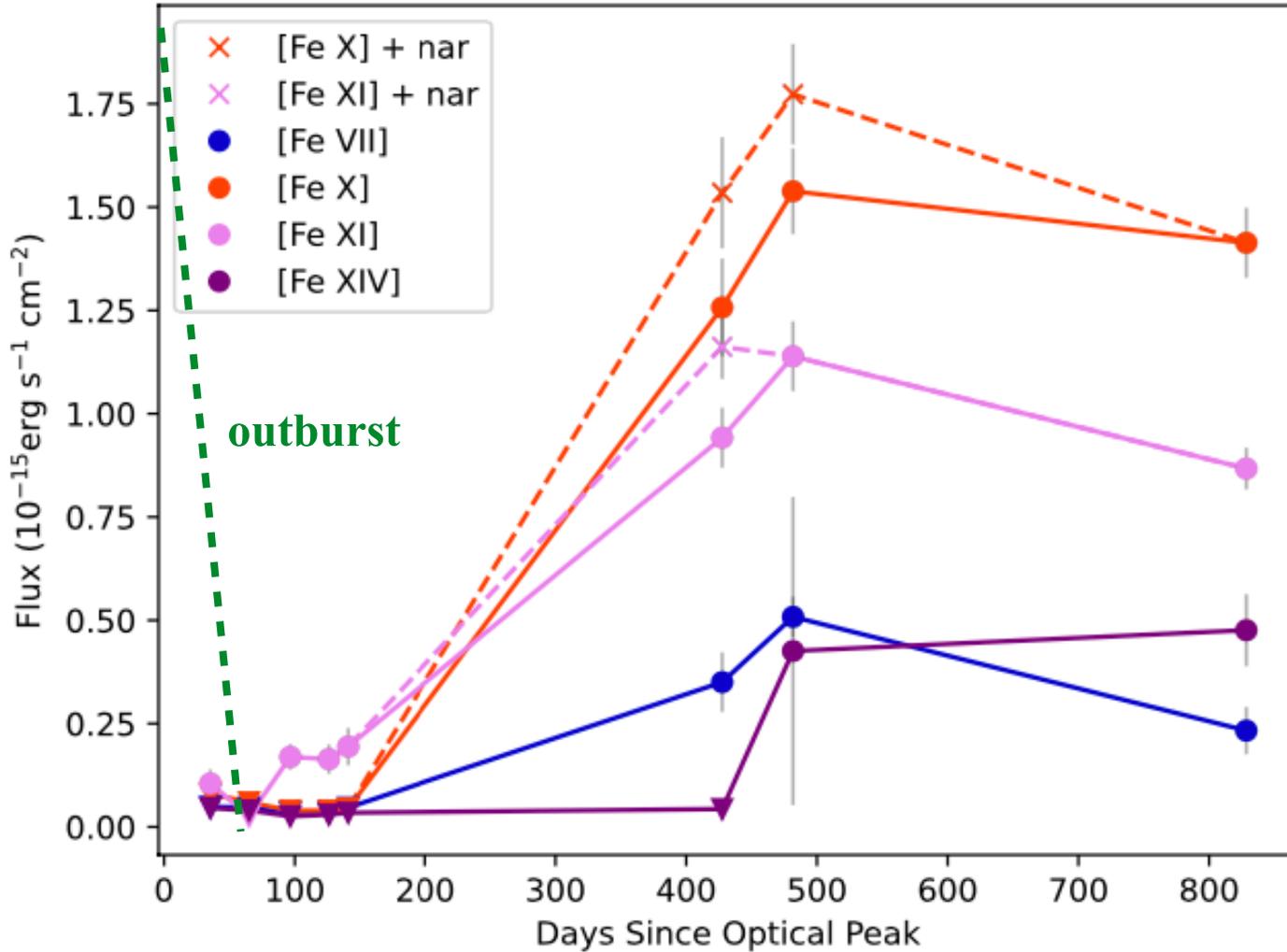
Short et al 2022



mean delay



Fe Line Fluxes



material at
wide range of
angles / distances

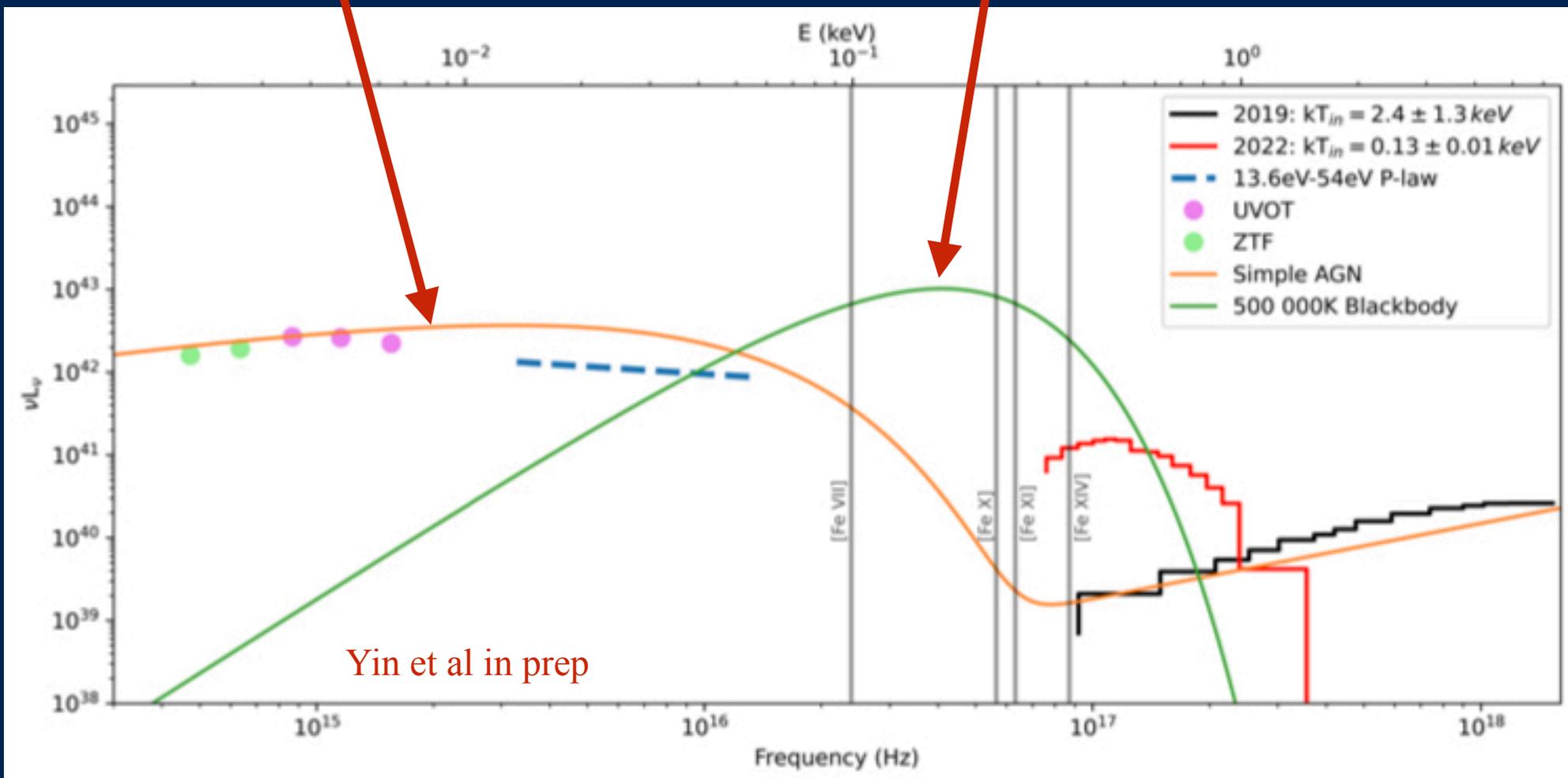
not made in this
outburst ... outflow
time ~ 5000 years



range of delays

standard AGN SED

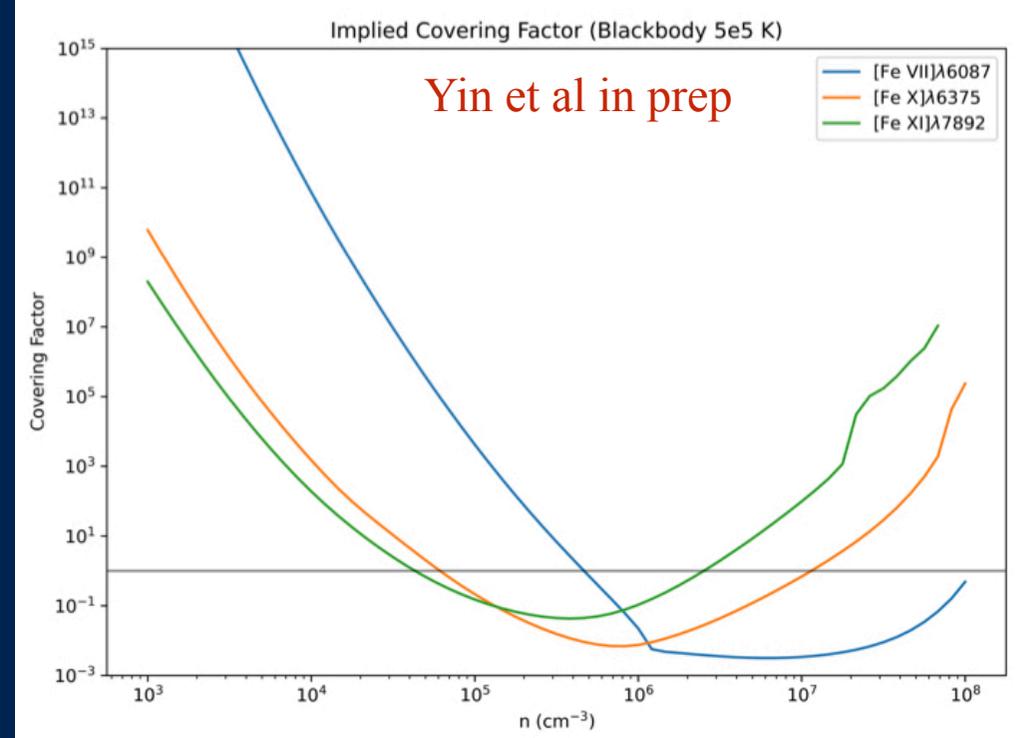
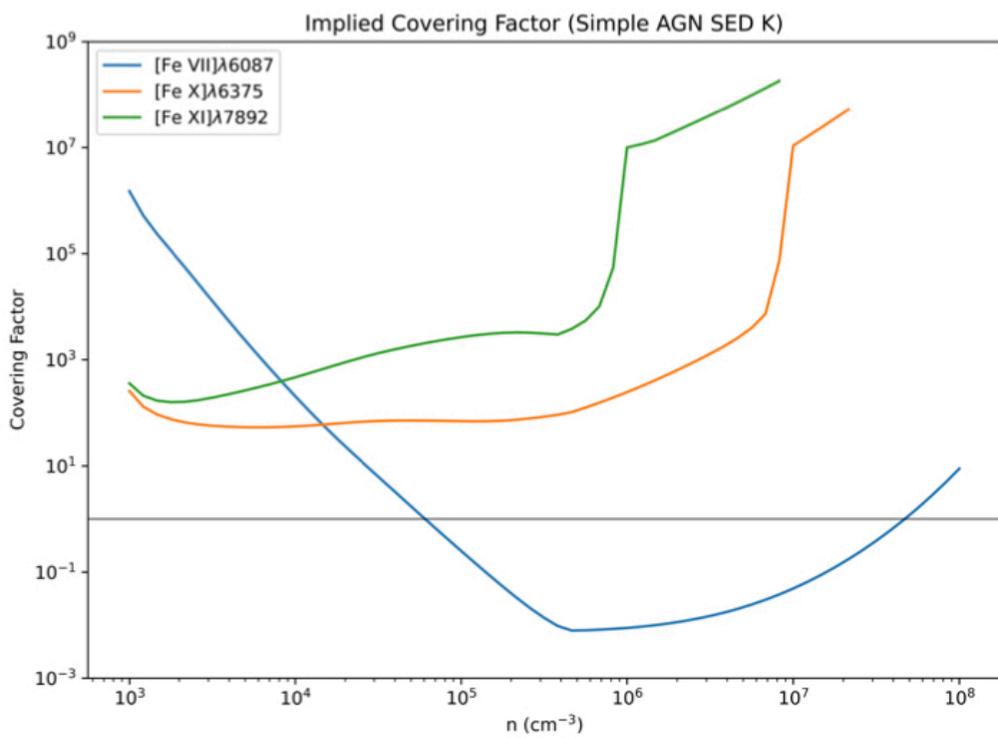
$T \sim 500\text{K}$ for $M_{\text{H}} \sim 10^6$



can we explain line strengths?

standard SED: hopeless

500K BB: much better



- [FeXI]/[FeVII] requires very hard continuum
- $n \sim 10^{5-6}$ intermediate between BLR and NLR
- covers about 1% of sky
- mass $\sim 1-5$ Msun

not random ISM
needs previous AGN activity
(or previous TDE??)

WHY THIS ONE??

we observed ten more TDEs
two years after outburst...

and saw no more coronal lines...

The EUV continuum is really there

Material already out there

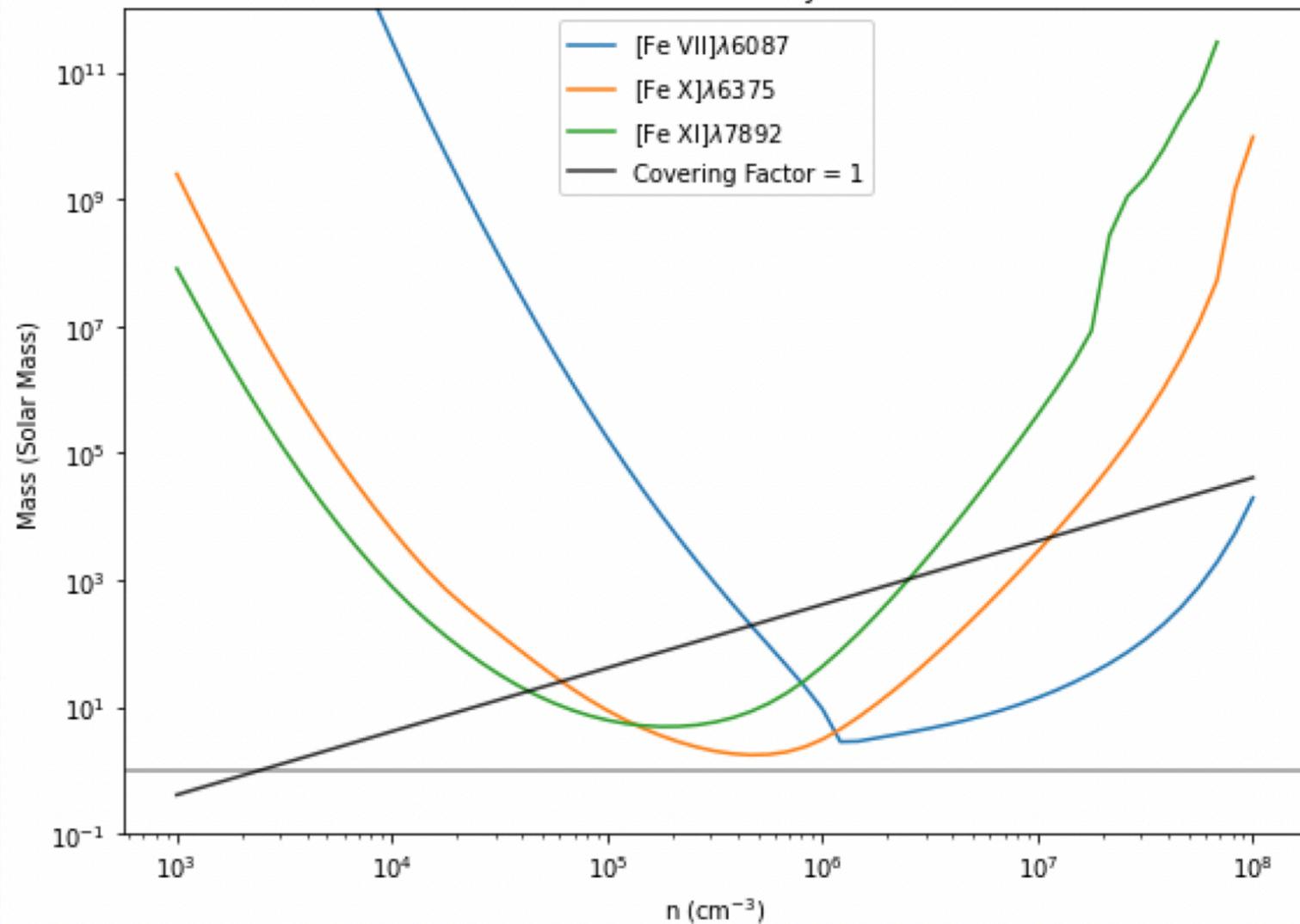
Made by previous activity

Between BLR and NLR
in both distance and density

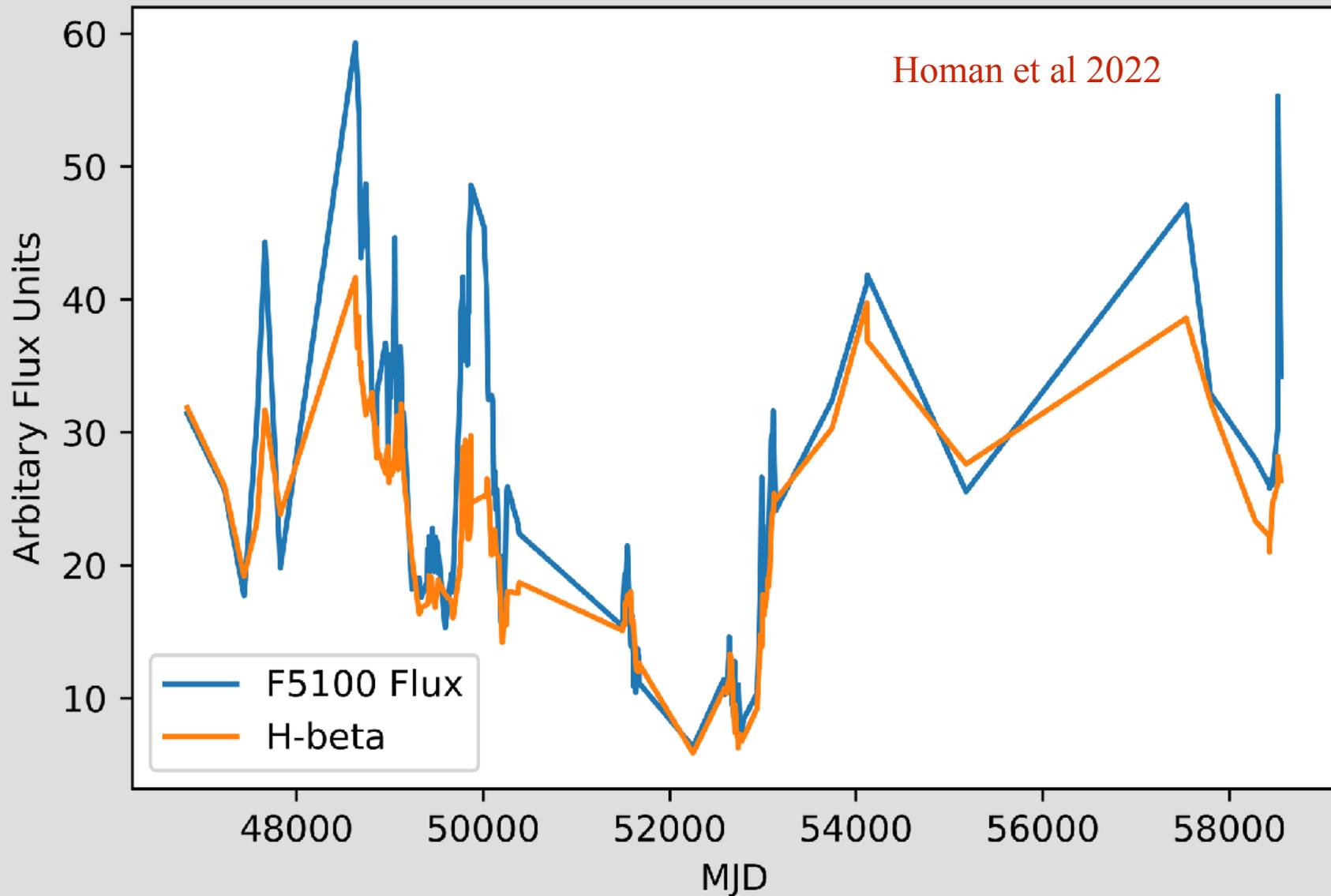
FIN

Bonus material

Total Gas Mass (Blackbody 5e5 K SED)

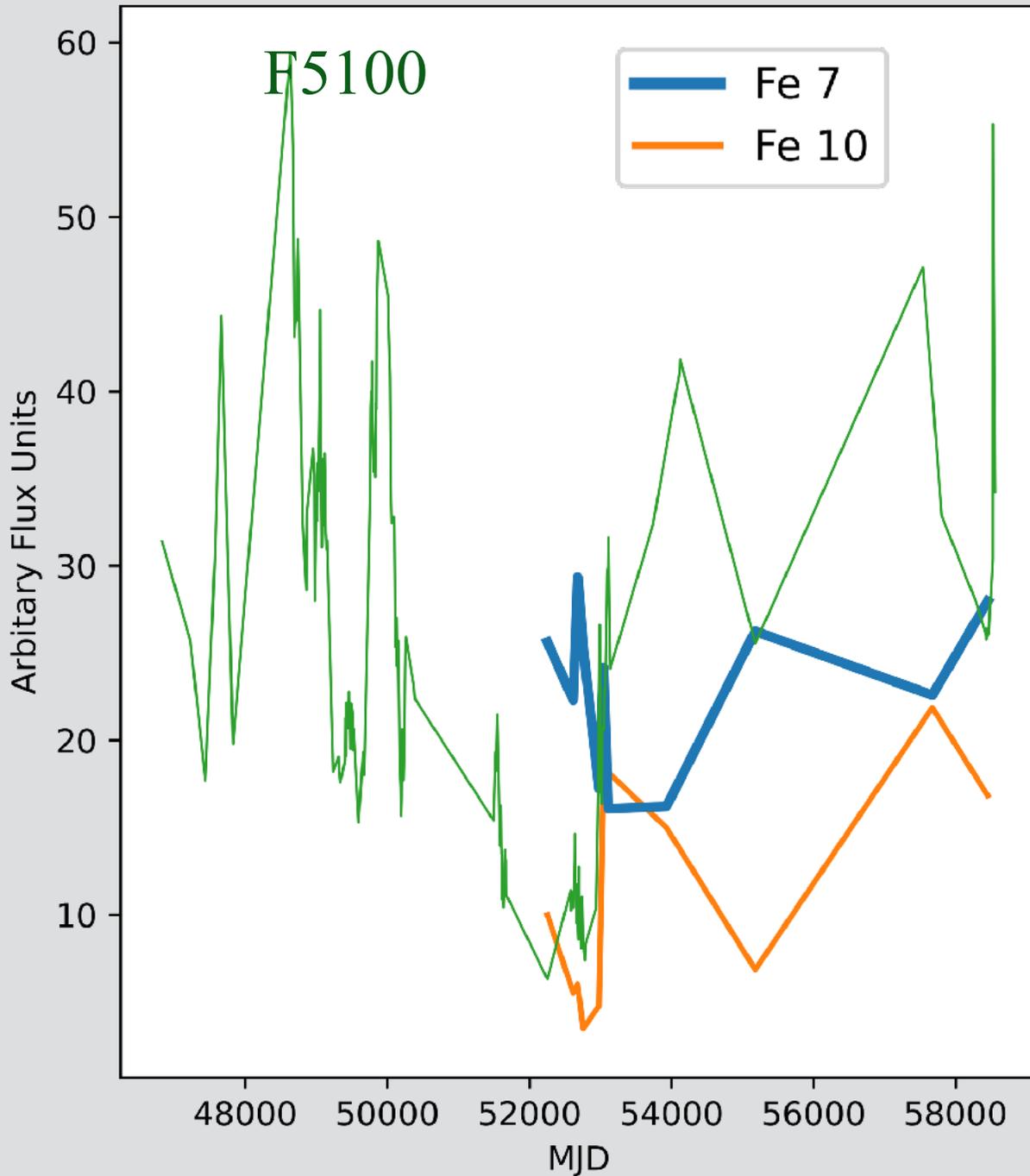


Thirty year light curve of MKN 110

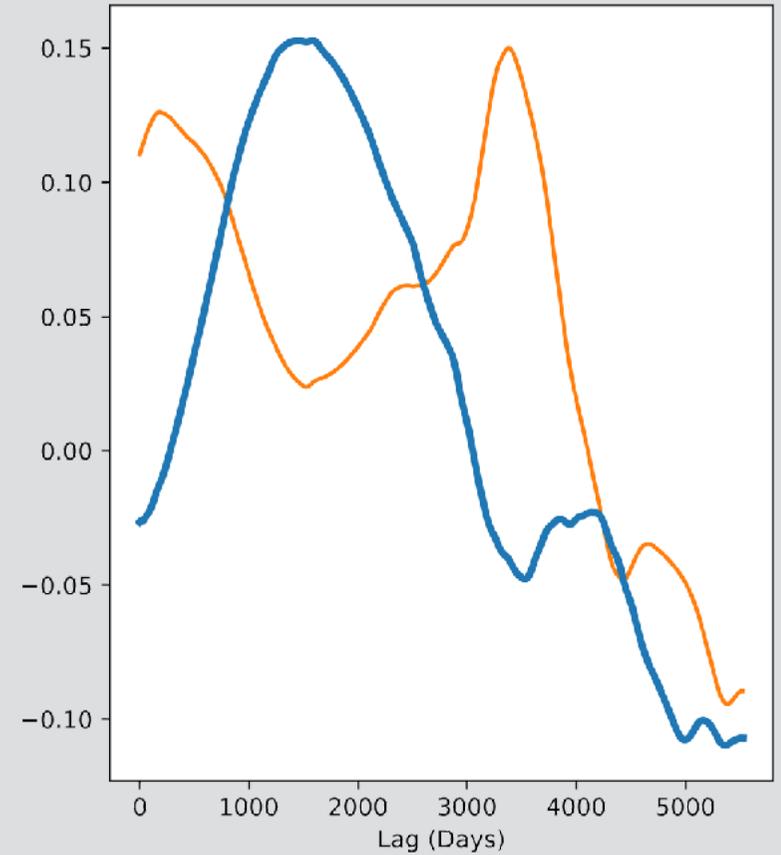


Hbeta tracks historic dip

Fluxes Over Time



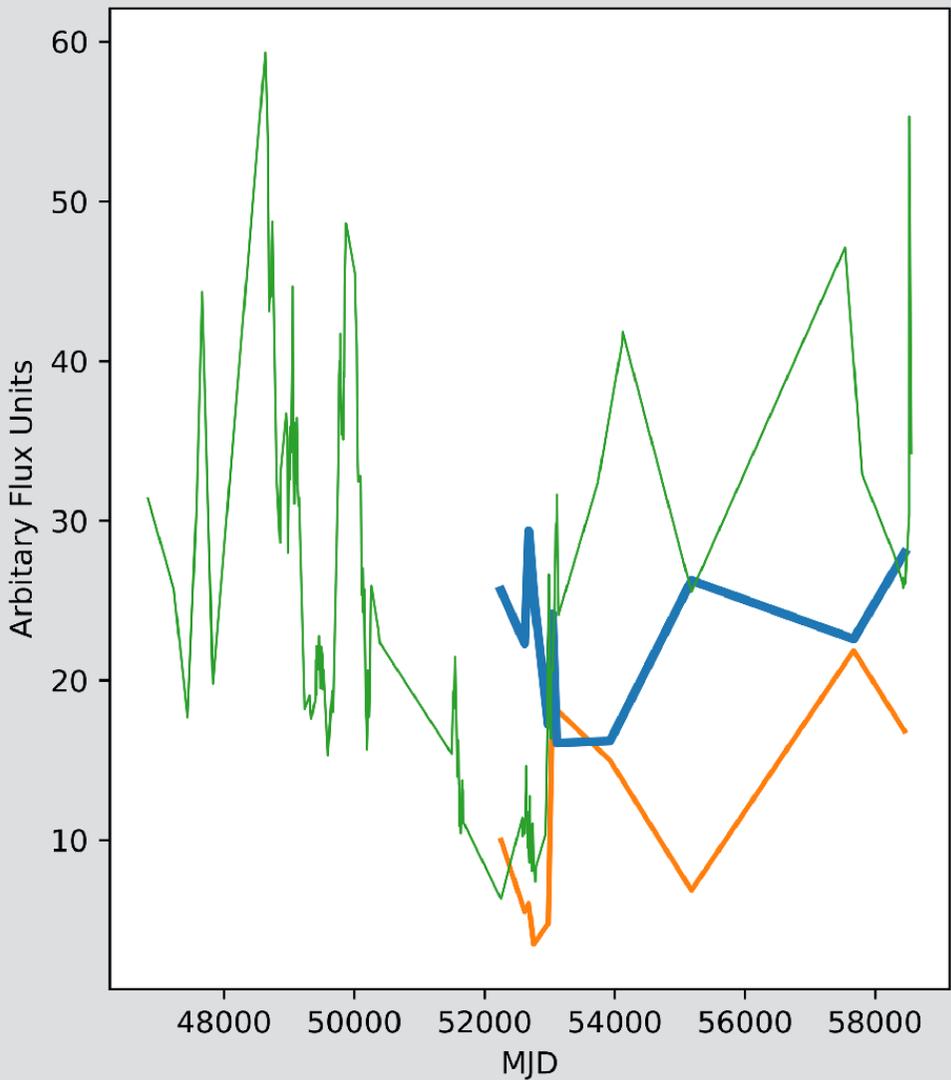
Fe 7 and 10 Cross-correlated with F5100



[FeVII] lags
by 1600 days?

cf broad Hbeta
lag 24 days

Fluxes Over Time



original

shifted

