TDE and Nuclear Transients

SOXS WG10

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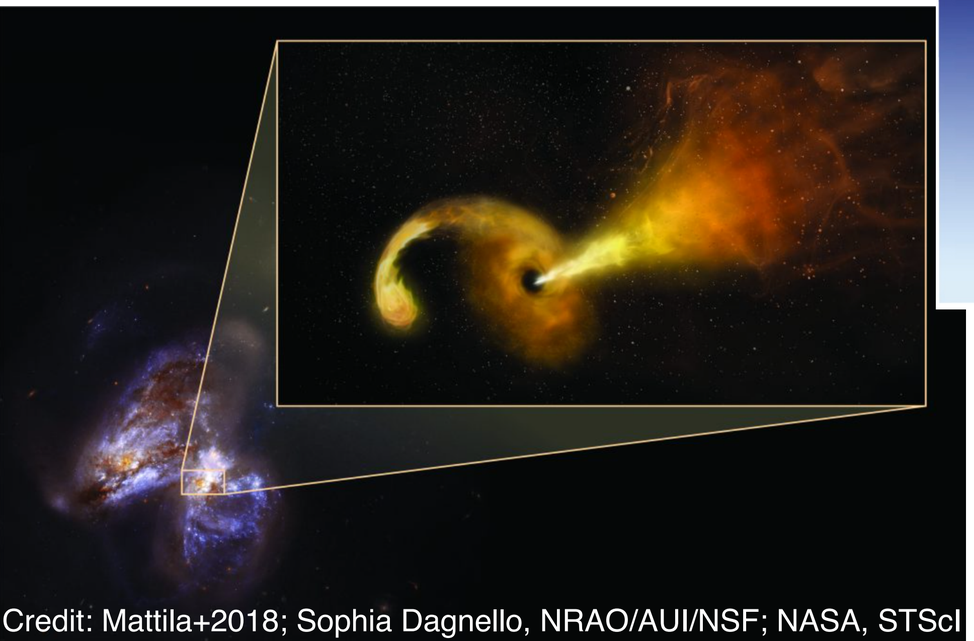
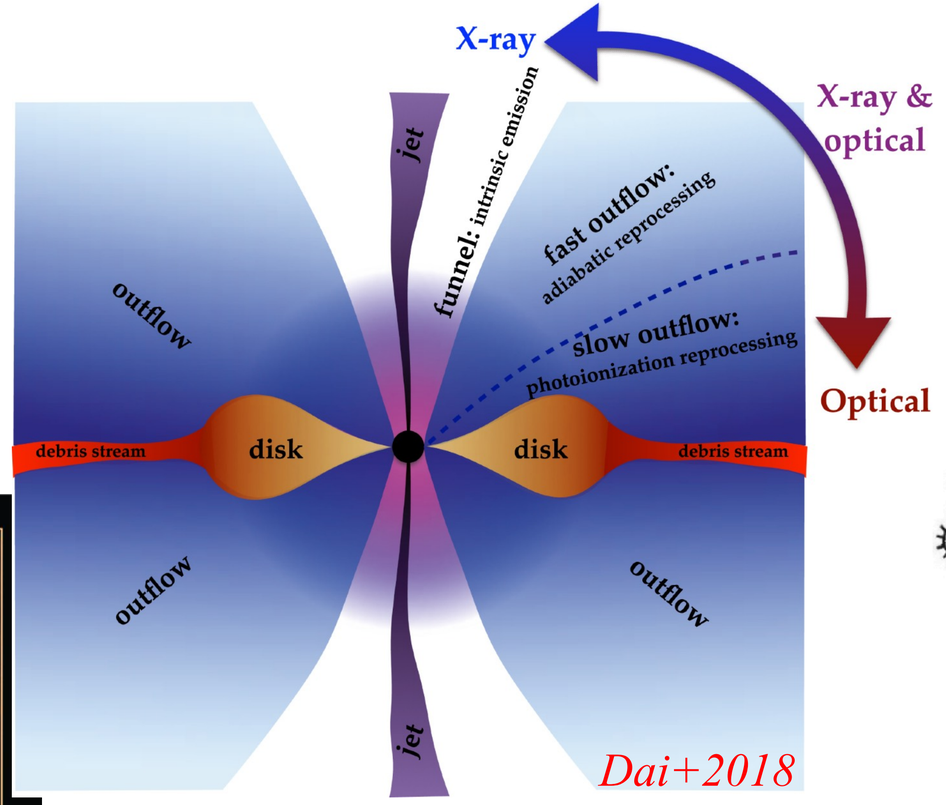
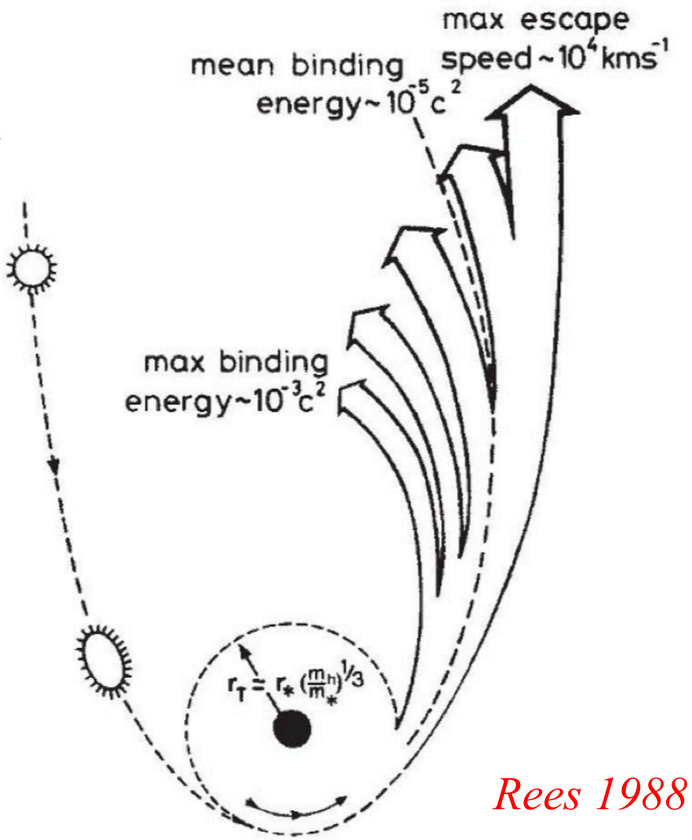
Massimo Della Valle (INAF-OANa, IT)

TDE and Nuclear Transients





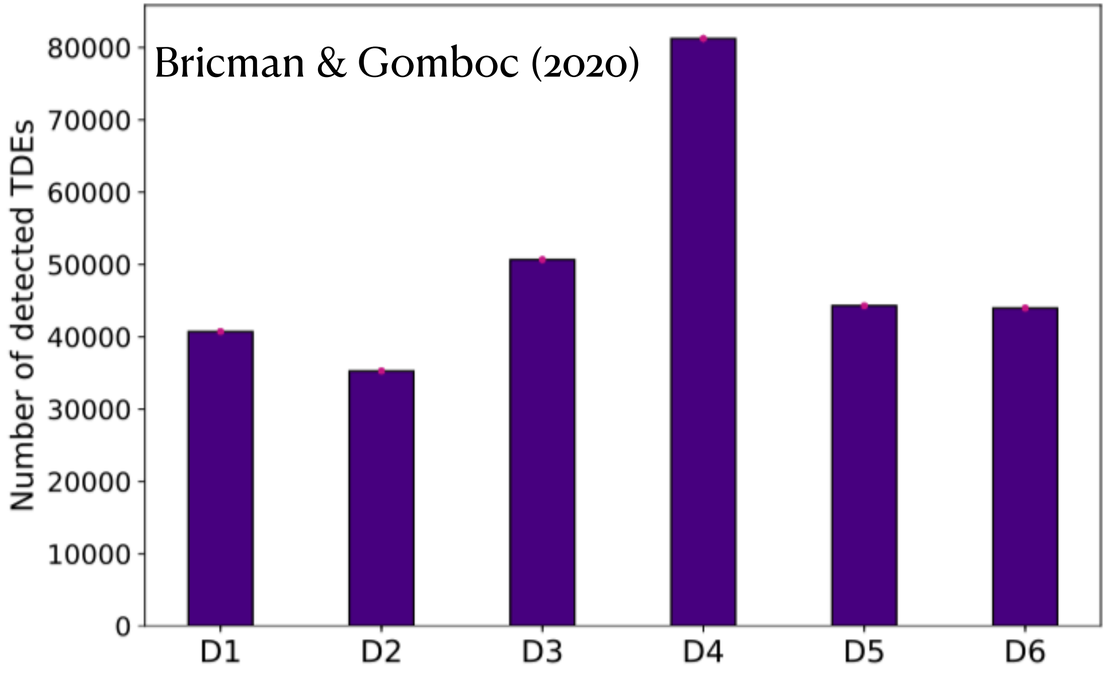


Why use SOXS for TDEs and nuclear transients?

- SOXS will provide a spectral resolution not typically available in previous observations of TDEs R ~ 4500 (< 100 km/s)
  - More accurate removal of underlying nuclear background (especially in AGN)
  - New opportunities to study line profiles and possible narrow line components in TDE spectra
- Near-IR spectra of TDEs currently lacking: SOXS will open new opportunities to cover these wavelengths systematically to all observed events - spectral lines and thermal continuum from local dust (IR echo)?
  - Useful mainly for the most nearby/luminous and/or dust obscured objects
- The whole spectroscopic dataset obtained in a controlled way from a single instrument will allow more accurate host galaxy subtraction using template spectra
  - ADC will allow to use a fixed position angle for the slit
- Time available over 5 yrs will allow systematic follow-up of long-lasting events

How many TDEs are in the reach of SOXS?

- Assuming M(peak)~ -19 to -20, this implies a volume within z~0.15-0.2 for mag<20
- Assume a TDE rate of ~2 x 10^{-4} galaxy^{-1} year^{-1} (Hung+18, van Velzen+18)
- Local galaxy space density to M~ -20 (-18) is ~4 x 10^{-3} (~6 x 10^{-3}) galaxy Mpc^{-3} => ~200-800 TDE yr^{-1}

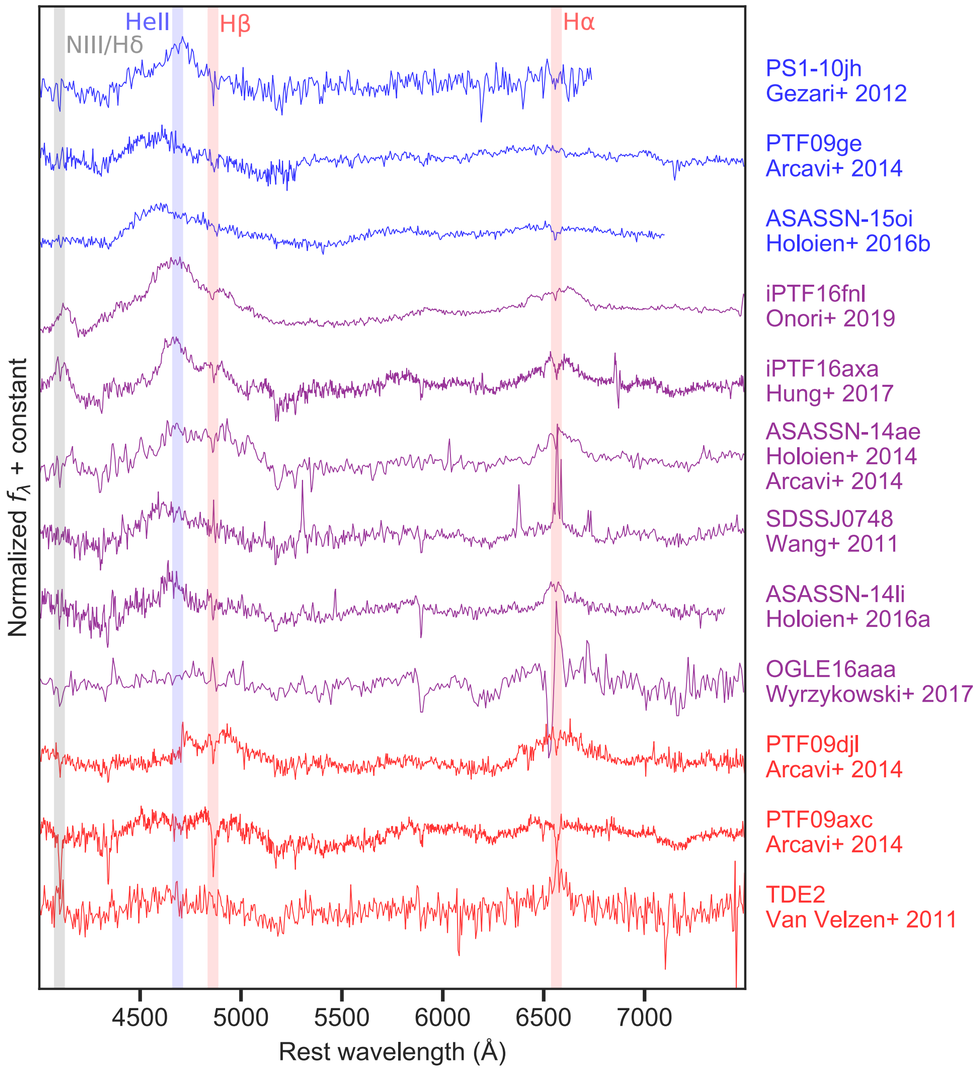


- Expect ~35 000 - 80 000 TDEs detected by LSST over 10 yrs
- ~3500 - 8000 TDE within z < 0.2 i.e. ~350 - 800 TDE yr^{-1}
- Let's assume rates are overestimated and we may not be able to identify all of these, so say 100 TDE yr^{-1}

Nuclear transients science for SOXS

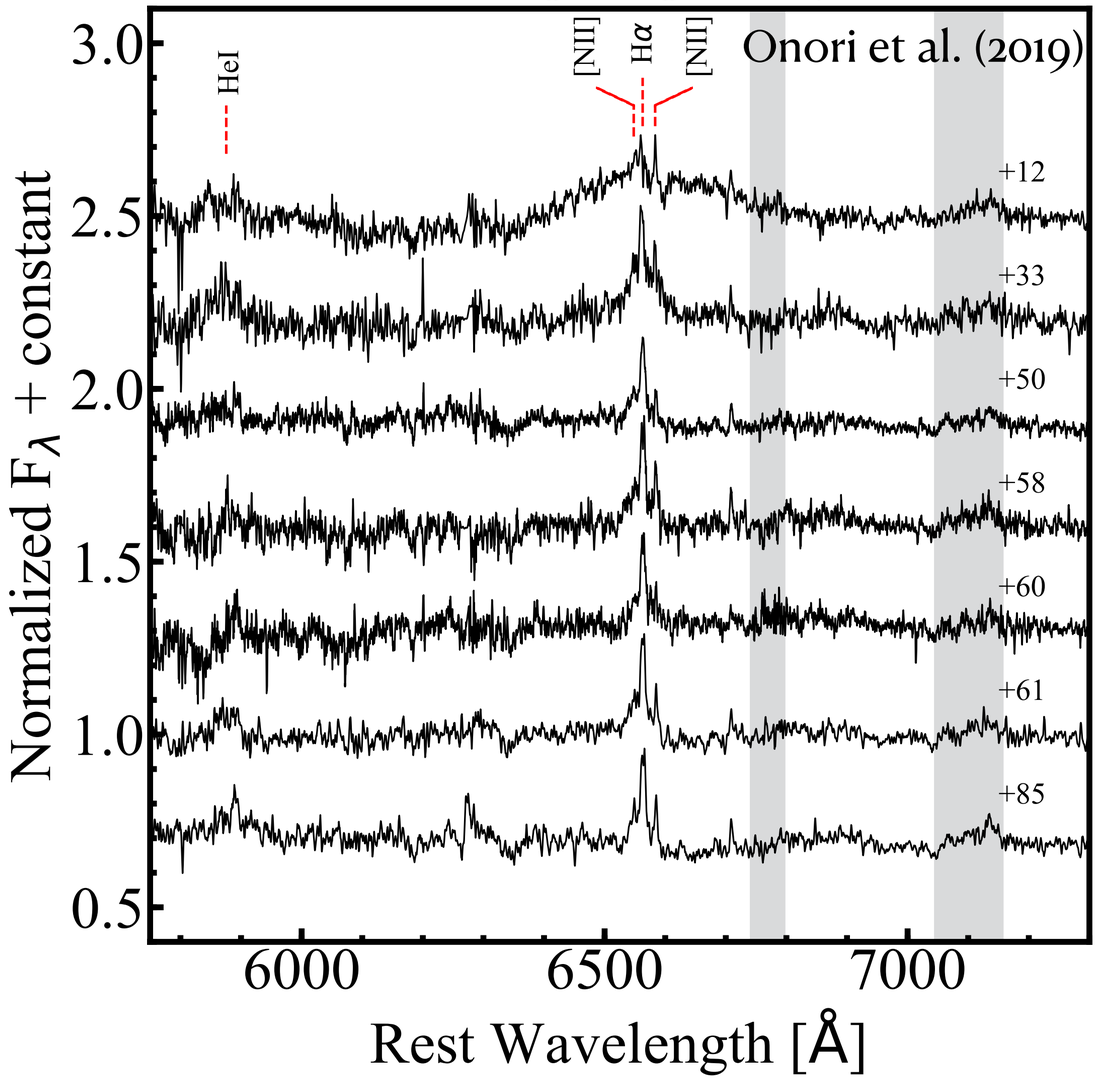
- Complete sample of TDE within 100 Mpc for legacy purposes
- Spectral evolution to see how lines evolve with emphasis on spectra before the peak
- Dense spectroscopic monitoring on early stages to constrain the mass of the disrupted star
- One spectrum near the peak for every TDE within z ~ 0.2 for demographics of TDE types and hosts
- Highly-energetic (~10^{52} erg) narrow-line (~1000 km/s) nuclear transients e.g. PS1-10adi and PS16dtm
- Luminous nuclear transients in AGN e.g. Gaia16aax, AT 2017bgt, OGLE17aaj
- Energetic $10^{51\text{-}52}$ erg nuclear transients in obscured environs of galaxy mergers and LIRGs

Mapping spectral types & evolution of TDEs



Compilation from van Velzen et al. (2020)

Electron-scattering wings vs. dynamics



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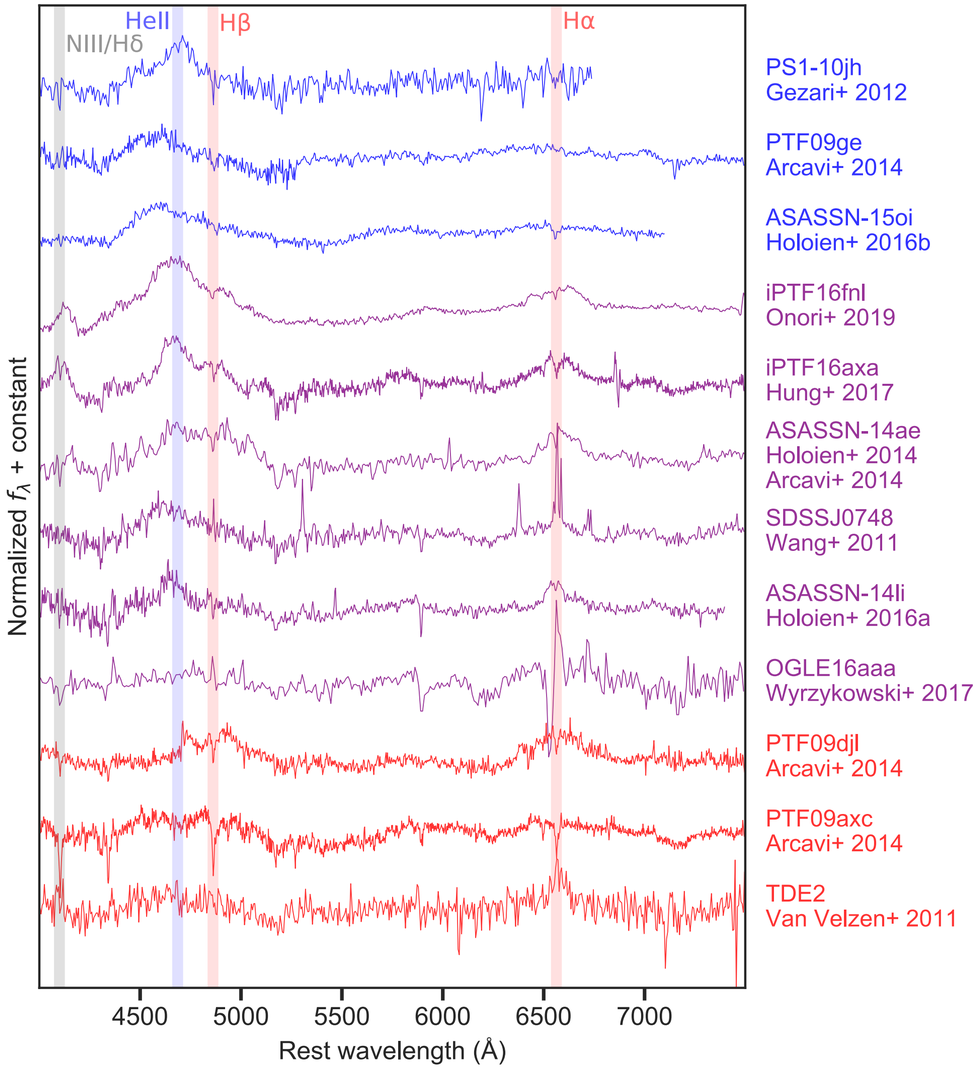

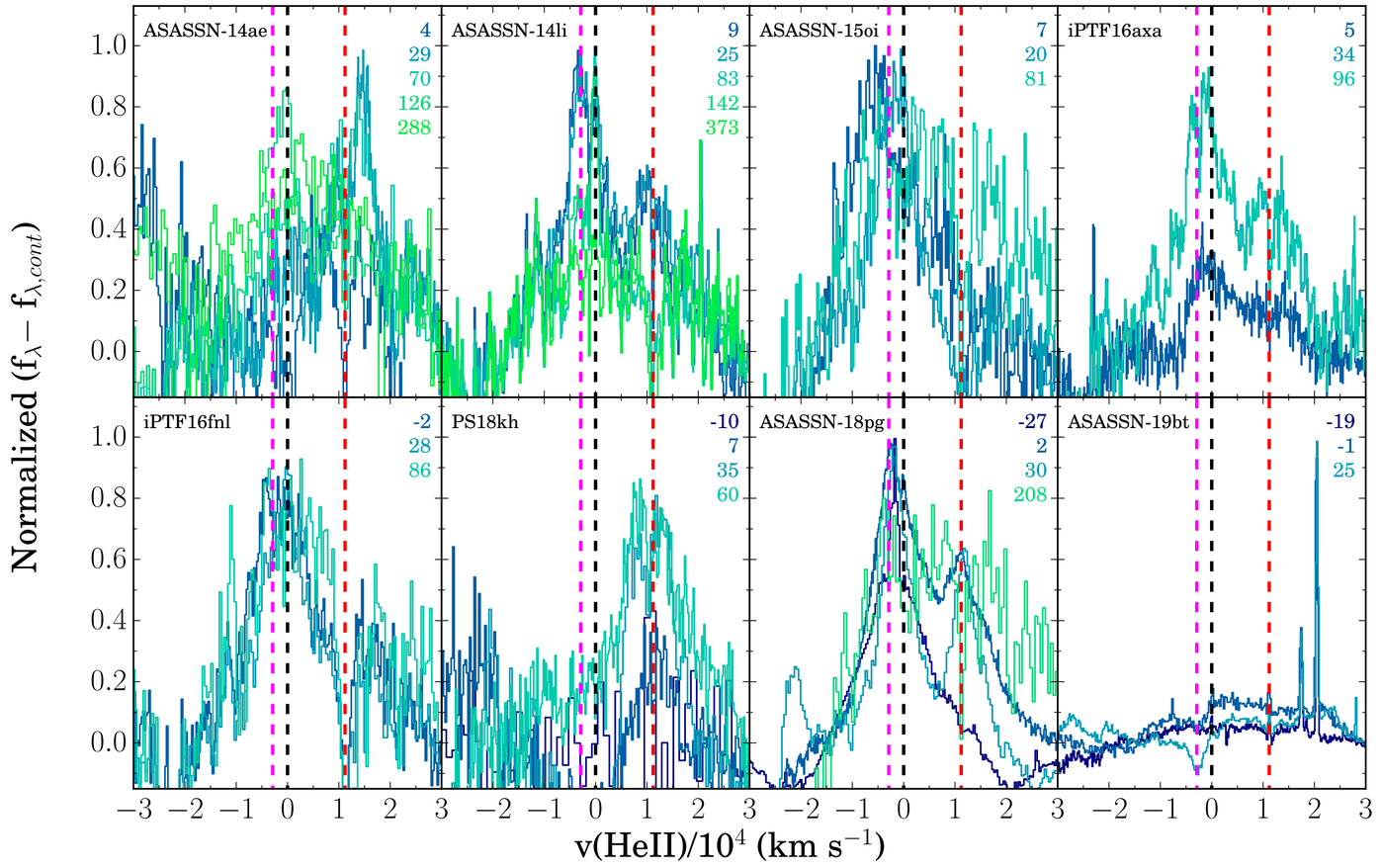

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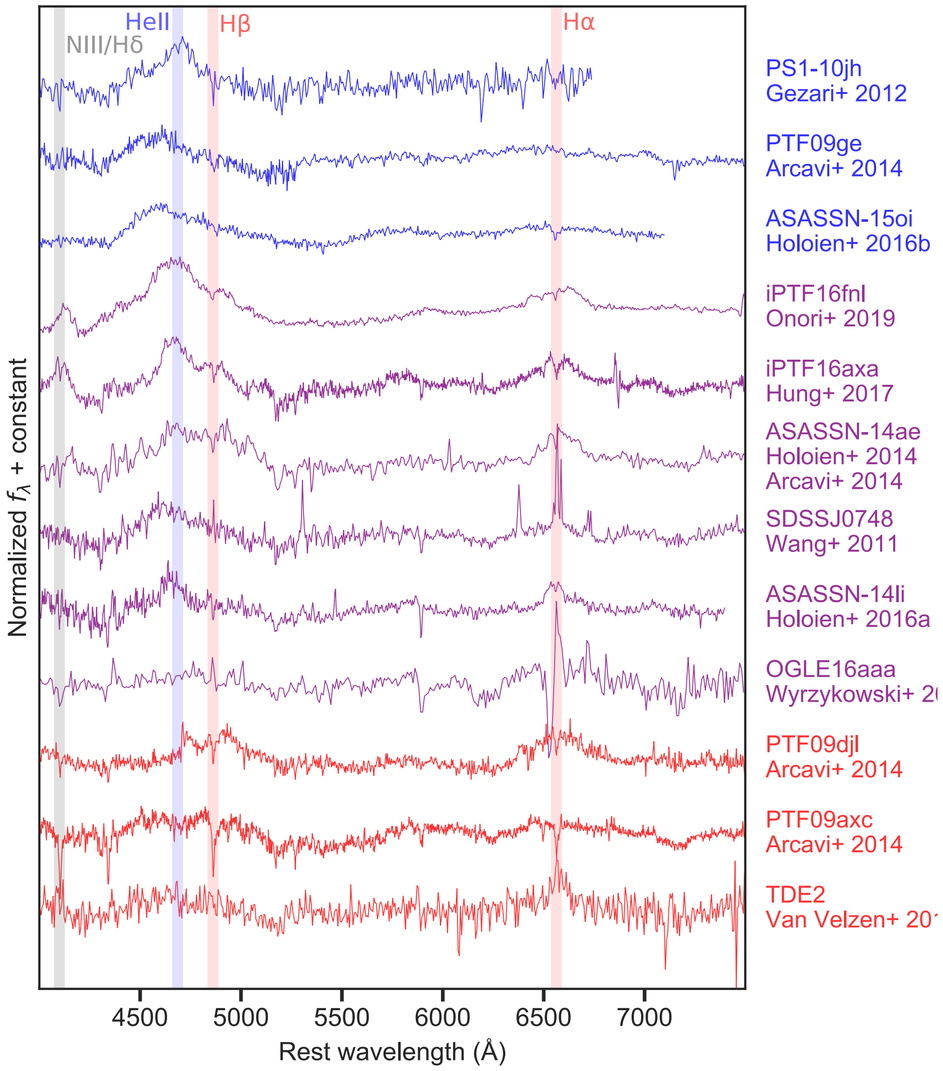

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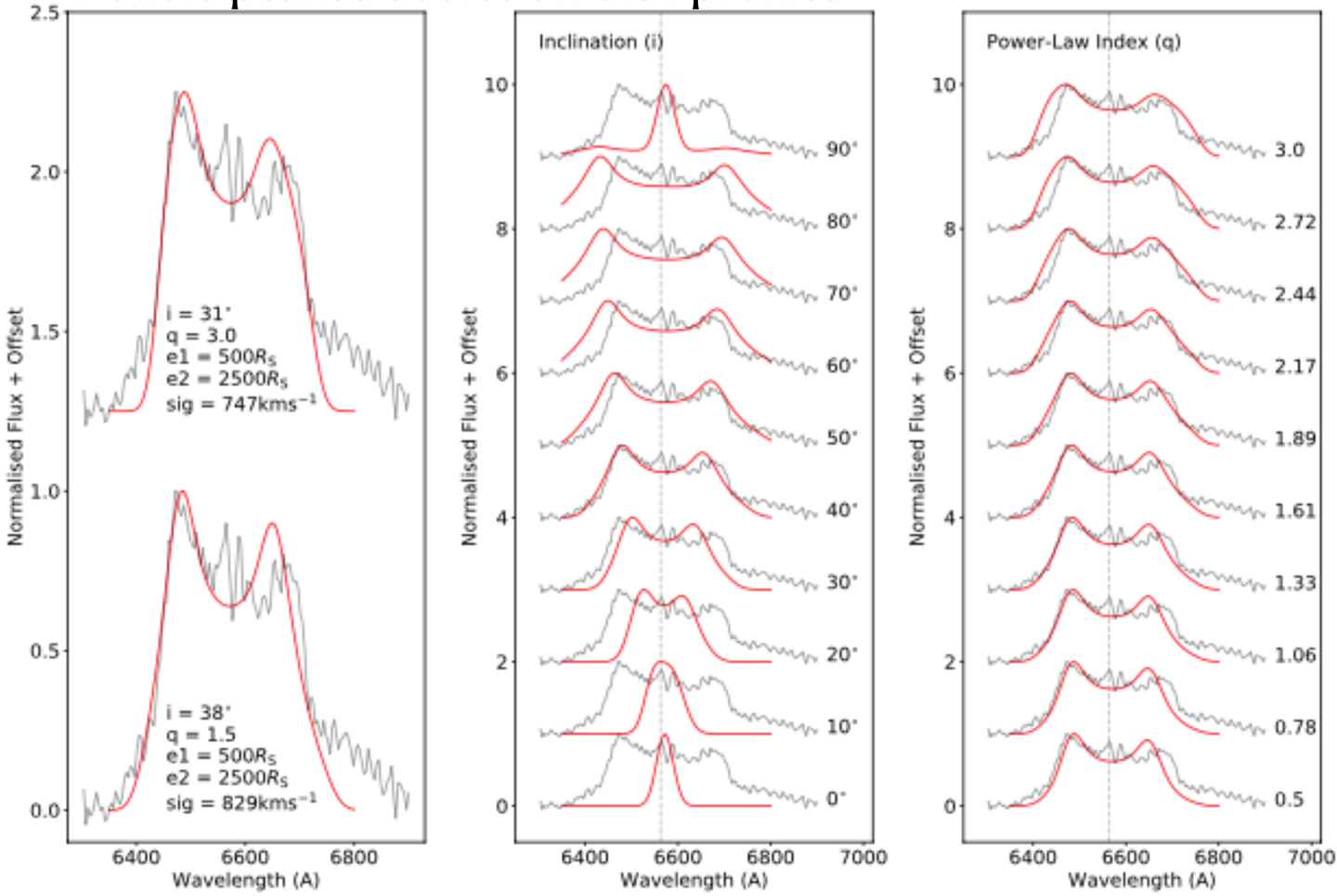
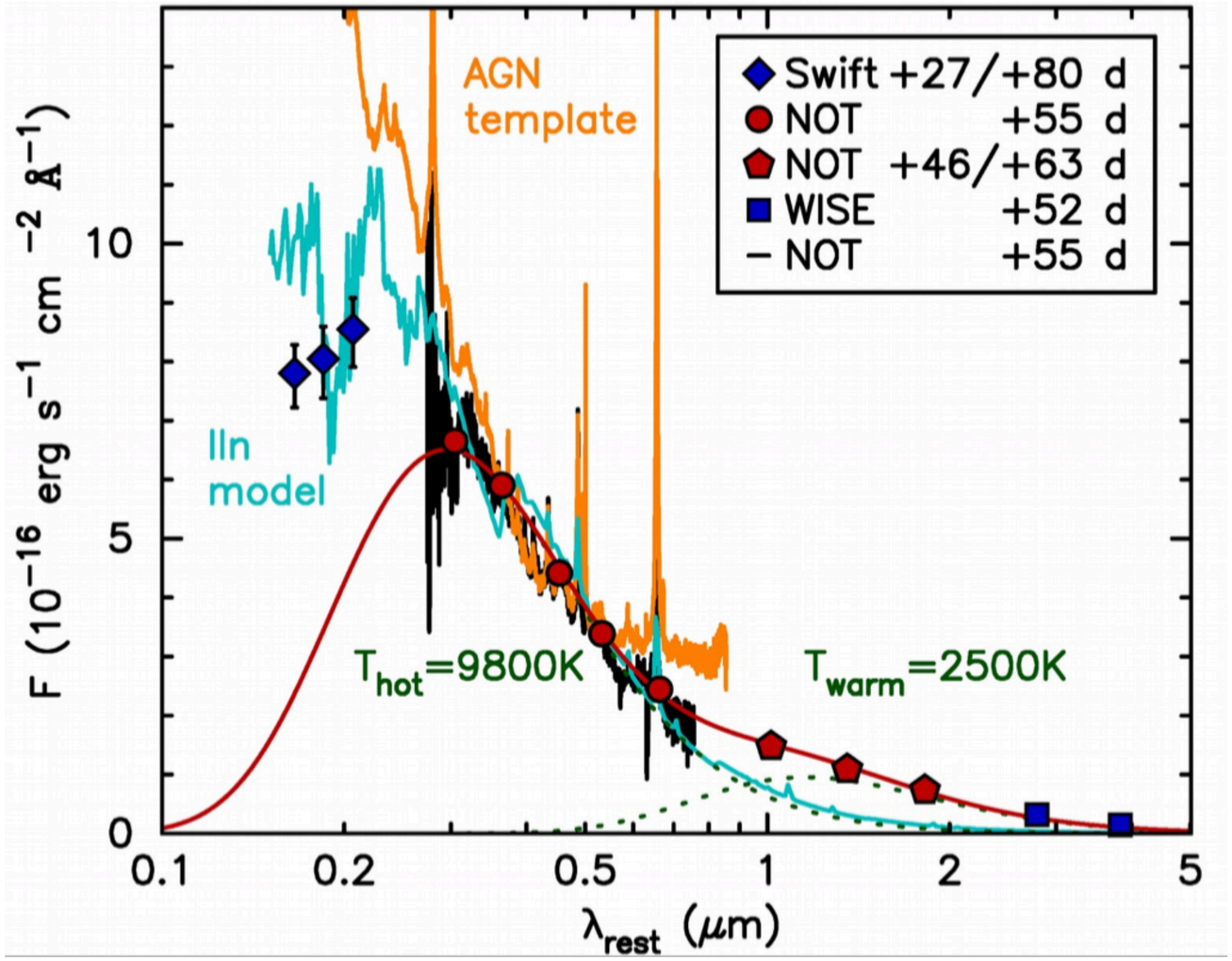
Double peaked accretion-disk profiles

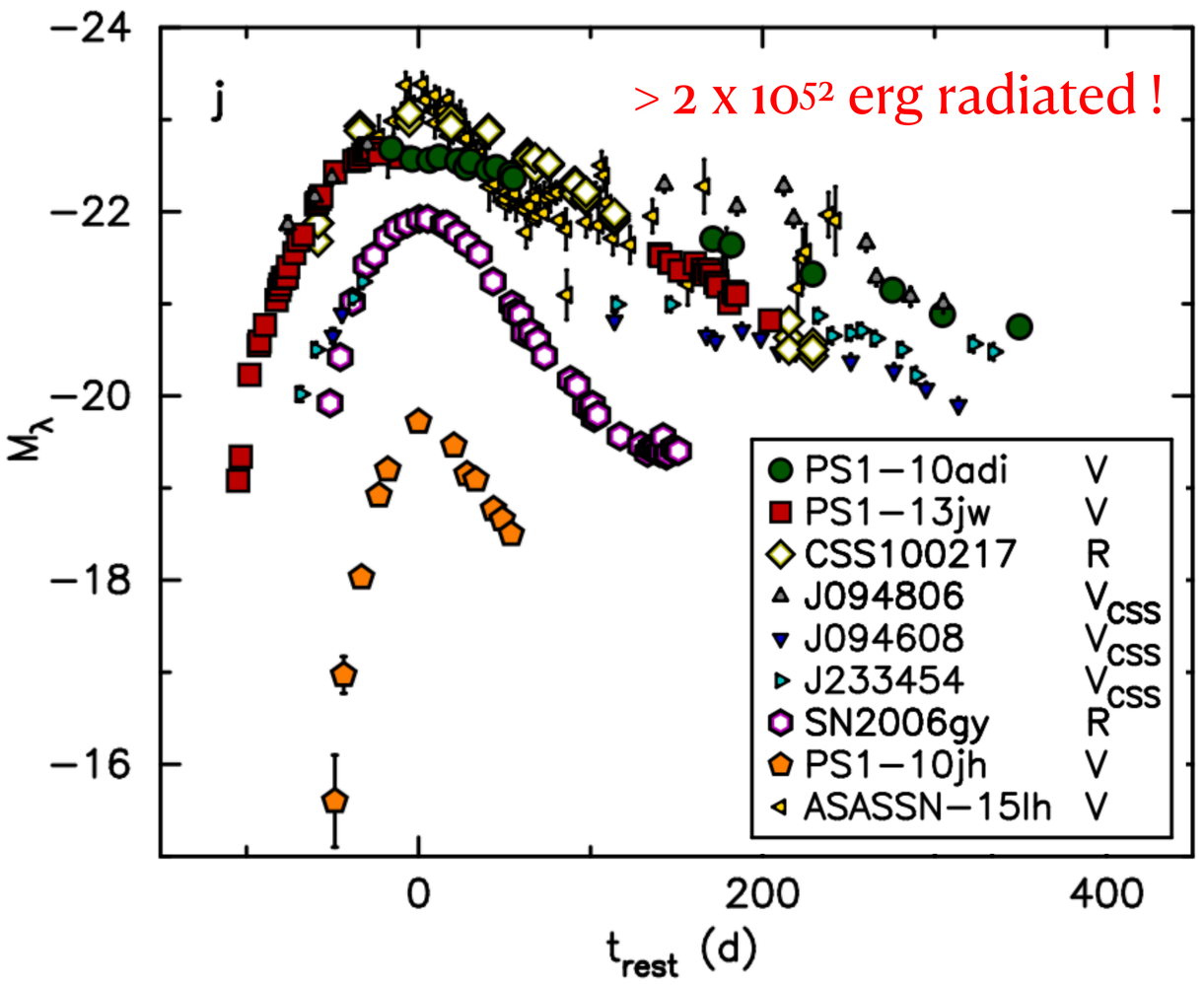


Short et al. (2020), see also Hung et al. (2020)

Energetic nuclear transients in AGN / LIRGs

PS1-10adi: Kankare et al. (2017)





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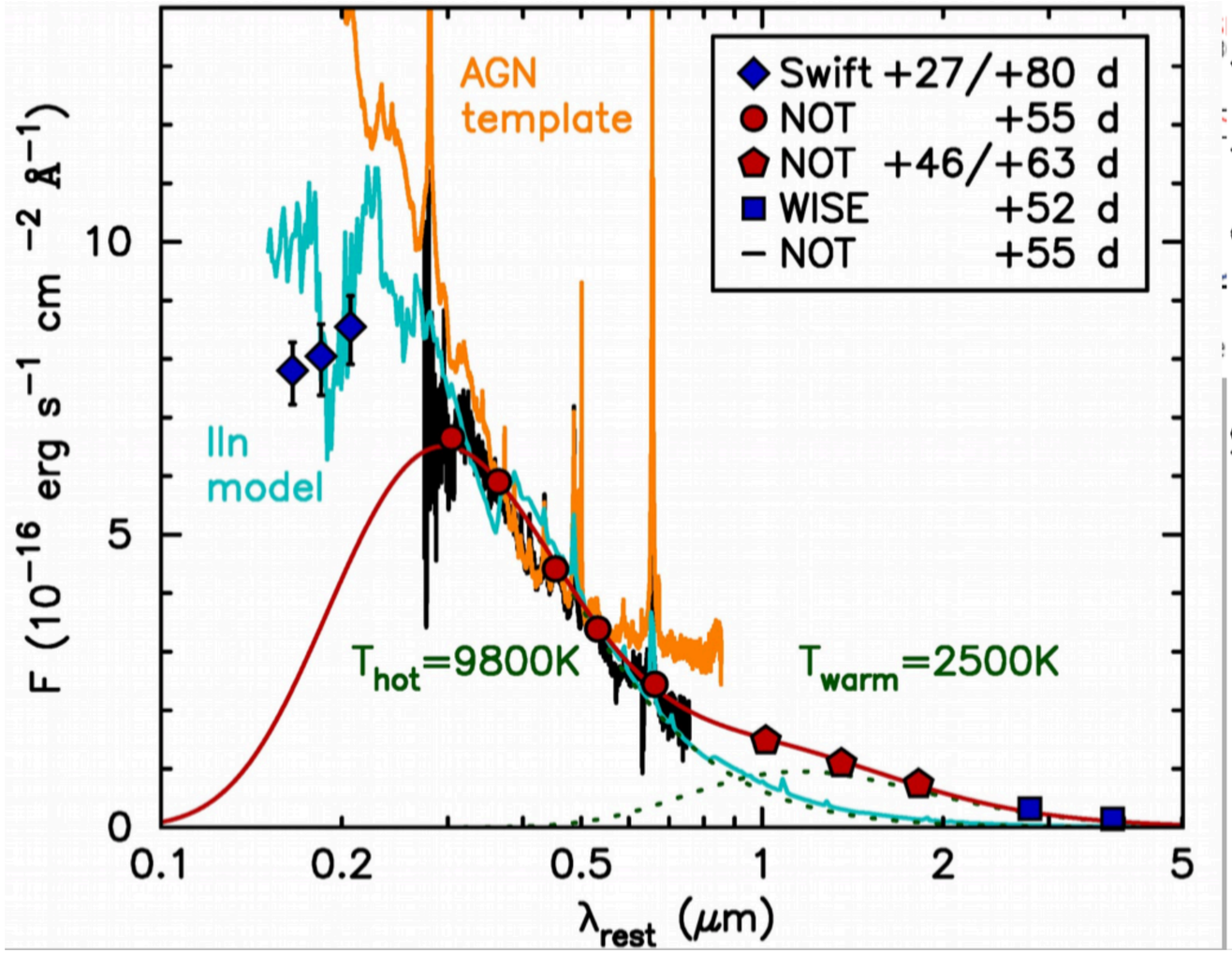
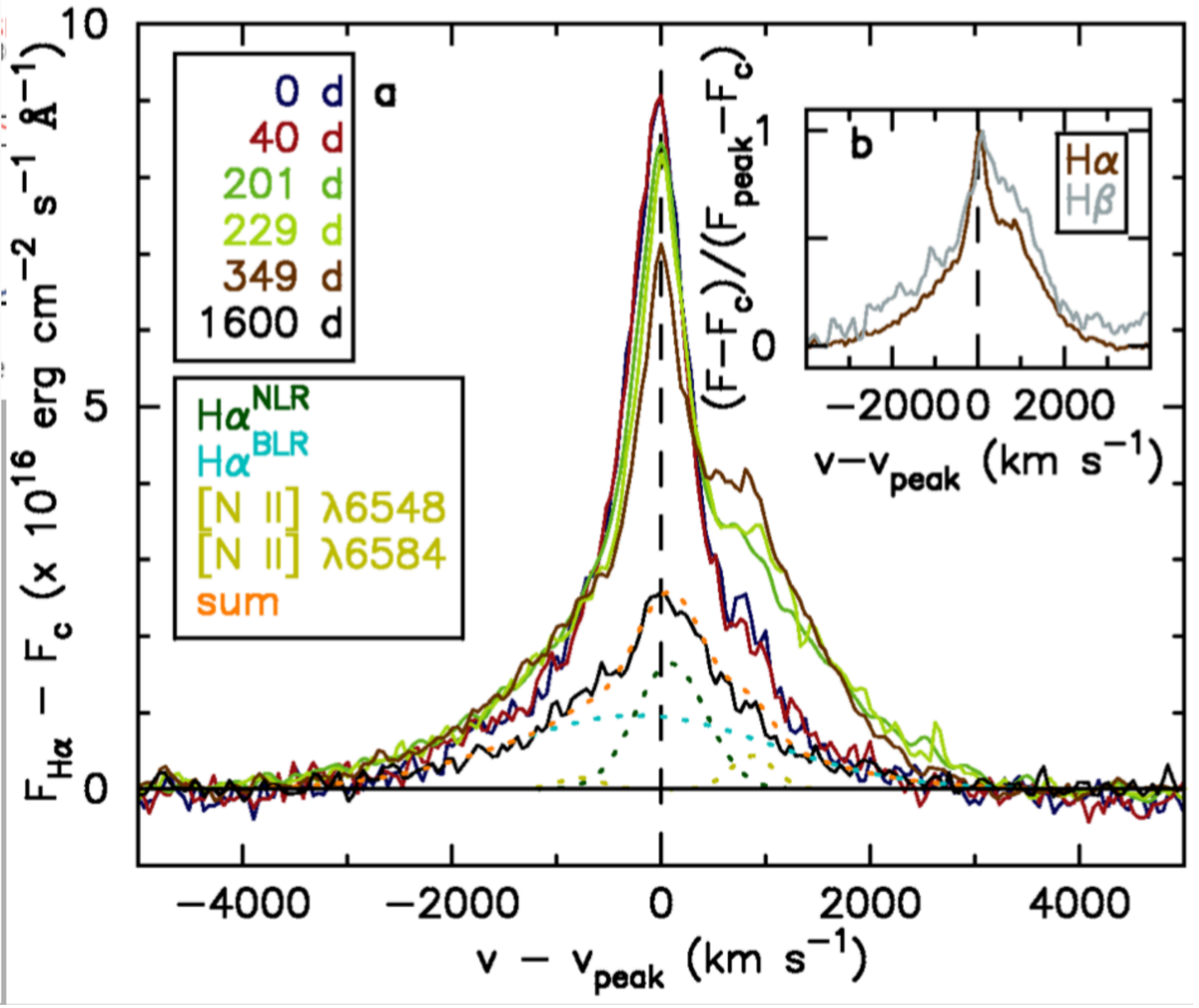
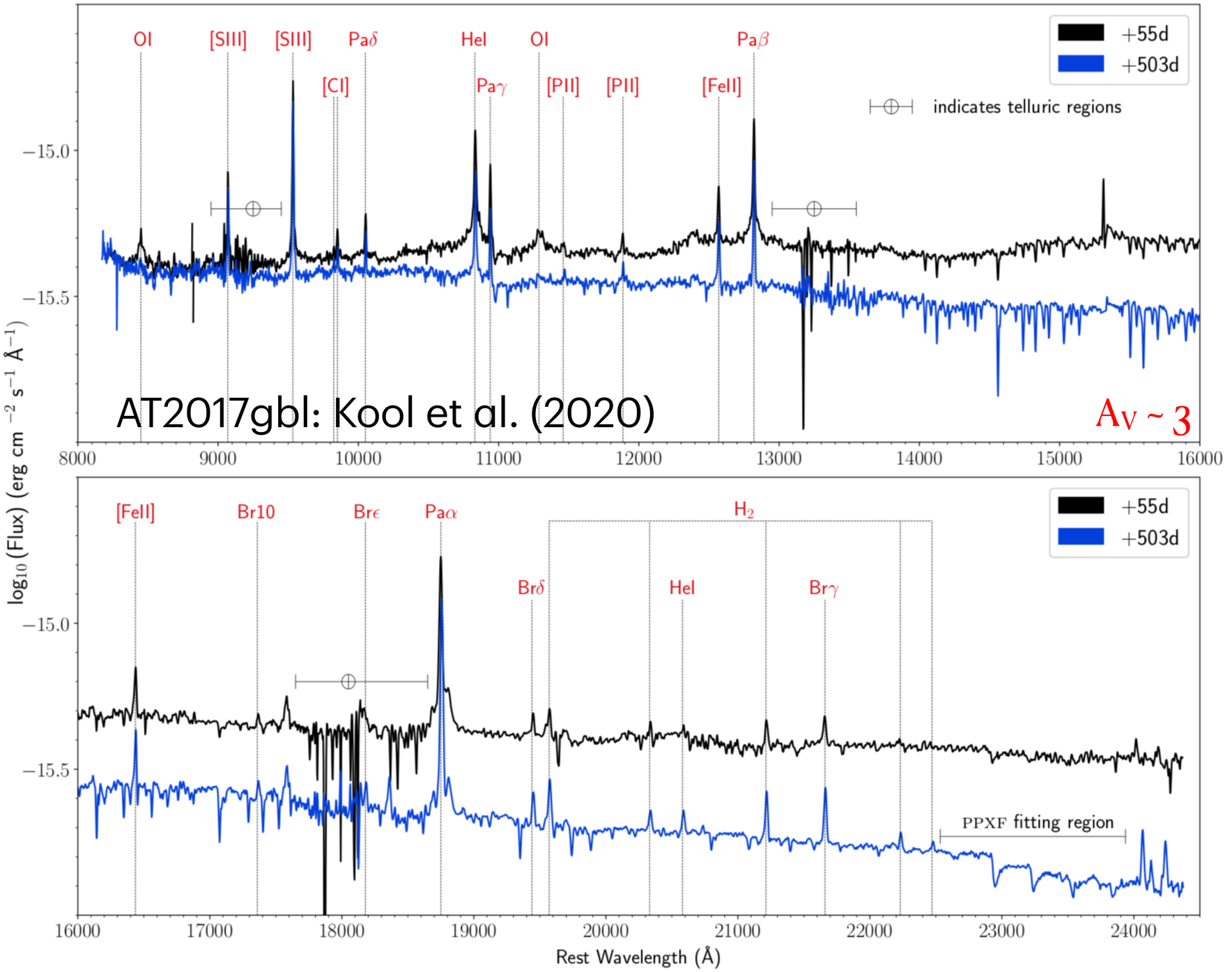
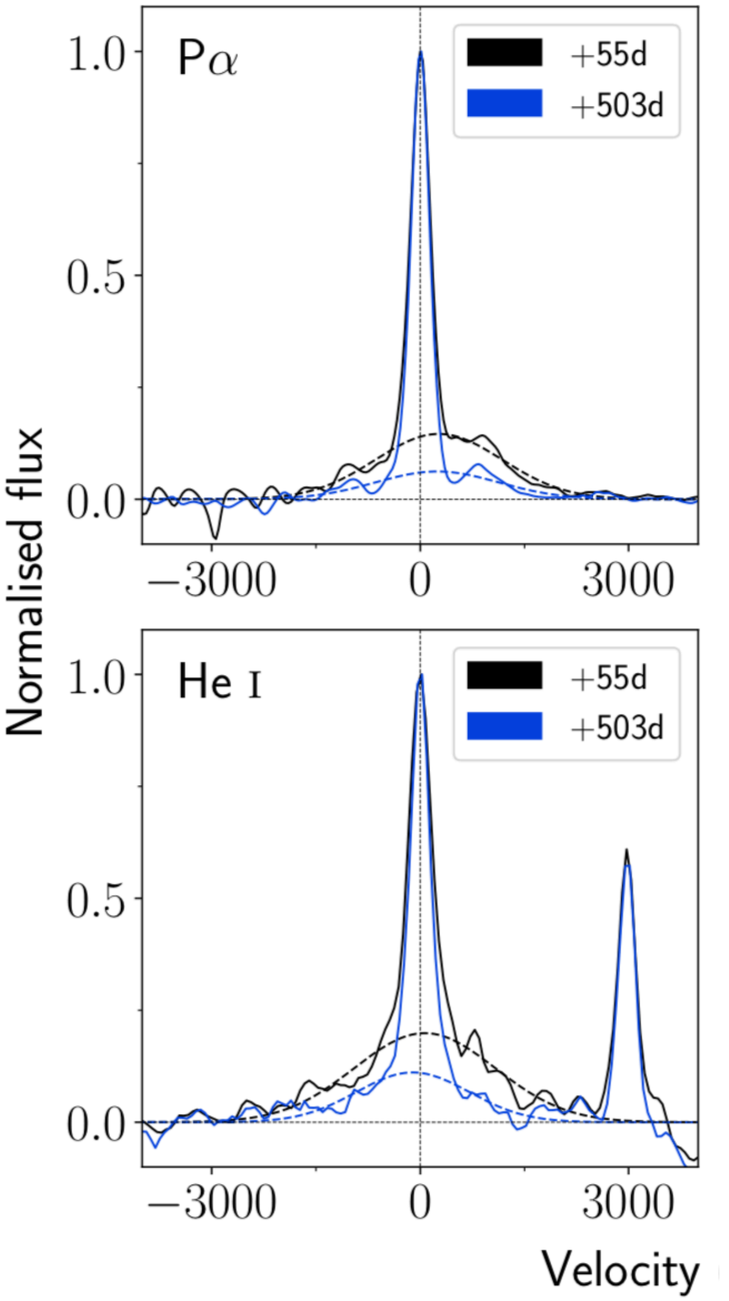





OI
[SIII]
[SIII]
Paδ
HeI
OI
Paβ
[CI]
Paγ
[PII]
[PII]
[FeII]
+55d
+503d
indicates telluric regions
AT2017gbl: Kool et al. (2020)
Av ~ 3
[FeII]
Br10
Brϵ
Paα
H2
Brδ
HeI
Brγ
PPXF fitting region
log10 (Flux) (erg cm −2 s−1 Å−1)
Rest Wavelength (Å)


Pα
+55d
+503d
He I
Normalised flux
Velocity

Total time request for WG10

Topic	people	targets	observations	time per year
Complete (100 Mpc) sample of TDEs	Campana et al.	>2	>10	0 hours
Spectral evolution of TDEs	Arcavi et al.	12	12	140 hours
Spectral evolution before peak	Campana et al.	1	10	10 hours
Nuclear transients in AGN	Mattila, Kankare, Nagao, Kotak, Bauer et al.	5	6	15 hours
Nuclear transients in LIRGs	Mattila, Kankare, Nagao, Kotak	0.5	10	5 hours
Demographics of TDE types	Bauer et al.	100	1	100 hours
Extreme variable AGN	Bauer et al.			6-10 hours
Monitoring changing look AGN	Marziani et al.			6 hours

Total request for WG10 170 hours per year to split between TAU : INAF : UTU : PUC/MAS

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Possibilities to carry out the 'TDE demographics' project as a part of the classification group?

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Possibilities to carry out the 'TDE demographics' project as a part of the classification group?

Overlap on nuclear transients in AGN with the AGN WG - agreed on collaboration !

SOXS WG10 look forward

- Prepare one internal proposal including all the nuclear transients topics
- Total request of SOXS time 170 hours per year over 5 yrs to be divided between TAU, INAF, UTU and PUC/MAS national GTO shares
- Overlap with the AGN WG on nuclear transients in AGN: agreed on collaboration on case by case bases
- Possibility of observe a large number of TDE candidates (1 spectrum per event) in the classification WG for demographics of TDE types and hosts
- Anyone not yet included in WG10 and interested in these topics please contact Seppo and Iair !

Access to feeder surveys and other observing facilities

- feeders: LSST, BlackGEM, ZTF, GOTO, Gaia Alerts, ULTRASAT, eROSITA
- optical photometry: LCO, REM
- near-IR photometry: GROND
- radio: though collaborations: MeerKAT, ASKAP, VLA sky survey
- X-ray: eROSITA, XMM, Swift
- UV: HST