Temporally Resolving Changing-~~Look~~State AGN
and
New Types of Flares from Accreting SMBHs

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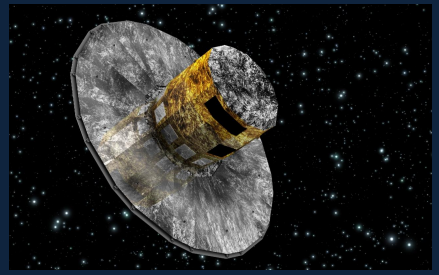
Tel Aviv University

with: Iair Arcavi (TAU), Chelsea MacLeod (CfA), Claudio Ricci (UDP), Erin Kara (MIT), Dan Stern (Caltech), Andy Howell (UCSB), Peter Jonker (SRON), Griffin Hosseinzadeh (CfA), Łukasz Wyrzykowski (Warsaw), Mariusz Gromadzki (Warsaw), Hagai Netzer (TAU), and many others...

Quasars in Crisis! Edinburgh, 8 August 2019

New Surveys: *the renaissance of time-domain astronomy*



gaia

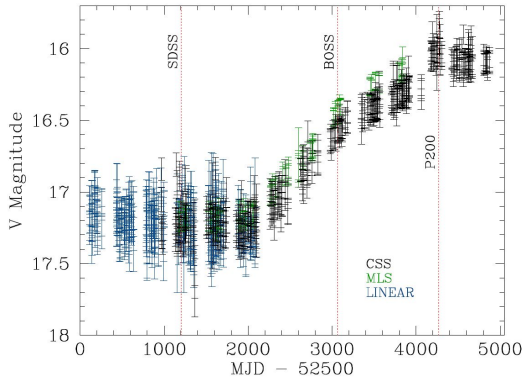
ASAS SN

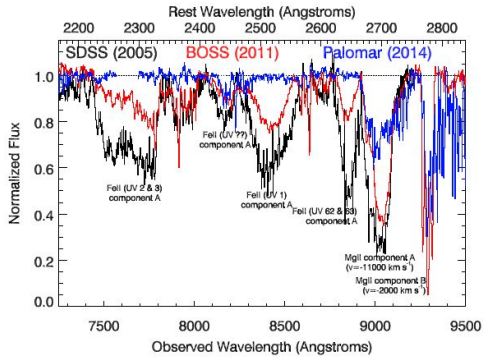
Catalina Real-time Transient Survey Stats (All data)

Telescope	All OTs	Supernovae	Cataclysmic Variables	Blazars	Asteriods/Flares	CV or SN	AGN	Other
CSS (CRTSII)	737	171	39	26	27	34	104	335
CSS (CRTS)	5540	1723	987	270	378	567	651	1054
MLS (CRTSII)	3702	1003	112	40	53	324	842	1343
MLS (CRTS)	5879	886	119	109	299	890	2787	1004
SSS (CRTS)	700	105	256	18	13	109	33	171
SNHunt	324	302	0	0	0	0	0	22
Total	16882	4190	1513	463	770	1924	4417	3929

New Surveys: *newly identified types of SMBH transients*

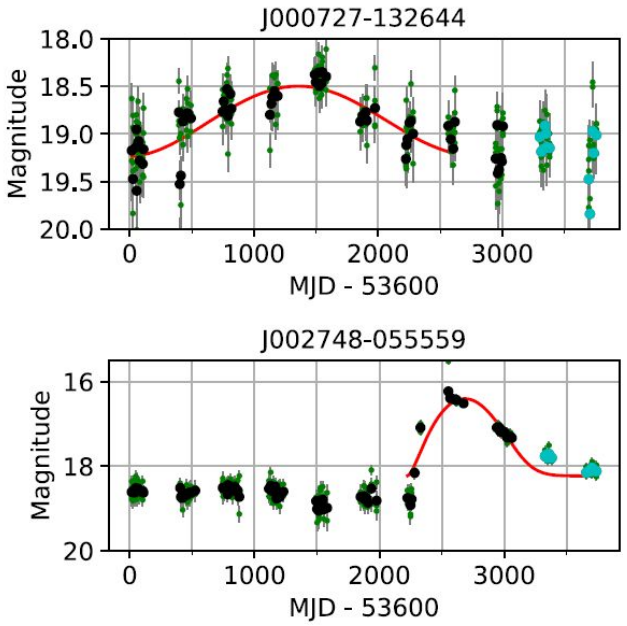
Changing look AGN





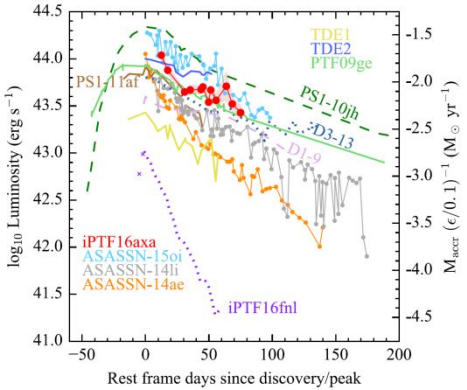
Stern+17 – CRTS J0841, CL-BAL-AGN?

Extreme quasar variability



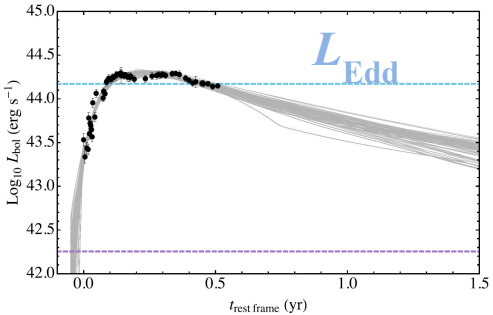
Graham+17 – Catalina (CRTS)

Tidal disruption events



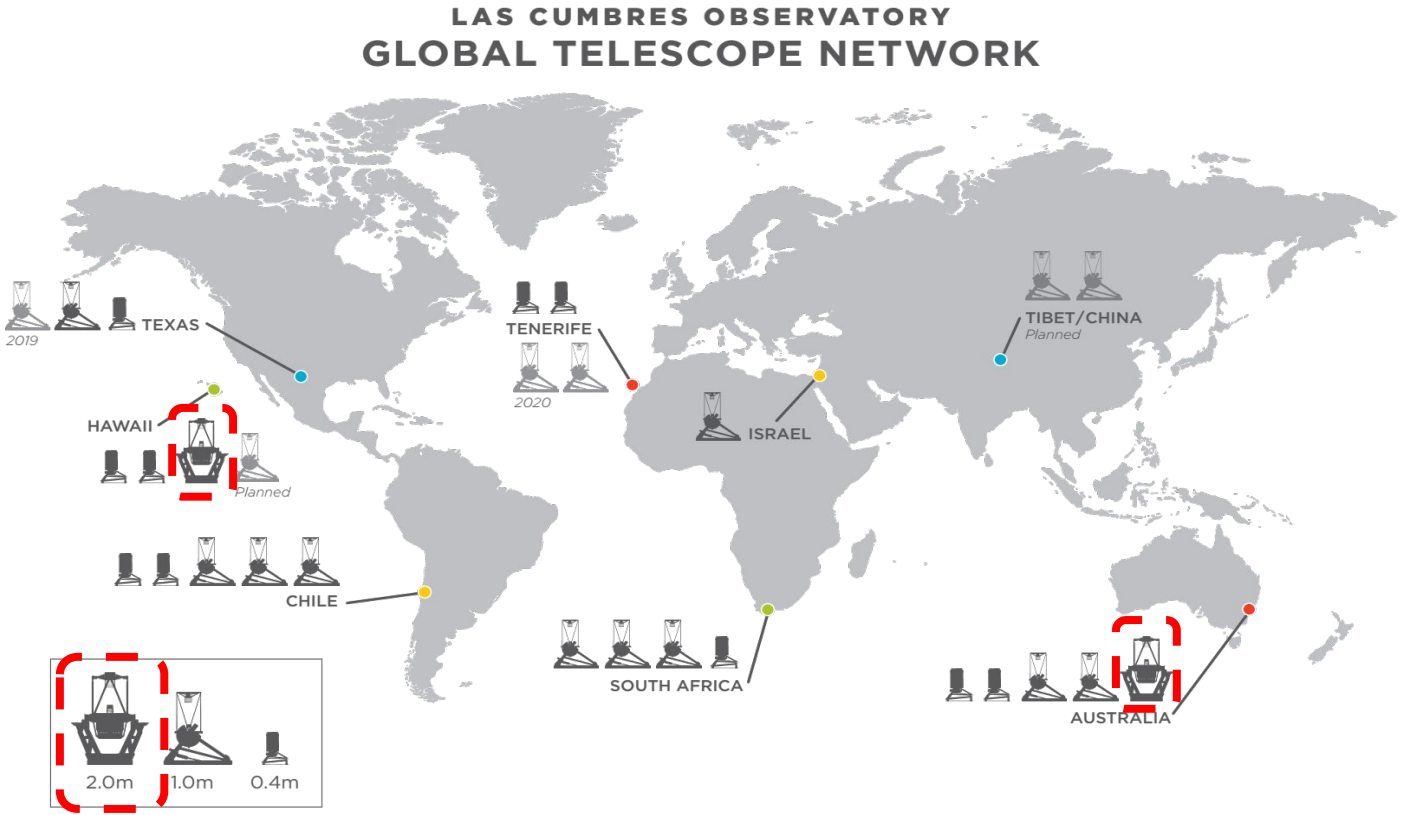
Hung+17 – iPTF16axa

Other nuclear transients?



Blanchard+17 – PS16dtm

New Surveys: *responsive spectroscopic follow-up facilities*



THE Sun

Thursday, January 11, 1979 7p TODAY'S TV: PAGES 6 and 7

CRISIS? WHAT CRISIS?

Rail, lorry, jobs chaos—and Jim blames the Press

By WALTER TERRY
Political Editor

SUN - TANNED Premier Jim Callaghan breezed back into Britain yesterday and asked: Crisis? What Crisis?

FEAR

BRINK

BRITAIN IN TURMOIL Page 2

FRANKLIN'S VIEW Page 6

Continued on Page 2

Please don't shoot the pianist

THE SUN is much slimmer than usual again today.

This is due to an acute shortage of newsprint arising from the lorry drivers' strike and is, of course, entirely beyond our control.

Just so that our readers and advertisers know exactly what is going on, we would like to explain one or two further consequences of the strike.

Sorry

* * *

Battle

Meanwhile, please don't shoot the pianist. He's doing his best!

In the news..

ROD'S KISS

ROCK star Rod Stewart stunned Olivia Newton-John with a kiss—and Russian diplomats with his sexy act at a New York concert.

See Page 5

In the news..

NURSE GUILTY

NURSE Olwen Peel (above) who claimed she was paid £800 for sex with a wheelchair-bound patient, was yesterday found guilty at Wakefield of stealing the money.

See Page 3

In the news..

RANDALL MARATHON

DEREK RANDALL kept Australia's bowlers at bay for 589 minutes in the heat of Sydney to score 150 runs and give England a 162-run lead yesterday.

See Page 14

HARD LINES...THE PICTURE WHICH TELLS IT ALL—CENTRE PAGES

1. A Changing Look AGN Caught in the Act

(and not just any AGN…)

2. A New Class of Flares from SMBHs

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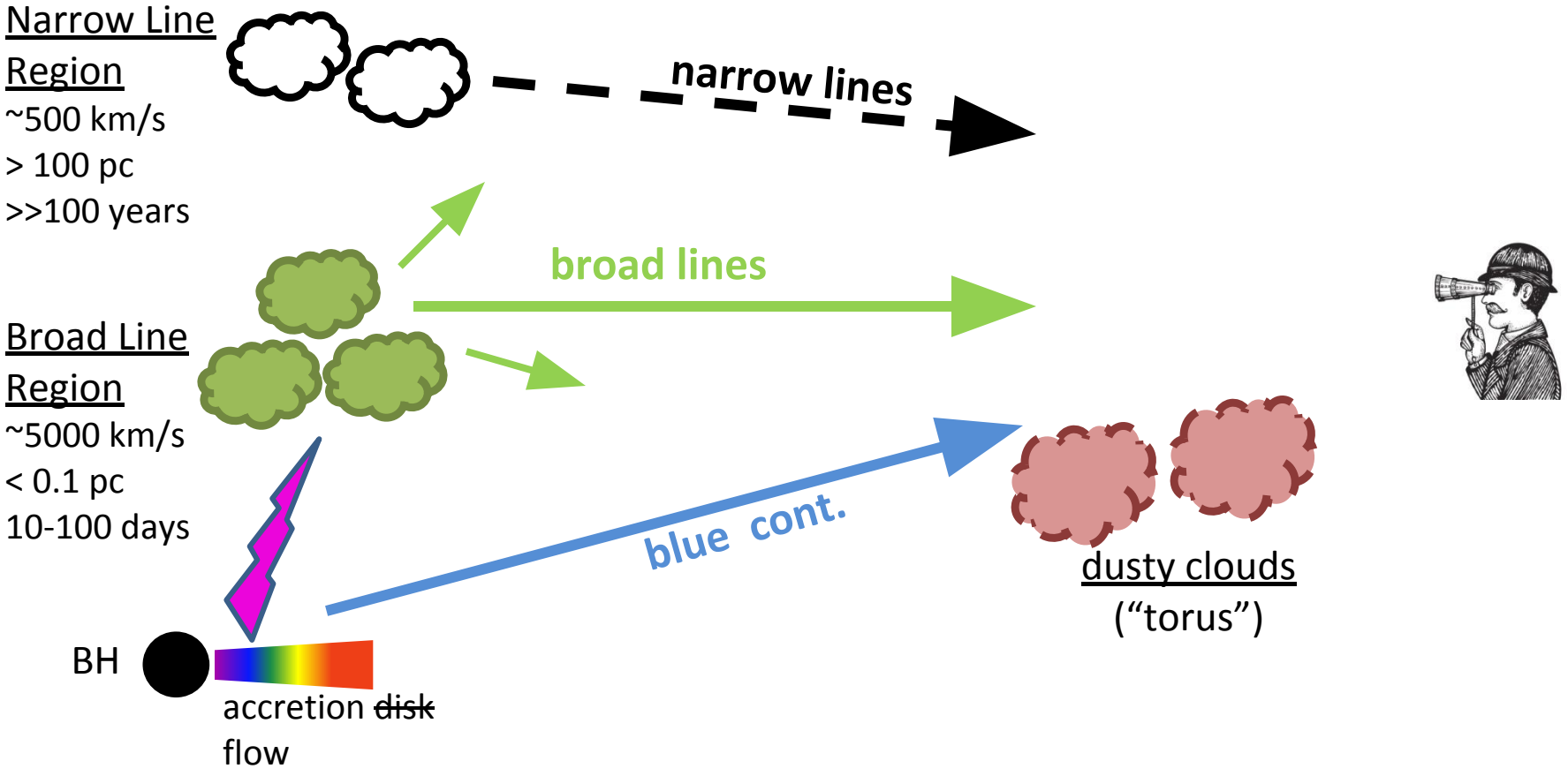
Changing-look AGN: *changes in accretion flow or obscuration?*



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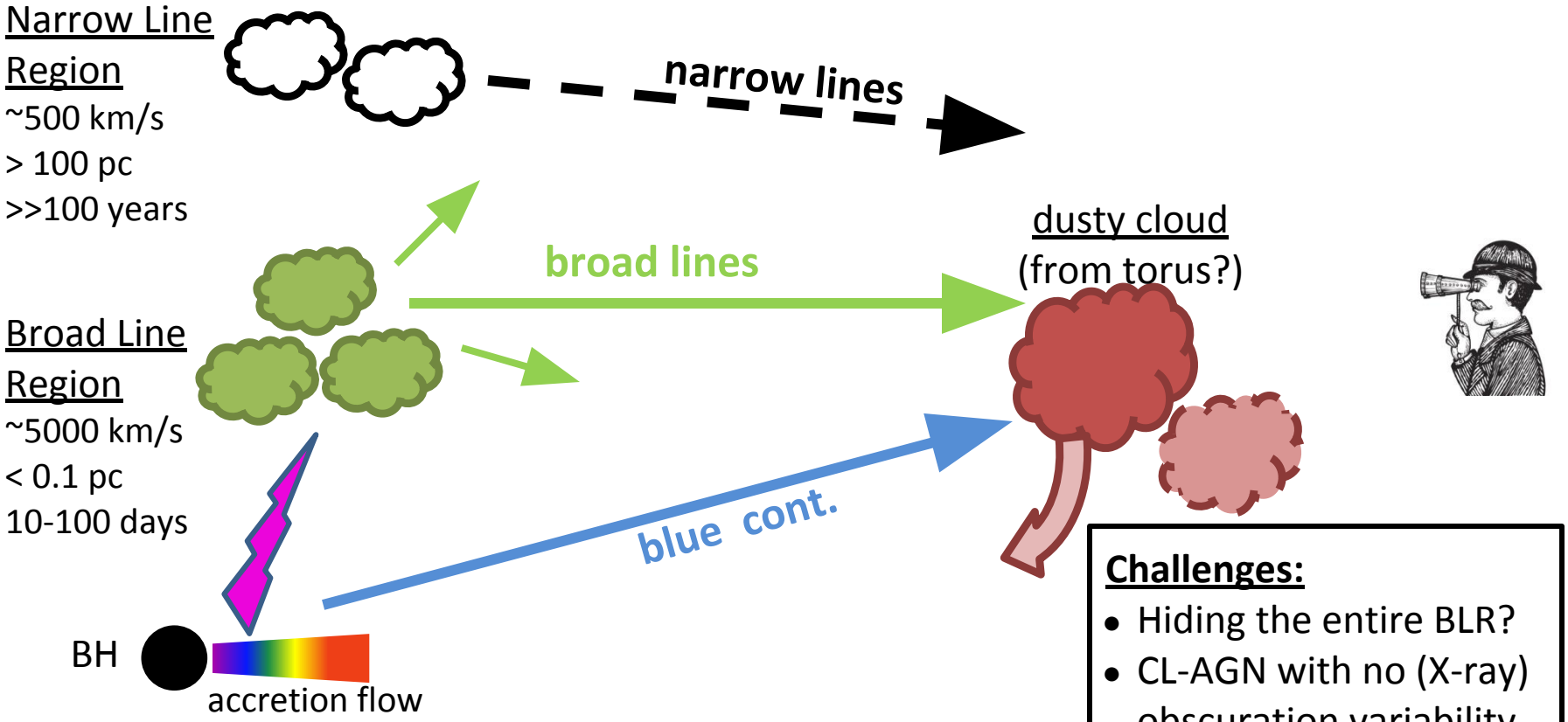


Challenges:

- Hiding the entire BLR?
- CL-AGN with no (X-ray) obscuration variability

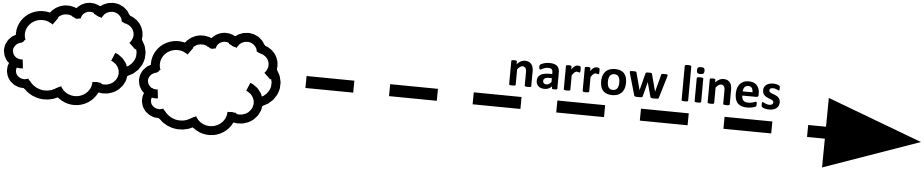
Changing-look AGN: *changes in accretion flow or obscuration?*

Narrow Line Region

~500 km/s

> 100 pc

>>100 years

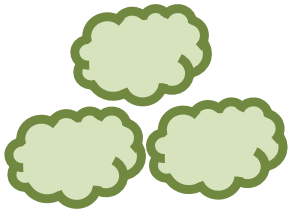


Broad Line Region

~5000 km/s

< 0.1 pc

10-100 days



BH

accretion flow

Changing-look AGN: *changes in accretion flow or obscuration?*

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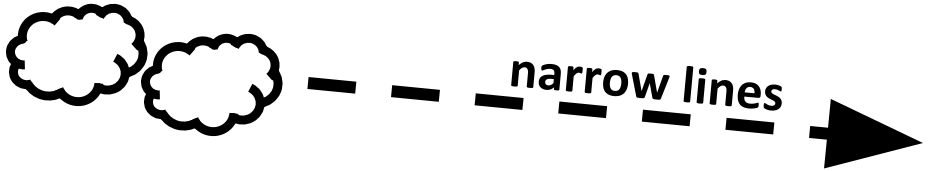

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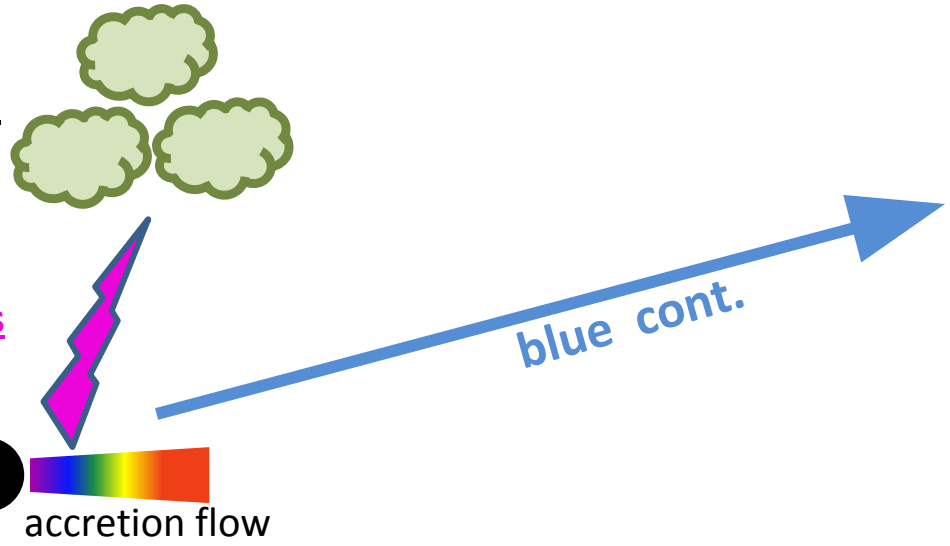
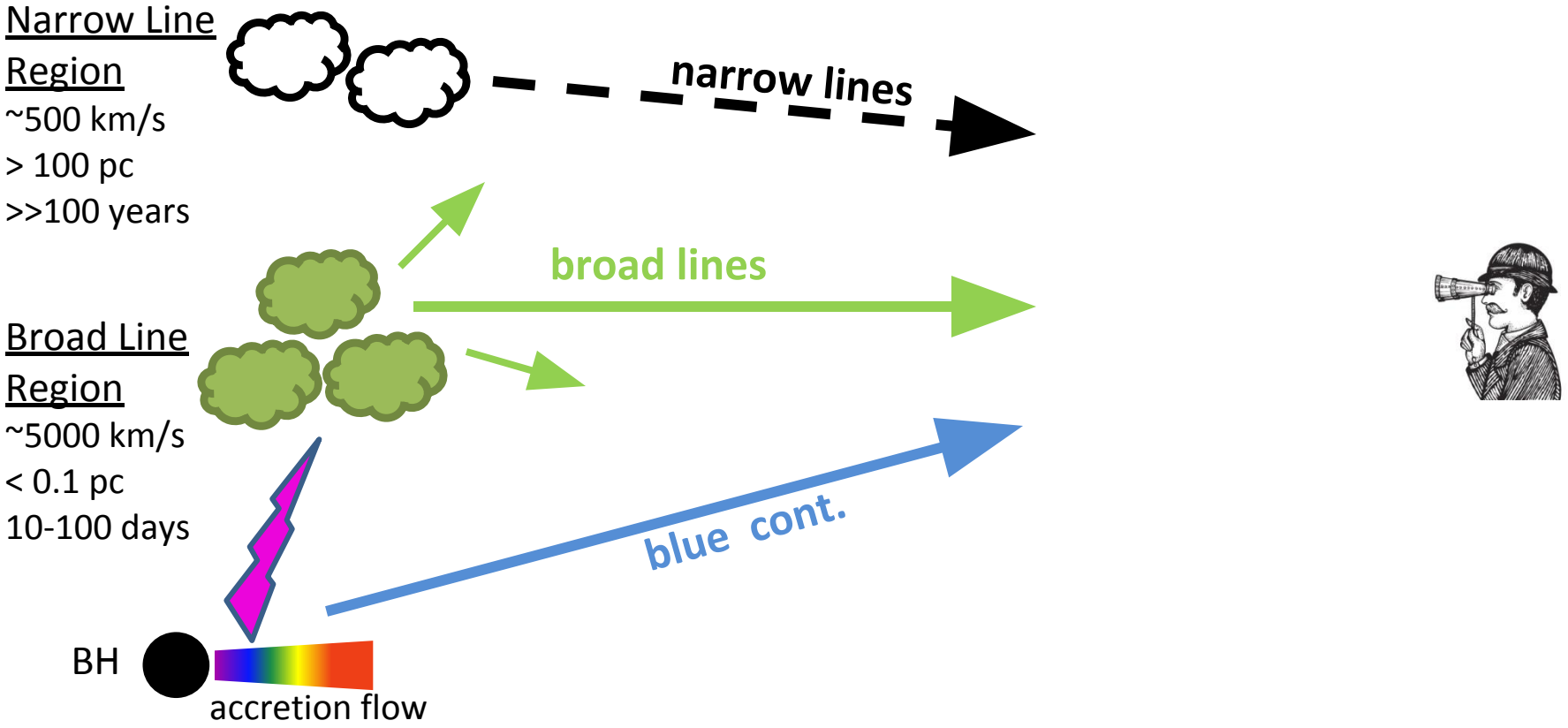


Changing-look AGN: *changes in accretion flow or obscuration?*



Changing-look AGN: *changes in accretion flow or obscuration?*

Narrow Line Region
~500 km/s
> 100 pc
>>100 years

narrow lines

broad lines

Broad Line Region
~5000 km/s
< 0.1 pc
10-100 days

blue cont.

BH

accretion flow

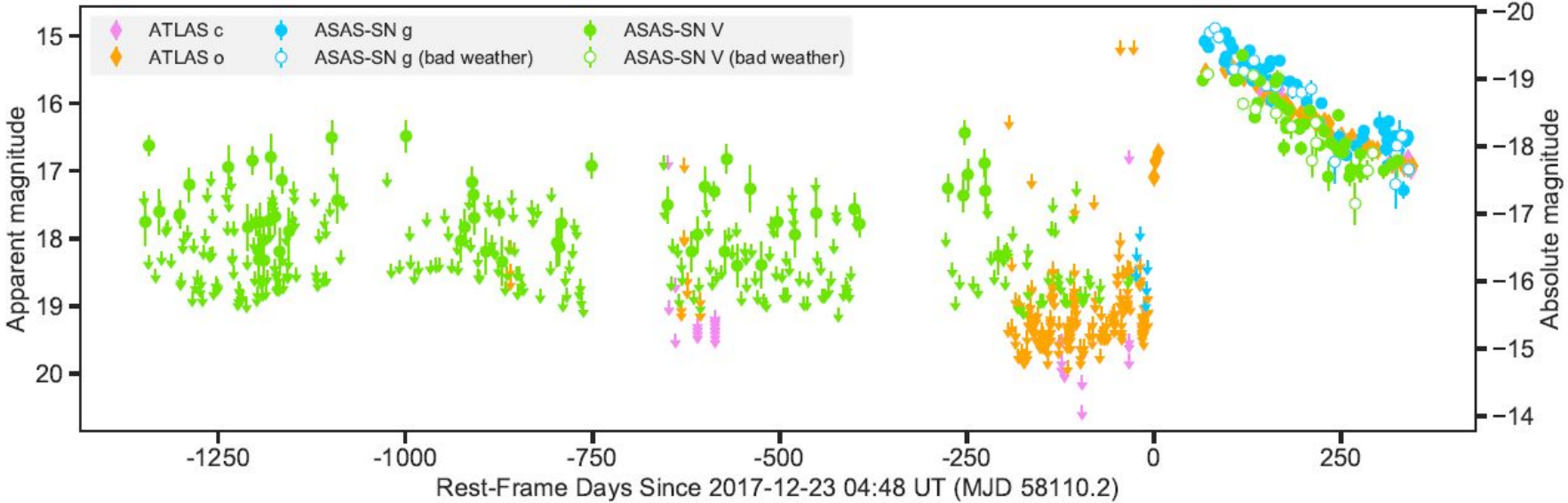
Challenges:

- Resolving the sequence
- Some CL-AGN with obscuration variability

1ES 1927+654: *optical light curve and flare detection*

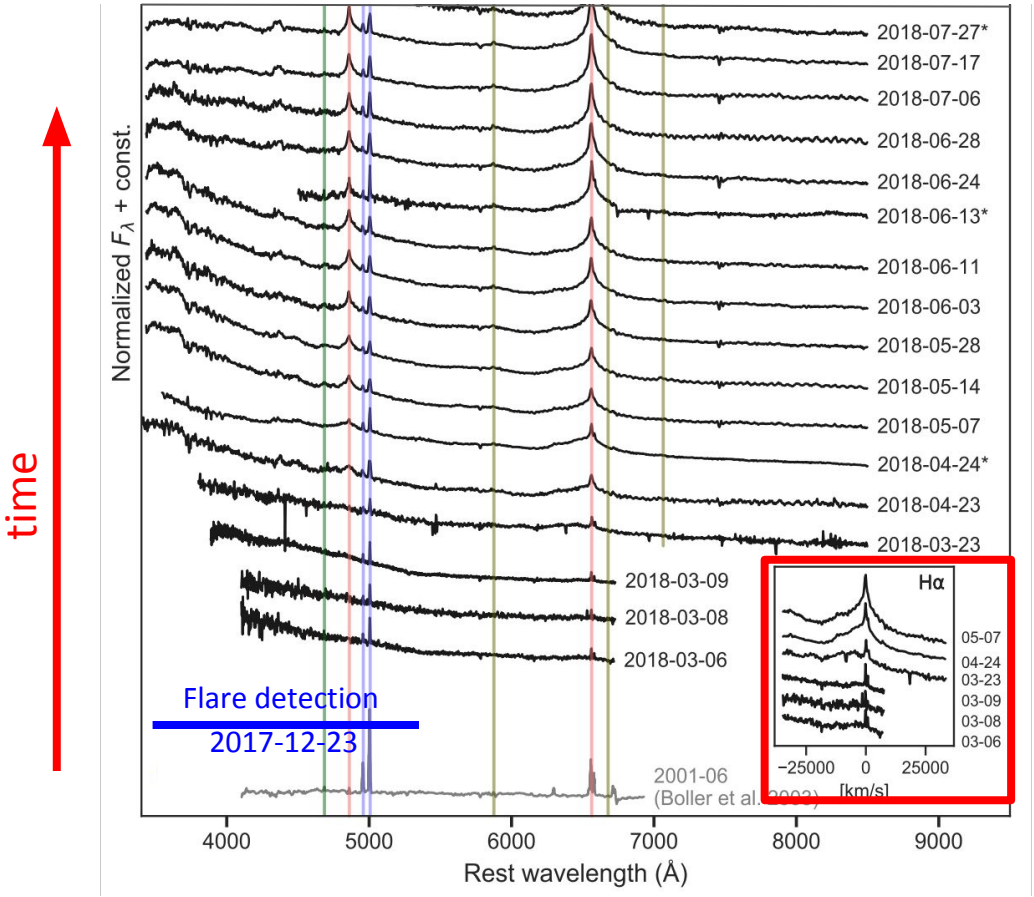
Detected by ATLAS, 2017 December 23
sharp rise in ~1 month: UV/opt increased by x40!
then slow decline

Trakhtenbrot+19b (arXiv:1903.11084)



Note: host-subtracted light-curve; early "detections" in ASAS-SN data are likely spurious…

1ES 1927+654: *fast follow-up optical spectroscopy*



- Historically: a “true Type-2”

Spectroscopic monitoring with:
LCO (robotic), MDM, Palomar, Keck

- Blue continuum appears first
- Broad emission lines appear
  ~3 months after peak UV
- Lag consistent with the BLR size!
  as expected from reverberation mapping scaling relations:

$$R_{\rm BLR} = (32.9^{+2.0}_{-1.9}) \left[\frac{\lambda L_\lambda (5100\ \text{Å})}{10^{44}\ \text{ergs s}^{-1}} \right]^{0.700 \pm 0.033} \text{lt-days}$$

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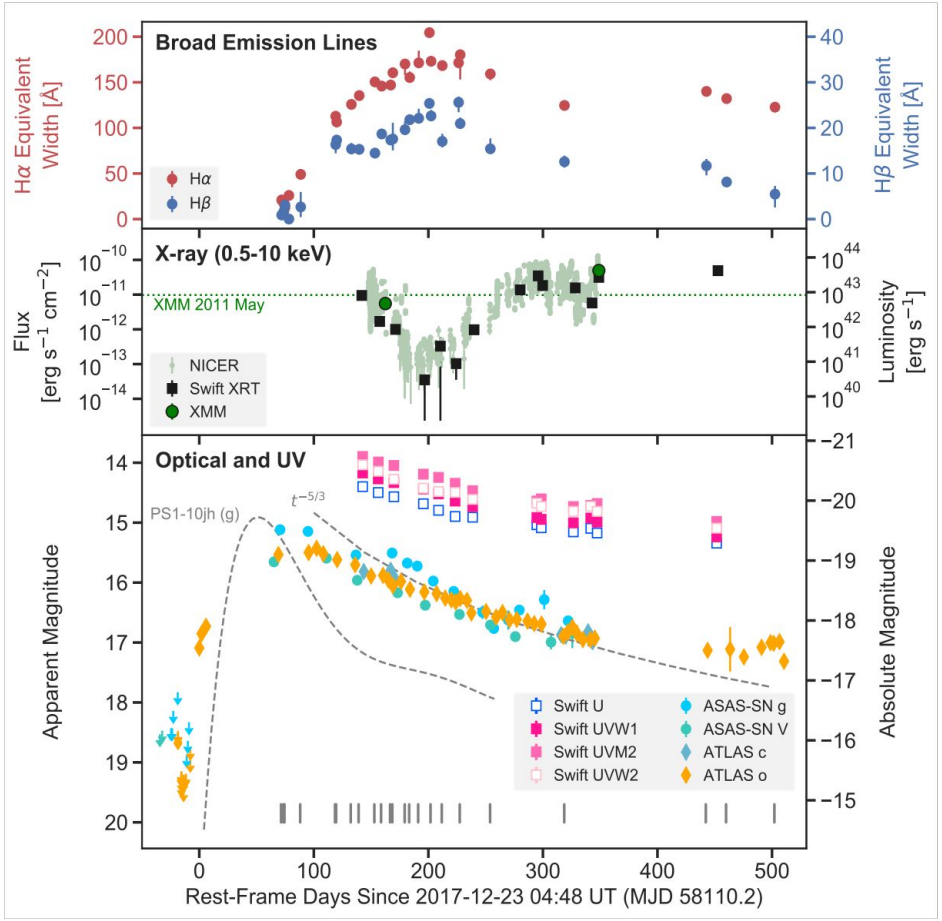

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> 100 pc
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narrow lines

broad lines

Broad Line Region
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< 0.1 pc
10-100 days

blue cont.

BH

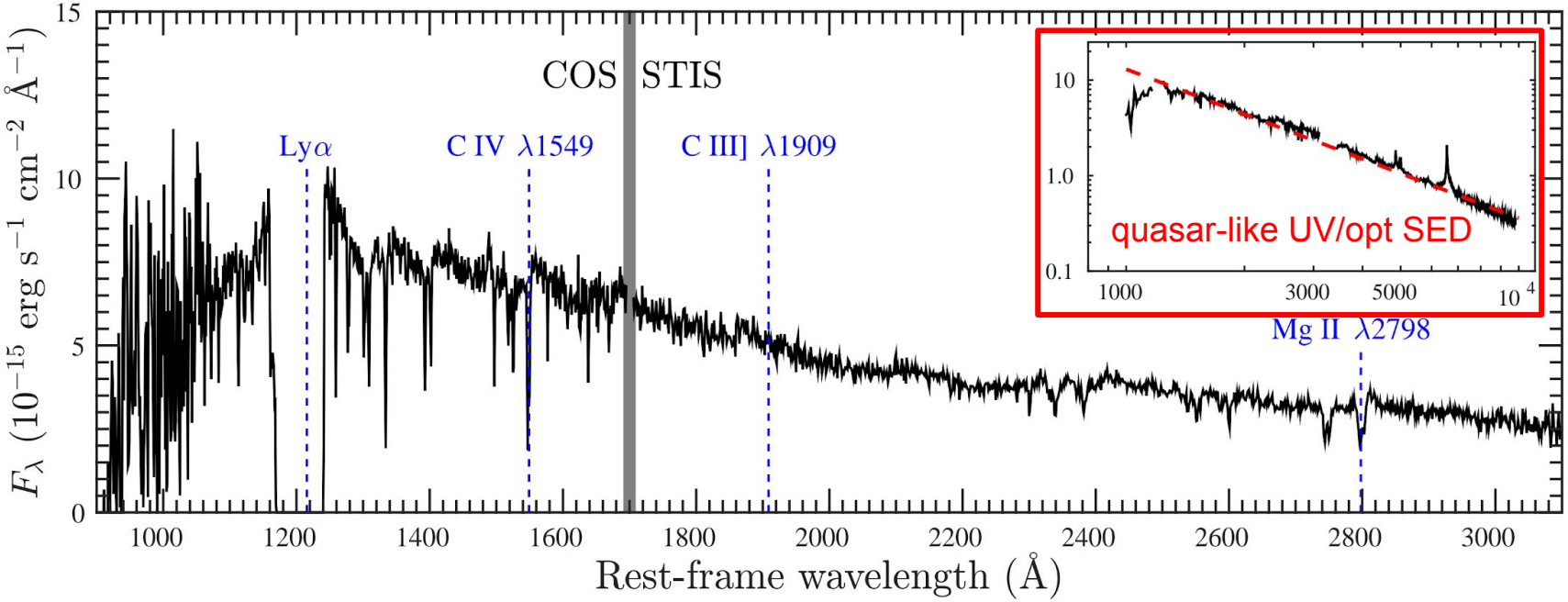
accretion flow

Challenges:

✓ Resolving the sequence

- Some CL-AGN with obscuration variability

1ES 1927+654: *HST/UV spec. – no high-ionization lines?*

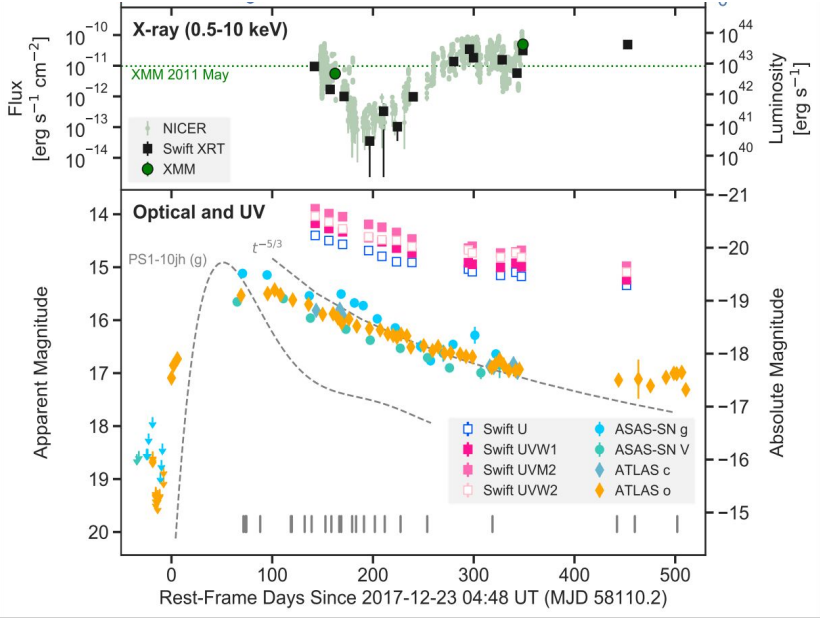


Challenge 1: high-ionization lines should originate closer to the SMBH!

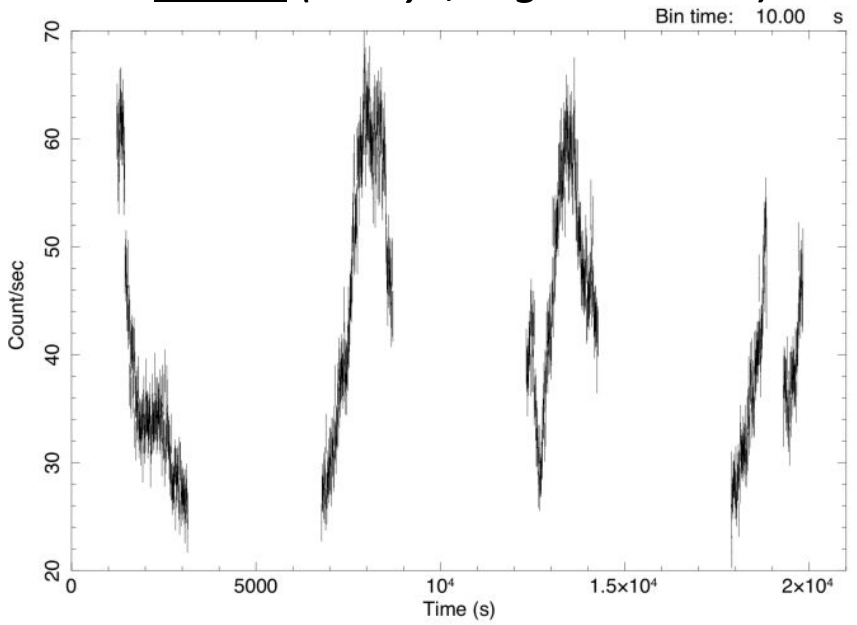
maybe a dusty BLR but a dust-free continuum l.o.s.?

1ES 1927+654: *X-ray and UV light curves - wait, what?!*

Swift *(X-rays and UV/opt.)*



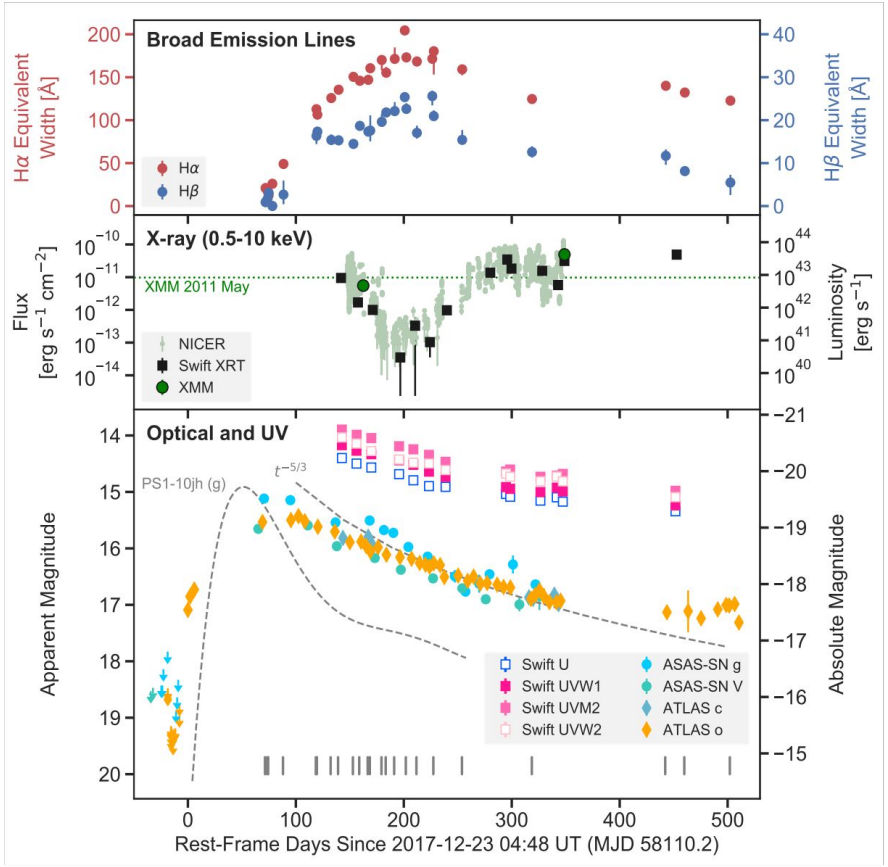
NICER *(X-rays, high cadence)*



Challenge 2: X-ray behavior doesn't follow the UV/opt, and is weird…

X-ray corona destroyed by UV "flash", then re-forms? (Ricci+ in prep.)

1ES 1927+654: *Final thoughts / questions*



- Was the BLR gas always there, and is "now" illuminated?

  <u>OR</u>:

- Is the BLR gas "fresh", linked to the accretion enhancement?

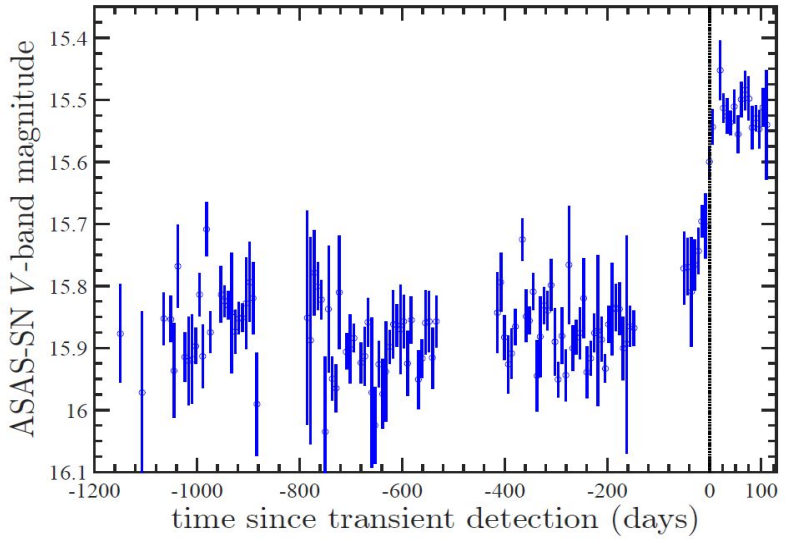
- What initiated the event?
  <u>a TDE in an AGN</u>?!
  (see Merloni+15, Chan+19)

1. A Changing Look AGN Caught in the Act

(and not just any AGN…)

2. A New Class of Flares from SMBHs

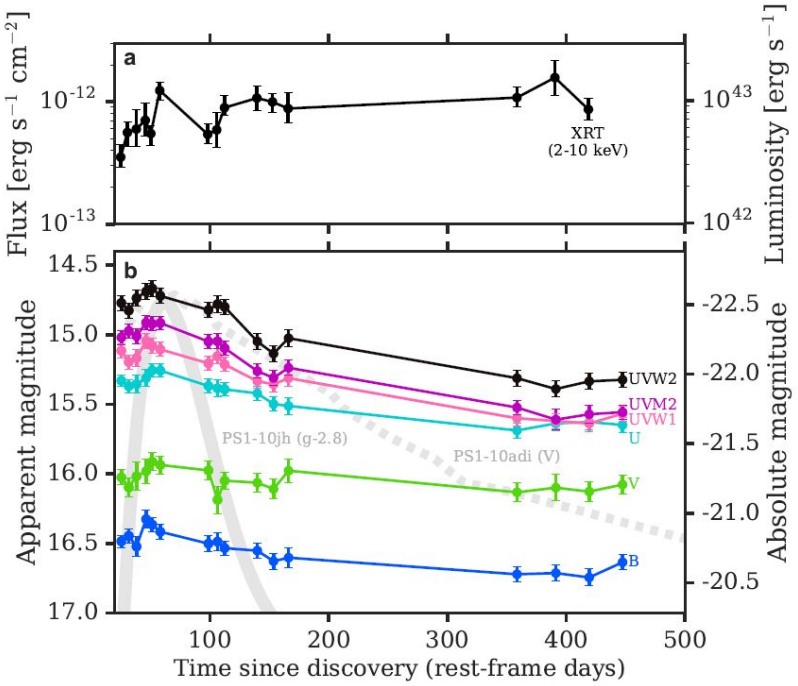
AT2017bgt: *a UV/opt.-bright SMBH flare lasting >1 year?*



AT2017bgt: sharp rise in optical/UV emission, then plateau

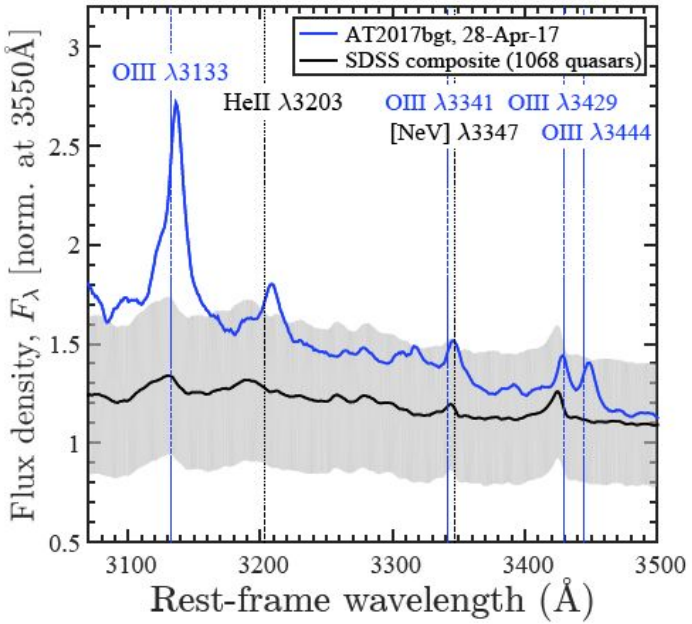
- UV increased by x75 (~10^{45} erg/s)
- X-ray increased by x2-3 (~10^{43} erg/s)
- UV-brighter than typical AGN, by x50

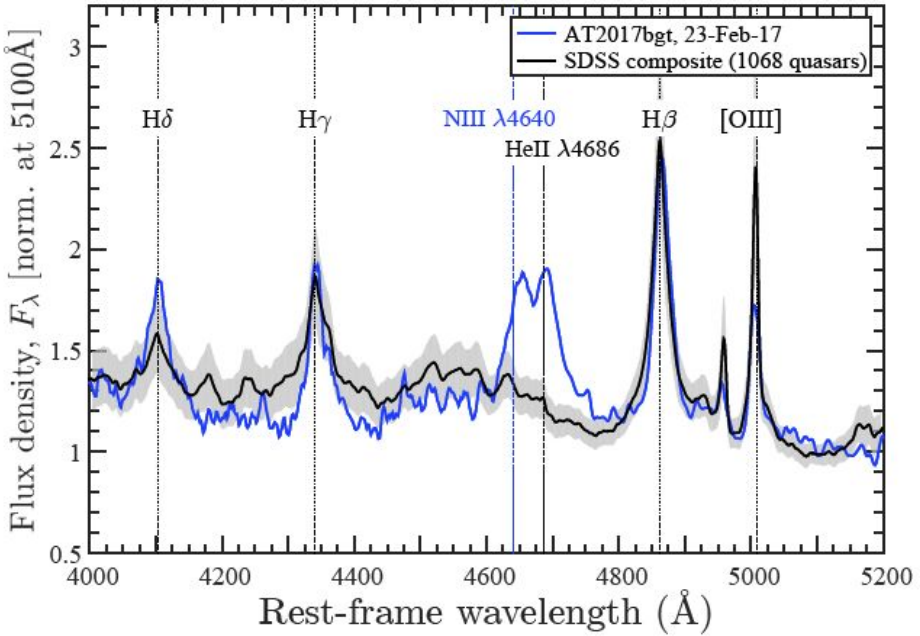
Trakhtenbrot+19a (arXiv:1901.03731)



archival UV measurement

AT2017bgt: *peculiar optical emission lines*



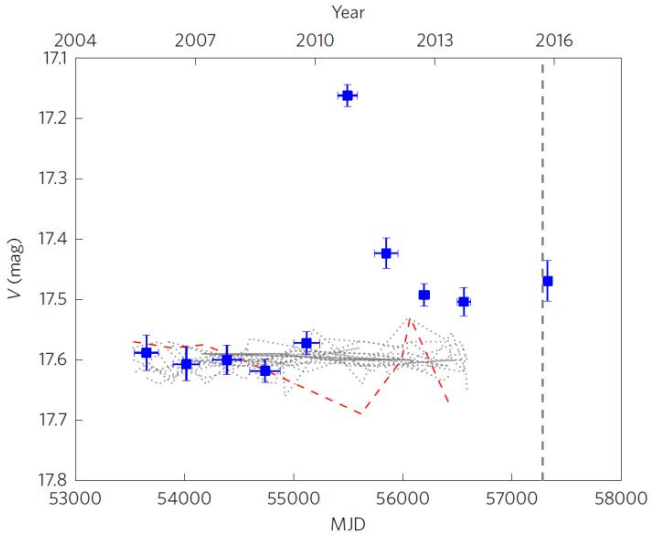


Combination of persistent spectral features

- AGN-like broad Balmer lines (~2000 km/s)
- **Broad Bowen Fluorescence lines – first robust identification!** (prediction: Netzer+85) driven by the Lyα-like line of HeII 303.8Å ⇒ Extreme UV emission?

Not Alone: *a new class of flares from SMBHs?*

F01004-2237 - Tadhunter et al. (2017)

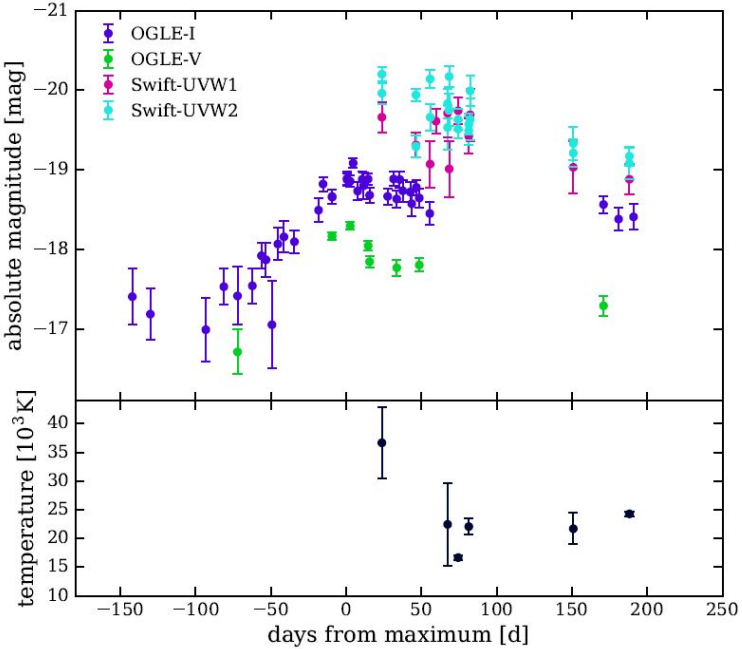


nature astronomy
LETTERS
PUBLISHED: 1 MARCH 2017 | VOLUME: 1 | ARTICLE NUMBER: 0061

A tidal disruption event in the nearby ultra-luminous infrared galaxy F01004-2237

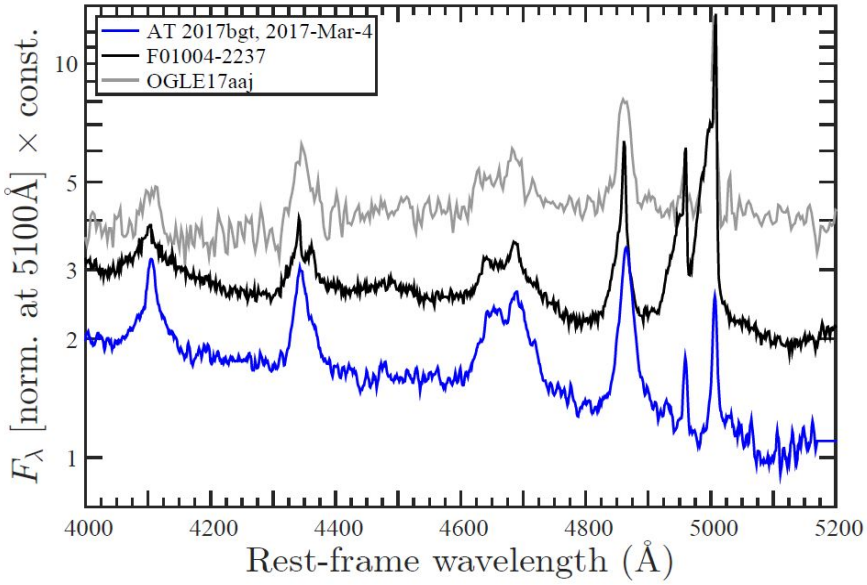
C. Tadhunter*, R. Spence, M. Rose, J. Mullaney and P. Crowther

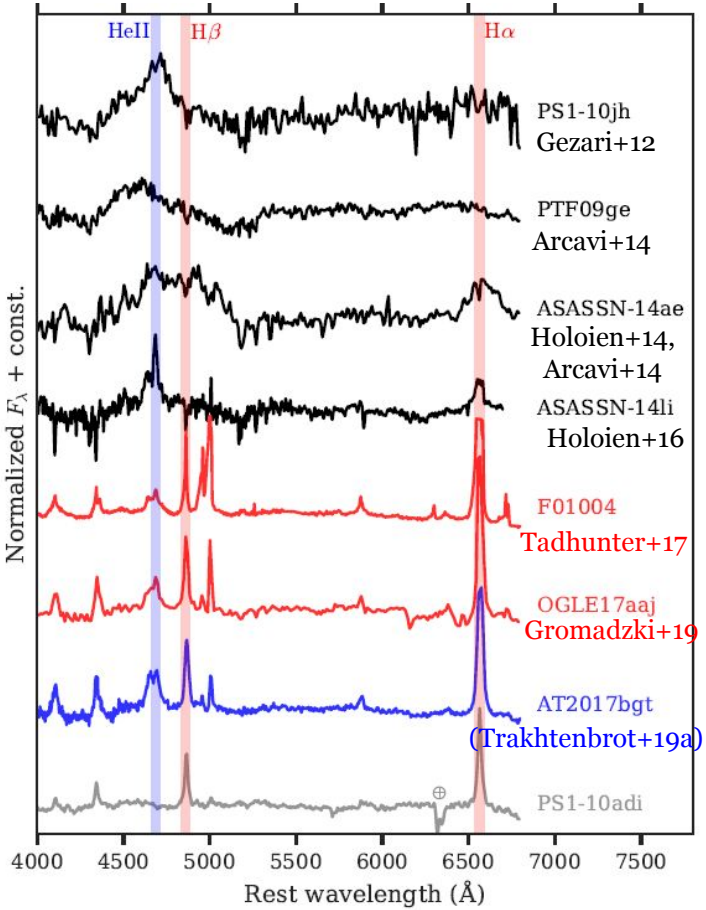
OGLE17aaj - Gromadzki et al. (2019)



… additional events under study!

Not Alone: *a new class of flares from SMBHs?*





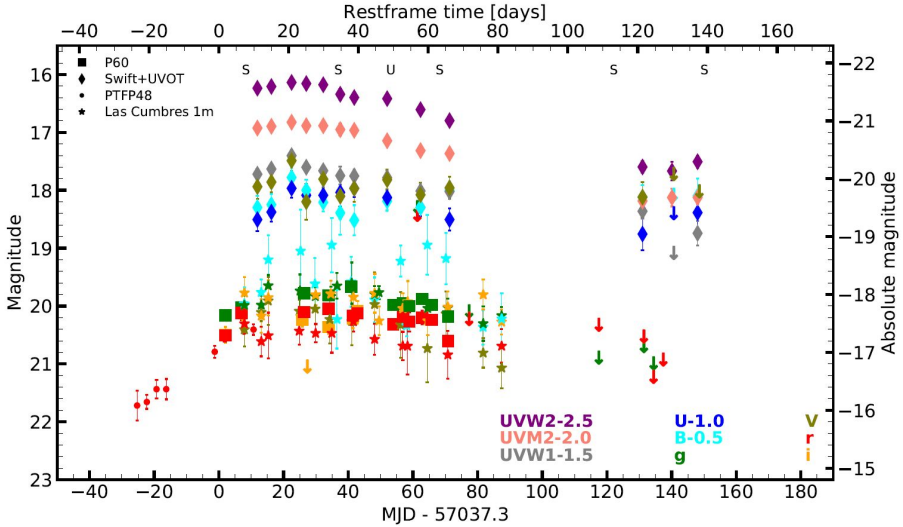
- Sharp rise in optical/UV emission, plateau
- Persistent AGN + Bowen fluorescence lines
  - ***not*** similar to TDEs
  - all are ***in NLSy1s***! related to fast-growing SMBHs?

Not Alone: *Bowen fluorescence in SMBH flares & TDEs?*

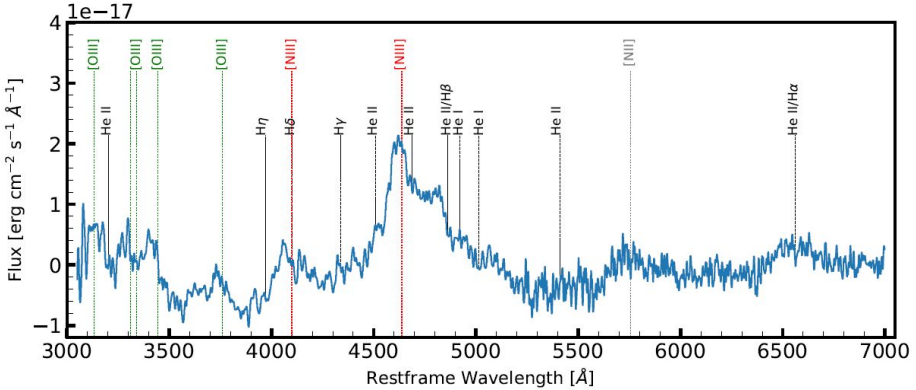
The Broad Absorption Line Tidal Disruption Event iPTF15af:

N. Blagorodnova,[1] S. B. Cenko,[2,3] S. R. Kulkarni,[1] I. Arcavi,[4,5,*] J. S. Bloom,[6] G. Duggan,[1] A. V. Filippenko,[6,7] C. Fremling,[1] A. Horesh,[8] G. Hosseinzadeh,[9] E. Karamehmetoglu,[10] A. Levan,[11] F. J. Masci,[12] P. E. Nugent,[13,6] D. R. Pasham,[14,*] S. Veilleux,[2,15] R. Walters,[1] L. Yan,[1] and W. Zheng[6]

arXiv: 1809.07446



- Slowly evolving UV-optical light-curve
- Extremely UV-bright (UV/X higher than AGN by x40)



- Clear TDE properties: high He/Hβ
- BF lines from the OIII and NIII cascades

see also ASASSN-18pg / AT 2018dyb
Leloudas+19, arXiv: 1903.03120

Summary

1. **New surveys** provide samples of extreme events related to SMBH accretion

2. **A CL-AGN caught in the act...**
   - CL-AGN driven by changes in accretion flow
   - multi-wavelength behavior is still puzzling
   - was the BLR gas always there? TDEs in AGN?

3. **New classes of transients** from accreting SMBHs:
   - AGN with sharp rise (~1 month) in UV-optical, then ~stable (>1 year)
   - new probes of extremely UV-bright accretion
   - probe lower-mass SMBHs? super-Eddington accretion?
   - ***diagnostics and models are badly needed!***

4. **Upcoming surveys** will turn the trickle into a flood …
   - *fast/responsive spectroscopic (and multi-λ) follow-up is key!*

1ES 1927+654: *X-ray spectra and radio data*

X-rays - *Ricci+ (in prep.)*

- *XMM, NuSTAR, NICER*
- sharp spectral changes
- corona gone? (& reappeared?!)

Radio/VLBI - *Yang, Ho+ (in prep.)*

- EVN (5 GHz) + [*NICER, sim.*]
- x20 drop in radio flux
- radio / X-ray ~ 10^{-5}
- radio SED much steeper?
- linked to state changes in corona?