Changing–look NLS1s?

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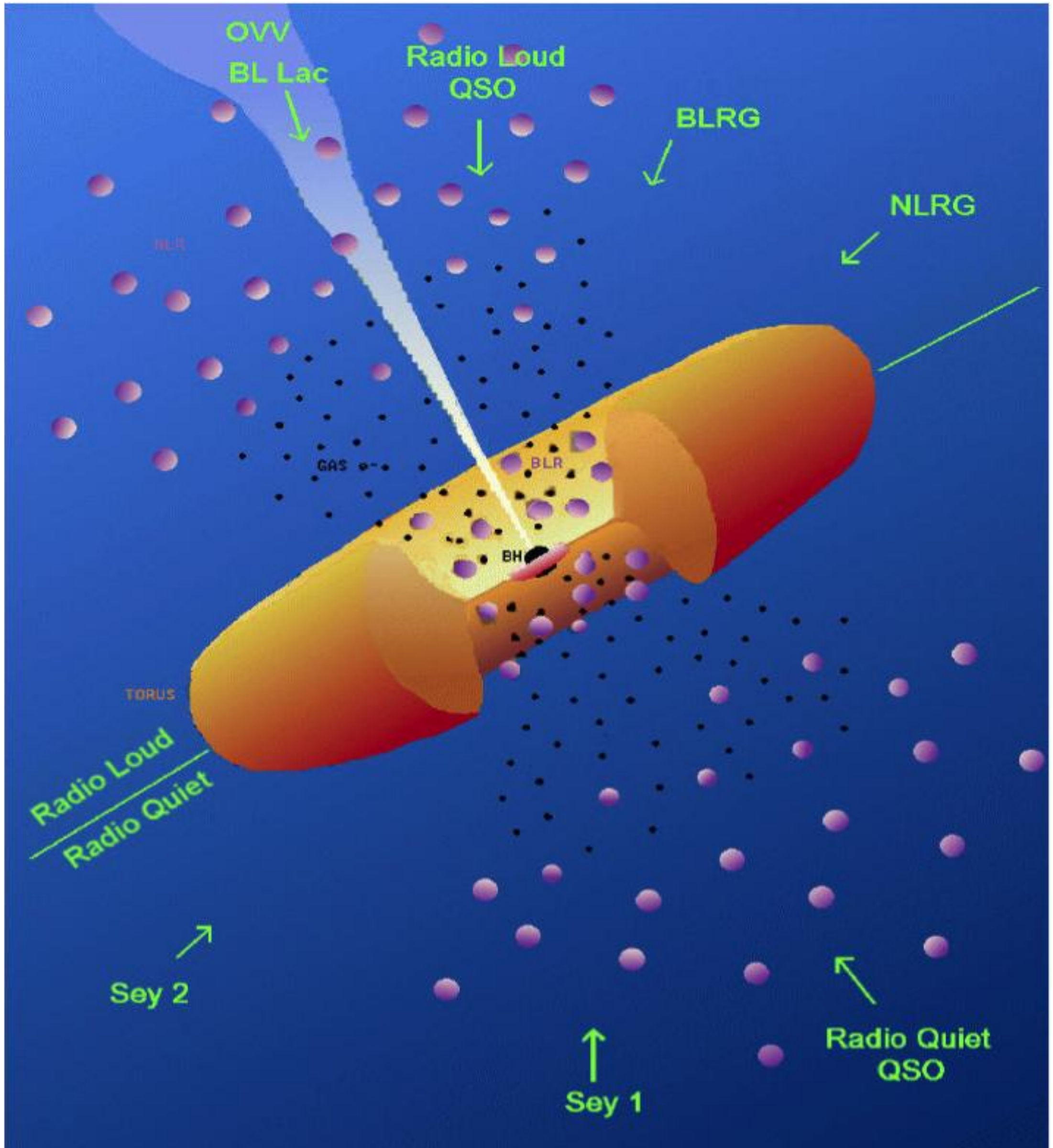
A common cartoon of a thermal AGN:



Two of the biggest challenges to simple AGN unification schemes:

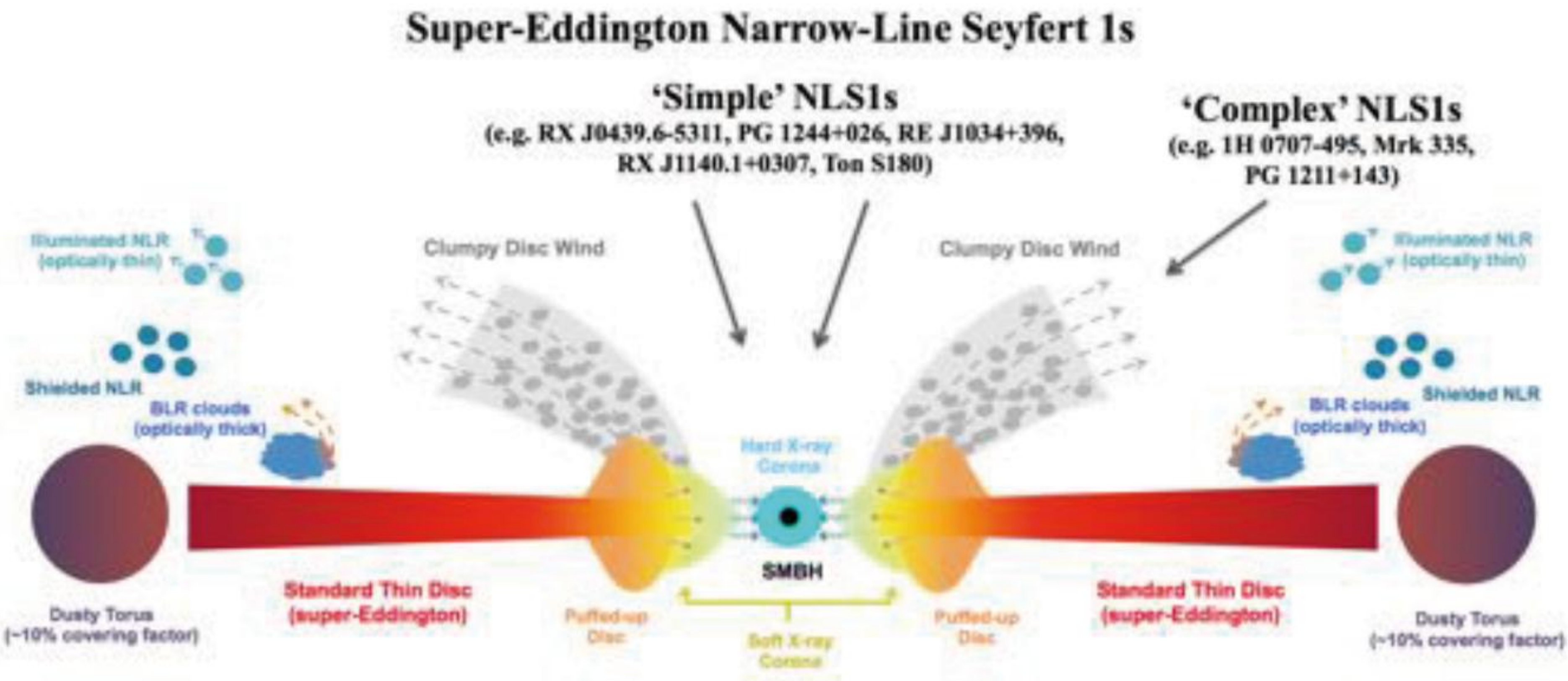
1. NLS1s

2. "Changing-look" (CL) AGNs.

∴ important to look at the relationship between these two phenomena.

(After Urry & Padovani 1995; see Keel 1980; Krolik&Begelman 1988; Antonucci 1993)

A Unified Picture for *All Super-Eddington* NLS1s



(Jin et al., 2017b, submitted)

Different types of CL AGNs

1. **Vanishing or strong decreasing of broad-line components for period of months to years.**

Examples:

NGC 3516 (Andrillat, 1968)

NGC 4151(Lyutyj, Oknyanskij, Chuvaev 1984; Penston and Perez, 1984; Oknyansky, Lyuty & Chuvaev 1991)

NGC7603, Mrk 372, 3C390.3. Mrk993, NGC7469 (Chuvaev, Lyutyi and Doroshenko 1990)

NGC 6814 (Sekiguch and Menzies, 1990),

NGC 5548 (Shapovalova et al. 2004).

- It is known more than 20 CL QSOs (Ruan et al. 2016; MacLeod et al. 2016;)
- [See references in Shappee et al. (2014) and Koay et al. (2015); Yang et al. 2017].

2. **Appearance of broad-line components in AGNs which are usually seen as type-2 AGNs for a long time.**

Examples:

Mrk 6, Mrk 1018, NGC 1097, NGC 7582, Mrk 590, NGC 2617.

In some cases they have been seen to be return to their usual low state (a type-2 appearance) after few years (NGC 7582) or after very long time (Mrk 6 and Mrk 590).

For some of these objects the changing look is connected with appearing of some blue shifted broad emission components (*e.g.*, Mrk 6, 3C 390.3)

NOTE: CL AGNs ARE NOT A RARE PHENOMENON! ALMOST EVERY WELL-MONITORED AGN SHOWS THE PHENOMENON!

NGC 4151: a Seyfert 2 in a deep photometric minimum

V. M. Lyutyĭ, V. L. Oknyanskiĭ, and K. K. Chuvaev

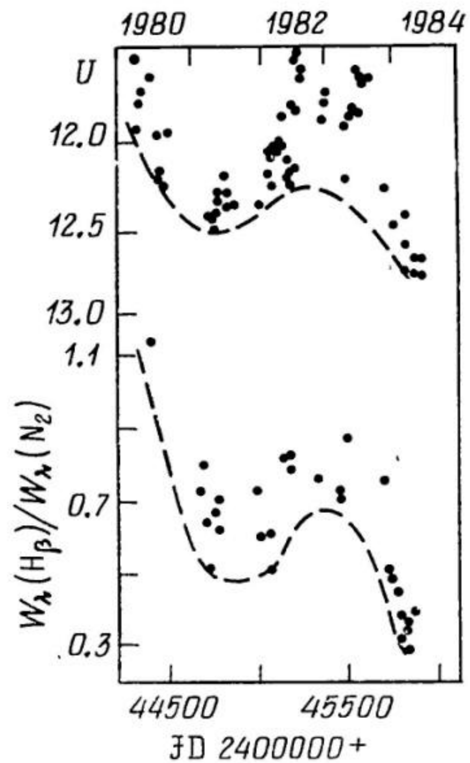
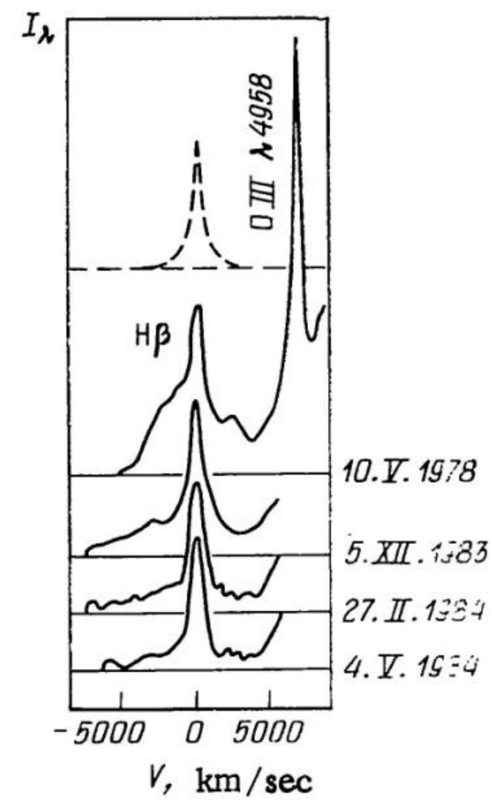
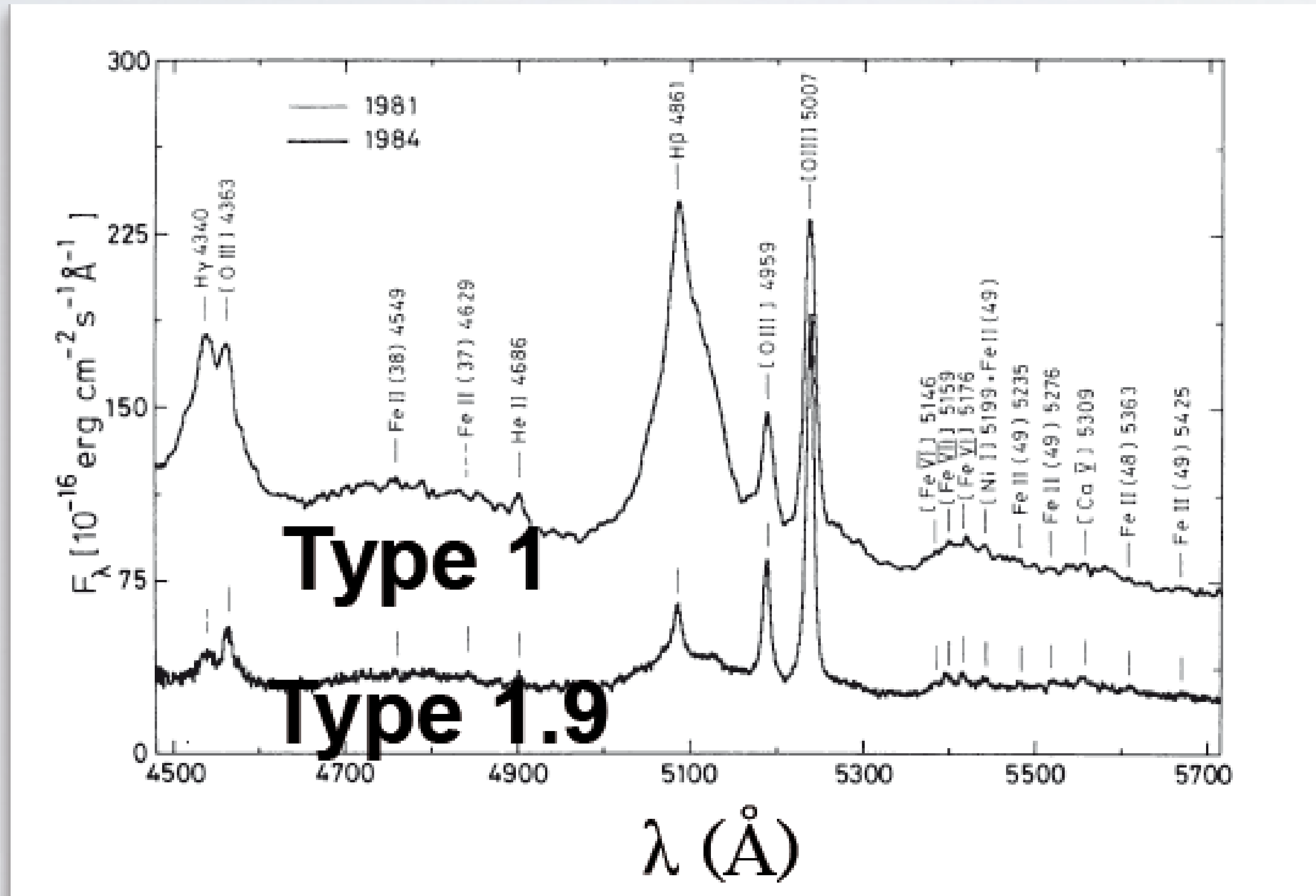


FIG. 1. Comparative variations in the optical continuum (U magnitude) of the NGC 4151 nucleus and the ratio $W_\lambda(H\beta)/W_\lambda(N_2)$. The lower envelopes outline the slow fluctuations.



Fairall 9, 1981-4



Kollatschny & Fricke 1985

From MacLeod (2017)

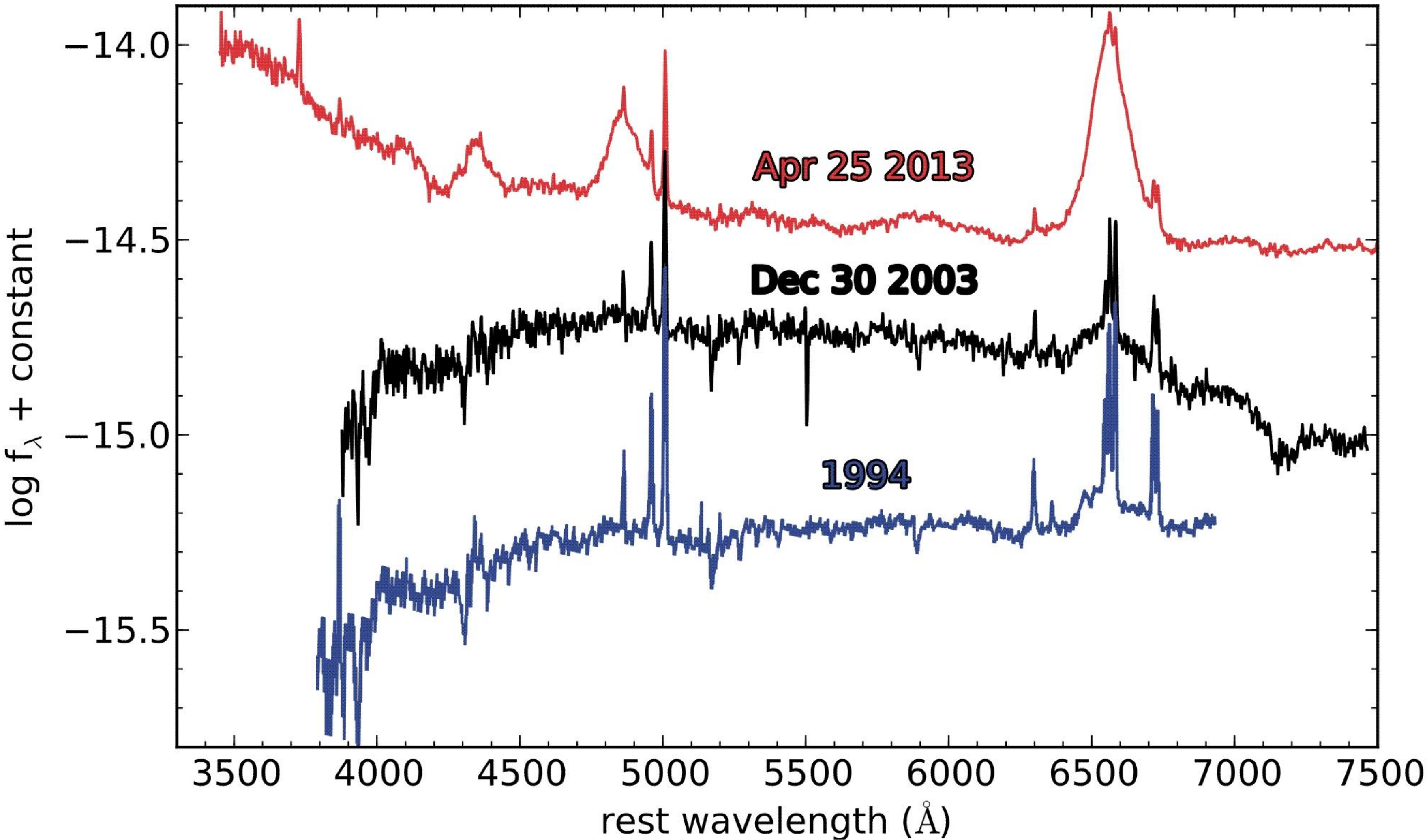
More types of the CL AGNs

3. More than 20 AGNs are changing look at X-ray spectral properties (see references in Reachi et al. 2016). Some of these AGNs were also noted before as the changing look in optical spectral region (NGC4151 and Mrk6) **NLS1s ARE FAMOUS FOR THEIR STRONG X-RAY VARIABILITY!**
4. Other changing-look AGNs which do not fit in categories 1 – 3. Objects with strong continuum variation of factors of hundred without significant variation of lines. *E.g.*, changing from a QSO to BL Lac state (QSO 1256+295 Wills et. al. 1983).
5. TDEs observed in non-AGN galaxies
6. CL NLS1? (few cases of CL for each of these types are suspected)

Are all CLQs part of the low Eddington ratio tail, or are some one-off events with different physics, *e.g.*, TDEs? (MacLeod, 2017)

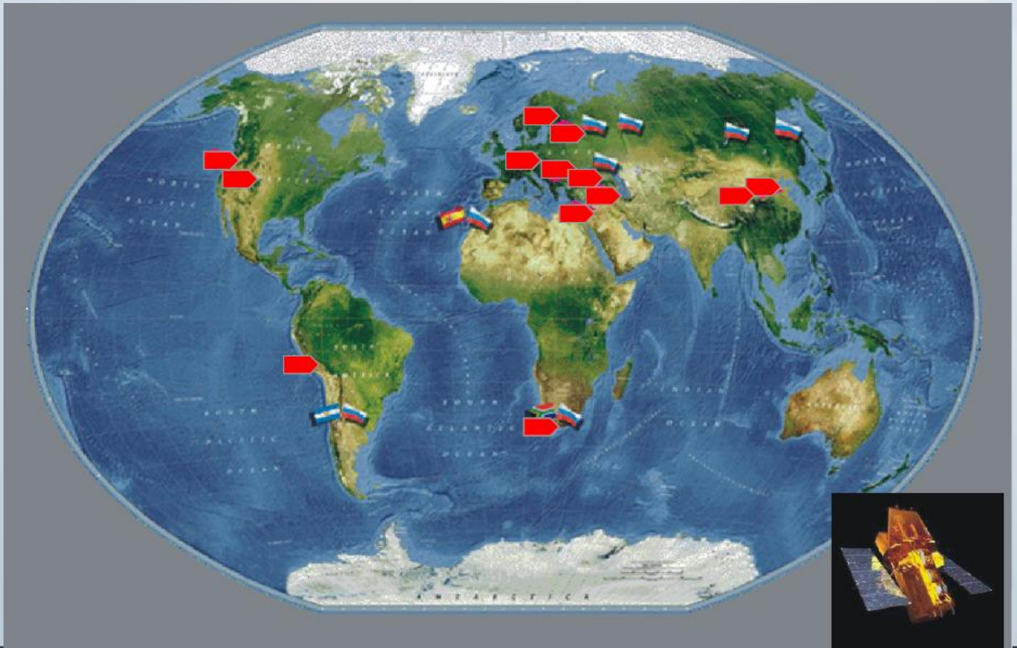
NGC 2617

"The man behind the curtain… " Shappee et al. (2014)



Multi-Wavelength Monitoring of the Changing-Look AGN NGC 2617 During State Changes

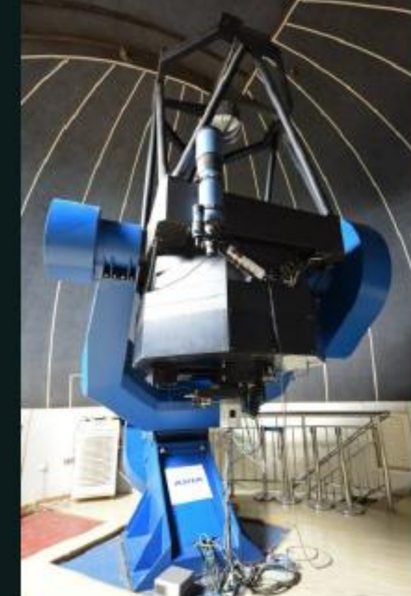
V.L. Oknyansky *(M.V. Lomonosov Moscow State University, Moscow, Russia),* ***V.M. Lipunov, N.I. Shatsky, E.S. Gorbovskoy, A.M. Tatarnikov, V.G. Metlov, M.A. Burlak , K.L.Malanchev , C.M. Gaskell*** *(UCSC, USA),* ***N.A. Huseynov*** *(Shamakhy Astrophysical Observatory, Azerbaijan),* ***I.A. Alikberov, Kh.M. Mikailo****v ,* ***S.S. Tsygankov*** *(Tuorla Observatory, Piikkiö, Finland),* ***M.B. Brotherton*** *(University of Wyoming, Laramie, USA) ,* ***D. Kasper****,* ***P. Du*** *(Institute of High Energy Physics, Chinese Academy of Sciences, Beijing , China),* ***X. Chen*** *(Handong University, Shandong, China),* ***D.A.H.Buckley*** *(The South African Astronomical Observatory, Observatory, South Africa) ,* ***M. Gromadzki*** *(University of Warsaw, Poland),* ***H. Winkler*** *(University of Johannesburg, Auckland , South Africa)* ***, B. Paul, F. van Wyk, R.Rebolo*** *(The Instituto de Astro fisica of Canarias, Tenerife, Spain),* ***M. Serra-Ricart, R. Podesta (****OAFA, San Juan, Argentina),* ***H.Levato*** *(ICATE, San Juan , Argentina)*

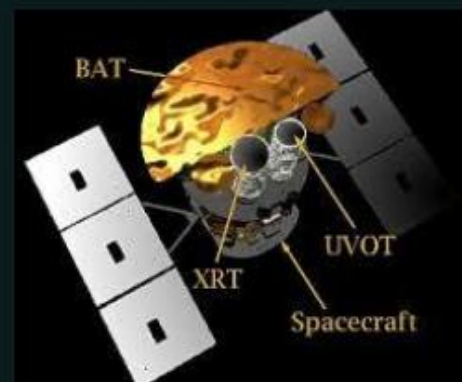


Our observations of the NGC 2617

- IR ***JHK*** _ 2.5-m, CMO SAI, (2016-2017)
- ***BVRI*** _ AZT-5, CS SAI MSU (2016-2017)
- ***BVRI*** _ 0.6-m, CS SAI MSU (2016-2017)
- ***BVRI*** _ 0.6-m, ShAO, (2016-2017)
- ***BV*** _ 1-m, China, Shandong (2016-2017)
- ***WBV*** _ MASTER (2010-2017)
- Optical spectra (2 nights) _ 1.9-m, SAAO (2017)
- Optical spectra (18 nights) _ 2-m, ShAO (2016-2018)
- Optical spectra (**68** nights) _ 2.3-m, WIRO WU (2017-2018)
- Optica spectra (4 nights)_ 11-m , SALT, SAAO (2017-2018)
- X-Ray, UV, ***BV***_ SWIFT (2013-2018)

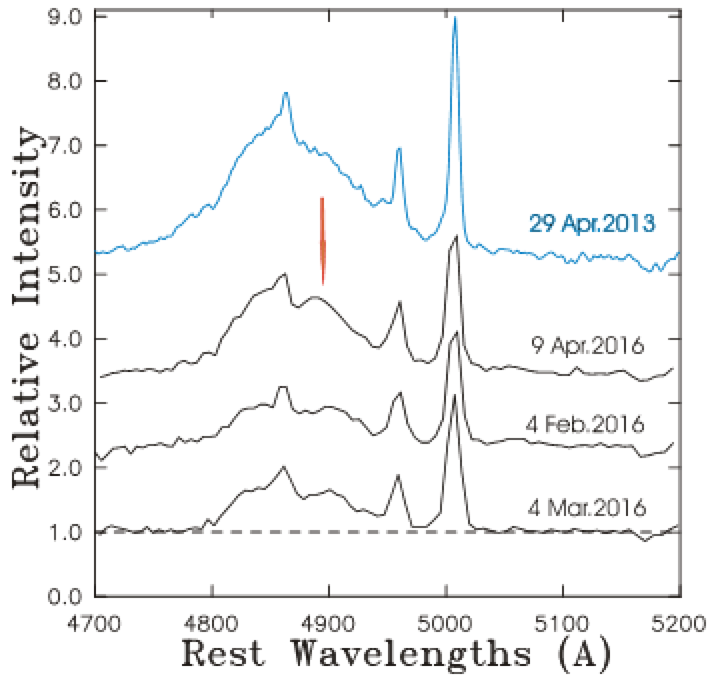




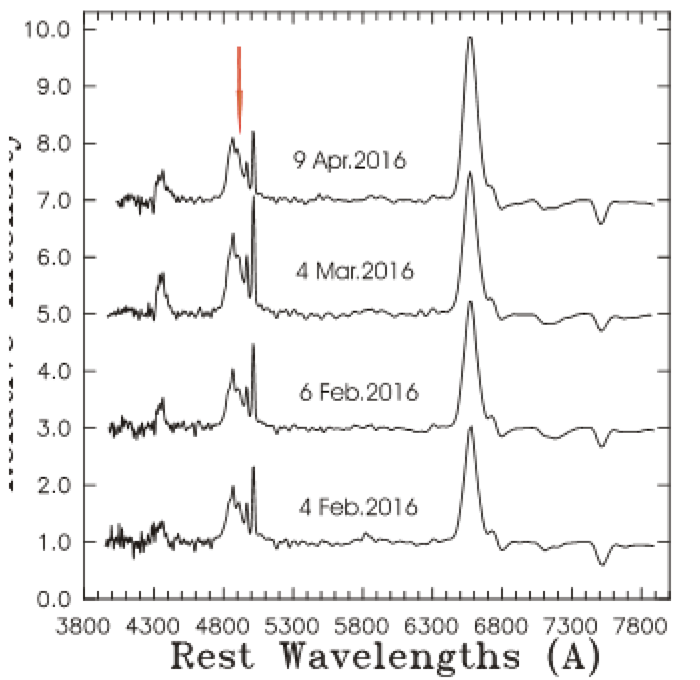


BAT
XRT
UVOT
Spacecraft

2013

2016



Relative Intensity
29 Apr.2013
9 Apr.2016
4 Feb.2016
4 Mar.2016
Rest Wavelengths (A)



9 Apr.2016
4 Mar.2016
6 Feb.2016
4 Feb.2016
Rest Wavelengths (A)

The curtain remains open: NGC 2617 continues in a high state

V. L. Oknyansky ✉; C. M. Gaskell; N. A. Huseynov; V. M. Lipunov; N. I. Shatsky;
S. S. Tsygankov; E. S. Gorbovskoy; Kh. M. Mikailov; A. M. Tatarnikov;

Table 1.

Lags from the reverberation mapping analysis with the MCCF and JAVELIN methods in days. MCCF and JAVELIN 1σ confidence limits are presented.

	MCCF		JAVELIN	Time
	τpeak	τcent	τJAV	
J from *B*	$2.8^{+1.2}_{-0.8}$	$3.0^{+1.0}_{-1.2}$	$2.7^{+1.2}_{-1.4}$	2016
H from *J* + *B*	$18.2^{+3.0}_{-4.0}$	$13.9^{+4.0}_{-3.0}$	$10.7^{+1.2}_{-1.2}$	–
K from *J*	$21.5^{+2.4}_{-2.6}$	$20.5^{+2.2}_{-2.4}$	$19.9^{+1.4}_{-1.6}$	–
K from *J* + *B*	$25.3^{+3.4}_{-2.3}$	$24.5^{+3.1}_{-2.6}$	$26.0^{+2.1}_{-2.1}$	–
UV from Xray	$2.0^{+0.7}_{-0.5}$	$1.5^{+0.7}_{-0.5}$	$2.7^{+0.4}_{-0.2}$	–
UV from ΓX	$0.8^{+0.5}_{-0.5}$	$0.9^{+0.4}_{-0.2}$	$0.8^{+0.3}_{-0.3}$	–
BW from *UV*	$1.0^{+0.5}_{-0.5}$	$0.5^{+0.5}_{-0.5}$	$0.6^{+0.3}_{-0.5}$	–
UV from Xray	$2.5^{+0.5}_{-0.7}$	$2.9^{+0.5}_{-0.8}$	$2.5^{+0.6}_{-0.8}$	2013–2014
BS from *UV*	$0.4^{+0.4}_{-0.4}$	$0.6^{+0.3}_{-0.3}$	$0.4^{+0.2}_{-0.2}$	–

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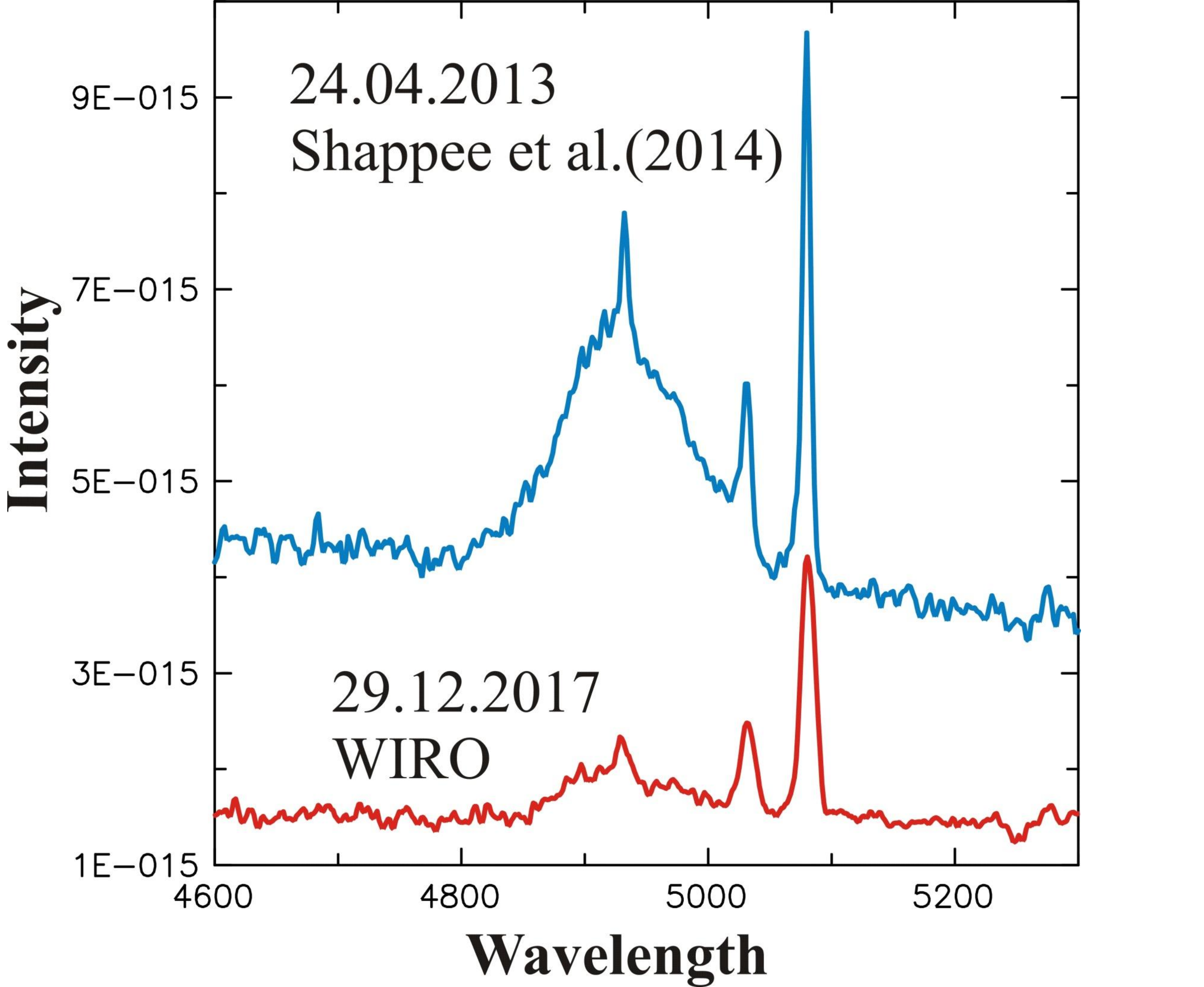
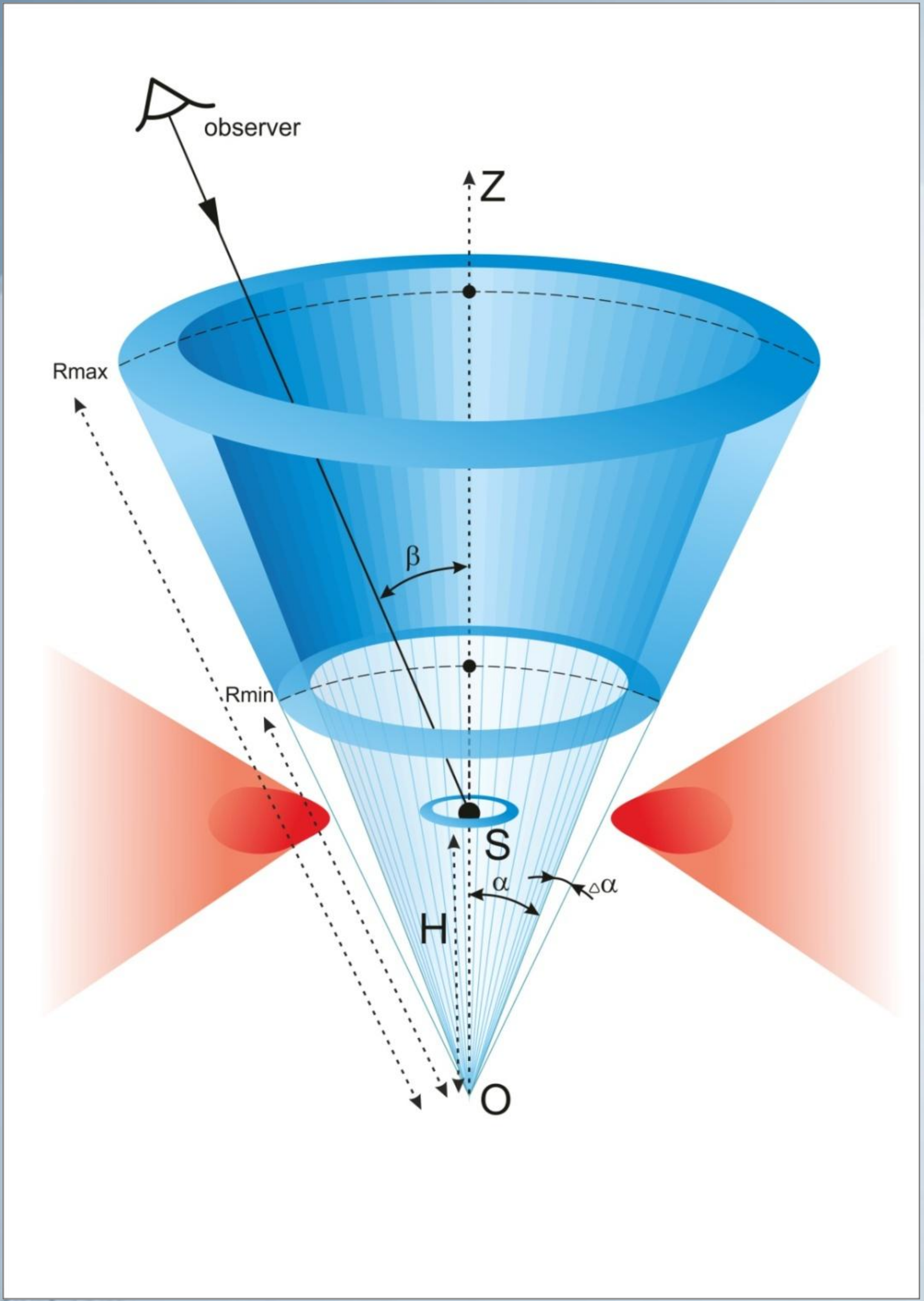
May 2017


24.04.2013
Shappee et al.(2014)
29.12.2017
WIRO
Intensity
9E-015
7E-015
5E-015
3E-015
1E-015
4600
4800
5000
5200
Wavelength

SUMMARY (just for NGC2617)

- NGC 2617 remains in a high (Seyfert1) state, but from the end of the March 2017 till the April 2018 the object was in very low level of brightness and variability. **The X-ray flux was at an all-time low in December 2017 (lowest since monitoring began in1982.)** The spectral type was **Sy 1.7**.

  We suspect that this is the transient state of the object and **we expect the changing of its type back to Sy 1.8 soon.**
- Light-travel-time delays (X-ray → UV, Opt., IR) increase with wavelength, but **Hard X-rays lag to Soft ones ~0.1 day.**
- New IR data from October 2016 to May 2017 confirm our published (2016) result: ***K*** band lags ~ 25 days relative to UV/optical. **This lag is probably smaller now (~15 days) and we suspect that it is result of dust recovering in the minimum state.**
- The reason for a significant change in the luminosity of the object is not a change in absorption alone. **We propose that a change in the energy-generation rate led to a change in absorption. What caused the change in energy generation remains the main mystery**.



Proposed model of IR emission

(Oknyansky&Gaskell 2015; Oknyansky et al. 2015,2017; Gaskell&Harrington 2018)

Sublimation and recovering of dust on the line of sight (following the strong lumininisuty variations) can explain CL events.

[Thanks to graphics designer Natalia Sinugina]

CL NLS1 ?

Optical spectra

1) Narrow line

NLS1 ⇒ BLS1?

2) Strong Fe II lines

NLS1 ⇔ NLS2 ?

few cases of the broad emission lines appearance :

PS16dtm (Blanchard et al. 2017) TDE?

CSS100217 (Drake et al. 2011) SN?

PS16dtm

NLS1 CLQ (MacLeod, 2017)

3)HeII λ 4686 nearly dissappeared NGC4051(Peterson et al. 2000)

X-ray spectra

1) Compton-thin ⇔ Compton-thick

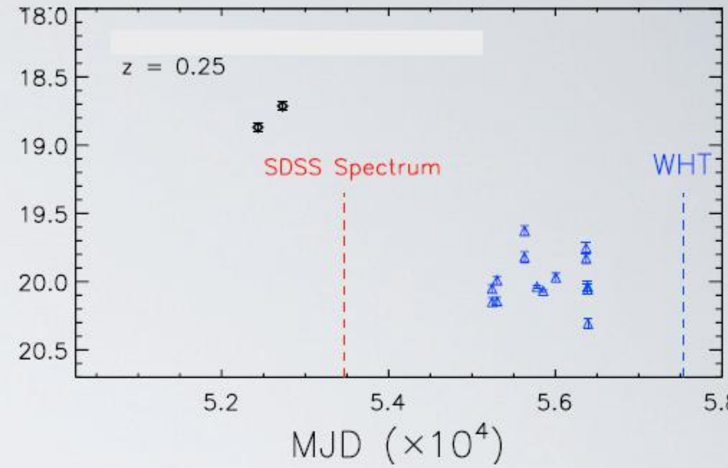
NGC4051 (Guainazziet al. 1998)

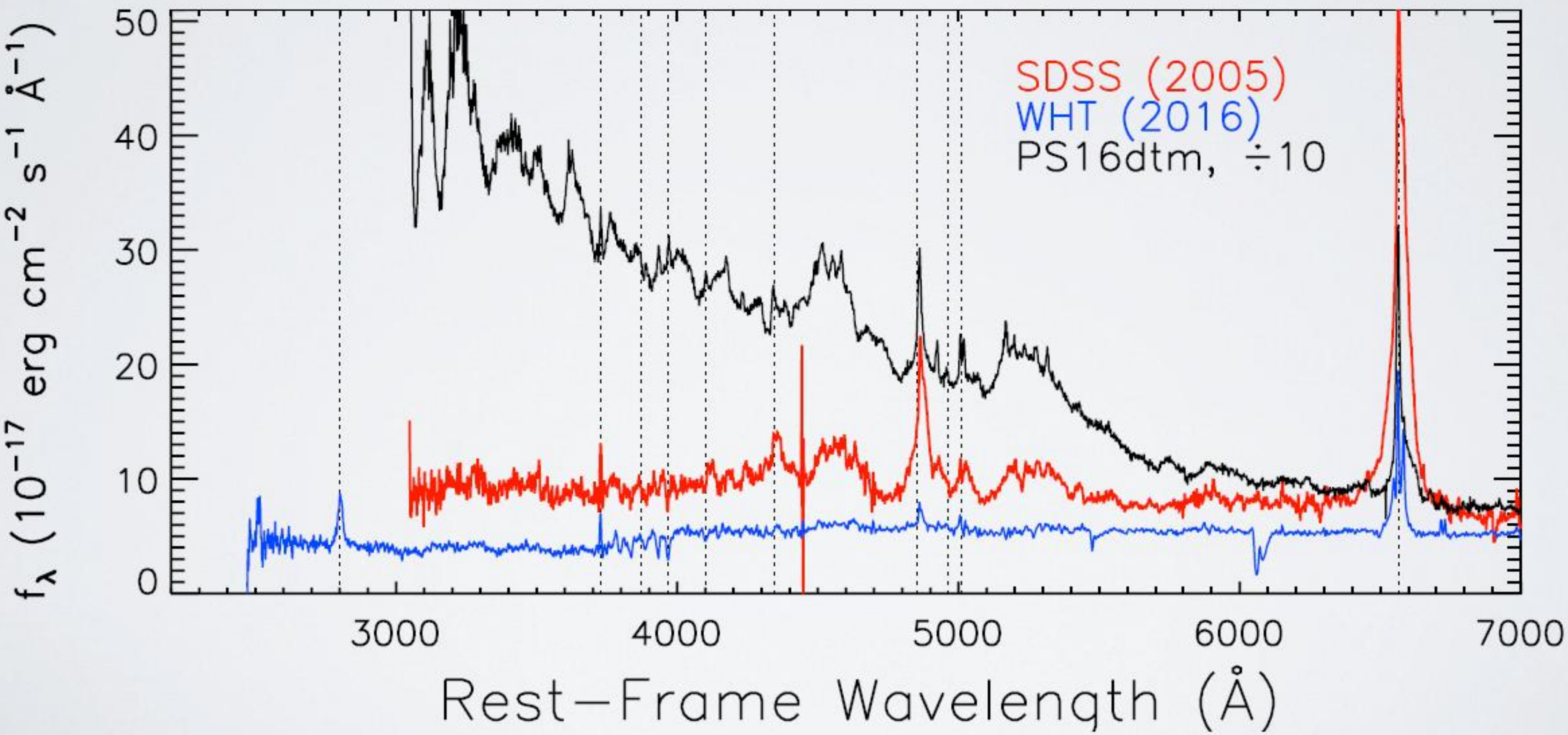
2) Soft weak ⇒ Not weak

PG 1535+547 (Ballo et al. 2017)

NLS1 CLQ

- $\log(L/L_{Edd}) = -1.057$, Strong FeII line change
- Similar to TDE candidate (Blanchard+17)





From MacLeod et al. (2016)

Post Script

- Tidal disruption events occur when a star passes too close to a massive black hole and it is totally ripped apart by tidal forces. It may also happen that the star is not close enough to the black hole to be totally disrupted and a less dramatic event might happen. If the stellar orbit is bound and highly eccentric, just like some stars in the centre of our own Galaxy, repeated flares should occur. (Campana et al., 2015, Ivanov and Chernyakova, 2006).

It is my pleasure to thank the organizers of the conference for their invitation and all of you for attention.

*Thanks to **Pavel Ivanov** and **Nikolay Shakura** for useful discussions, thanks to the **SWIFT** and **MASTER** teams for organizing the observations.*

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