1H 0323+342 IN OUTBURST: UV, X-RAY VARIABILITY AND PROSPECTS FOR MULTI-BAND FOLLOW-UP

Valentina Rosa

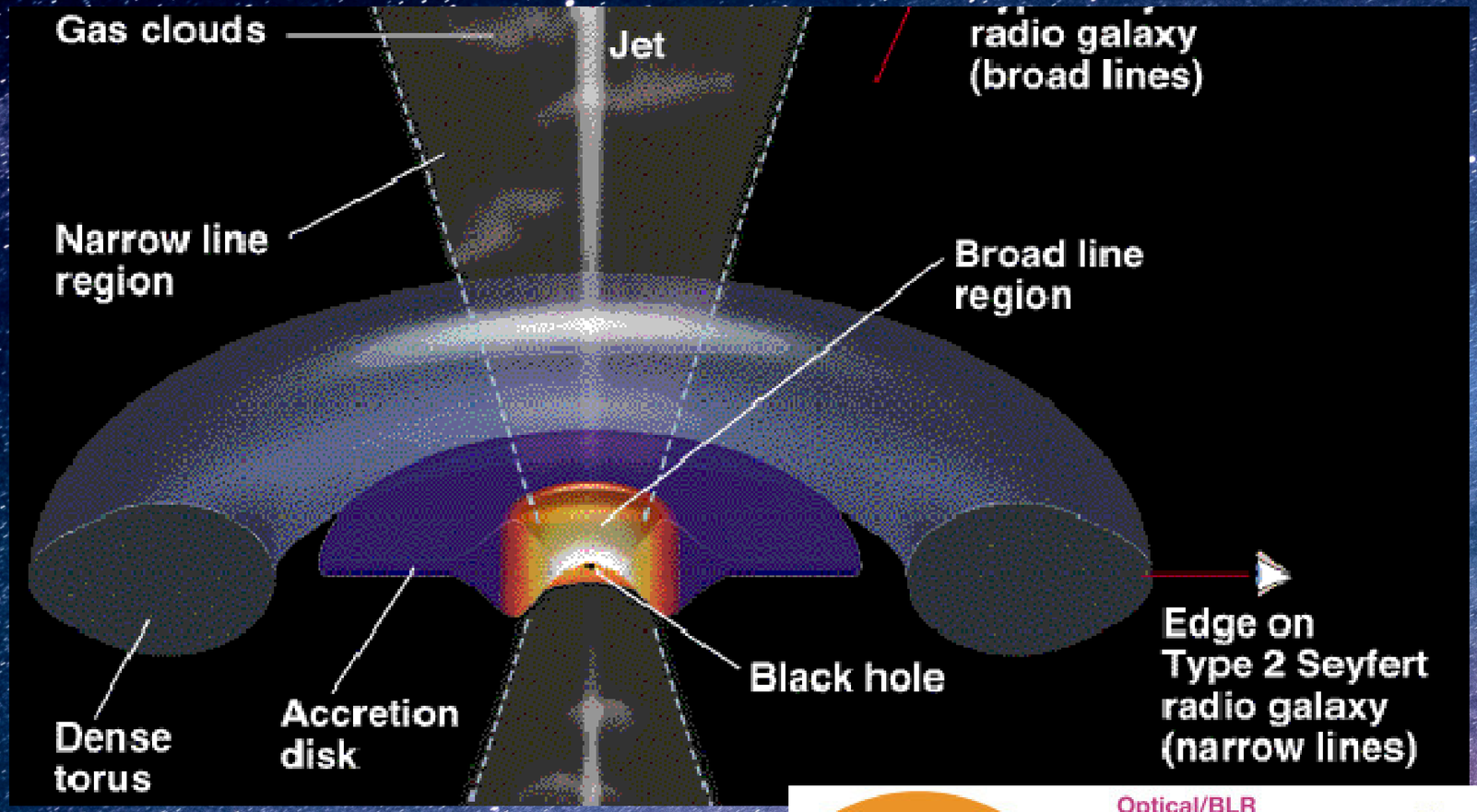
Astronomical Institute of the Czech Academy of Sciences

rosa@asu.cas.cz

OUTLINE

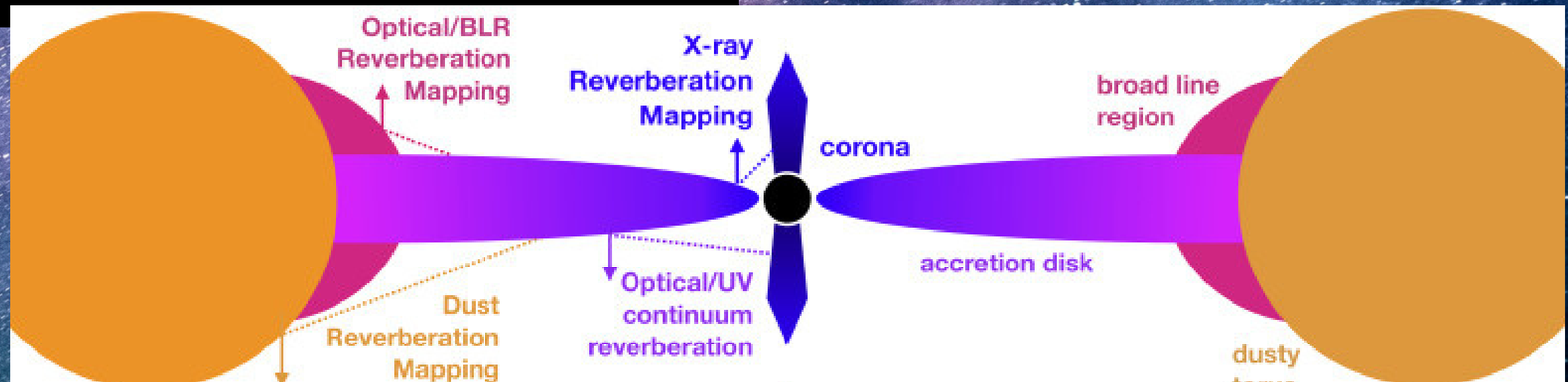
- Overview on NLS1 galaxies
- The case of 1H 0323+342
- Brief Gamma-Ray analysis
- X-ray analysis
- UV-optical comparison
- Target for future missions

AGN UNIFICATION MODEL



(Rodrigues, 2008)

(Cackett, 2021)



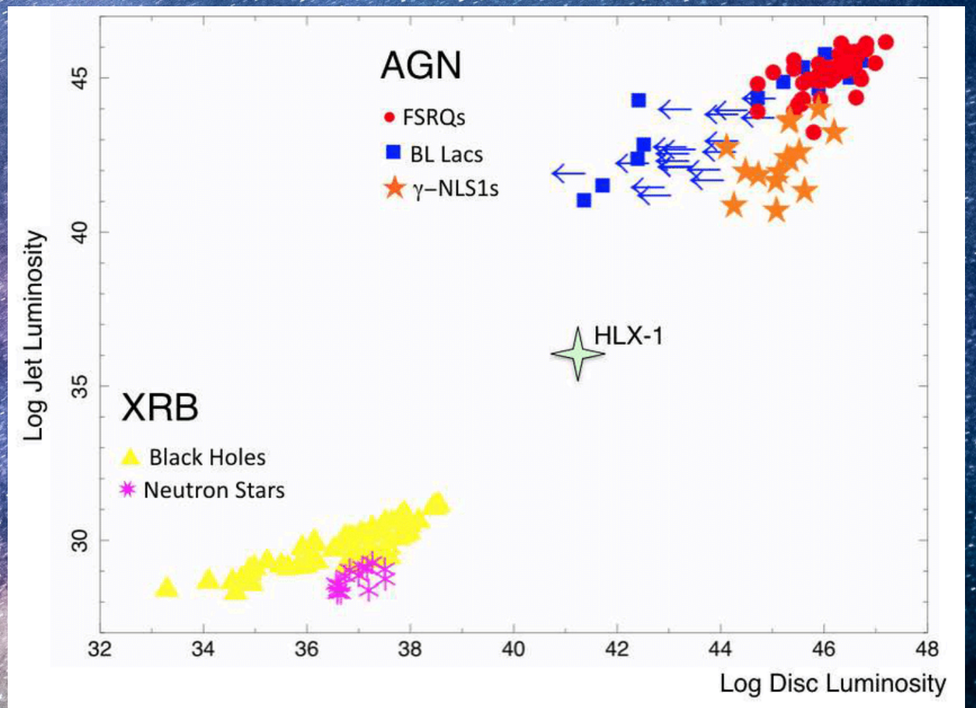
NLS1 GALAXIES

- Lower SMBH Mass (10e6 -10e8 solar masses)
- Narrow emission lines from Broad Line Region

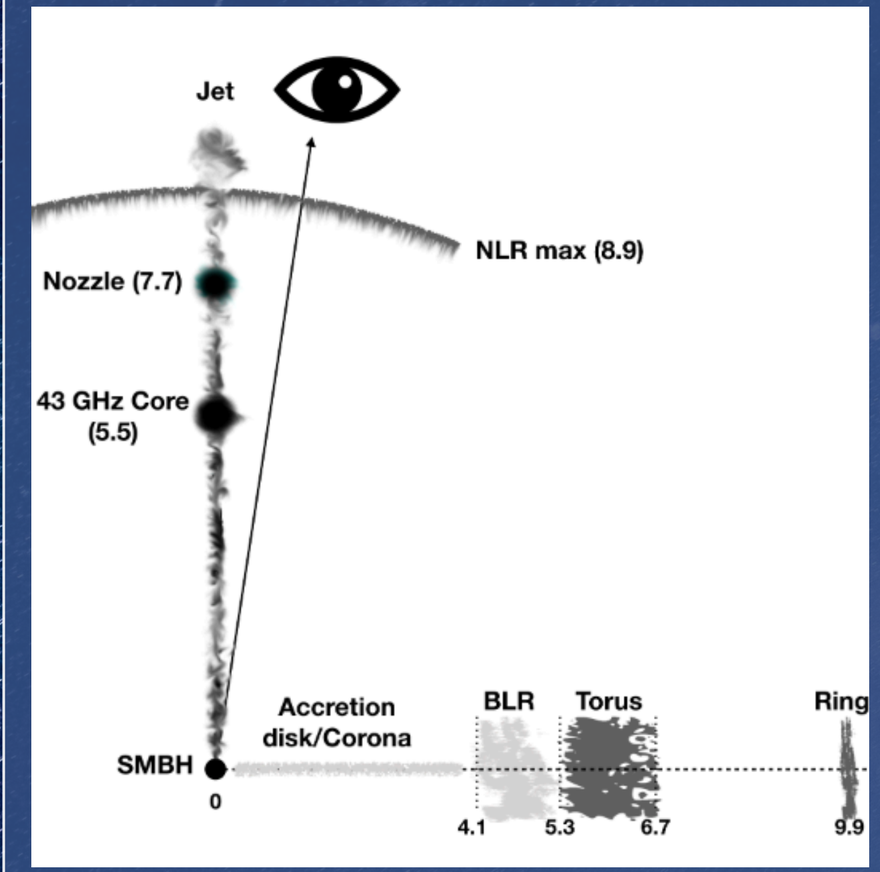
- Disk-like BLR almost face on→ reduced Doppler broadening. (Decarli et al.2008)
- High accretion rate causes BLR to be pushed outwards → slower rotation. (Marconi et al. 2008)

JETTED NLS1

- About 7 per cent of NLSy1 are radio-loud (Komossa et al. 2006).
- High-energy γ-ray emission has been detected in six RL-NLS1 by Fermi-LAT (Abdo et al. 2009)
- Possible counterpart for Neutron Star LMXB in AGN characterization as shown in the figure below (Foschini 2017)

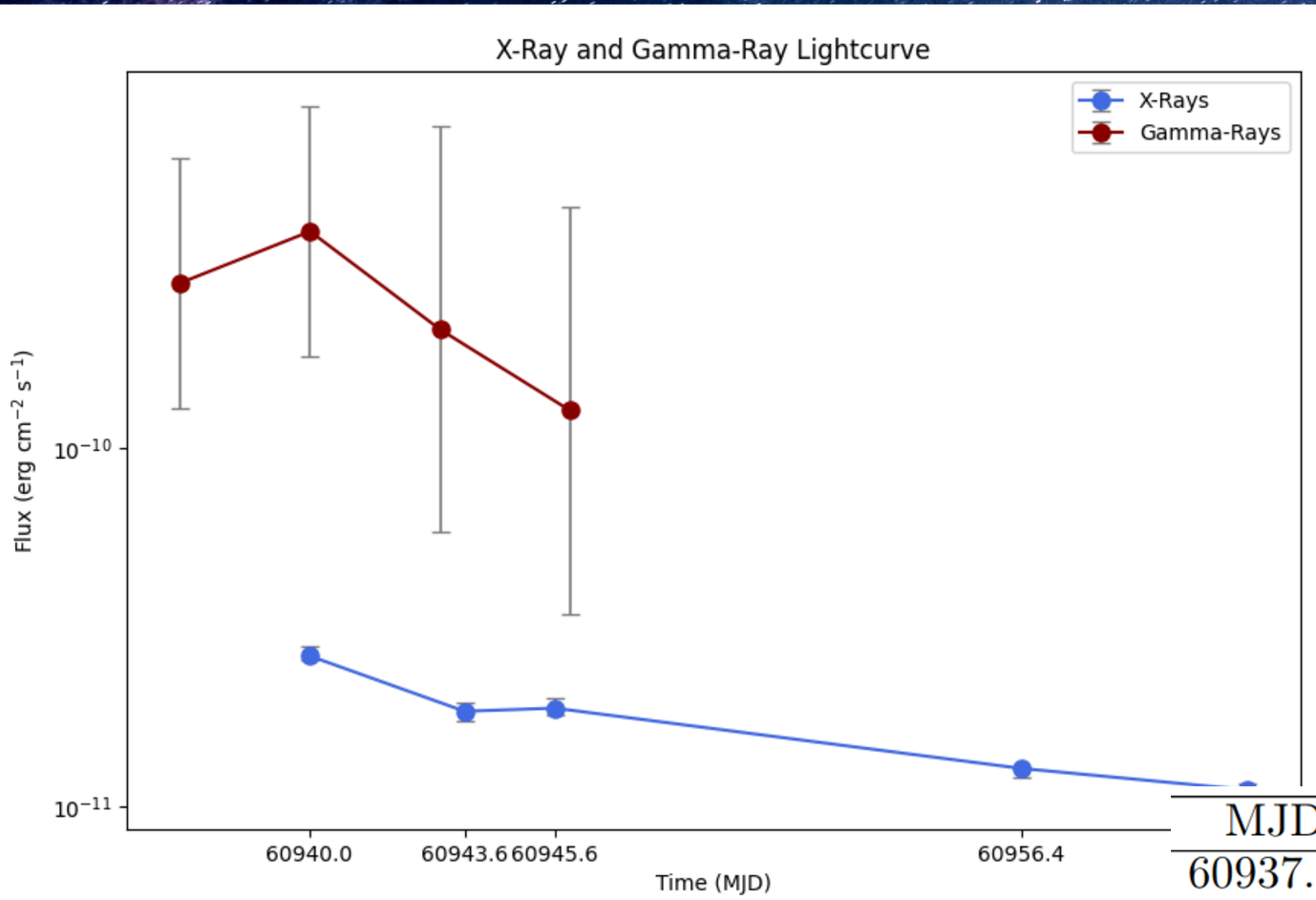


THE CASE OF 1H0323+342



- The closest jetted NLS1, z=0.063.
- Black Hole Mass: about 2.2· 107 solar masses.
- Relativistic jet first observed in 2007 (Zhou et al.) and then confirmed by gamma-ray detection (Abdo et al. 2009).
- Supposed jet inactivity for 10 years (Rosa et al. 2025) and recent outburst detected from Fermi LAT and Swift! (ATel 1747- 17411)
- Last peak of gamma ray emission on September 21, 2025.
- Analysis of Swift data from that day.

GAMMA-RAY LIGHTCURVE

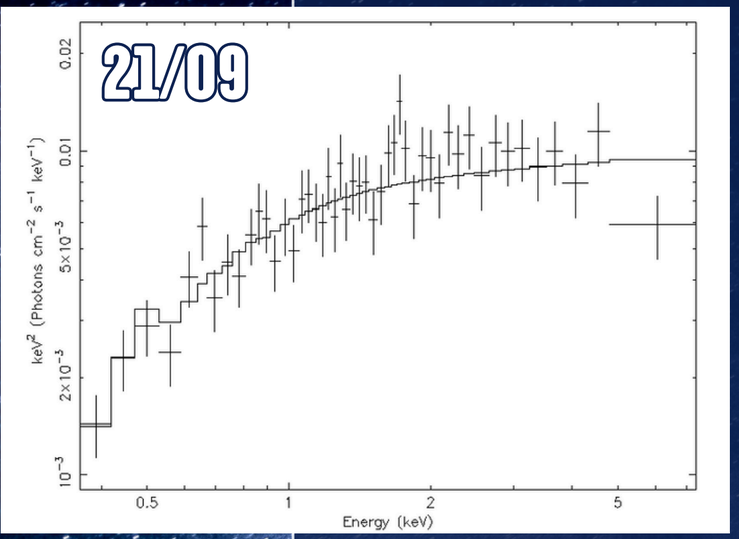


- Overall decrease in flux values in both bands.
- No Gamma emission after 27 Sep

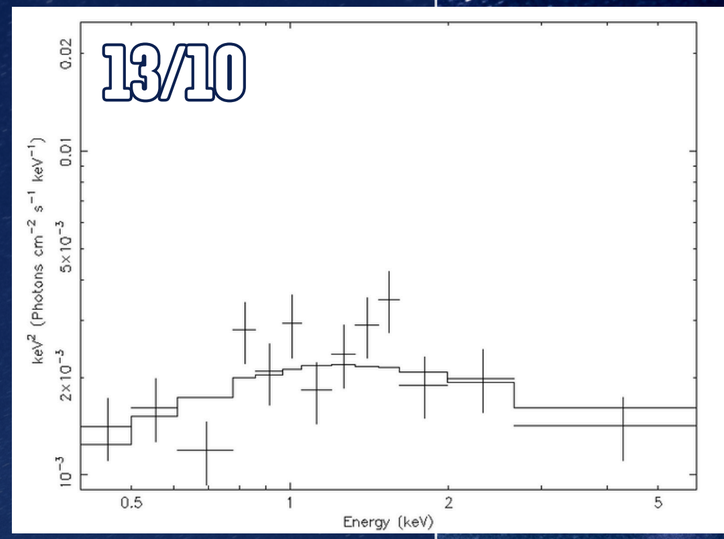
- 21 Sep (MJD 60940) has the highest TS, coincides with highest X-ray and Gamma-Ray flux

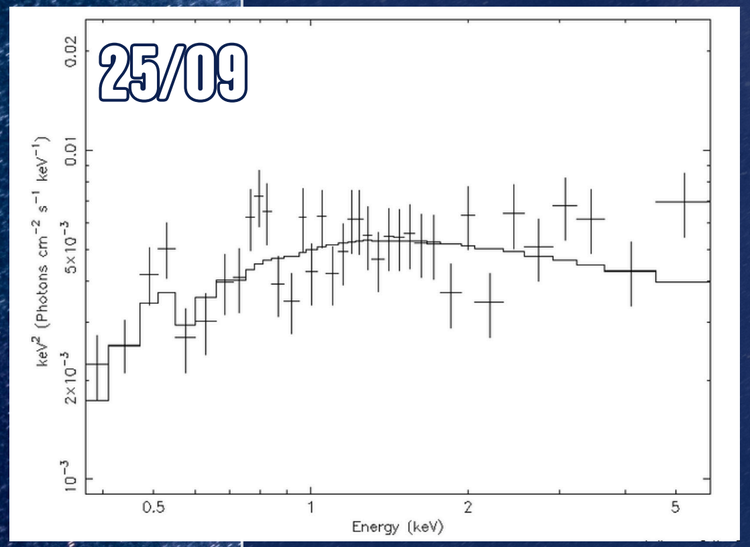
MJD	Γ	**Flux** (10^{-10} erg cm^{-2} s^{-1})	TS
60937.00	3.08 ± 0.29	1.417 ± 0.314	62.89
60940.00	2.96 ± 0.22	1.547 ± 0.315	75.25
60943.00	2.58 ± 0.26	1.300 ± 0.511	33.86
60946.00	2.55 ± 0.30	1.096 ± 0.512	22.77

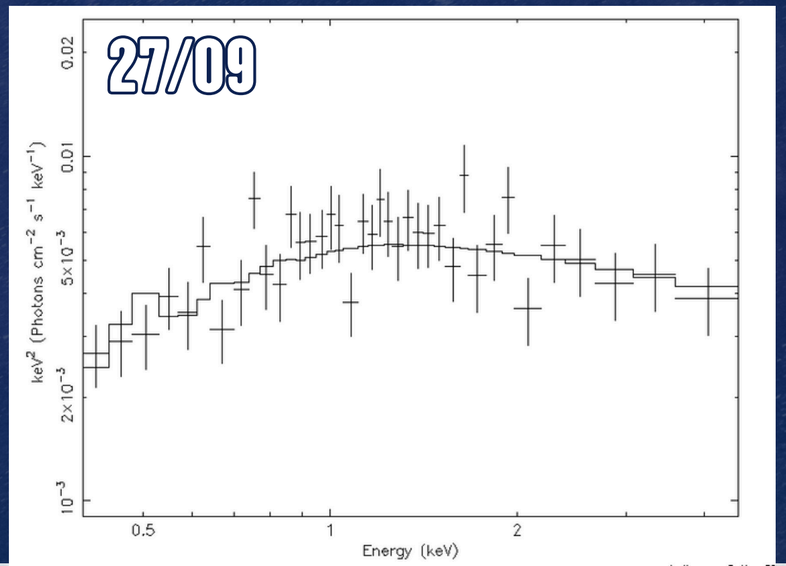
X-RAY SPECTRAL ANALYSIS

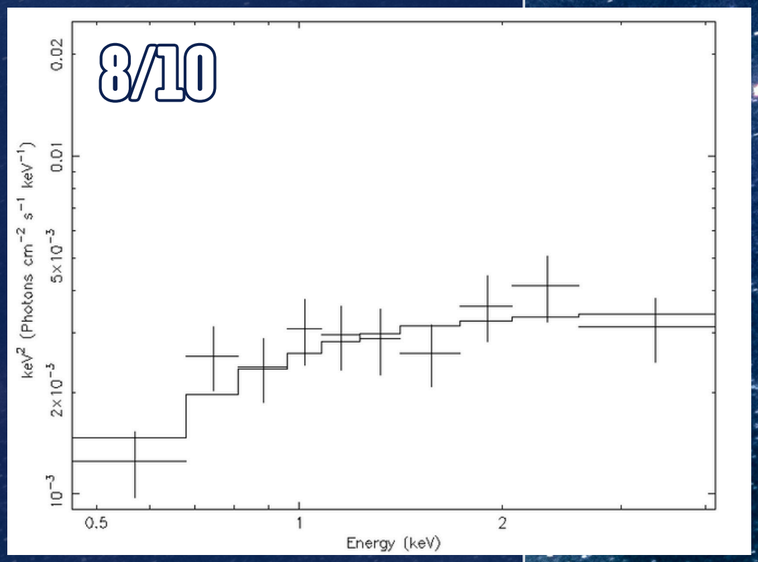


- Spectral Analysis with XSPEC of 5 Swift observations starting Sep 21.
- Best fit model: tbabs(powerlaw) with absorption frozen at nh=1.17e21
- Corrected flux calculated with model cflux.









X-RAY VARIABILITY

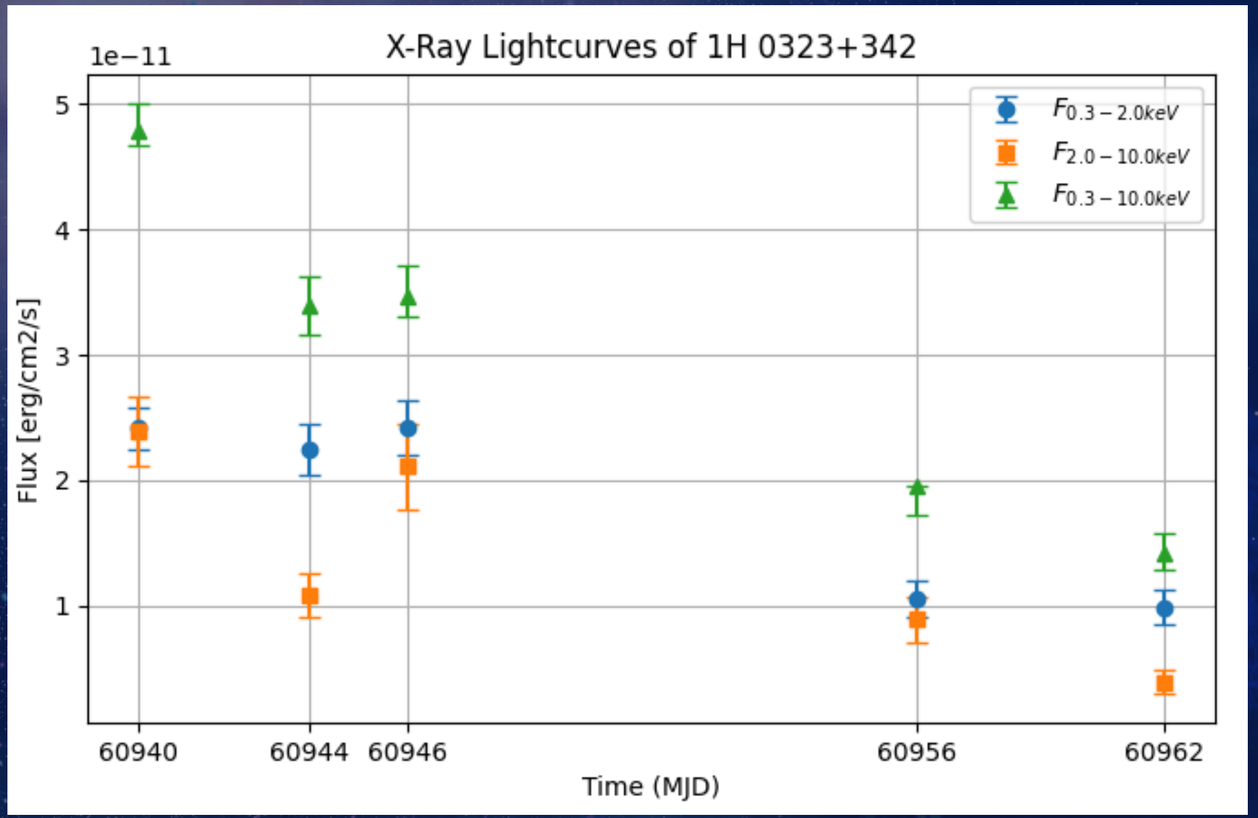
- Typical photon index values for non jetted NLS1s are > 2.0-2.1
- Overall softening of the spectrum

MJD	ObsID	Model	Γ	$\log F_{0.3-10\ \mathrm{keV}}$	χ^2/dof
60939.97	00035372003	zpowerlaw	$1.91^{+0.08}_{-0.08}$	$-10.32^{+0.02}_{-0.01}$	37.6/45
60943.57	00035372004	zpowerlaw	$2.31^{+0.12}_{-0.12}$	$-10.47^{+0.03}_{-0.03}$	38.2/33
60945.65	00035372005	zpowerlaw	$2.38^{+0.11}_{-0.10}$	$-10.46^{+0.03}_{-0.02}$	35.5/35
60956.41	00035372006	zpowerlaw	$2.00^{+0.22}_{-0.22}$	$-10.77^{+0.001}_{-0.05}$	4.3/7
60961.65	00035372007	zpowerlaw	$2.45^{+0.18}_{-0.18}$	$-10.85^{+0.05}_{-0.04}$	13.8/10

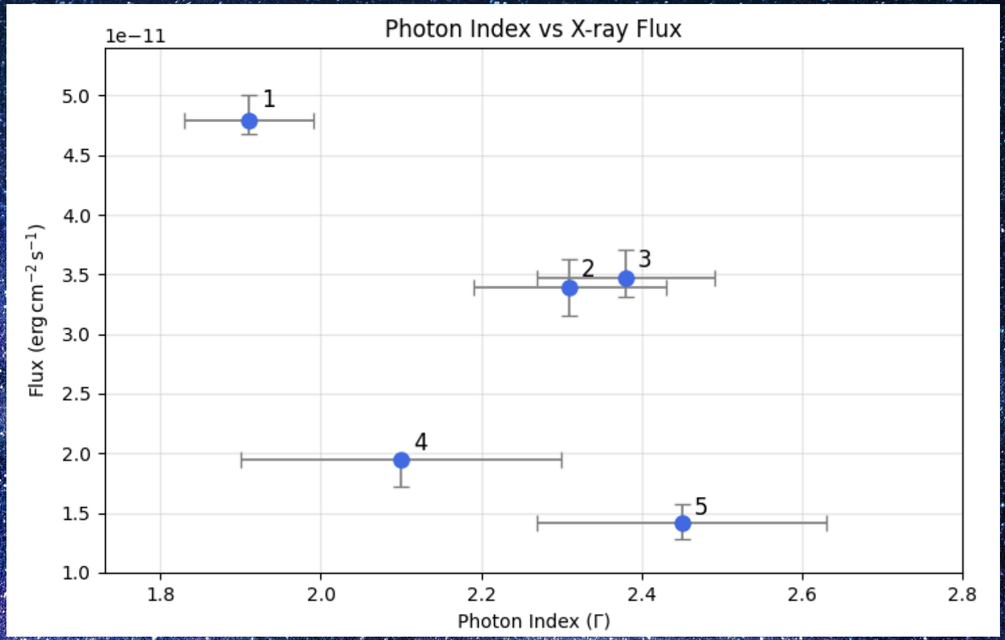
Band	0.3–10.0 keV	0.3–2.0 keV	2.0–10.0 keV
$\langle F \rangle$ (10^{-11})	3.001	1.824	1.374
S^2 (10^{-22})	1.796	0.5441	0.7113
Var (%)	44.2 ± 2.8	39.2 ± 4.5	59.1 ± 7.6

$$F_{var} = \frac{\sqrt[2]{S^2 - \langle {\sigma_{err}}^2 \rangle}}{F_{mean}}$$

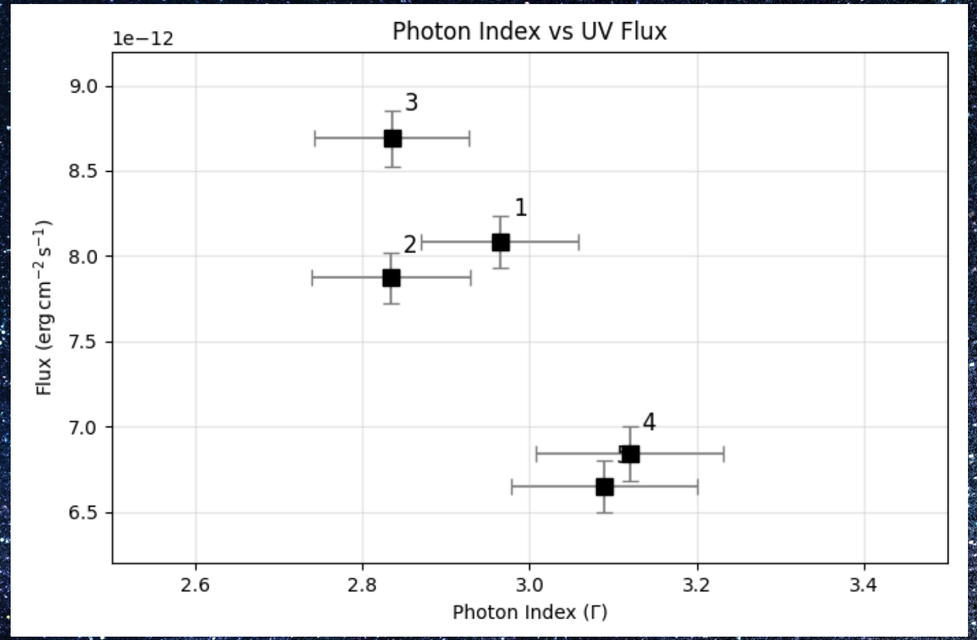
- Major changes observed especially in the 2.0-10.0 keV band.

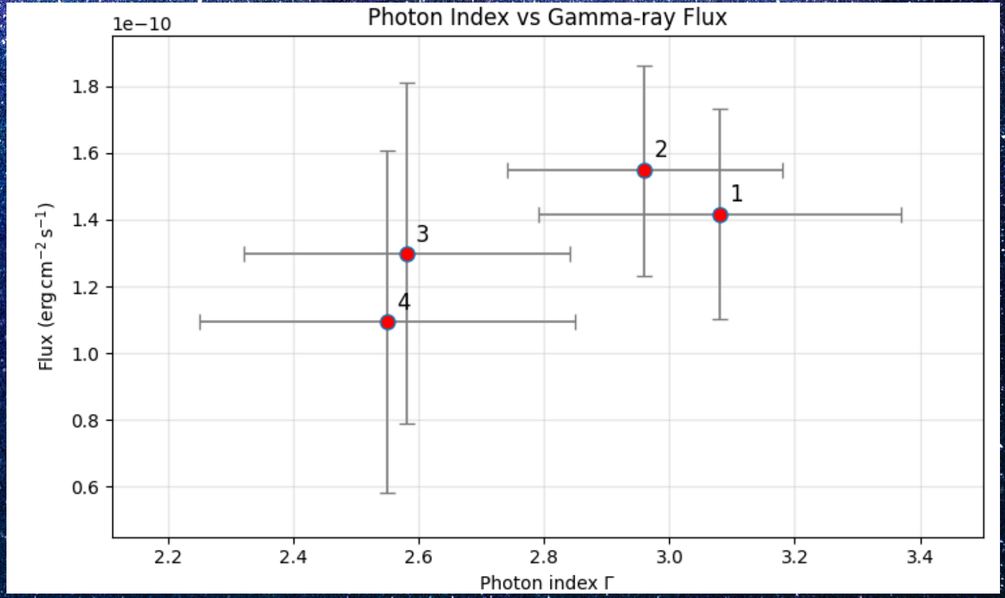


MULTIWAVELENGTH COMPARISON

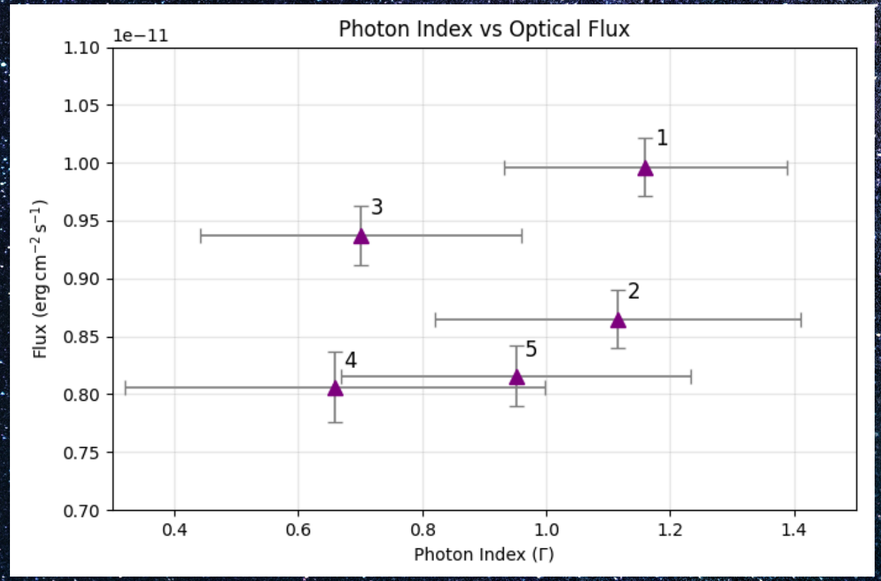


- Overall softening of the spectrum
- Decrease in flux values
- Less variations in the UV band





- Decrease in flux values
- Even though the trend seems to be hardening while the flux decreases it is not statistically significant.

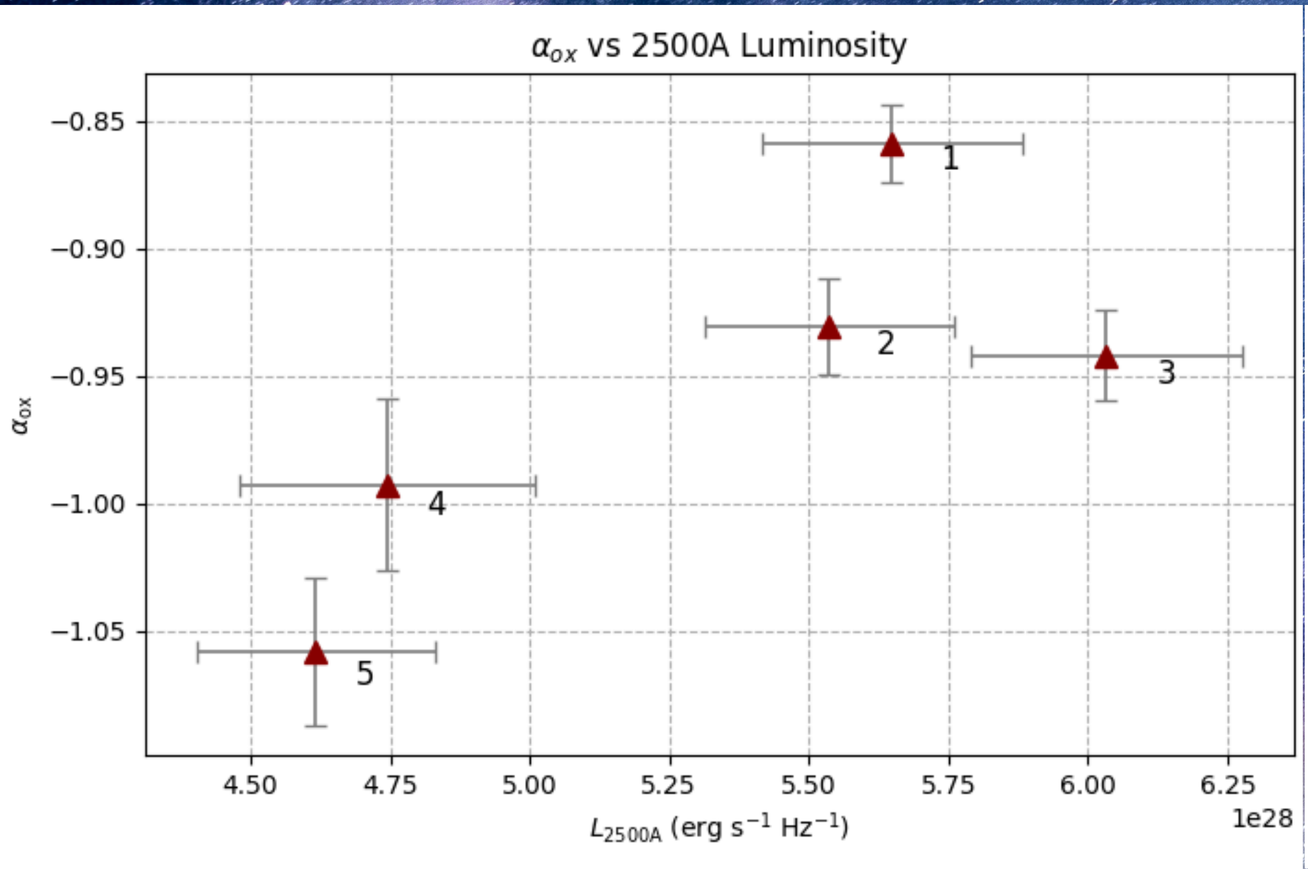


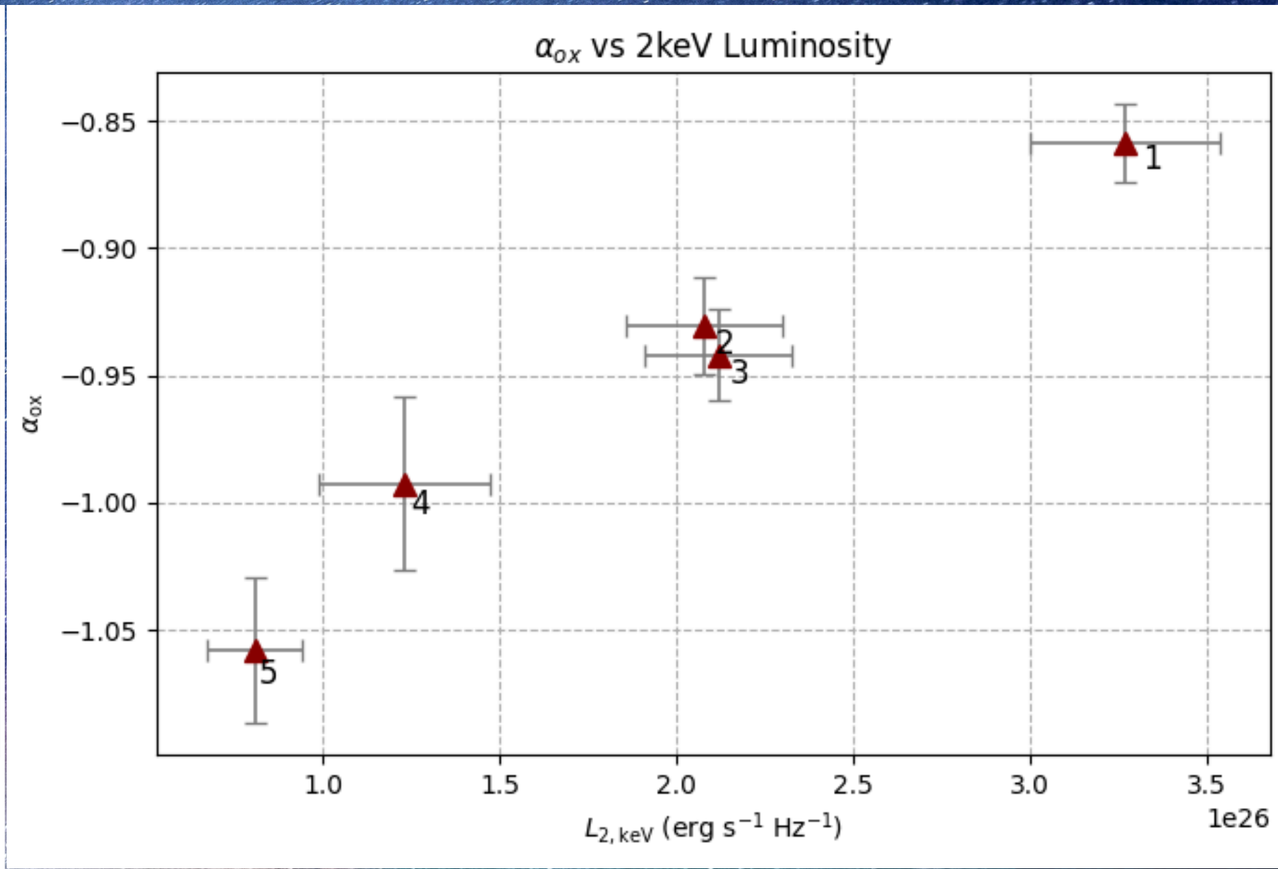
XRAY - UV RELATION

- Even at higher UV Luminosities, the parameter stays in its lower range.

$$\alpha_{ox} = 0.3838 \times log_{10}\left(\frac{L_{2keV}}{L_{2550A}}\right)$$

- During the peack of X-ray (and Gamma ray) emission, a_ox is at its lowest value.





A JUMP TO THE PAST...

Band	% Var (Int 1, no jet)	% Var (Int 2)
V	8.6 ± 2.3	9.9 ± 2.2
B	1.1 ± 0.9	7.8 ± 1.8
U	2.1 ± 1.8	7.7 ± 1.7
W1	5.1 ± 2.8	10.8 ± 2.0
M2	1.9 ± 1.4	10.1 ± 2.1
W2	3.0 ± 1.9	14.2 ± 1.9
X	29.6 ± 1.6	44.2 ± 1.8

- Jet might affect especially the UV and X-ray emission, impacting variability.
- V band is moderately variable in both intervals, likely due to disk.

- Interval 1: 5 observations from Jan 23 2023 to Feb 9 2023.
- No Gamma-ray emission detected from Fermi LAT during these dates.
- Soft powerlaws modelling X-ray emissions.

- Interval 2: 5 observations from Sep 21 2025 to Oct 13 2025.
- Significant Gamma-ray emission
- One X-ray emission modeled with harder powerlaw.

...AND A JUMP TO THE FUTURE!!

CANDIDATE FOR FUTURE MISSIONS

example - criteria for QUVIK mission (Werner, 2025) (but can be generalized):

- Near UV Magnitude threshold: 21.5 AB Mag.
- For 21.5 mag and exposure time 5400s, SNR > 5
- Fast variability: cadence of observations was > 1 day so limited information about this.

its

MJD	ObsID	NUV Mag	FUV Mag
60939.97	00035372003	16.544 ± 0.069	17.631 ± 0.073
60943.57	00035372004	16.608 ± 0.069	17.489 ± 0.073
60945.65	00035372005	16.514 ± 0.069	17.445 ± 0.073
60956.41	00035372006	16.735 ± 0.092	18.092 ± 0.091
60961.62	00035372007	16.770 ± 0.083	18.079 ± 0.091

SNR

$$\sqrt[2]{\left(\frac{t_{exposure}}{5400}\right) 10^{-\left(\frac{(m-21.5)}{2.5}\right)}} \times 5$$

Time	U	W1	M2	W2
60939.977	10.73	10.75	15.84	11.97
60943.565	10.20	10.66	9.37	11.62
60945.648	10.22	10.49	9.58	12.03
60956.412	6.53	6.46	6.12	7.11
60961.620	8.12	8.10	7.58	8.93

SUMMARY

- Renewed phase of jet activity after a long quiescent period.
- X-ray band shows strong variability, with spectral softening as flux decreases.
- The UV and optical emission show increased variability during the jet-active interval, especially in the higher-frequency UV bands.
- The α_{ox} evolution confirms that the jet enhances high-energy emission relative to the disk.
- This source is an good candidate for future follow-ups, which can reveal fast variability and jet–disk interactions in real time.

THANK YOU FOR YOUR ATTENTION!

This work is still in progress!
I would really appreciate any feedback, questions, and suggestions.

Valentina Rosa
Astronomical Institute of the Czech Academy of Sciences
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