Variable γ-ray emitting NLS1 galaxies

Anna Luashvili[1], Catherine Boisson[1], and Andreas Zech[1]

[1]Laboratoire Univers et Théories, Observatoire de Paris, Université PSL, Université Paris Cité, CNRS, F-92190 Meudon, France

LUTH Laboratoire Univers et THéories | l'Observatoire de Paris | PSL

anna.luashvili@obspm.fr

Introduction

Gamma-ray-emitting narrow-line Seyfert 1 galaxies (NLS1) constitute an intriguing small population of Active Galactic Nuclei (AGN) with unexpected gamma-ray emission and debated fundamental properties, similar to low power flat-spectrum radio quasars (FSRQ). They are jetted, gamma/radio-loud Seyfert galaxies, with relatively low BH masses, accreting at exceptionally high, near-Eddington rates. Two bona-fide NLS1 1H 0323+342 and PMN J0948+0022, and one intermediate object between NLS1 and FSRQ sub-classes B2 0954+25A are considered in this work. We analyzed quasi-simultaneous multiwavelength data for two different gamma-ray activity states and present the results of their broad-band SED modelling, complemented by a maximum number of physical constraints. Two different scenarios are discussed, in the framework of a one-zone leptonic model, where the high energy emission is due to the inverse Compton scattering of BLR (EIC-BLR) or torus (EIC-torus) photons by energetic electrons of the jet.

Broad-band SED modelling

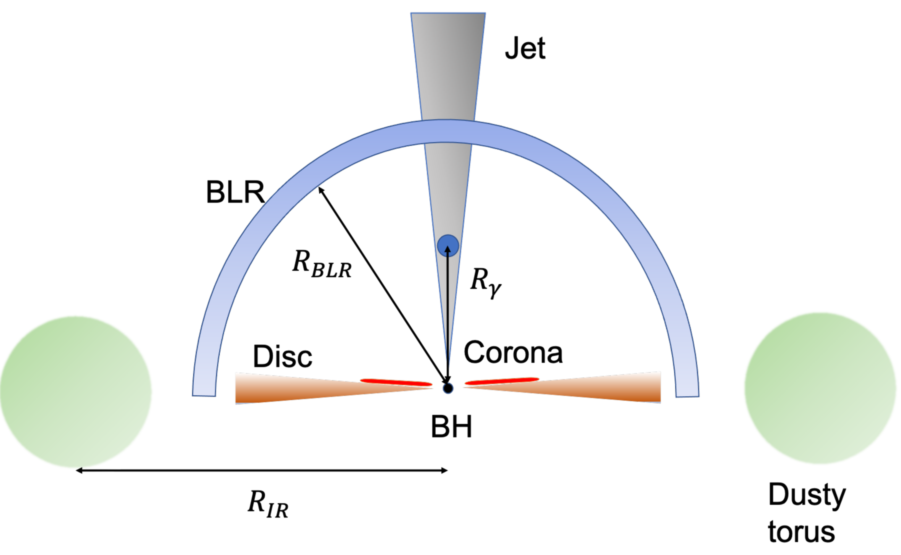


Figure 1: Central engine of AGN

BLR and **torus dominated** scenarios are tested to explain the HE emission, based on:

- a standard one-zone synchrotron self-Compton (SSC) model (Katarzyński et al., 2001)
- modelling of External inverse-Compton (EIC) processes following Dermer and Menon, 2009, Cerruti et al., 2013.

Variable γ-NLS1 galaxies

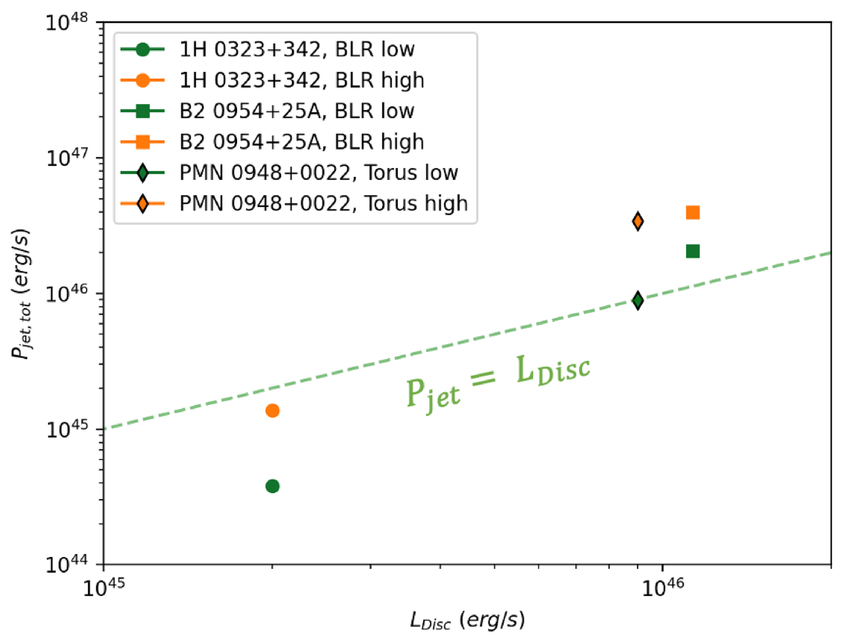
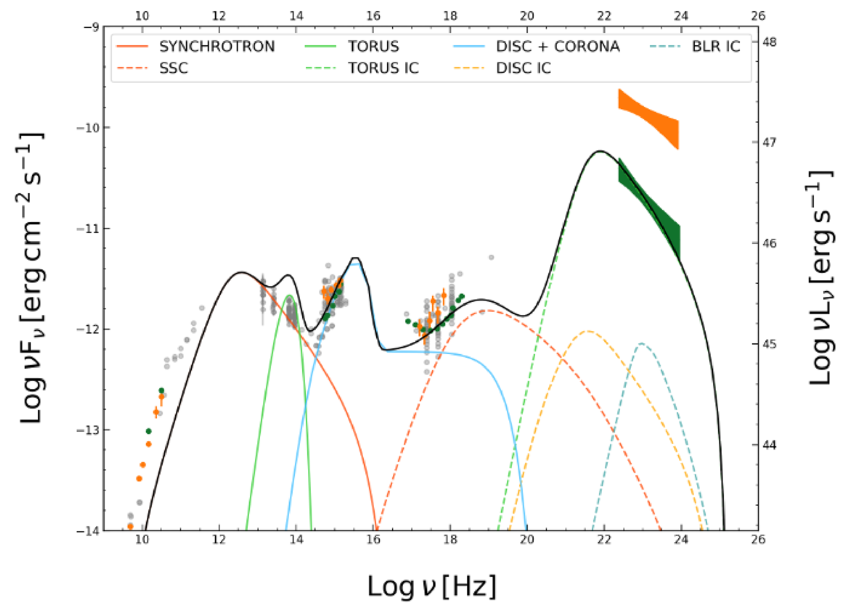


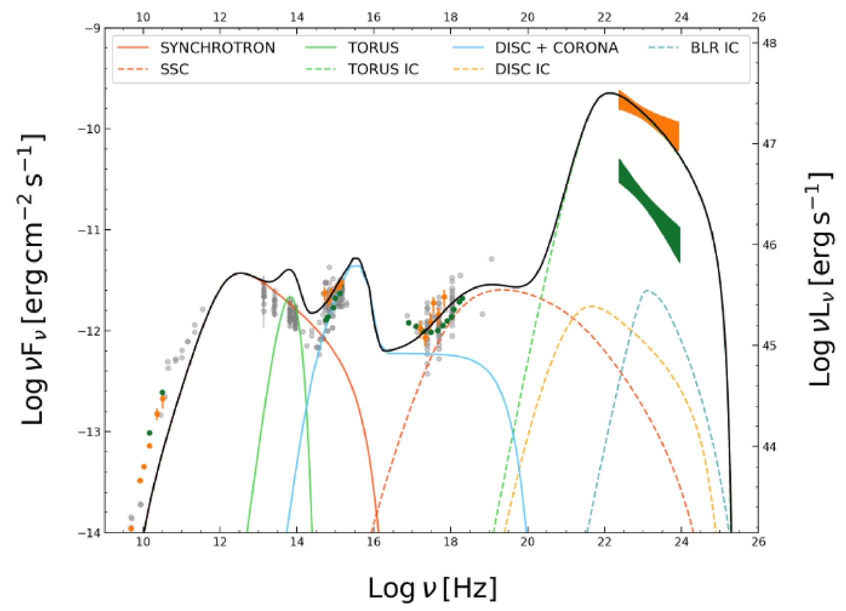
Figure 2: Total jet power vs disc luminosity

- Jet powers generally dominate disc luminosities, except for 1H 0323+342, which appears to be a relatively low power γ-NLS1.
- Flaring states require more jet powers than intermediate/low states.
- PMN J0948+0022 has a jet power comparable to the disc luminosity in a low state, whereas its jet power starts to dominate during a flaring state.
- B2 0954+25A exhibits a more blazar-like behavior than the two genuine γ-NLS1s.

Torus dominated scenario

PMN J0948+0022 (z=0.5846) is well described by the torus-dominated scenario, where the blob is located **at the outer radius of the BLR**.





Fixed parameters

θ	$3°$
$M_{BH}[M_\odot]$	1.5×10^8
$L_D[erg\ s^{-1}]$	9×10^{45}
l_{Edd}	0.48

State	Low	High
δ	10	12
$n_e\ [cm^{-3}]$	12.80	16.37
$R_{blob}\ [cm]$	9.37×10^{16}	9.35×10^{16}
$B\ [G]$	0.20	0.12
n_2	3.9	3.5
γ_b	900	1×10^3

Transition between low and high states explained mainly by:

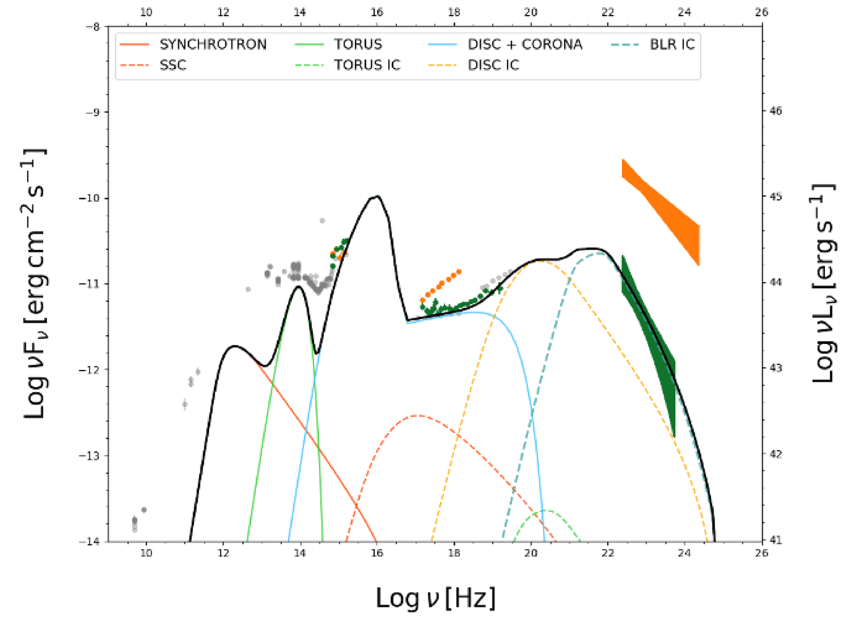
- Changes in the injected particle spectrum and density
- Magnetic field intensity
- Larger Doppler factor during the flare

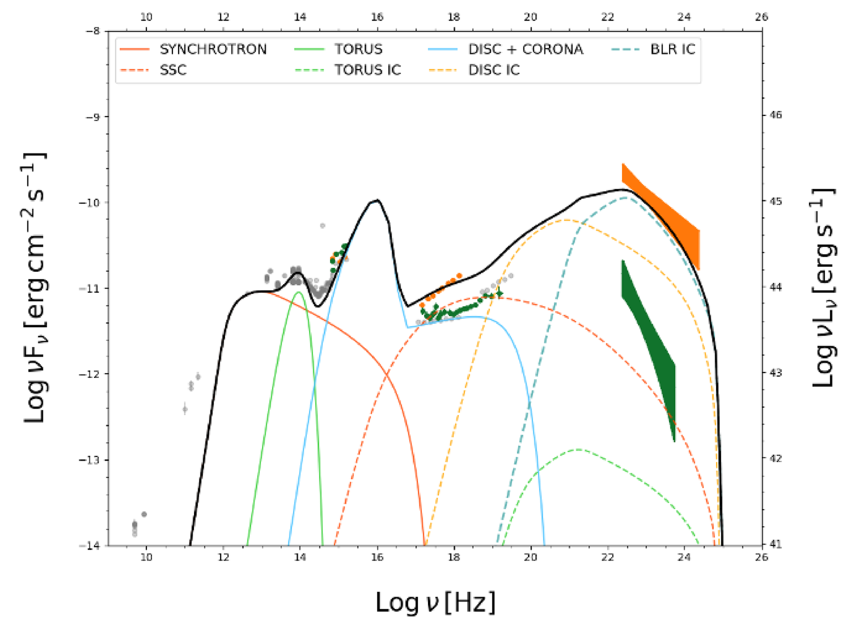
Conclusion

- The comparison between BLR and torus-dominated scenarios helps constraining the location of the emitting region.
- The transition between low and high activity states can be explained by a denser and more relativistic blob in the flaring phase, compared to the quiescent/intermediate state.
- Both scenarios favor the stationary shock scenario, i.e. the presence of recollimation shocks in the jet, at the origin of the observed enhanced high energy emission.
- Multi-epoch modelling of γ-NLS1 galaxies shows a variable jet power.

Disc and BLR dominated scenario

1H 0323+342 (z=0.0625) is well described by the torus-dominated scenario, where the blob is located **below the inner radius of the BLR**.





Fixed parameters

θ	$5°$
$M_{BH}[M_\odot]$	2×10^7
$L_D[erg\ s^{-1}]$	2×10^{45}
l_{Edd}	0.80

State	Low	High
δ	9	10
$n_e\ [cm^{-3}]$	2.56×10^4	6.03×10^4
$R_{blob}\ [cm]$	1.15×10^{15}	1.01×10^{15}
n_2	4.2	3.4
γ_b	150	280

Transition between low and high states explained mainly by:

- Changes in the injected particle spectrum and density
- Size of the emitting region
- Larger Doppler factor during the flare

Note: We consider a broken power law particle distribution with n_1 and n_2 being the indices before and after the break energy γ_b, respectively. δ is the Doppler factor of the blob, B is the magnetic field intensity and n_e denotes the particle density.

References

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