Variable γ-ray emitting Narrow Line Seyfert 1 galaxies

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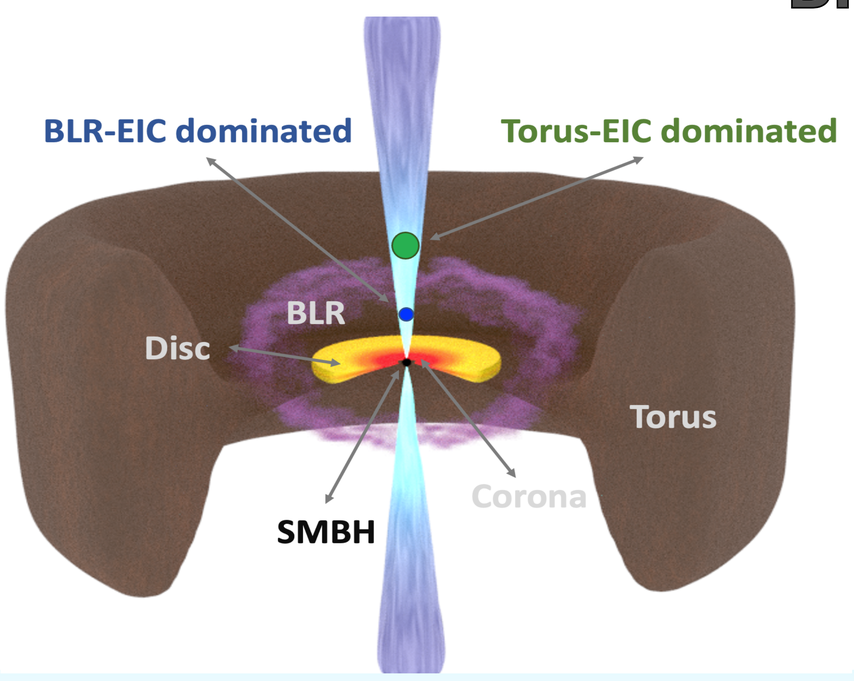
Gamma-ray emitting narrow line Seyfert 1 galaxies are a peculiar class of Active Galactic Nuclei (AGN). They are jetted, radio-loud Seyfert galaxies, with unexpected and variable high energy gamma-ray emission, sharing properties of Flat Spectrum Radio Quasar (FSRQ) objects, but host relatively low mass black holes (BH) and accrete at exceptionally high, near-Eddington rates. To investigate the origin of their variable gamma-ray emission, two typical γ-NLS1 1H 0323+342 and PMN J0948+0022, and one intermediate object between NLS1 and FSRQ sub-classes B2 0954+25A were selected for multi-epoch modelling of their broad-band spectral energy distributions (SED). We test two scenarios, where the observed high energy γ-ray emission is due to inverse-Compton (IC) scattering of (disc&)BLR or torus photons by relativistic electrons of the jet.

Broad-band SED modelling



Broad-band SED modelling of our sources is based on:

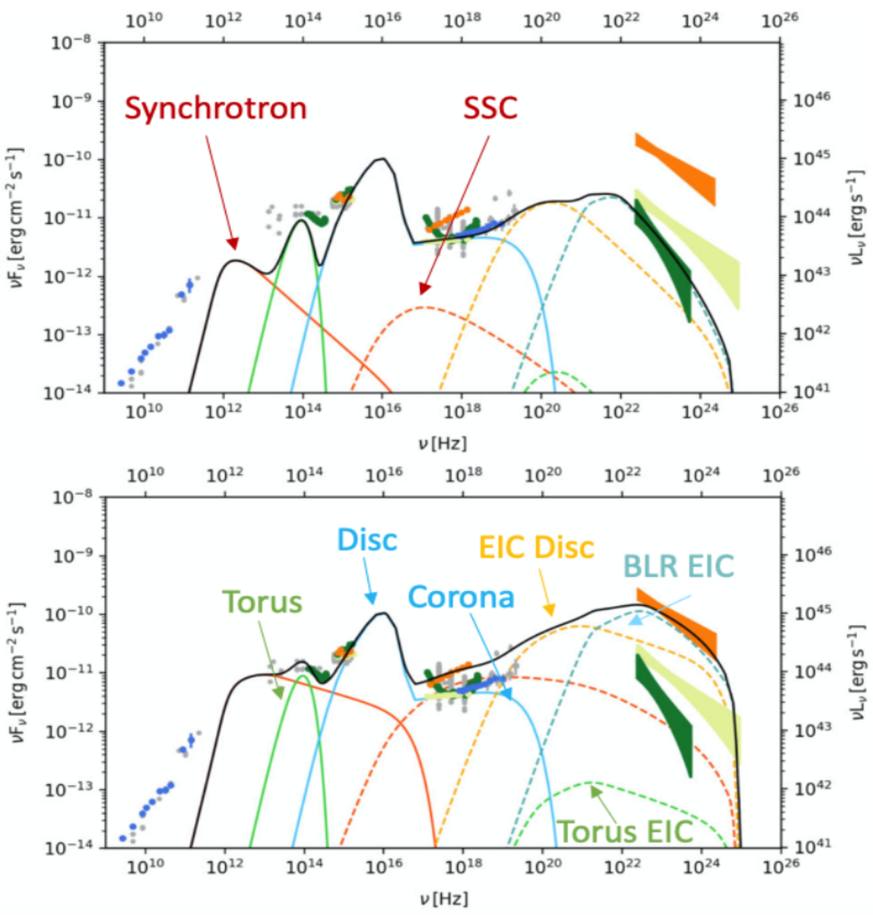
- one-zone synchrotron self-Compton (SSC) model by Katarzynski et al., (2001)

- external inverse-Compton (EIC) processes involving BLR and torus photons, modelled following Dermer & Menon (2009), Cerruti (2013).

BLR-dominated scenario: when the blob is located below te inner radius of the BLR

Torus-dominated scenario: when the blob is above the BLR

Disc & BLR dominated scenario



1H 0323+342

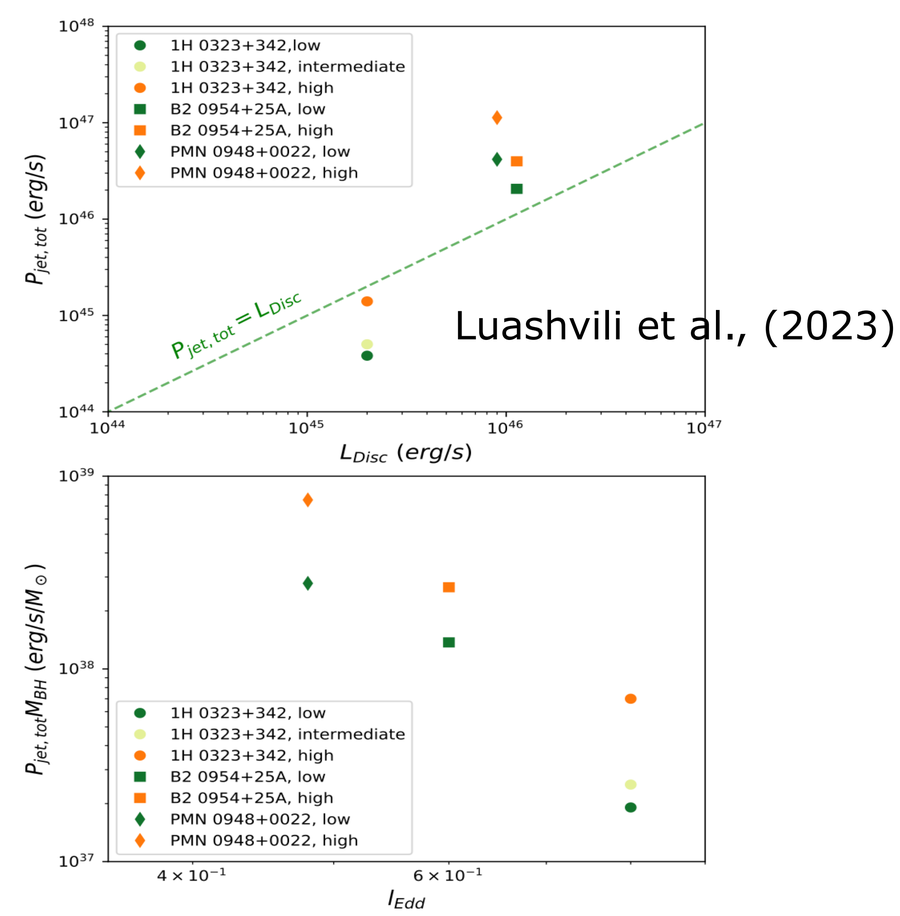
nearby γ-NLS1 (z = 0.0625) (Landt et al., 2017), with near-Eddington accretion rates (Kynoch et al. 2017)

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	1.74×10^4
$R_{blob}\ [cm]$	1.15×10^{15}	1.03×10^{15}
n_2	4.2	3.4
γ_{min}	50	120
γ_b	150	280

Transition between low and high activity states mainly explained by:
- Changes in the particle spectrum and density
- More compact emitting blob
- Larger Doppler factors for flaring states

Total jet powers



Luashvili et al., (2023)

Jet power vs disc luminosity diagrams (for only BLR dominated scenarios) show that:
- variable Pjet generally dominates over Ldisc, except for 1H 0323+342.
- γ-NLS1 PMN J0948+0022 appear as powerful as FSRQ B2 0954+25A, once BH mass normalized.

Conclusions

Both low and high states are modelled by a blob located at the same height in the jet - **stationary shock scenario**.

Torus-EIC dominated scenarios were rejected due to very high radiative efficiencies.

BH-normalized jet powers revealed that γ-NLS1 PMN J0948+0022 can be as powerful as the FSRQ B2 0954+25A, while 1H 0323+342 appears to be genuinly under-powered.

References

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