Gamma-Ray emission from kilo-parsec scale jet of Low-Luminosity AGNs

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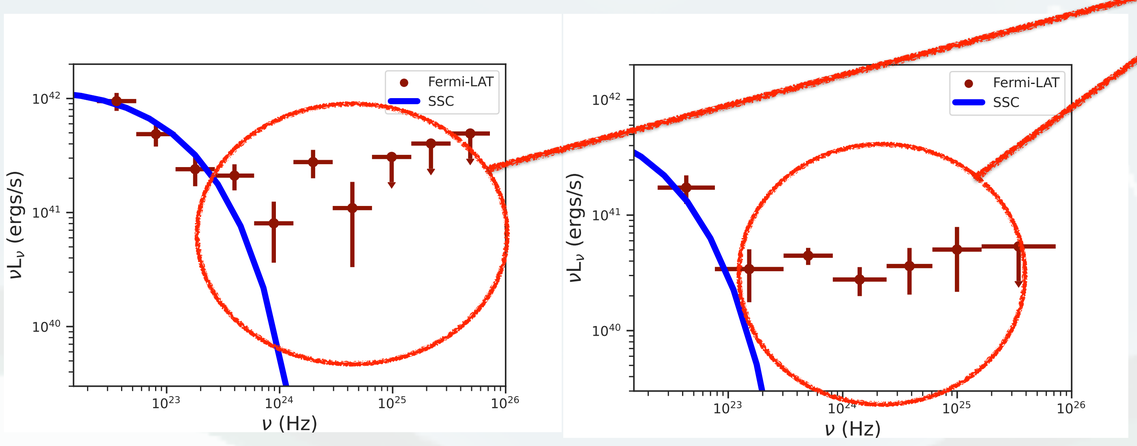
INTRODUCTION

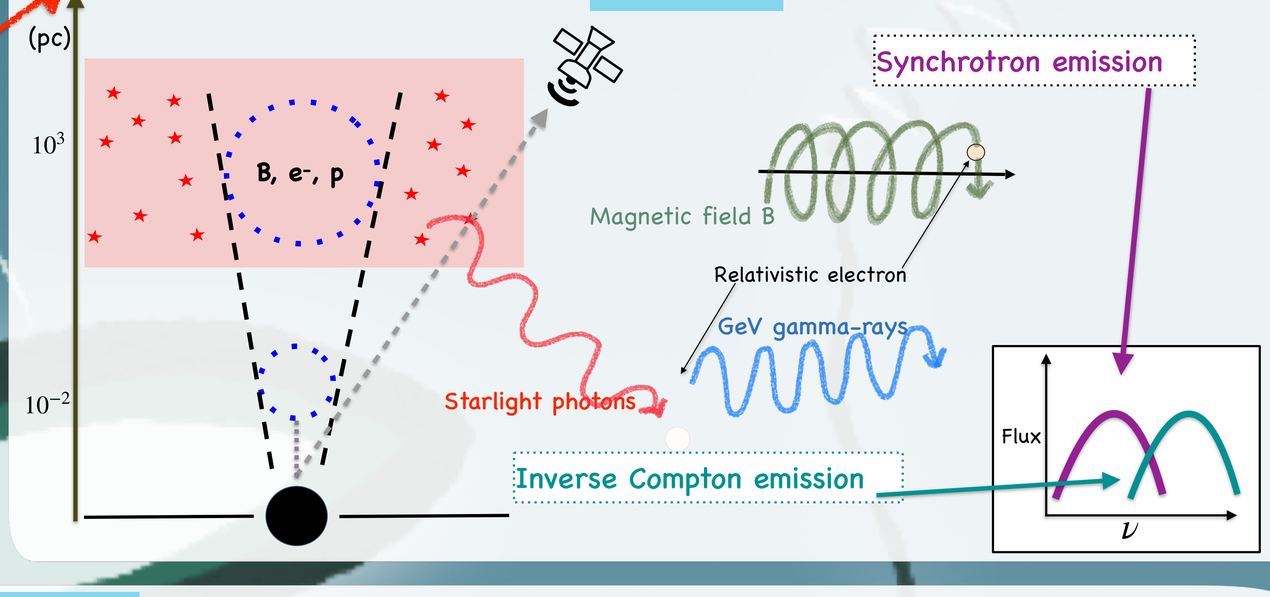
- **Low-Luminosity Active Galactic Nuclei (AGNs)** → Active Galactic Nuclei with sub-Eddington accretion rate.
  NGC 315 : $L_{Bol}/L_{Edd} = 4.9 \times 10^{-4}$ **&** **NGC 4261** : $L_{Bol}/L_{Edd} = 2.5 \times 10^{-5}$
- **Consists of radiatively-inefficient accretion flow, truncated disk and jet - relative contribution unknown.**
- **Kilo-parsec jets seen in radio and X-rays - gamma-rays are produced by inverse Comptonization of Starlight photons from the host galaxy.**

GAMMA-RAY EXCESS



Synchrotron Self-Compton emission from emission region at sub-parsec scale jet.

MODEL



METHODS

- Time-dependent code **GAMERA**
  Solves transport equation:

$$\frac{\partial N(E,t)}{\partial t} = Q(E,t) - \frac{\partial (bN)}{\partial E} - \frac{N}{t_{esc}}$$

Power-Law Energy distribution

$$Q(E) = L_o \frac{E^{-\alpha}}{E_{ref}}$$

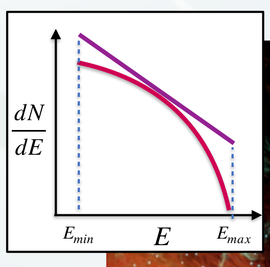
OR

Log-Parabola Electron Distribution

$$Q(E) = L_o \frac{E^{-\alpha-\beta ln(E/E_{ref})}}{E_{ref}}$$

Input

1. $Q(E,t)$
2. Radius of emission region, R
3. Magnetic field inside, B
4. Energy density (u_{ph}) and temperature (T) of the photon field.



Continuous injection of accelerated electrons

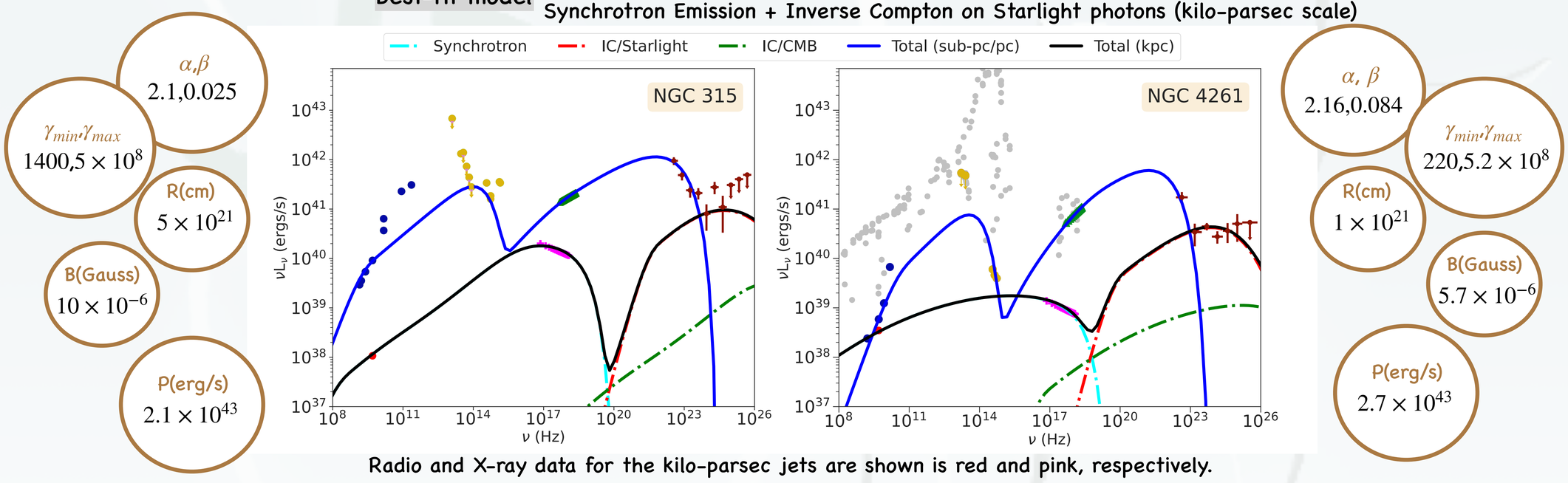
Synchrotron Emission

Output

Synchrotron Self-Compton Emission/Inverse Compton Emission

RESULTS

Best-fit model Synchrotron Emission + Synchrotron Self-Compton (sub-parsec scale)
Synchrotron Emission + Inverse Compton on Starlight photons (kilo-parsec scale)



Radio and X-ray data for the kilo-parsec jets are shown is red and pink, respectively.

** $P_{tot} = \pi R^2 \Gamma^2 c (U'_e + U'_B + U'_p)$ and $U'_e = \frac{1}{V} \times \int_{E_{min}}^{E_{max}} Q(E) E dE$, $U'_B = \frac{B^2}{8\pi}$ and $U'_p = n_p m_p c^2$; Primed quantities are measured in the co-moving frame of the jet.

CONCLUSIONS

- Multi-wavelength emission can be well explained by emission from sub-parsec jet upto few GeV.
- Above a few GeV, emission is explained by inverse Compton emission of starlight by relativistic electrons in kilo-parsec jet.

REFERENCES

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[3] de Menezes et al, 2020; MNRAS.
[4] Stawarz, L, 2003; ApJ.

Fermi Gamma-ray Space Telescope
Tenth International Fermi Symposium, Johannesburg 9th–15th October 2022