Modelling TXS0506+056 with internal $\gamma - \gamma$ secondaries

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Introduction

- TXS0506+056 is the first known astrophysical object which has 3.5 sigmas temporal and spatially coincident with IceCube neutrino event 170922A.
- Multi-wavelengths observations[1] for the flaring state of TXS0506+056 blazar reported by Fermi-LAT, MAGIC, Agile, H.E.S.S, Integral, Kanata, Swift, NuStar telescopes.
- We use the lepto-hadronic model to study the kinematics of TXS0506+056 blazar.
- Low energy photons are from the leptonic part of the spectral energy distribution(SED) and high-energy photons from the proton synchrotron.

Methodology

We consider a spherical region of radius R' inside the moving jet called a blob. Prime parameters are used for the jet frame and unprime parameters are used for the observer frame. We use the "Gamera Package"[3] for the modeling of TXS0506+056 blazar. The injected spectrum of electrons in the jet is defined as a power law

$$\frac{dN}{dE} = l_0 \left(\frac{E}{E_0}\right)^{-\alpha} \tag{1}$$

where dN/dE is number of particles in the spectrum with respect to energy and α is index parameter for electron spectrum and l_0 is the luminosity of injected electrons particles. In the blob charge neutrality condition is valid. The spectrum of the accelerated proton is defined as power-law with the exponential cut-off.

$$N_p(E) = N_0\, E_p^{-\alpha_p}\, exp(-E_p/E_0) \tag{2}$$

Emissivity calculation:[2] To calculate the number of electrons per unit volume per unit time from the interaction of low energy γ of the leptonic part of SED with high energy γ of proton synchrotron.

$$Q'_{e,\gamma\gamma}(\gamma'_e) = \frac{3\,\sigma_T\, c}{32} \int_{\gamma'_e}^{+\infty} d\epsilon'_\gamma \frac{n'_\gamma(\epsilon'_\gamma)}{{\epsilon'_\gamma}^3} \int_a^{+\infty} d\epsilon'_j \frac{n'_j(\epsilon'_j)}{{\epsilon'_j}^2} \times \left[\frac{4\,{\epsilon'_\gamma}^2}{\gamma'_e(\epsilon'_\gamma - \gamma'_e)} \ln\left(\frac{4\gamma'_e\epsilon'_\gamma(\epsilon'_\gamma - \gamma'_e)}{\epsilon'_\gamma}\right) - 8\epsilon'_\gamma\epsilon'_j + \frac{2{\epsilon'_\gamma}^2(\epsilon'_\gamma\epsilon'_j - 1)}{\gamma'_e(\epsilon'_\gamma - \gamma'_e)} - \left(1 - \frac{1}{\epsilon'_\gamma\,\epsilon'_j}\right)\left(\frac{{\epsilon'_\gamma}^2}{\gamma'_e\,(\epsilon'_\gamma - \gamma'_e)^2}\right)\right] \tag{3}$$

where $a = \dfrac{\epsilon'_\gamma}{4\,\gamma'_e\,(\epsilon'_\gamma - \gamma'_e)}$ σ_T is Thomson scattering cross-section and c is speed of light and γ'_e is Lorentz factor from $\gamma - \gamma$ pair production and $n'_\gamma(\epsilon'_\gamma)$ is number density of Photons of energy ϵ'_γ using total leptonic contribution and $n'_j(\epsilon'_j)$ is number density of photons of energyϵ'_j using proton synchrotron[4] and ϵ'_γ is low-energy Photons energy in the unit of $m_e\, c^2$(Hz) and ϵ'_γ is high-energy Photons energy in the unit of $m_e\, c^2$(Hz)and $f_{\epsilon j}$ is Observed photon flux in the unit $(erg\ cm^{-2}\ s^{-1})$

Summary

- We first modeled the low energy photons from radio to GeV γ-rays with leptonic channel. From the leptonic total energy we calculated the proton energy budget.
- Due to magnetic field of 36 Gauss from the modelling the proton also cool down through synchrotron.
- We calculated the cascade photons from these synchrotron photons and found it will contribute at the X-rays energy range.

Result

Parameters used in the lepto-hadronic model are

Parameters	Value	Parameters	Value
α	1.02	$l_0\ (1/erg)$	5×10^{45}
γ'_{emin}	1300	γ'_{emax}	7×10^3
δ	21.5	$B\ (Gauss)$	36
z	.3365	d(pc)	1.79×10^9
R (cm)	9.3×10^{14}	$N_0(1/erg)$	1.31×10^{42}
γ'_{pmin}	1	γ'_{pmax}	1.06×10^{10}
α_p	2	$t_{var}\ (days)$	60

Result

The secondary contribution of low energy photons from the leptonic part of the SED and high energy photons from the proton synchrotron is shown in fig(1)

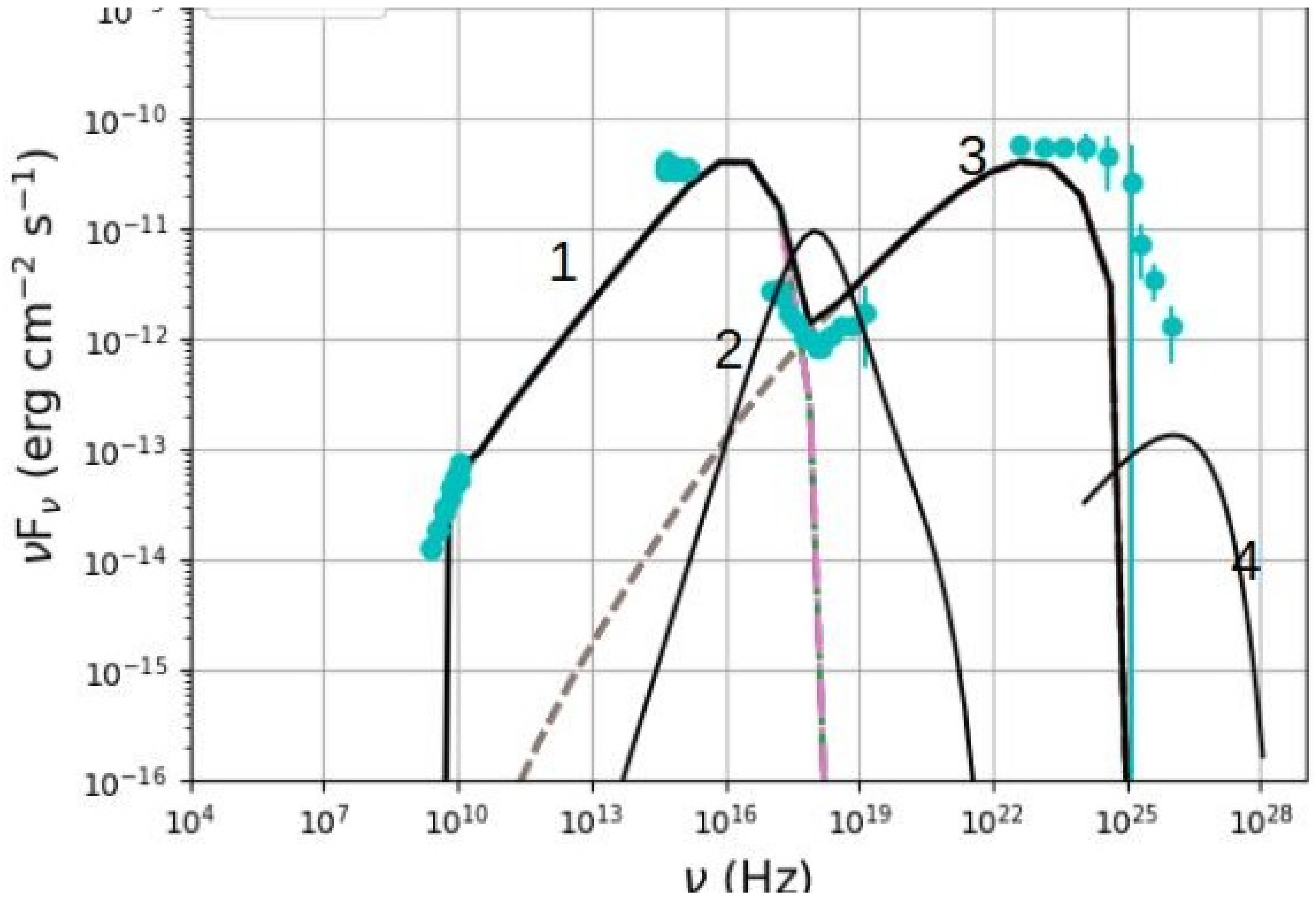

Figure 1: [The first curve characterizes electron synchrotron and the second curve denotes secondary contribution of gamma-gamma absorption and the 3rd curve shows SSC contribution and the 4th curve illustrates proton synchrotron contribution]

References

[1] IceCube Collaboration and Aartsen, *Multimessenger observations of a flaring blazar coincident with high-energy neutrino IceCube-170922A*(2018)

[2] Aharonian, F. A. and Atoian, A. M. and Nagapetian, A. M., *Photoproduction of electron-positron pairs in compact X-ray sources*(1983)

[3] J. Hahn *GAMERA - A Modular Framework For Spectral Modeling In VHE Astronomy*(2015)

[4] Aharonian, F. A., *TeV gamma rays from BL Lac objects due to synchrotron radiation of extremely high energy protons*(2000)