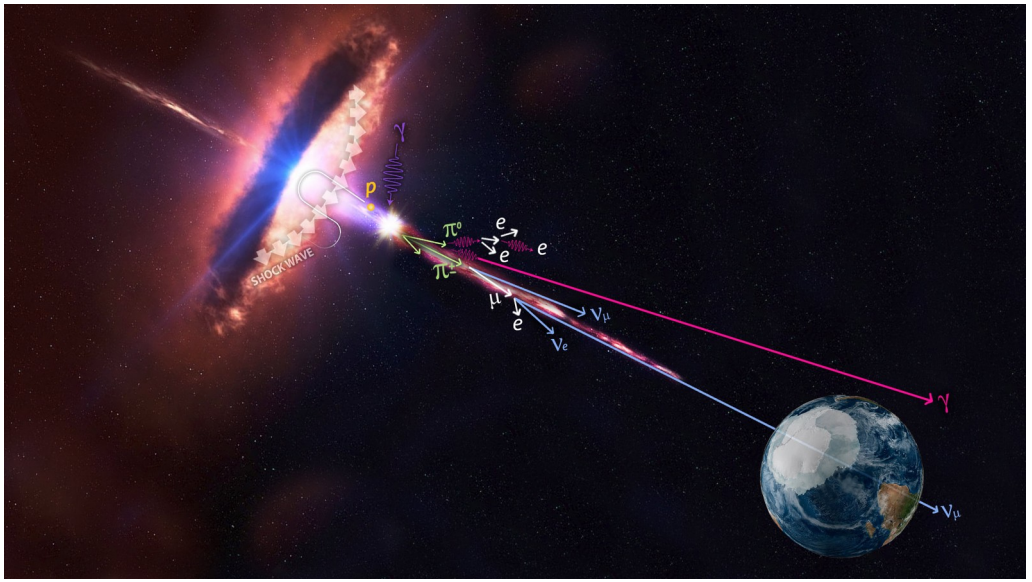
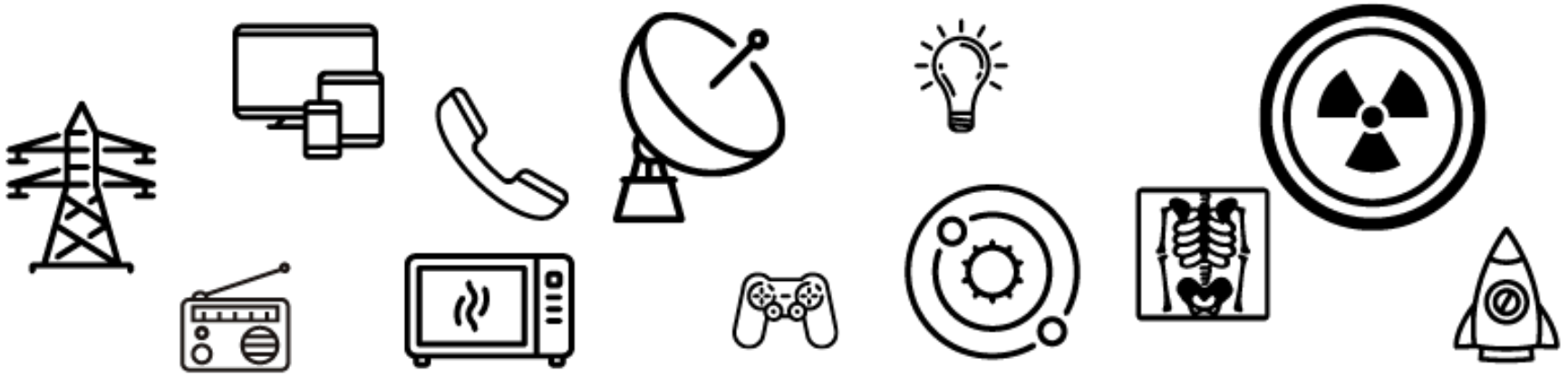


PRODUÇÃO DE RADIAÇÃO EM JATOS RELATIVÍSTICOS EM NÚCLEOS ATIVOS DE GALÁXIAS

Luiz Augusto Stuani Pereira (luizstuani@uaf.ufcg.edu.br)

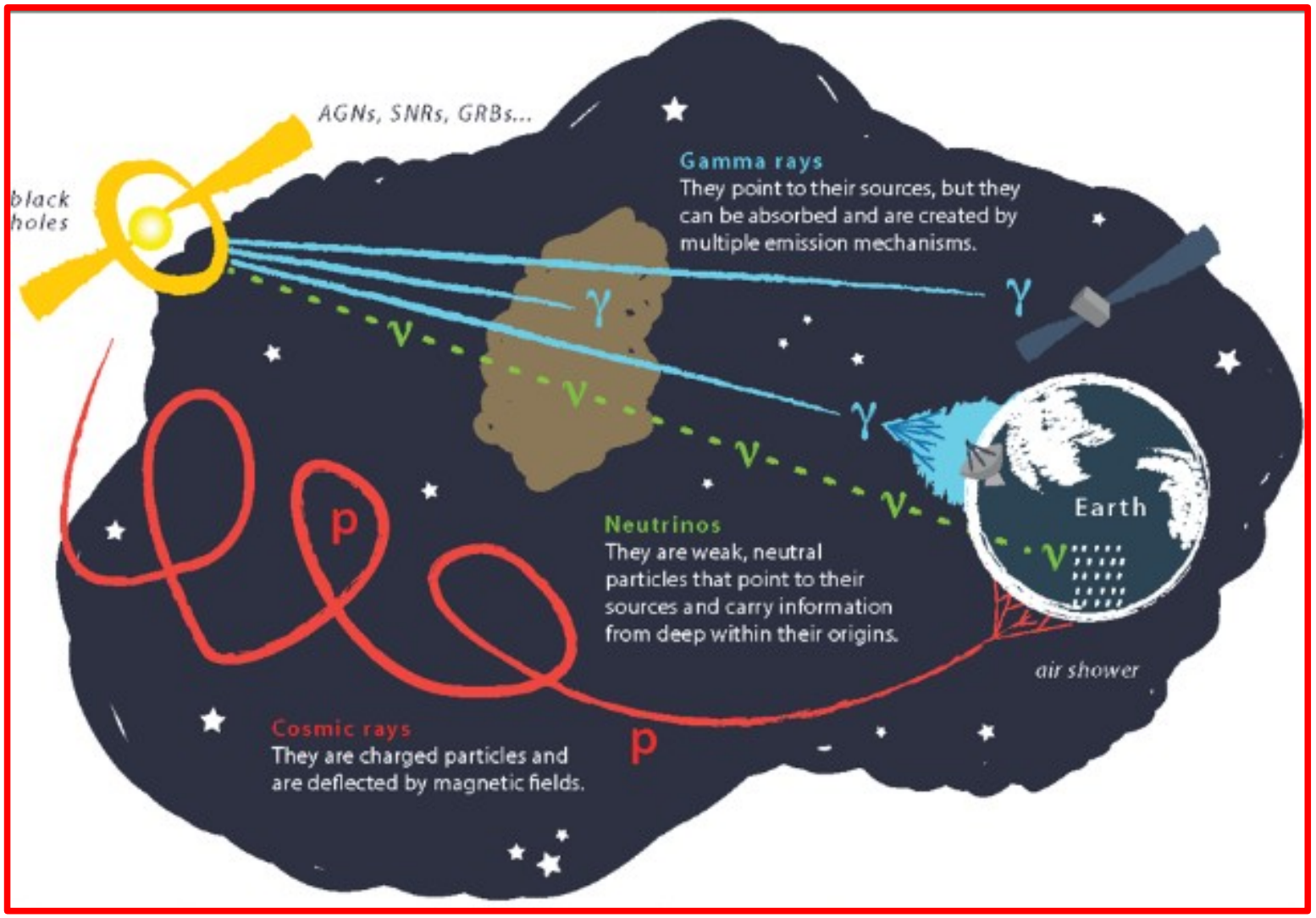
ESPECTRO ELETROMAGNÉTICO



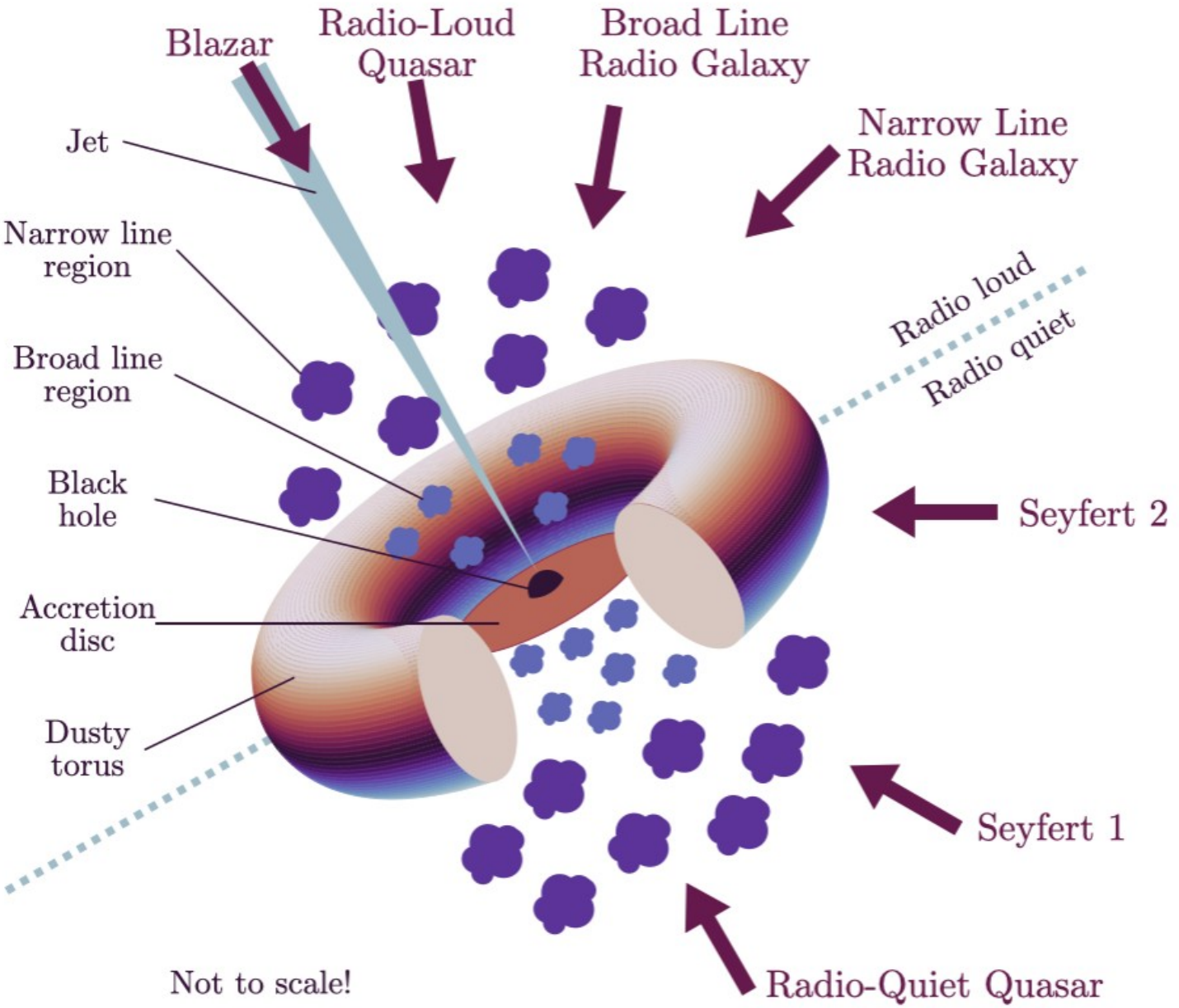
Ondas de rádio	Microondas	Infravermelho	Luz visível	Ultra-violeta	Raios X	Raios Gama	Raios cósmicos
Radiação não ionizante					Radiação ionizante		

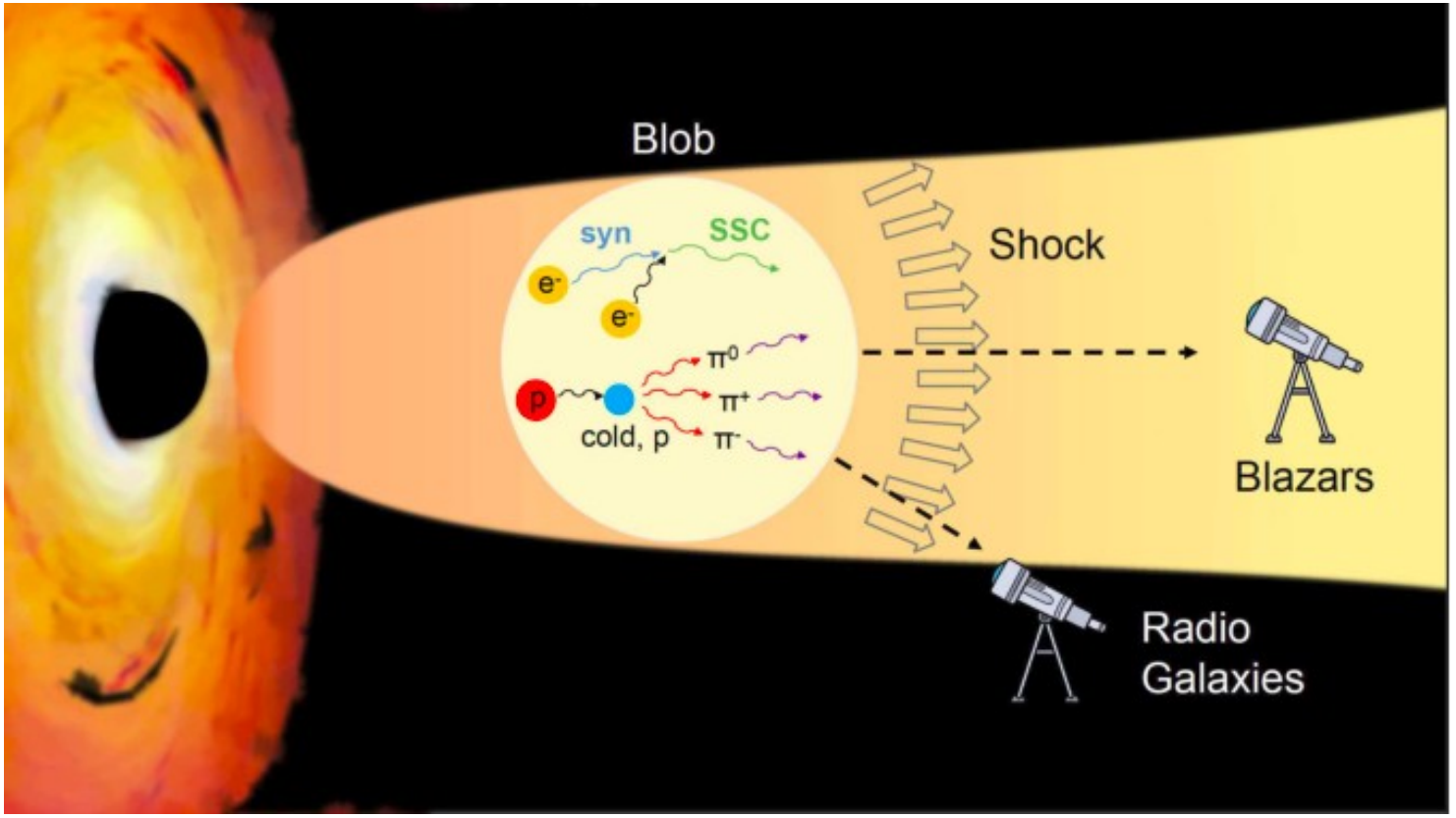
	Frequência																	
Hz	10^{4}	10^{5}	10^{6}	10^{7}	10^{8}	10^{9}	10^{10}	10^{11}	10^{12}	10^{13}	10^{14}	10^{15}	10^{16}	10^{17}	10^{19}	10^{21}	10^{23}	
	Energia																	
eV	10^{-10}	10^{-9}	10^{-8}	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	1	10^{1}	10^{2}	10^{4}	10^{6}	10^{8}	10^{10}	

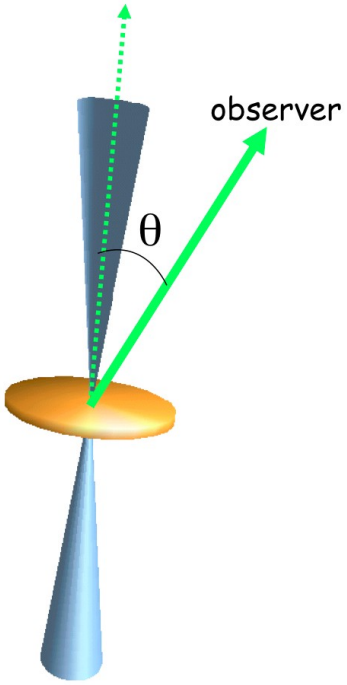
ASTROFÍSICA MULTIMENSAGEIRA



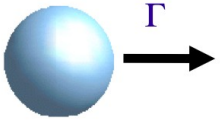
NÚCLEO ATIVO DE GALÁXIA (AGN)



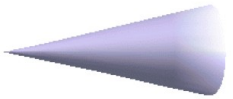




rest frame :
isotropic emission



Observer frame:
beamed

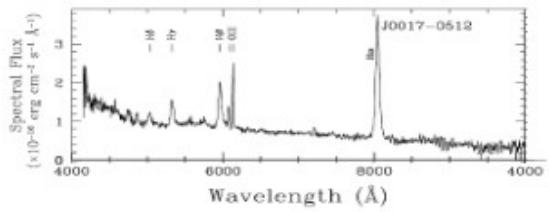


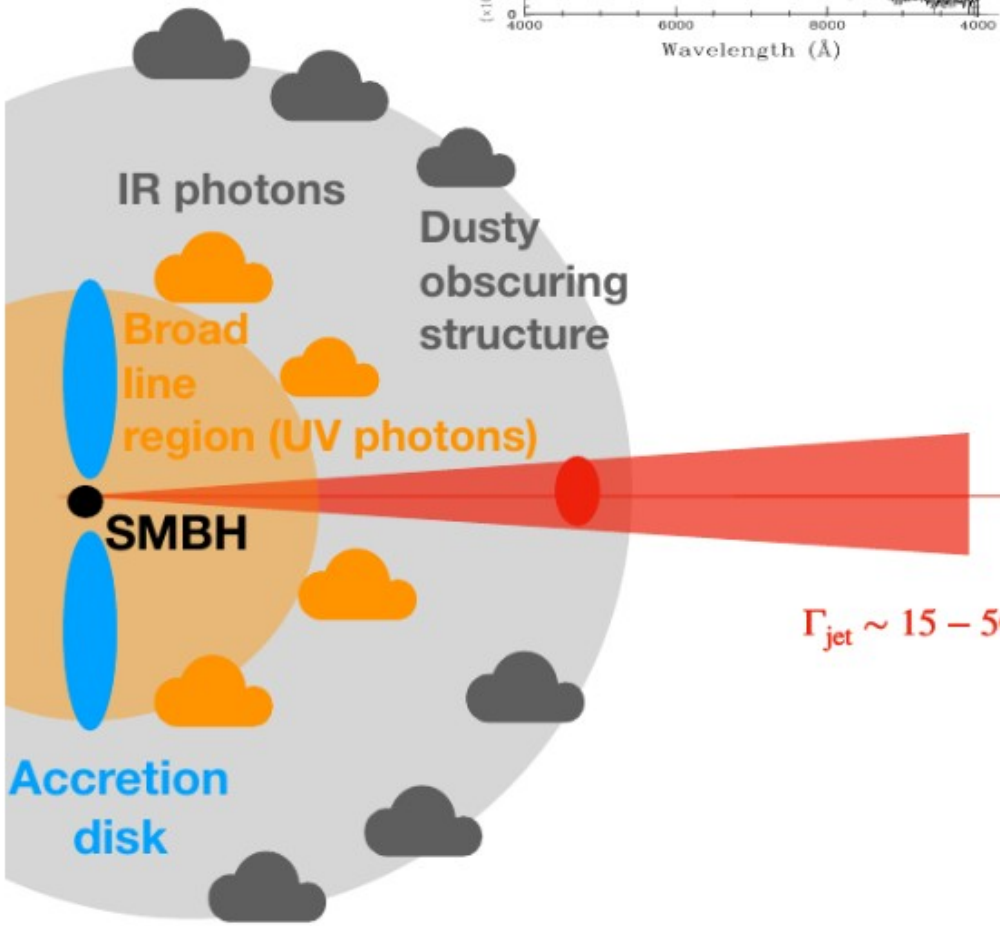
Beaming factor:

- $\delta = \frac{1}{\Gamma(1-\beta cos(\theta))}$
- $\theta = 1/\Gamma$

CLASSES DE BLAZARES

FSRQs

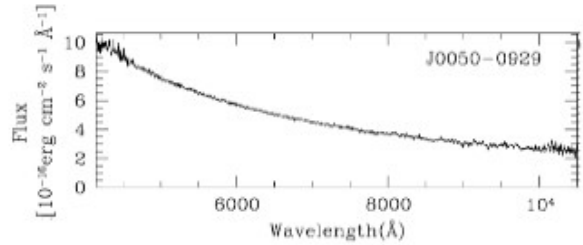


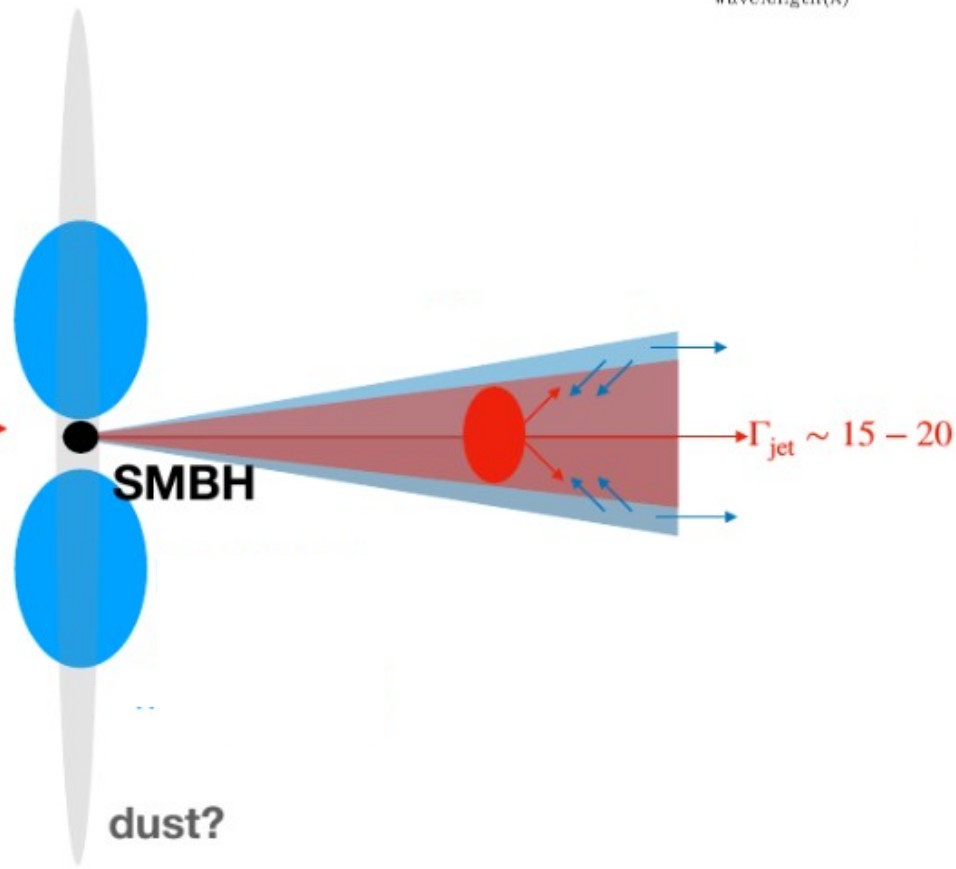


$\Gamma_{jet} \sim 15 - 50$

-Emissão de linhas largas no espectro óptico;
-Eficiência na emissão de radiação do disco;
-Acresção de matéria a taxas de Eddington;
-Alta potência do jato e luminosidade de raios gama.

BL Lacs

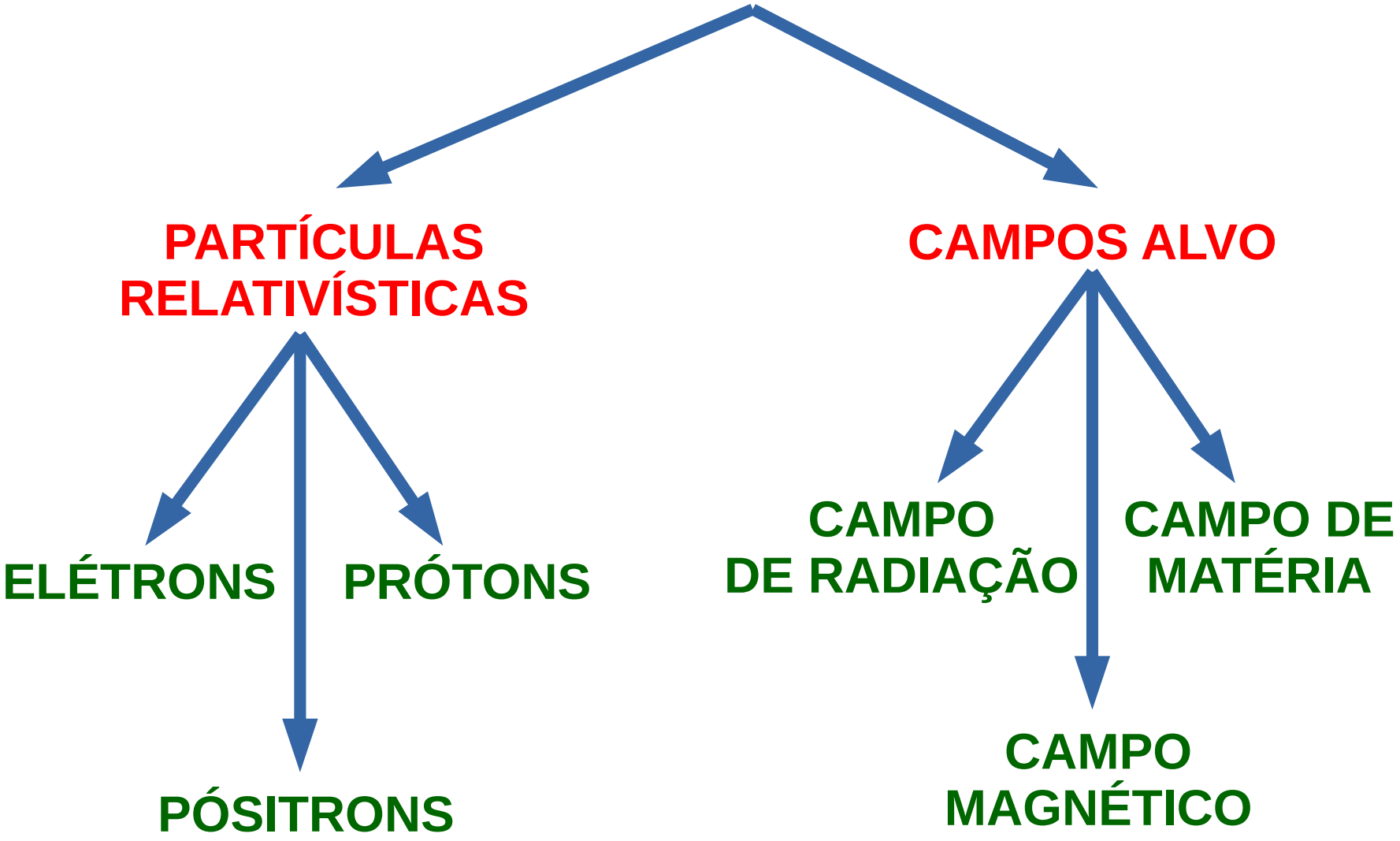




$\Gamma_{jet} \sim 15 - 20$

-Fraca ou pouca emissão de linhas largas no espectro óptico;
-Ineficiência na emissão de radiação do disco;
-Acresção de matéria a sub-taxas de Eddington;
-Baixa potência do jato e luminosidade de raios gama.

PRODUÇÃO DE RADIAÇÃO EM AMBIENTES ASTROFÍSICOS



PRODUÇÃO DE RADIAÇÃO EM JATOS RELATOVÍSTICOS

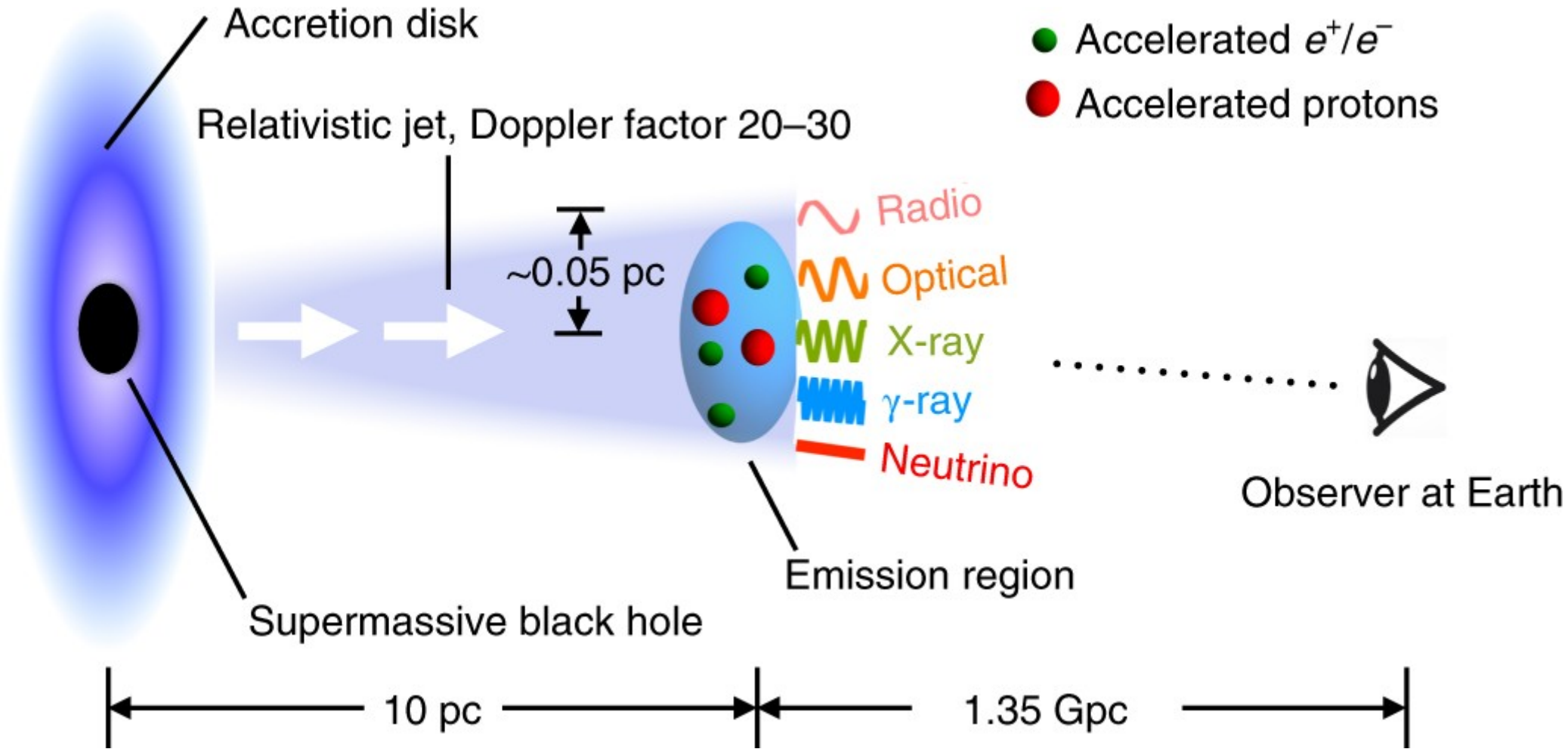
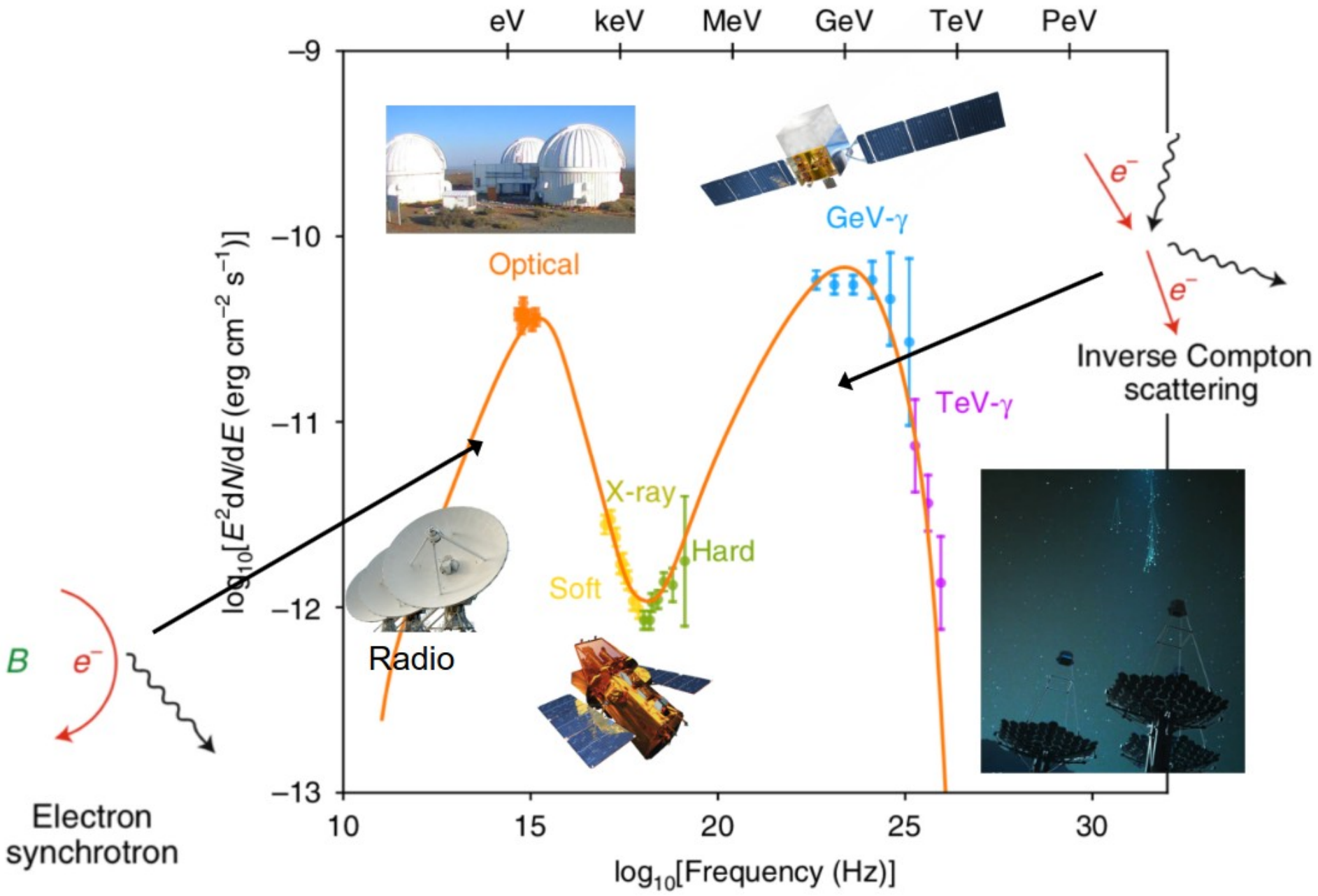
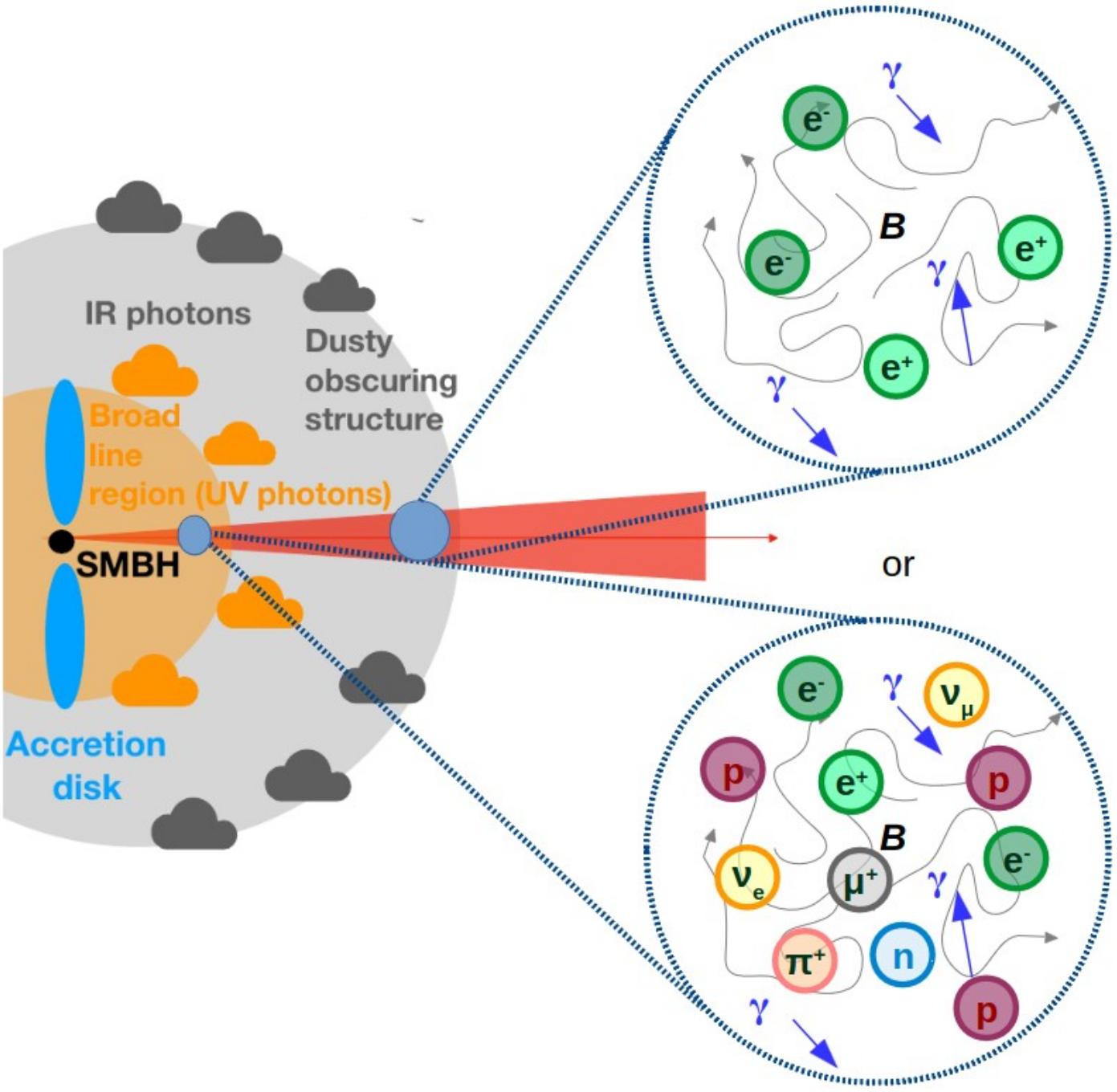


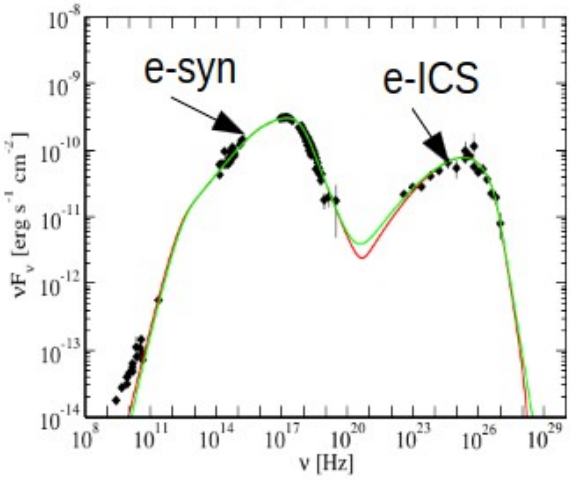
IMAGEM ELETROMAGNÉTICA DE BLAZARES



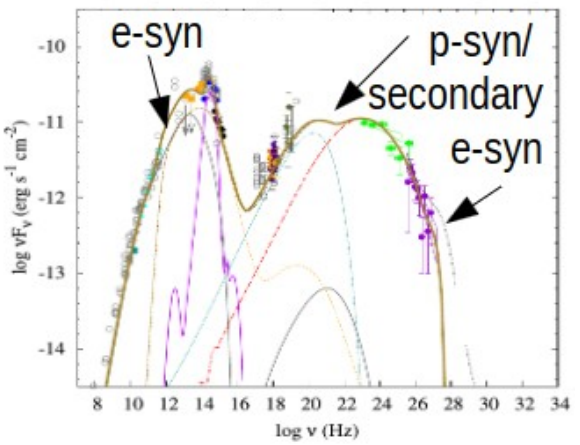
MODELOS DE EMISSÃO CONSIDERANDO UMA ÚNICA ZONA



Leptonic



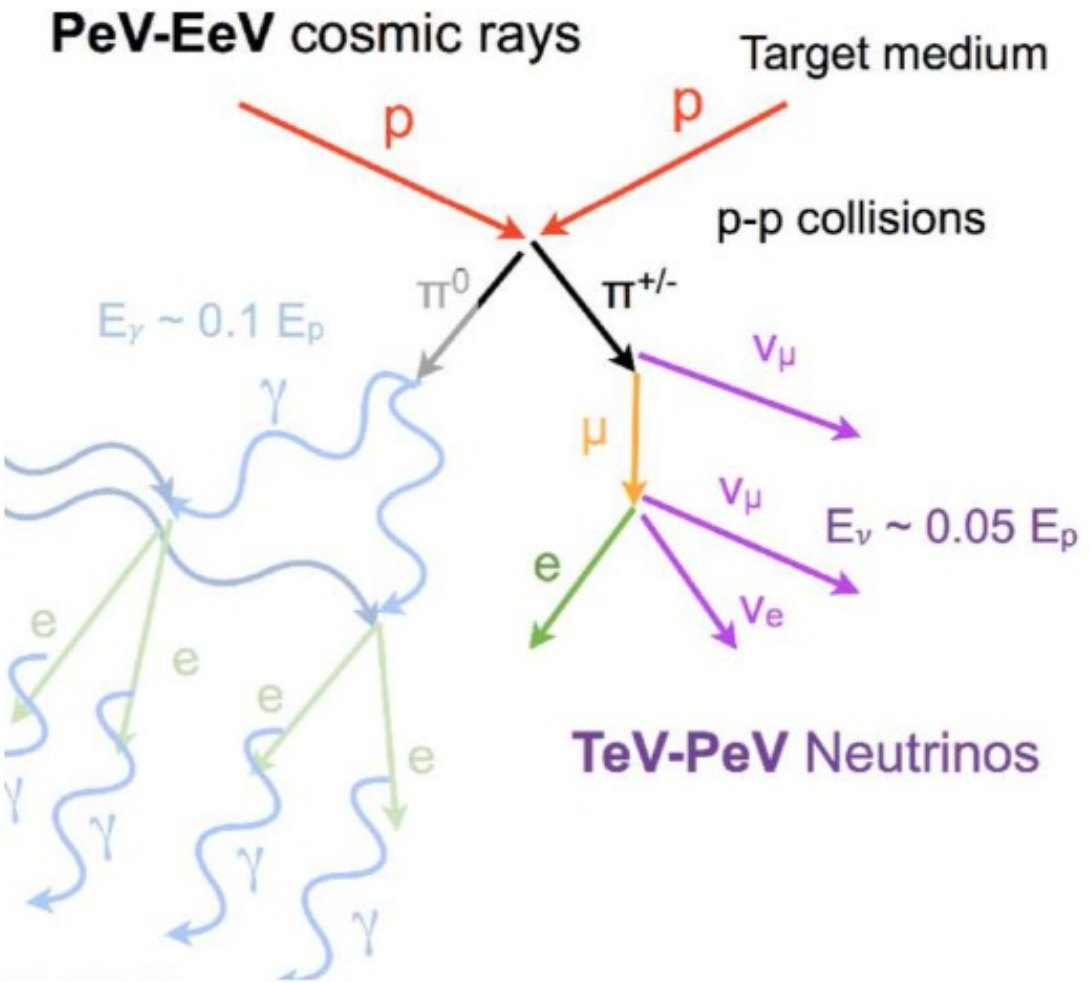
Leptohadronic



EMISSÃO HADRÔNICA EM JATOS RELATIVÍTICOS – PRODUÇÃO DE NEUTRINOS

DENSE GAS

Colisão pp

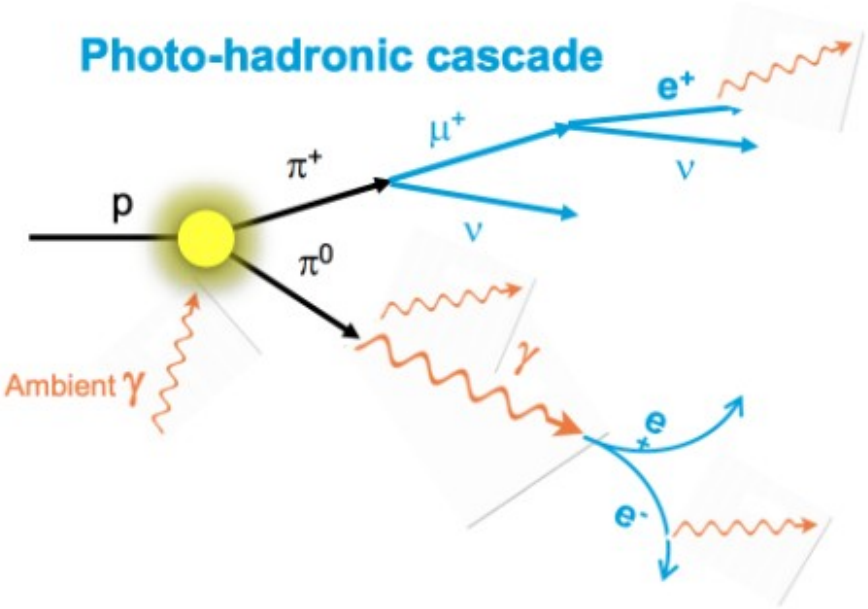


EMISSÃO HADRÔNICA EM JATOS RELATIVÍTICOS – PRODUÇÃO DE NEUTRINOS

Interação fotohadrônica/fotopíon (pγ)

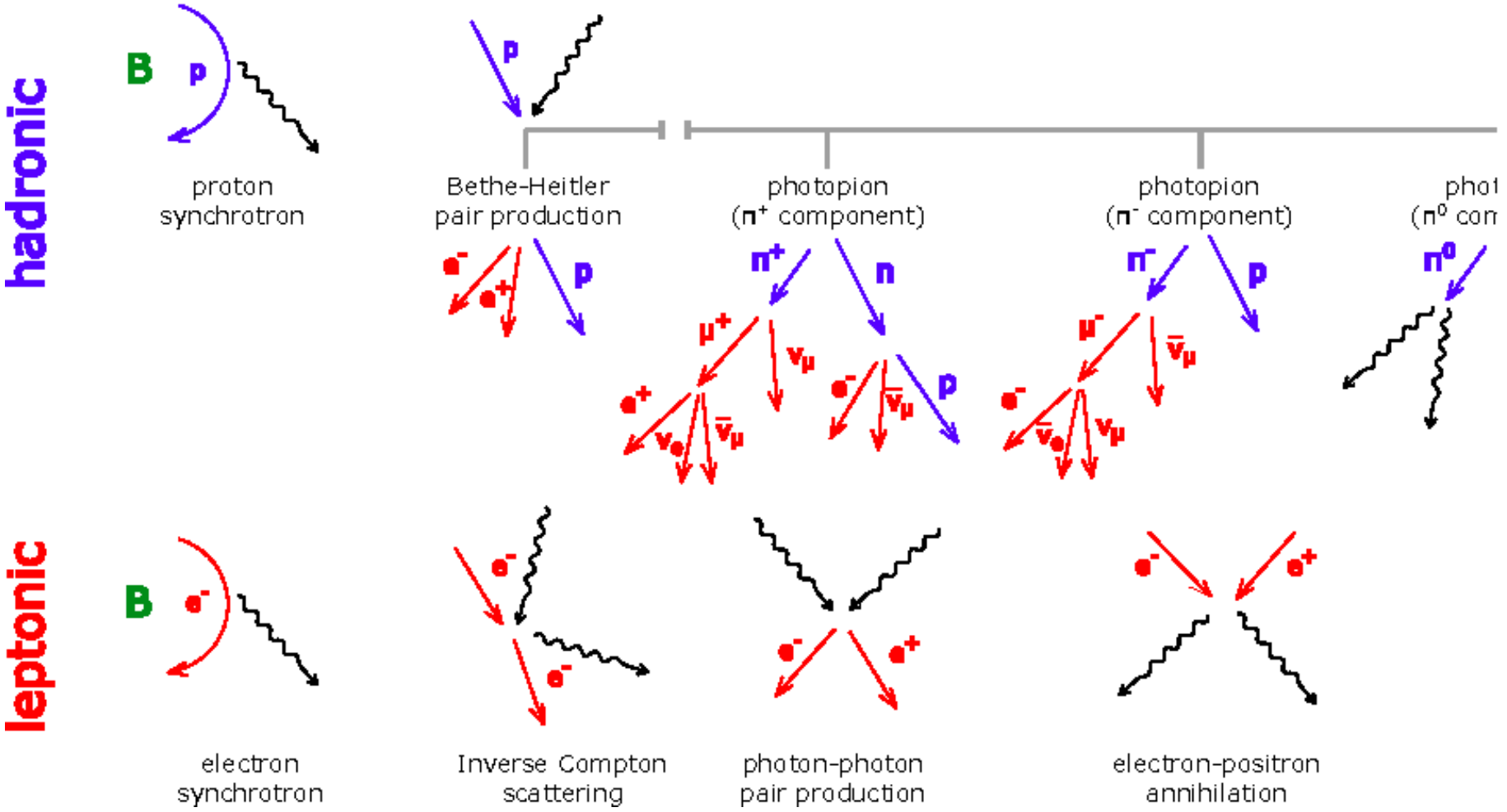
DENSE PHOTON FIELDS

$$p + \gamma \rightarrow p/n + \pi^{\pm}, \pi^{0} \rightarrow 2\gamma + 2\nu_{\mu} + \nu_{e}$$



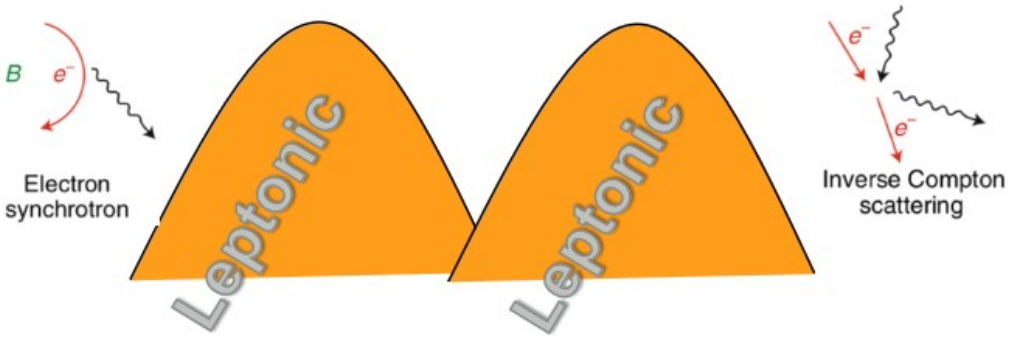
100 TEV NEUTRINO —> 2 PEV PROTON

PRODUÇÃO DE RADIAÇÃO EM JATOS RELATIVÍSTICOS DE AGNs

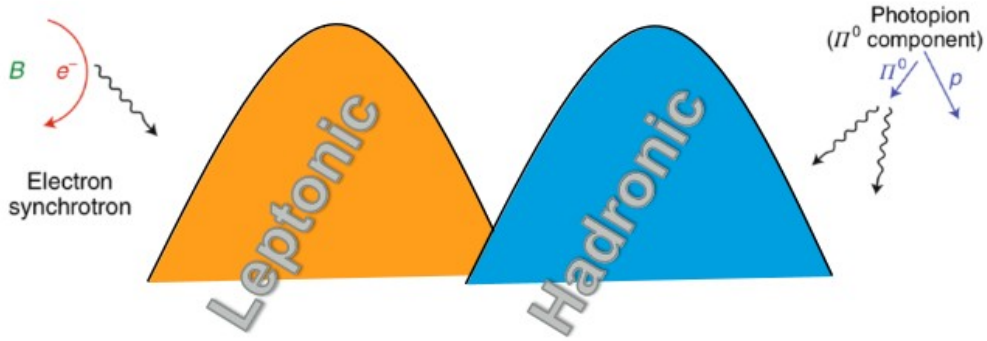


MODELOS DE DISTRIBUIÇÃO DE ENERGIA ESPECTRAL (QUALITATIVO)

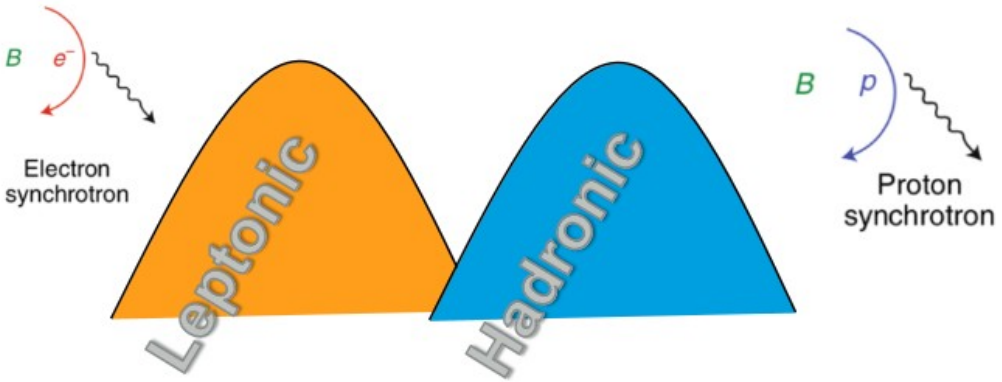
- Synchrotron self-Compton (SSC) or external Compton (EC) models



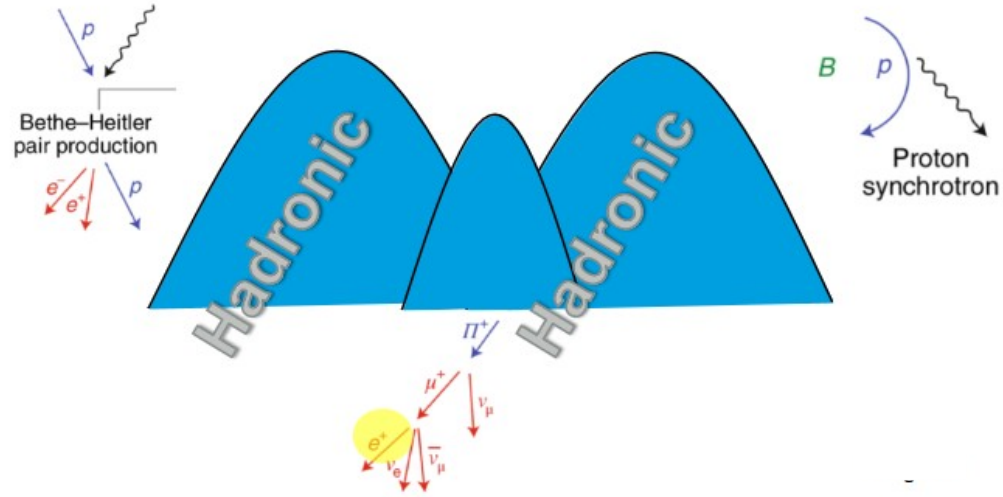
- Pion cascade models



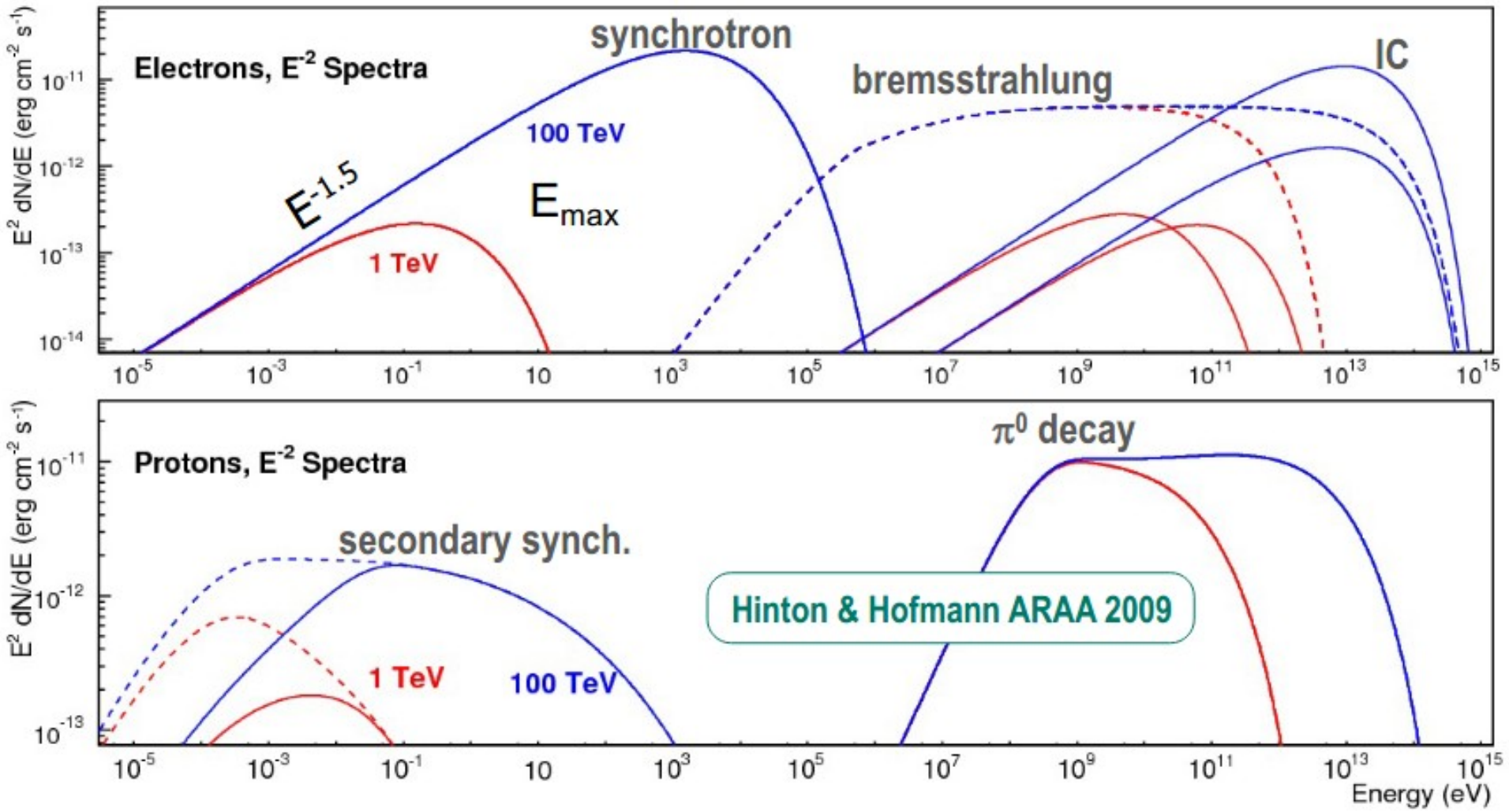
- Proton synchrotron models (require large B')



- More exotic hadronic models, for example:

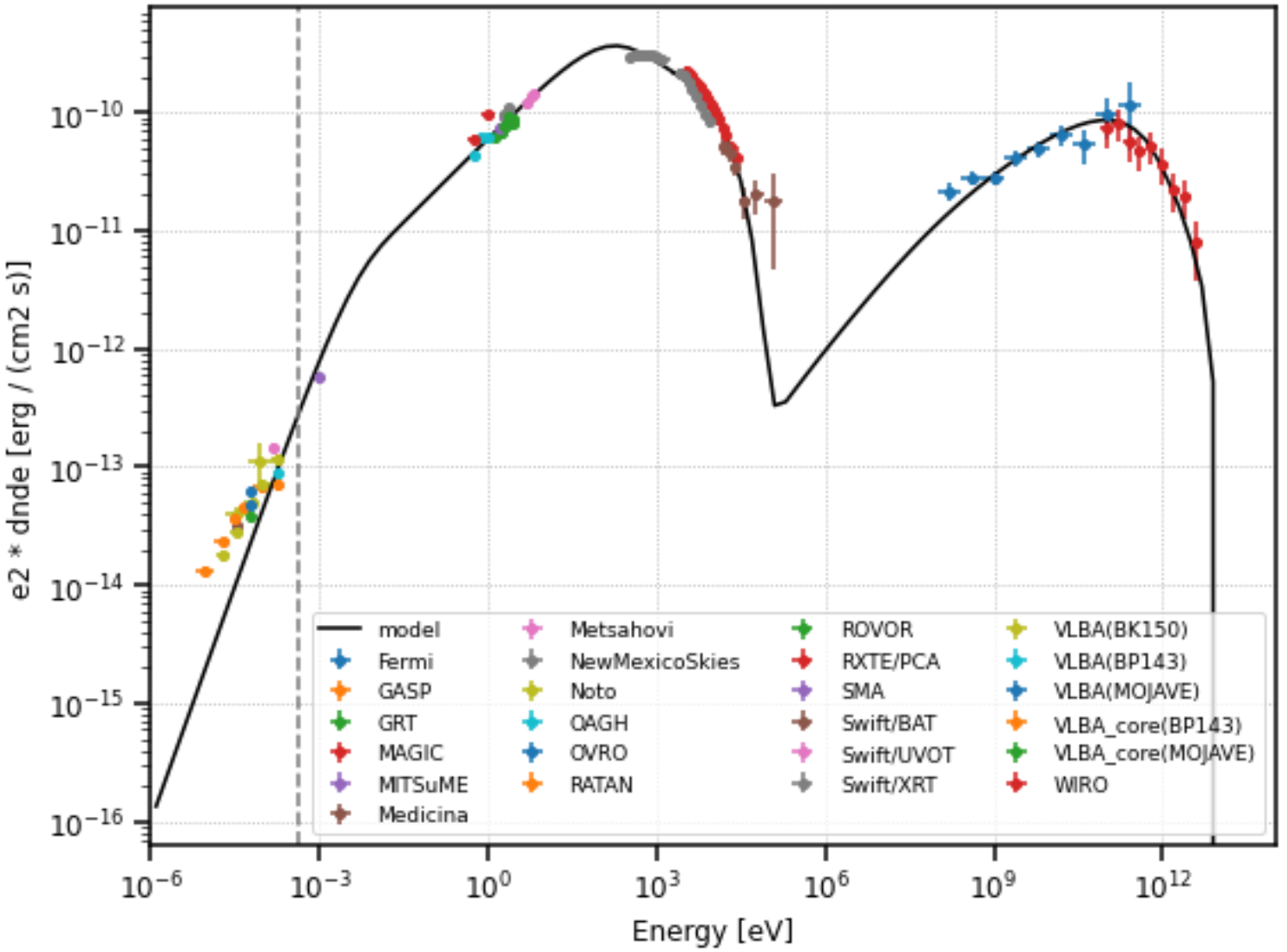


ESPECTRO DE EMISSÃO DE AGN DEVIDO A PROCESSOS LEPTÔNICOS E HADRÔNICOS

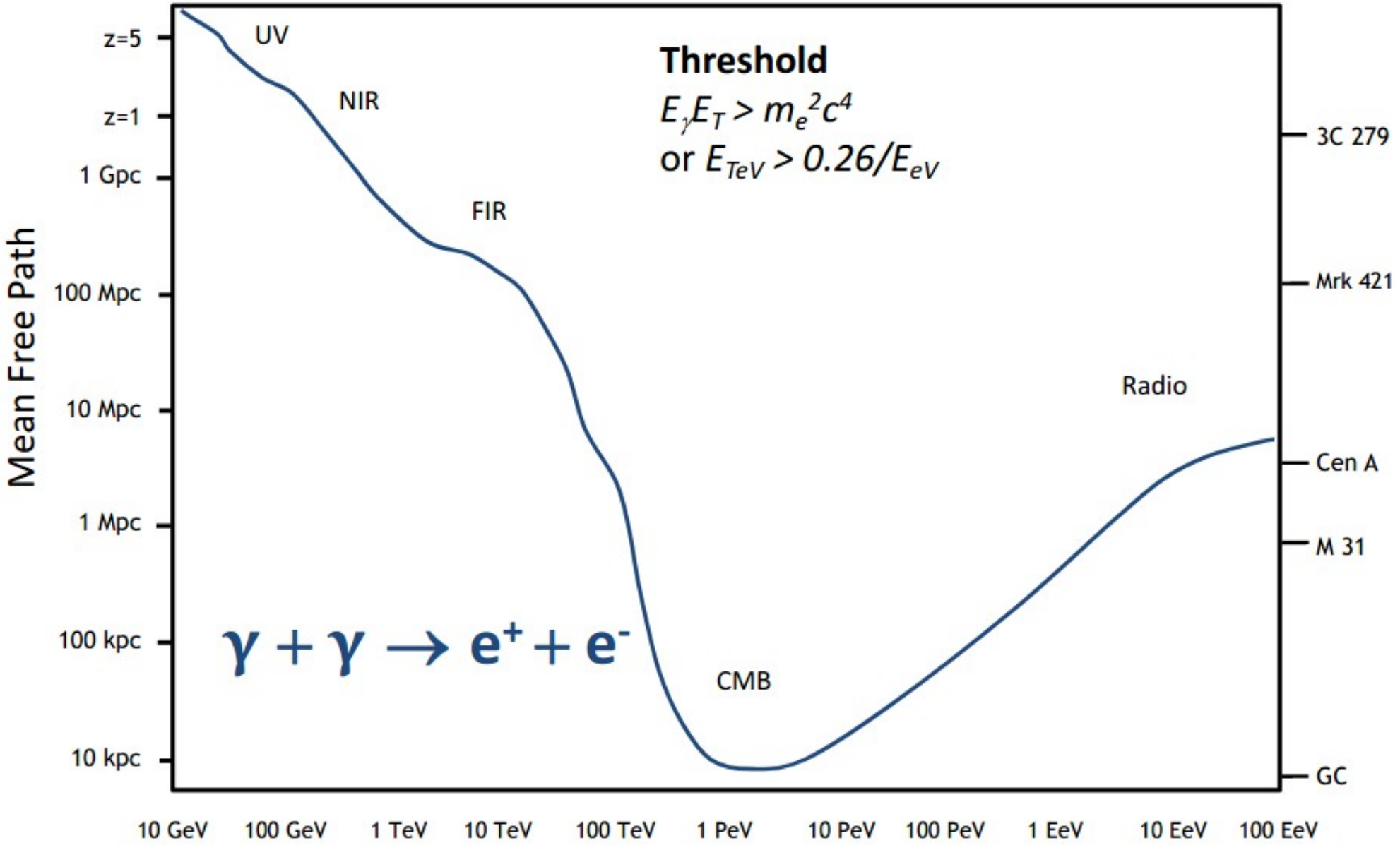


ESPALAHAMENTO COMPTON INVERSO E DECAIMENTO DO PÍON NEUTRO SÃO OS PROCESSOS DOMINANTES NA FAIXA DE TeV

ESPECTRO DE EMISSÃO DE UM BLAZAR

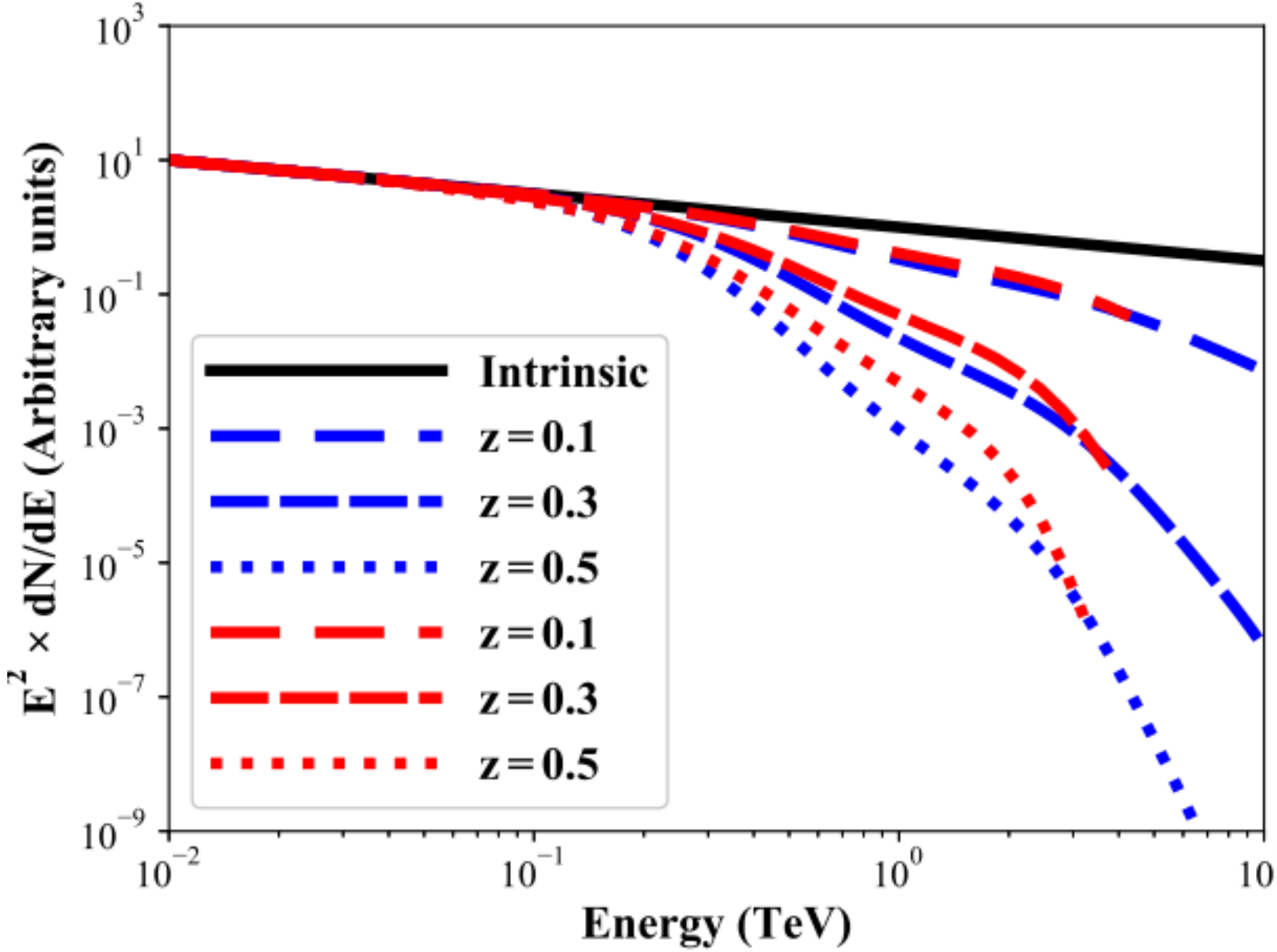


PROPAGAÇÃO DE RAIOS GAMA

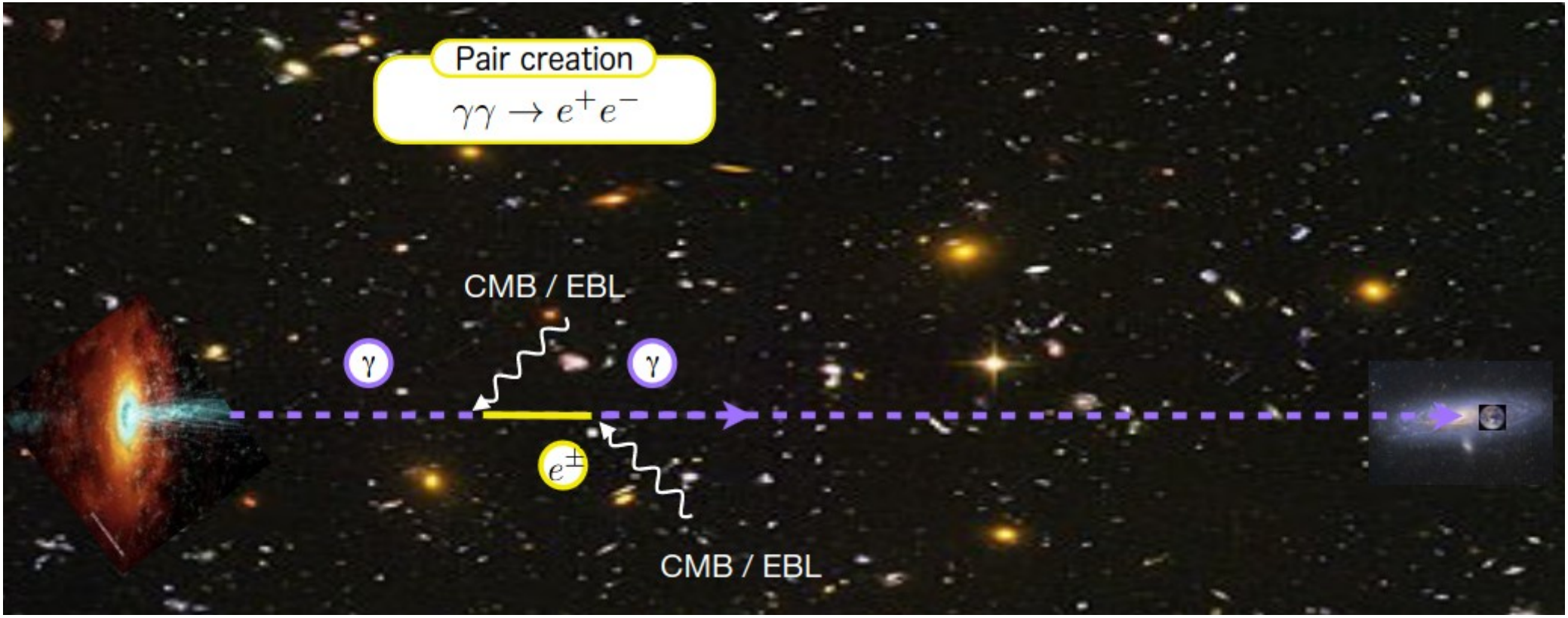


ATENUAÇÃO DO ESPECTRO DE RAIOS GAMA POR EBL

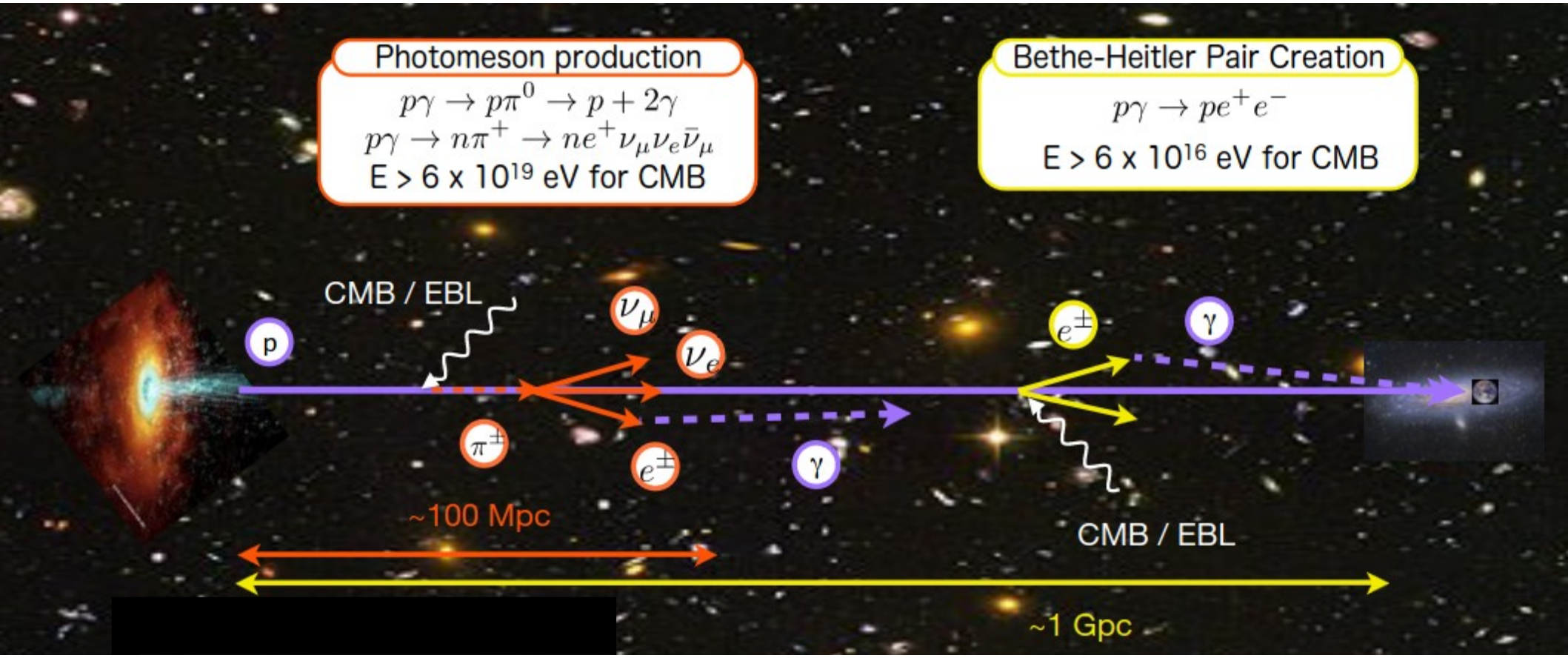
$$\Phi(E) = e^{-\tau_{\gamma\gamma}} \Phi_0(E)$$



CASCATA INDUZIDA POR RAIOS GAMA



CASCATA INDUZIDA POR RAIOS CÓSMICOS



PACOTES OPEN-SOURCE PARA MODELAGEM DA DISTRIBUIÇÃO DE ENERGIA ESPECTRAL

Software	Sources	Approach	Particles			Processes						Temp. ev.	Emission Region
			Thermal	Non-Thermal		Leptonic				Hadronic	Absorption		
				$e^{\pm}$	p	Synch.	SSC	EC	Brems.	pp	$\gamma\gamma$		
naima	PWN, SNR, GRB	numerical	✗	✓	✓	✓	✓	✓(CMB)	✓	✓ †	✓(EBL)	✗	not specified
GAMERA	PWN, SNR, AGN microquasars	numerical	✗	✓	✓	✓	✓	✓ ⊙	✓	✓ †	✓ *	✓ (only cool.)	multiple uniform
Jetset	jetted AGN, PWN microquasars, SNR	numerical	✗	✓	✓	✓	✓	✓	✓	✓ ‡	✓(EBL)	✓ (acc. + cool.)	multiple uniform acc. + rad.
agnpy	jetted AGN	numerical	✗	✓	✗	✓	✓	✓ *	✗	✗	✓ *	✗	single uniform
BHJet	binaries, AGN	numerical semi-analytical	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	whole jet
FLAREMODEL	synch. sources	numerical ray-tracing	✓	✓	✗	✓	✓	✗	✗	✗	✗	✓ (only cool.)	single radial dep.

† pp interaction: computing only gammas from π_0 decay. ‡ pp interaction: computation of radiation from secondaries of charged pions (pairs evolved in time to equilibrium) and of ν spectra. ⊙ Full angular dependency of the Compton cross section: anisotropic electrons and anisotropic photon fields. * Full angular dependency of the Compton or $\gamma\gamma$ cross sections: anisotropic photon fields.

Physical Processes	Codes			
	AM3	ATHEνA	B13	LeHa-Paris
electron synchrotron radiation	✓	✓	✓	✓
synchrotron self-absorption	✓	✓	✓	✓
electron inverse Compton scattering	✓	✓	✓	✓
electron-positron annihilation	✓	✓	✓	✗
photon-photon pair production	✓	✓	✓	✓
triplet pair production	✗	✓	✗	✗
proton synchrotron radiation	✓	✓	✓	✓
proton inverse Compton scattering	✓	✗	✗	✗
proton-photon pair production	✓	✓	✓	✓
neutron-photon pion production	✓	✓	✗	✗
kaon synchrotron radiation	✗	✓	✗	✗
pion synchrotron radiation	✓	✓	✗	✗
muon synchrotron radiation	✓	✓	✗	✓

AGNPY

AGNpy é um pacote Python open-source para modelar os processo radioativos em AGNs.

https://agnpy.readthedocs.io/en/latest/

agnpy
latest

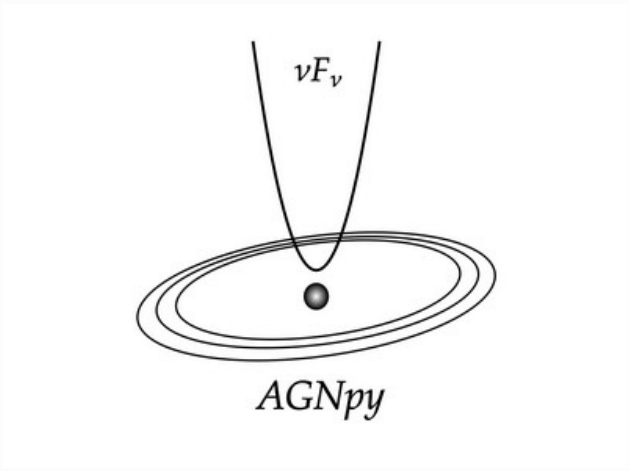
Search docs

- Non-thermal Electrons Spectra
- Emission Regions
- Synchrotron Radiation
- Photon Targets for External Compton
- Tutorial: Energy Densities of the Photon Targets
- A note on dust torus thermal emission
- Inverse Compton
- Tutorial: Synchrotron and Synchrotron Self Compton
- Tutorial: External Compton scattering
- Absorption by \(\gamma\)-\(\gamma\) pair production
- Tutorial: \(\gamma\)-\(\gamma\) Absorption in the Photon Fields of Line and Thermal Emitters
- Calculations of Energy Densities, Inverse Compton SEDs and \(\gamma

Read the Docs v: latest

Docs » agnpy docs

Edit on GitHub



agnpy docs

agnpy focuses on the numerical computation of the photon spectra produced by leptonic radiative processes in jetted Active Galactic Nuclei (AGN).

Description

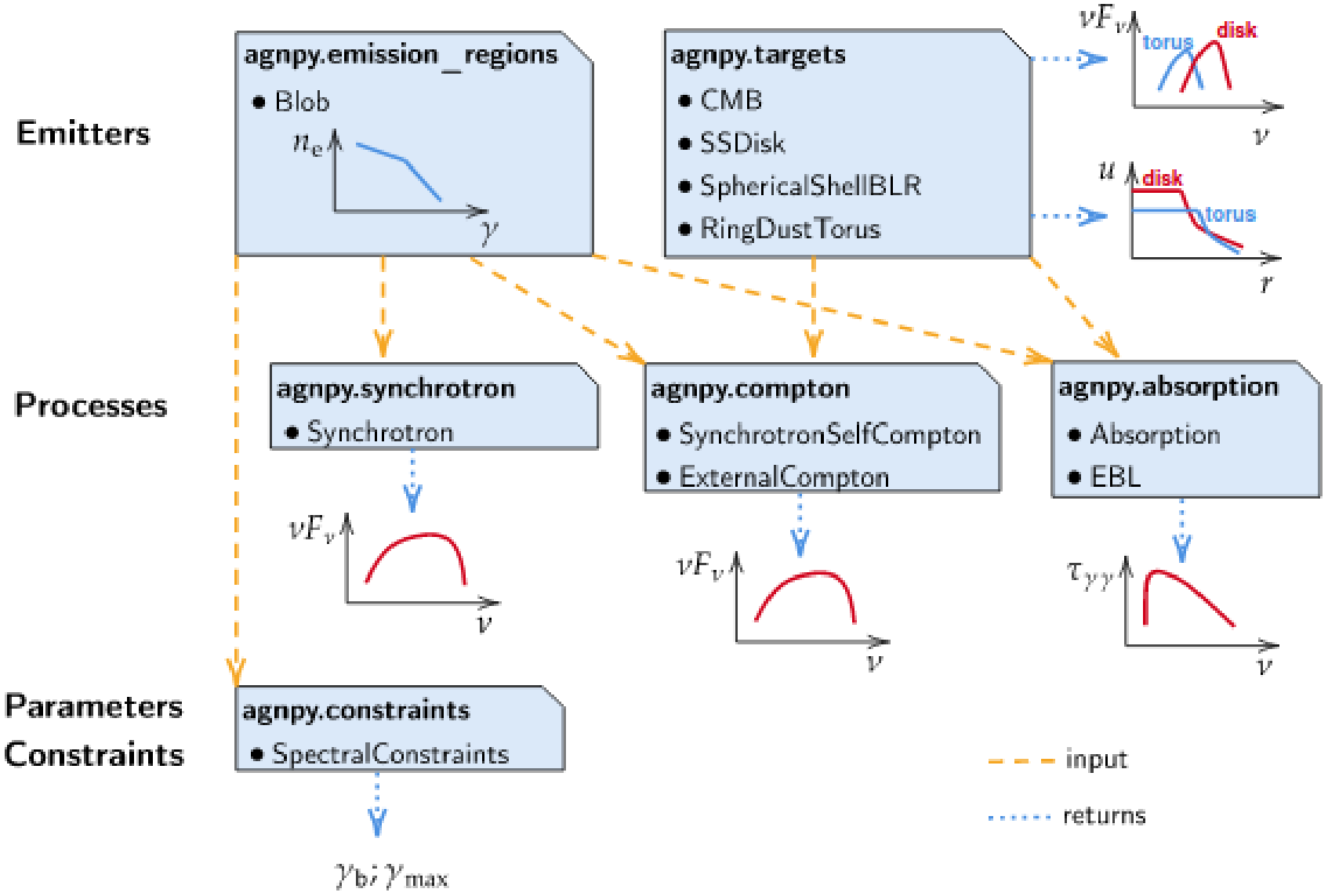
References

PARÂMETROS PRINCIPAIS PARA A MODELAGEM DA DISTRIBUIÇÃO DE ENERGIA ESPECTRAL DE FONTES ASTROFÍSICAS

	Symbol	Quantity
source properties	z	redshift
	Γ	Lorentz factor
	δ	Doppler factor
	R	size of region
	V	volume of region
	B	magnetic field
particle distributions	E	particle/ photon energy
	γ	particle Lorentz factor $\gamma = E'/m$
	p	slope of particle distribution $n(\gamma) = \frac{\mathrm{d}n}{\mathrm{d}\gamma} \propto \gamma^{-p}$
	ν	photon frequency $\nu = E_\gamma/h$
	ϵ	dimensionless photon energy $\epsilon = E_\gamma/m_e c^2$
observed quantities	F_ν	Differential energy Flux $F_\nu = \frac{\nu \mathrm{d}N}{\mathrm{d}\nu \mathrm{d}A\mathrm{d}t}$
	α	slope of $F_\nu \propto \nu^\alpha$
	νF_ν	Spectral Energy Distribution (SED) $\nu F_\nu = \frac{\nu^2 \mathrm{d}N}{\mathrm{d}\nu \mathrm{d}A\mathrm{d}t}$
	$'$ (primed)	comoving quantities

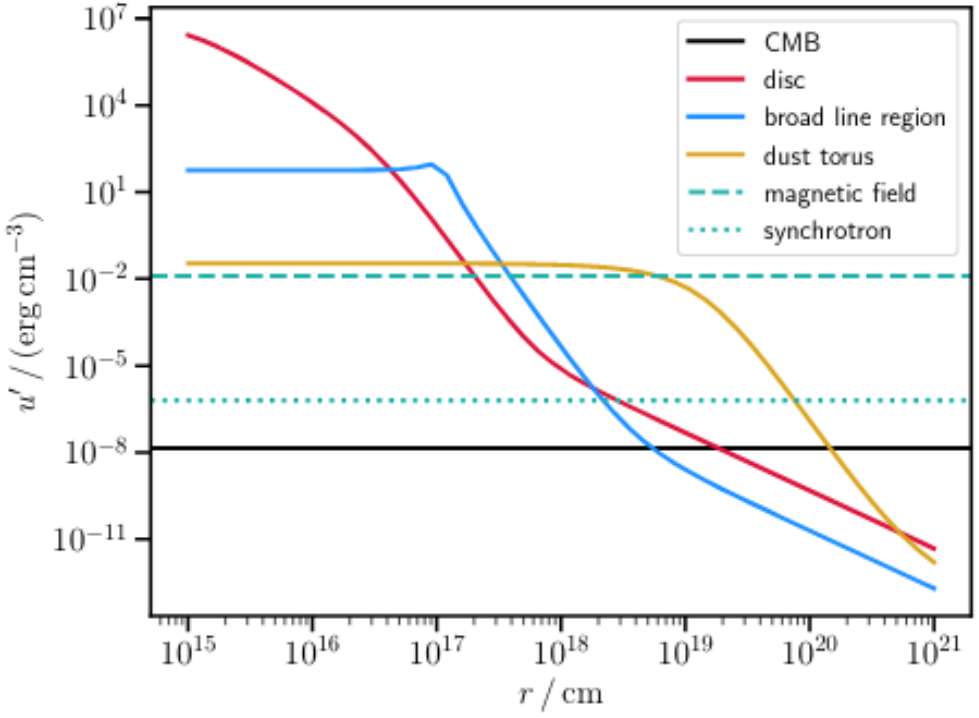
AGNPY

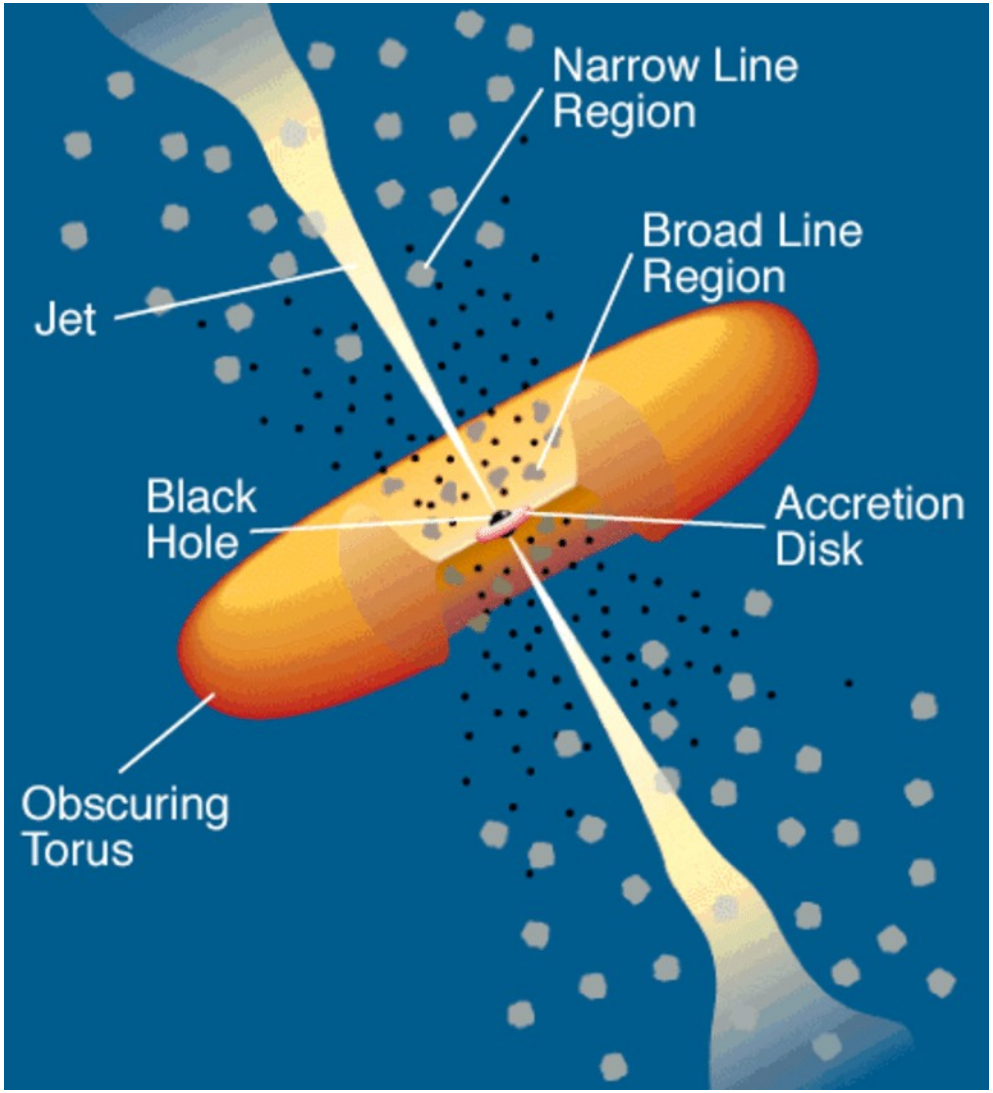
Representação esquemática dos módulos do AGNpy



AGNPY

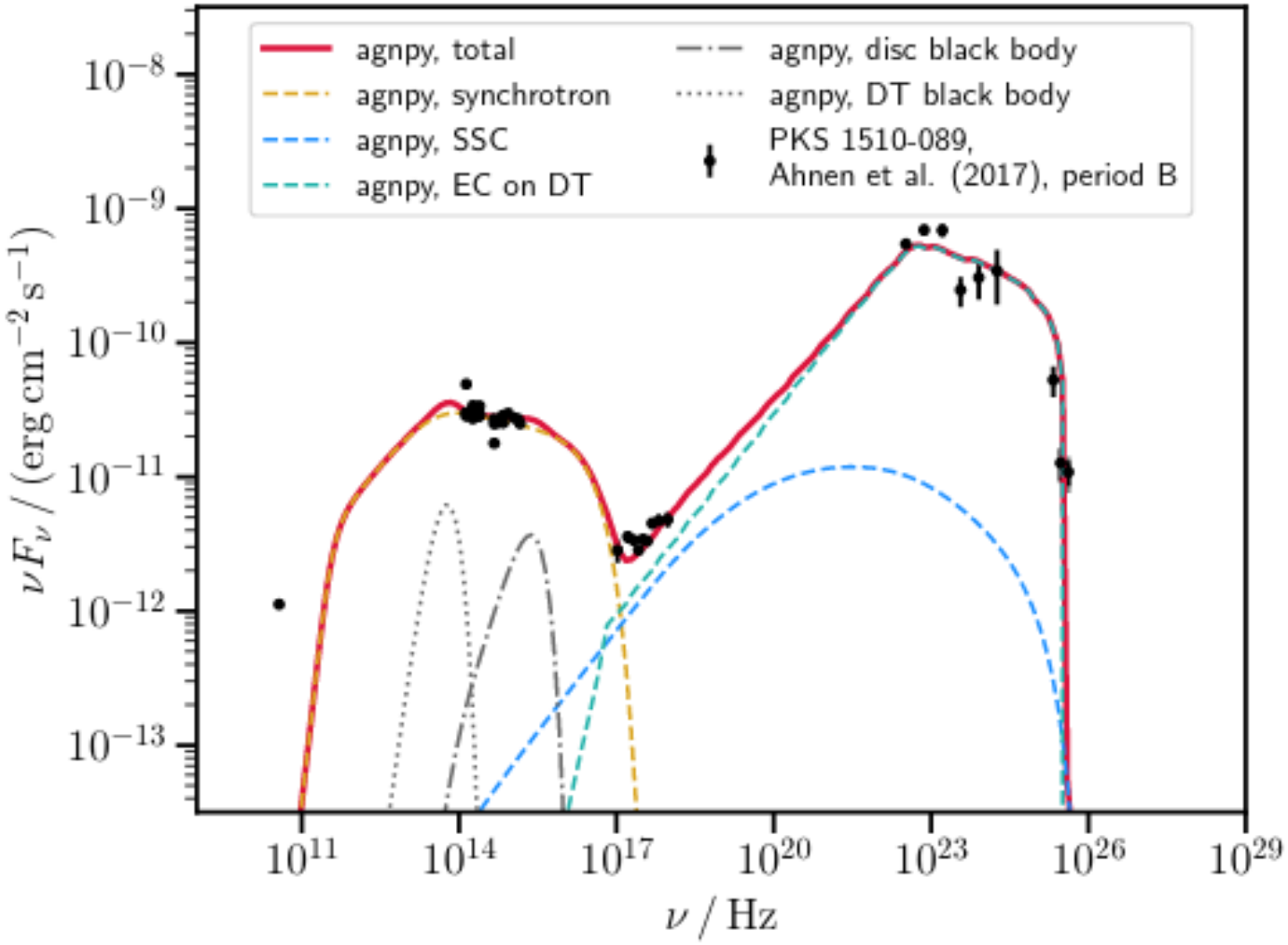
Densidades de energia de diferentes campos de fótons gerados peo CMB, disk, BLR e anel de torus



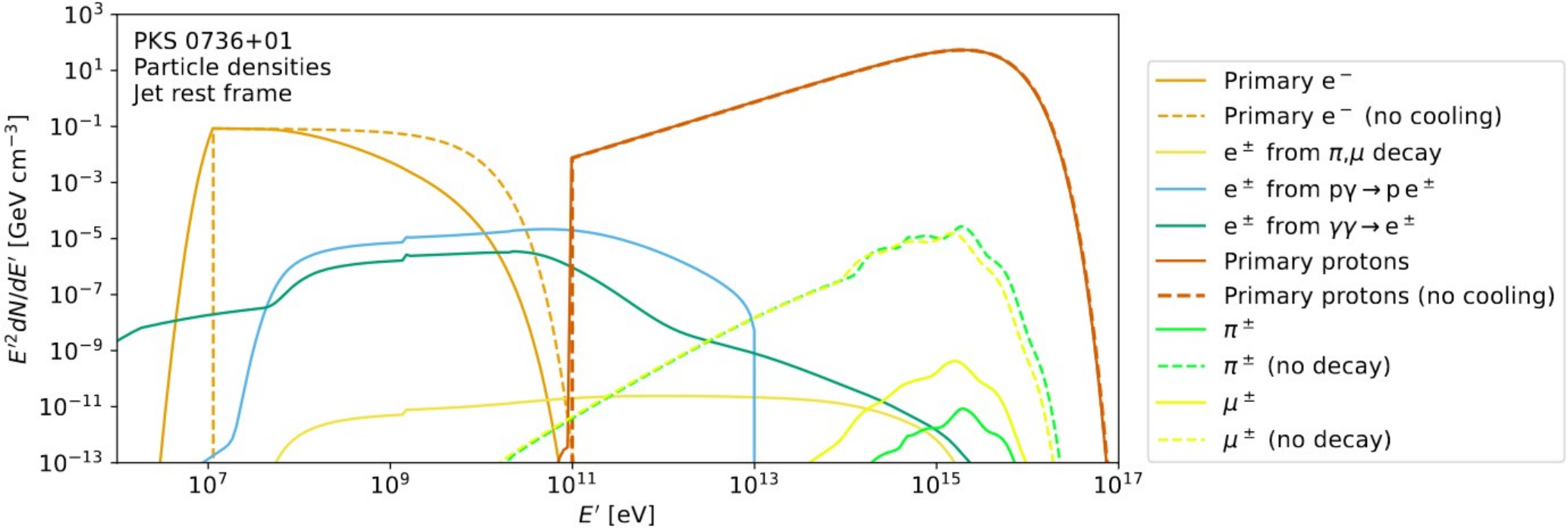


AGNPY

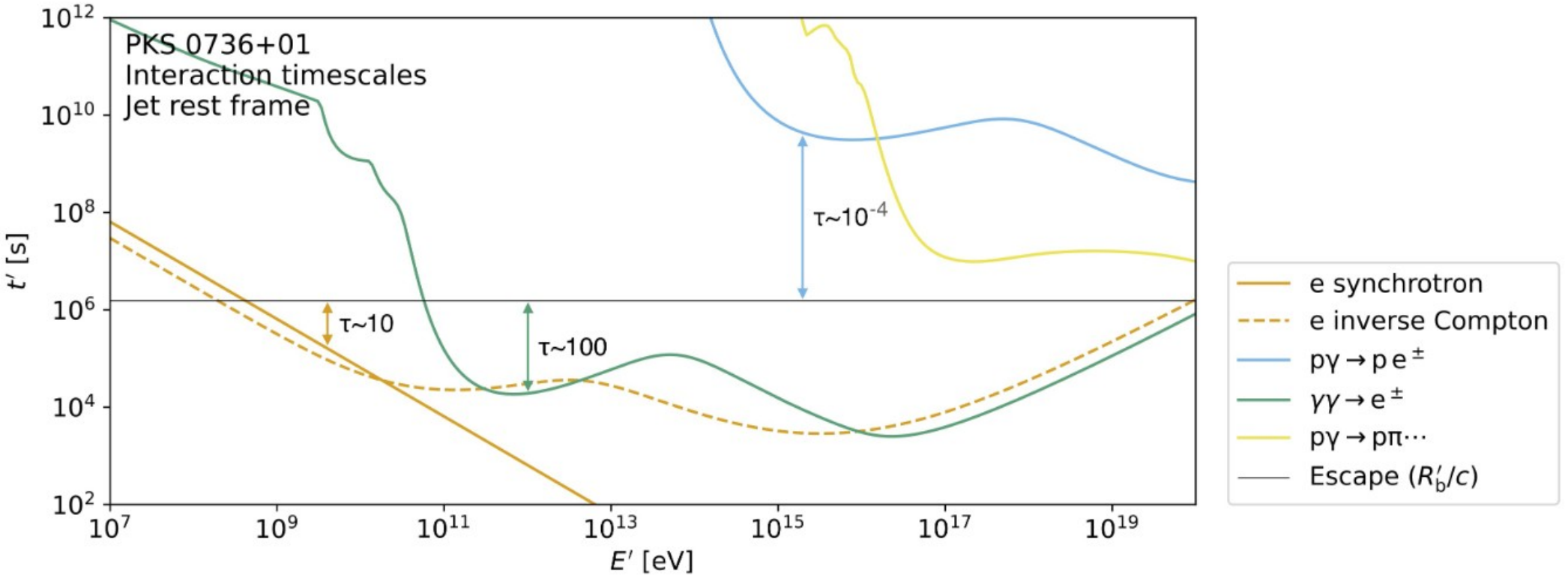
Distribuição de energia espectral (SED) da fonte PKS 1510-089 ajustado com o agnpy.



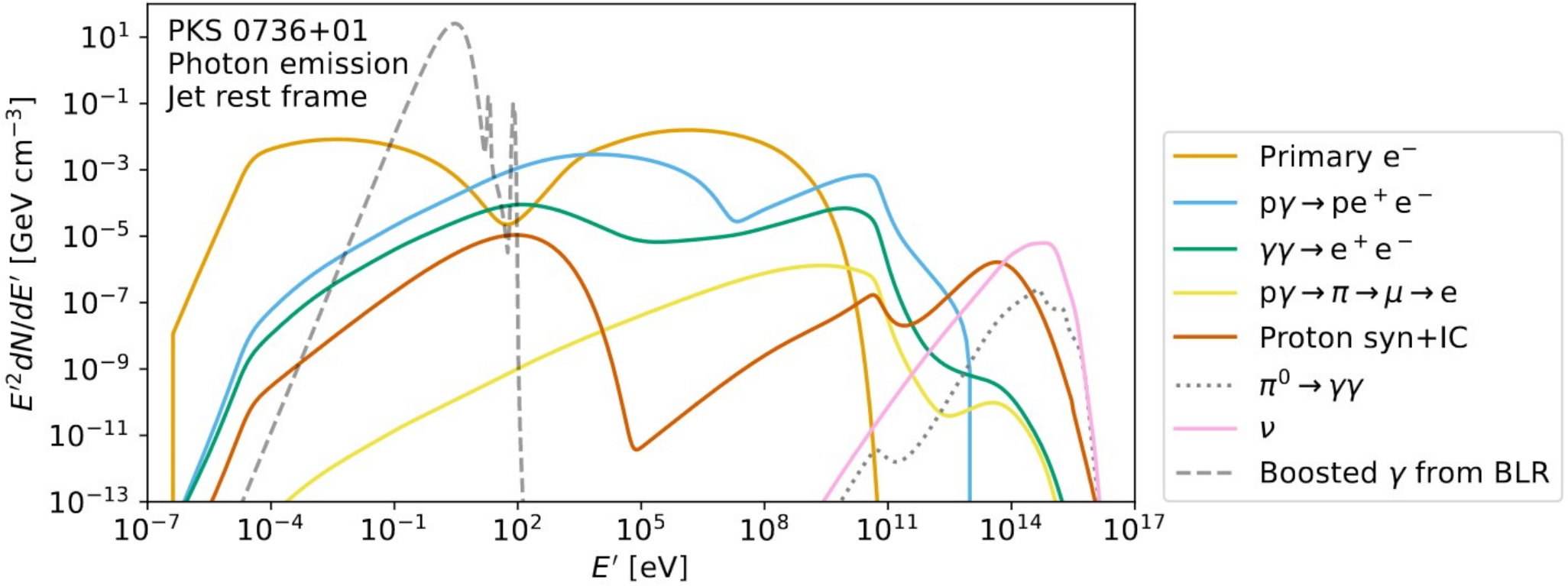
AM³: MODELAGEM LEPTO-HADRÔNICA DE FONTES ASTROFÍSICAS



AM³: MODELAGEM LEPTO-HADRÔNICA DE FONTES ASTROFÍSICAS



AM³: MODELAGEM LEPTO-HADRÔNICA DE FONTES ASTROFÍSICAS



PACOTES OPEN-SOURCE PARA MODELAGEM DE FONTES ASTROFÍSICAS

Katu: https://github.com/hveerten/katu

LeHaMoC: https://github.com/mariapetro/LeHaMoC

AM³: https://am3.readthedocs.io/en/latest/

Jetset: https://jetset.readthedocs.io/en/latest/

AGNpy: https://agnpy.readthedocs.io/en/latest/

GAMERA: http://libgamera.github.io/GAMERA/

NAIMA: https://naima.readthedocs.io/en/latest/

Flaremodel: https://github.com/ydallilar/flaremodel

Bjet_MCMC: https://github.com/Ohervet/Bjet_MCMC

OBRIGADO PELA ATENÇÃO!