ONLINE ICRC 2021
THE ASTROPARTICLE PHYSICS CONFERENCE
Berlin | Germany
37th International
Cosmic Ray Conference
12–23 July 2021

Session #48: Modelling/observing AGN's spectral energy distribution | GAD-GAI-MM

Sara Buson & Walter Winter

Schedule (2min x speaker)

1. Extreme blazars under the eyes of MAGIC — **Axel Arbert-Engels**
2. VHE gamma-ray spectral hint of two-zone emitting region in Mrk 501 — **Josefa Becerra González feat. David Peneque**
3. Multiwavelength observations in 2019-2020 of a new very-high-energy gamma-ray emitter: the FSRQ QSO B1420+326 — **Filippo D'Ammando**
4. Gamma Rays from Fast Black-Hole Winds — **Chris Karwin**
5. Gamma-ray emission from young radio galaxies and quasars — **Giacomo Principe**
6. Gamma-ray signatures from pair cascades in recombination-line radiation fields — **Christoph Wendel**
7. Discovery of TXS 1515-273 at VHE gamma-rays and modelling of its Spectral Energy Distribution — **Serena Loporchio**
8. Explaining the TeV detection of blazar AP Librae: constraints from ALMA and HST — **Agniva Roychowdhury**

———————————- **Q/A**

1. MAGIC and H.E.S.S. detect VHE gamma rays from the blazar OT081 for the first time: a deep multiwavelength study — **Marina Manganaro**
2. Detection of new Extreme BL Lac objects with H.E.S.S. and SWIFT — **Angel Priyana Noel**
3. TeV emission from FSRQs: The first systematic and unbiased survey — **Sonal Ramesh Patel**
4. A two-zone emission model for Blazars and the role of Accretion Disk MHD winds — **Stella Boula**
5. Modeling the non-flaring VHE emission from M87 as detected by the HAWC gamma ray observatory — **Fernando Urena Mena**
6. Building a robust sample of Fermi-LAT blazars that exhibit periodic gamma-ray emission — **Pablo Penil**
7. Exploring the High-Energy Gamma-Ray Spectra of TeV Blazars — **Qi Feng**
8. The luminosity function of TeV-emitting BL Lacs: observations of an HBL sample with VERITAS — **Manel Errando feat. Qi Feng**

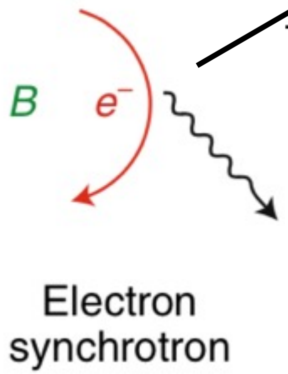
———————————- **Q/A**

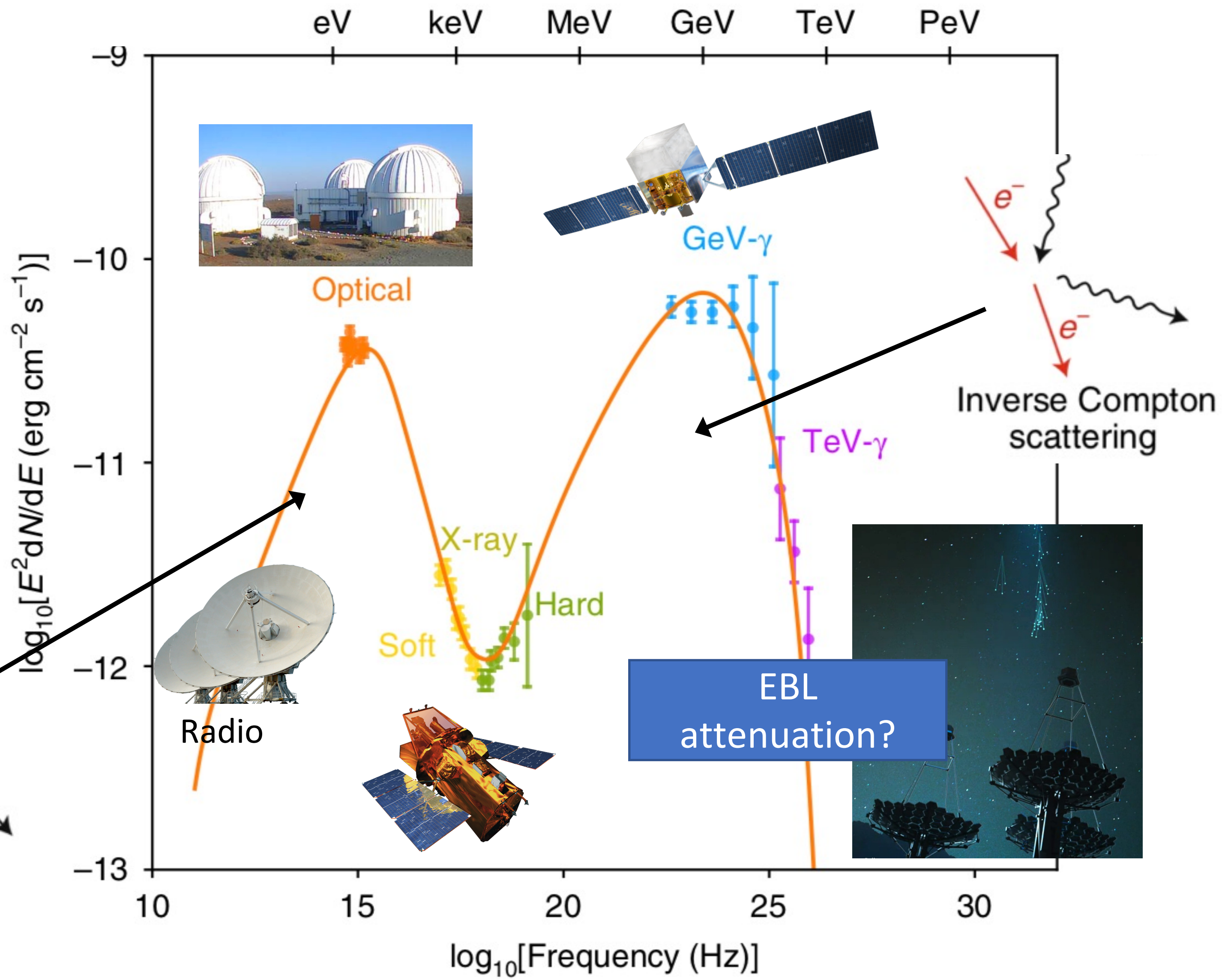
- **Open Discussion**

Electromagnetic picture of AGN blazars

- Exhibit a typical two-hump structure
- Measured over extremely large range of electromagnetic spectrum
- Often observation “campaigns” at same time, or follow-up searches of neutrinos

- Simplest explanation: first peak from electron synchroton, second from inverse Compton up-scattering of these synchrotron photons off the same electrons
(= SSC – “synchrotron self-Compton model”)



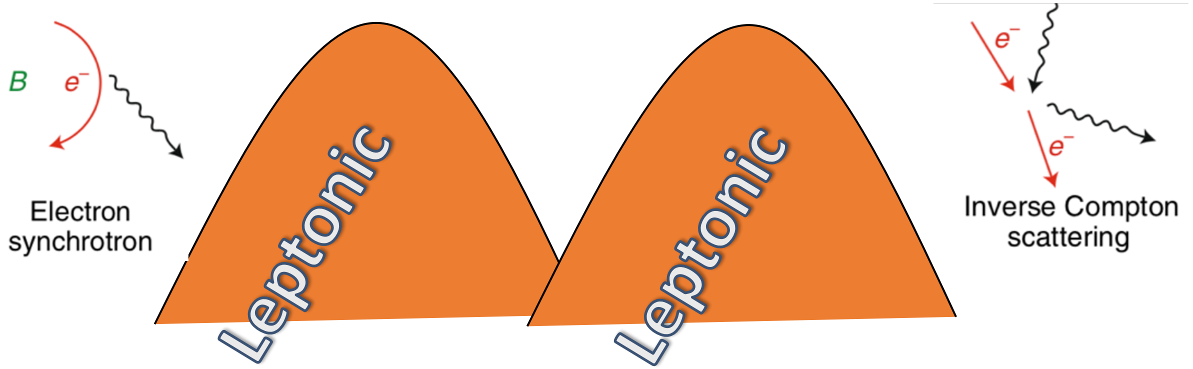


Credits: VLA, ASAS-SN, Swift, Fermi, MAGIC, DESY science comm. lab., Pian 2019, Gao et al, 2019

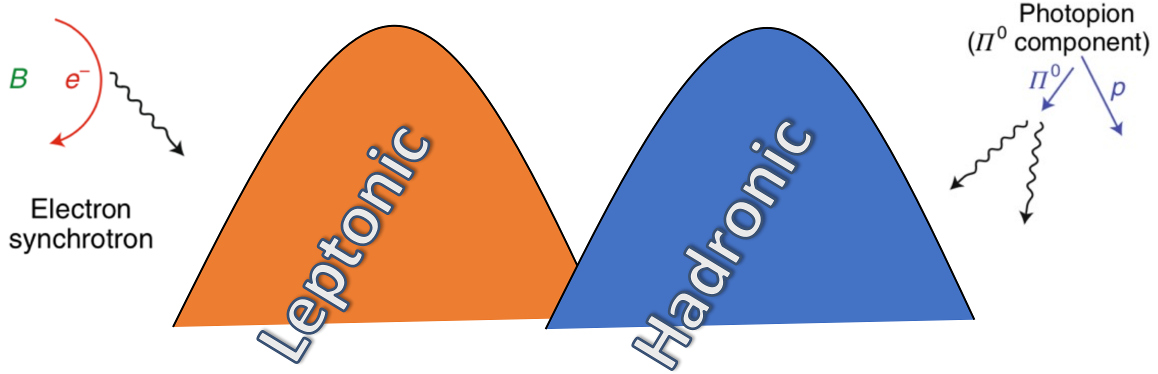
Typical SED models (qualitatively)

Hadronic contributions
→ Origin of cosmic rays, neutrinos!
(see also session #25 yesterday)

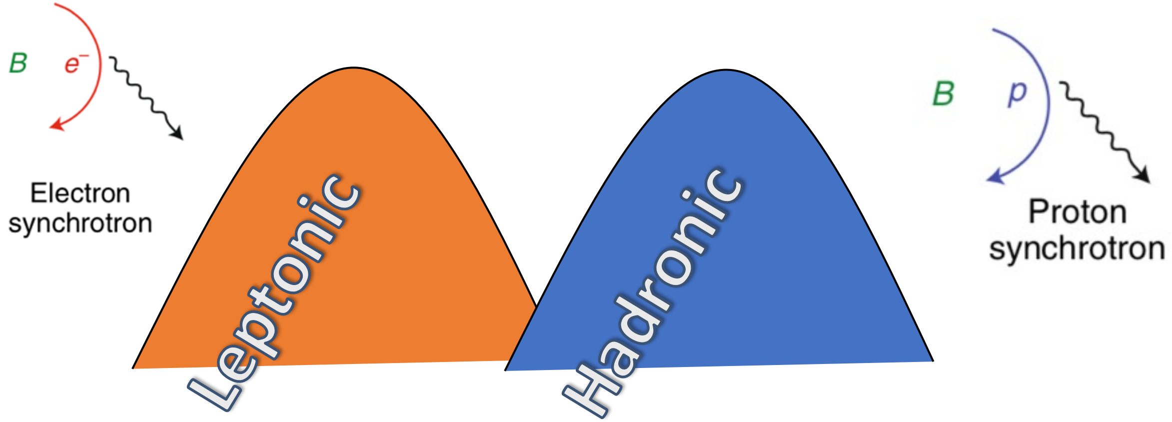
- Synchrotron self-Compton (SSC) or external Compton (EC) models



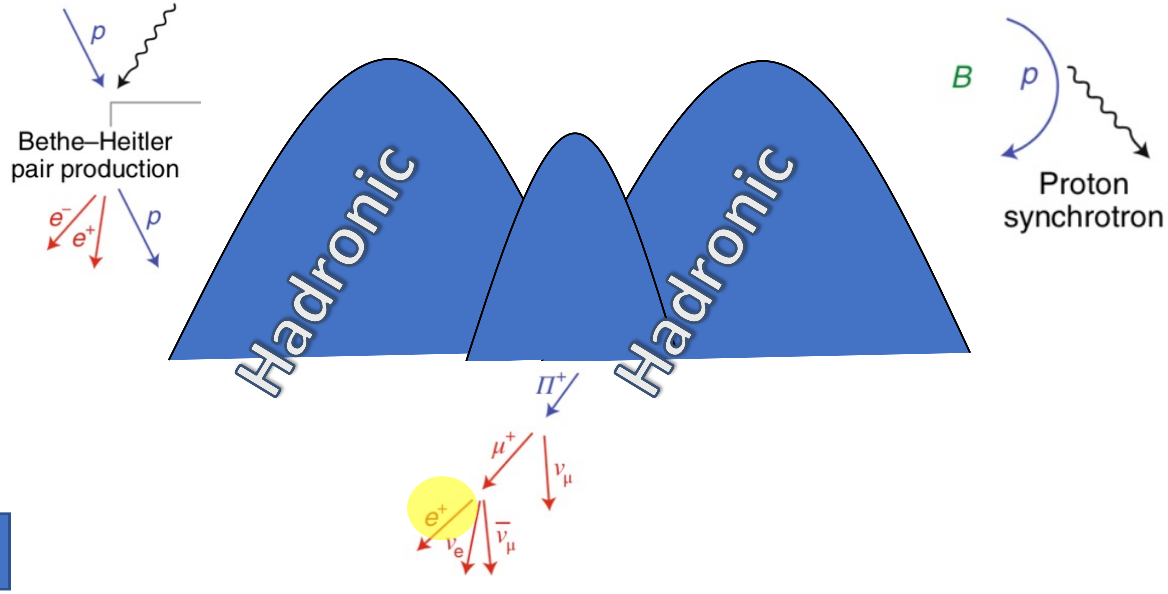
- Pion cascade models



- Proton synchrotron models (require large B')



- More exotic leptonic or hadronic models, for example:



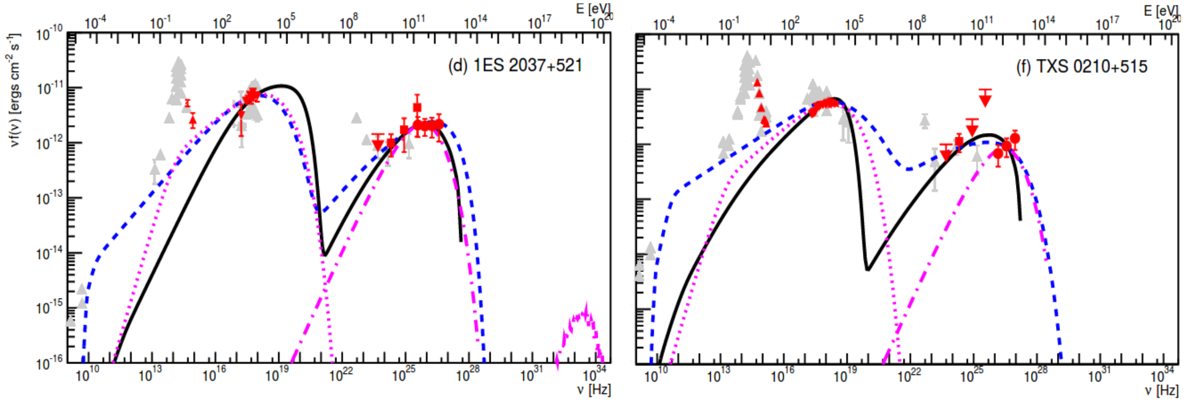
+ thermal components possible (e.g. disk, dust torus, ...)

Extreme blazars under the eyes of MAGIC

Axel Arbet-Engels
Institute for Particle Physics and Astrophysics, ETH Zürich

On behalf of the team: E. Prandini, S. Ventura, V. Fallah Ramazani, M. Cerruti, C. Arcaro, K. Asano, D. Dorner, M. Manganaro, G. Bonnoli, F. D'Ammando, L. Foffano, F. Tavecchio, J. Becerra-Gonzalez, J. Jormanainen, P. DaVela for the MAGIC and FACT Collaborations

MAGIC hard-TeV blazar catalog

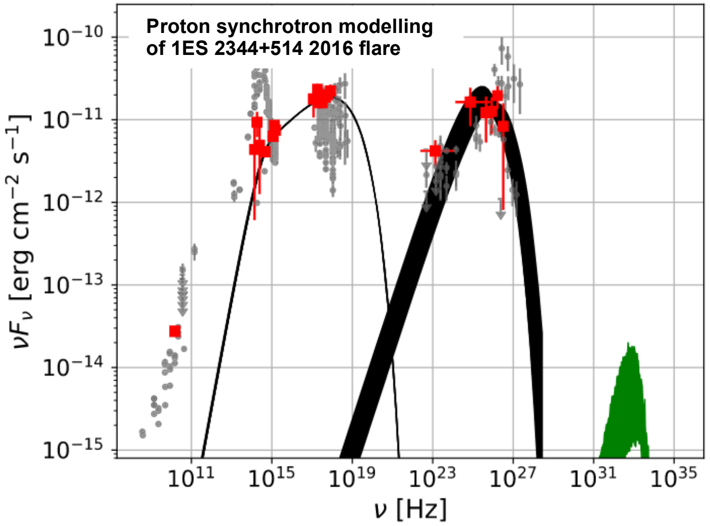


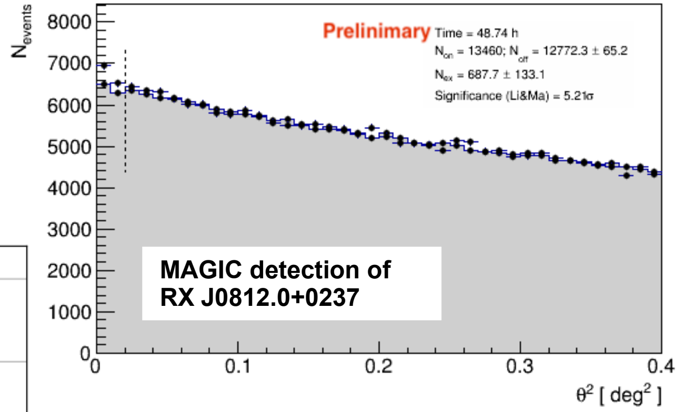
Extreme Blazars:
- Synchroton SED peaking >1keV
- Some have gamma-ray SED peaking >1TeV → hard-TeV extreme blazars
- Challenge standard acceleration/emission mechanisms
- Cosmological probes (e.g., EBL & IGMF)

MAGIC hard-TeV extreme blazar catalog:
- Observed 10 hard-TeV extreme blazar candidates
- 3 new VHE detections, 1 strong signal hint
- SEDs modelled using leptonic & hadronic scenarios

MAGIC VHE detection of RX J0812.0+0237:
- 5.21 sigma detection
- Power-law VHE spectrum: index 2.58+/-0.33
- Upcoming publication with MWL data

Bright VHE flare of 1ES2344:
- Extreme blazar behaviour when flaring
- Bright VHE flare during 2016
  → deep MWL coverage
- SED interpreted within leptonic and hadronic models



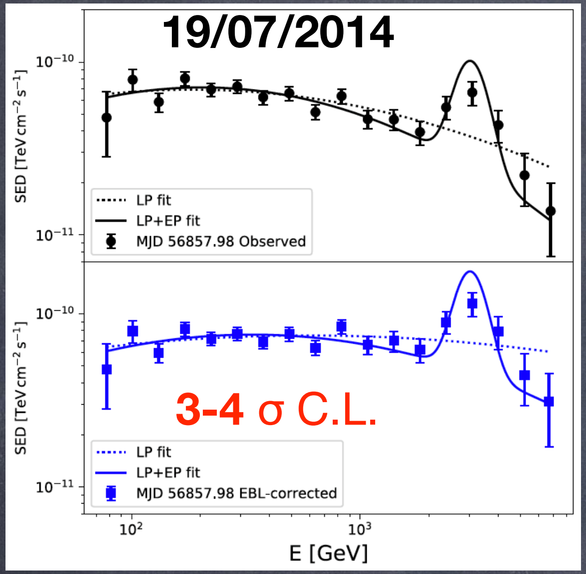


VHE gamma-ray spectral hint of two-zone emitting region in Mrk 501

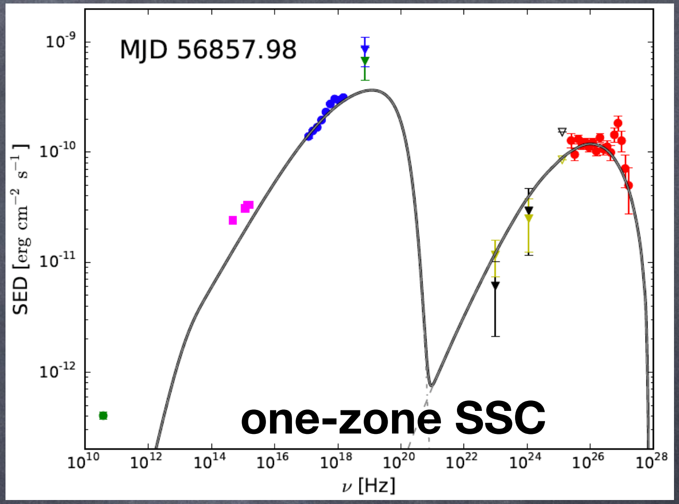
Josefa Becerra González, D. Paneque, C. Wendel, K. Noda, F. Tavecchio, K. Ishio, K. Mannheim, A. Tramacere ++
jbecerra@iac.es

MAGIC Major Atmospheric Gamma Imaging Cerenkov Telescopes

Fermi Gamma-ray Space Telescope



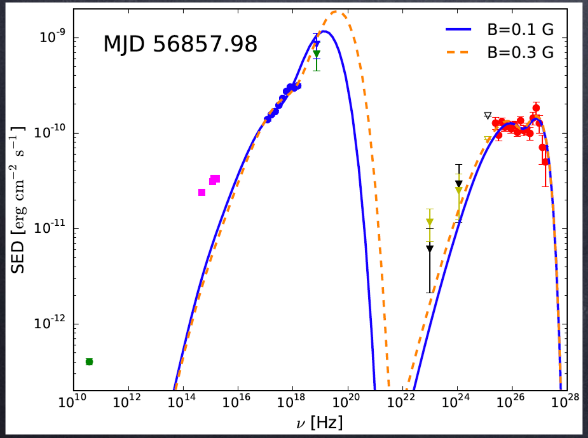
Talk #79

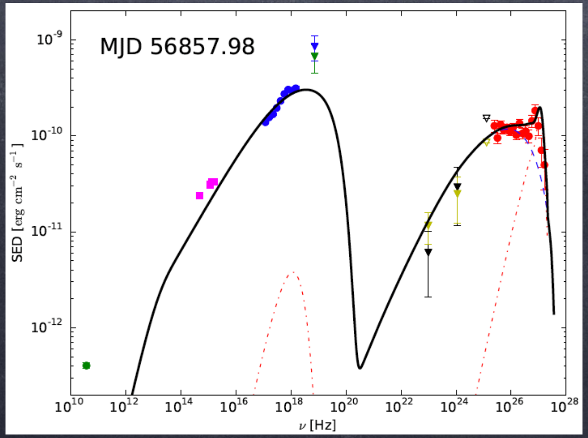


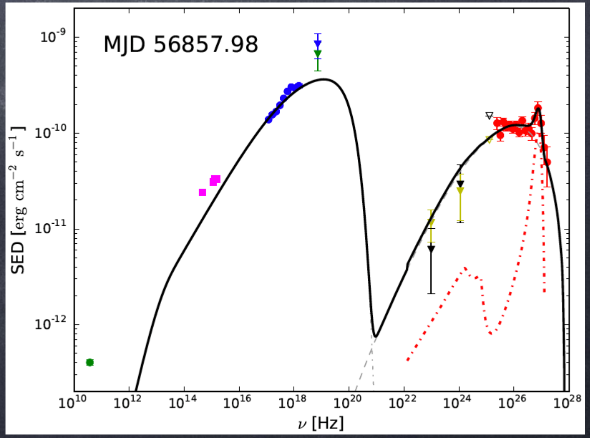
a) Pileup in electron distribution

b) Two-zone SSC

c) Magnetospheric vacuum gap





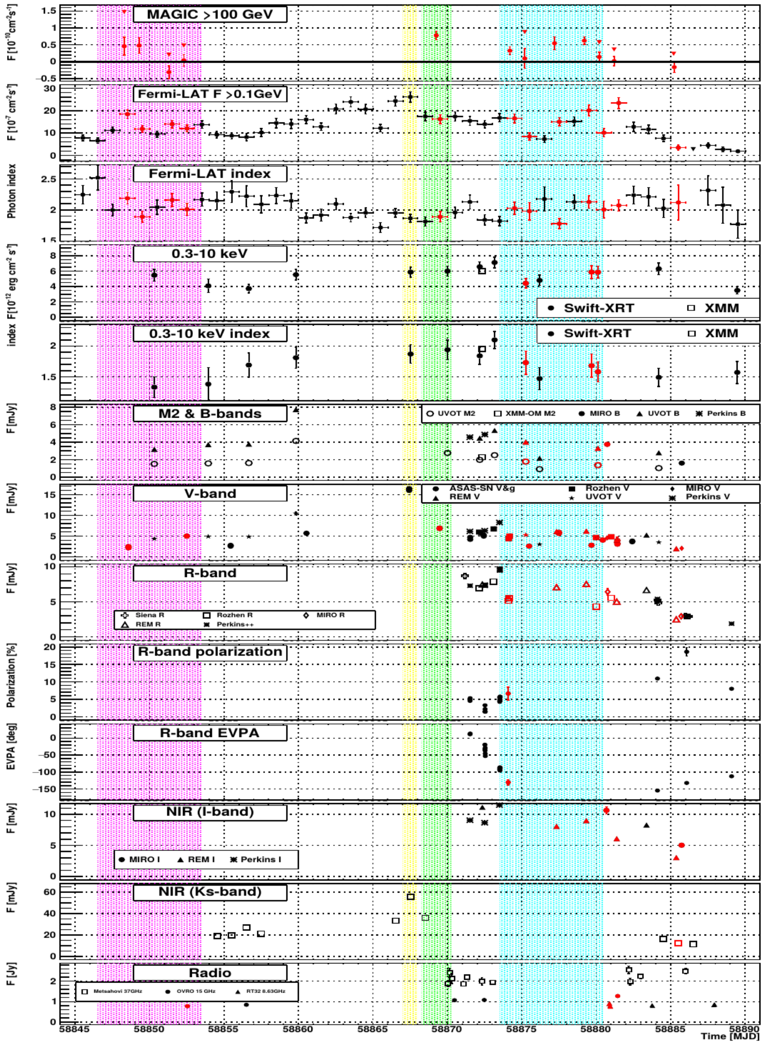


MAGIC Coll. (JBG, DP) 2020, A&A, 637, A86

Talk #141 by C. Wendel

MWL observations in 2019-2020 of a new VHE γ-ray emitter: the FSRQ QSO B1420+326

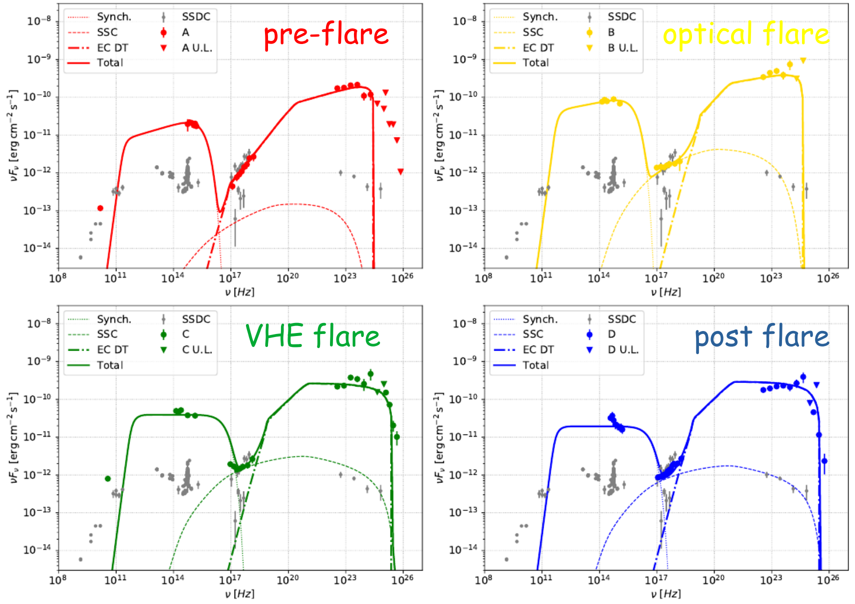
Filippo D'Ammando (INAF-IRA Bologna), R. Angioni, M. Orienti *on behalf of the Fermi LAT Collaboration*, J. Sitarek, S. Nozaki, E. Lindfors, G. Bonnoli, V. Fallah Ramazani *on behalf of the MAGIC Collaboration*, and S. Jorstad



Acciari et al. 2021, A&A, 647, A163

MWL campaign allow us to trace the broadband emission of the source through different phases of the flaring activity around the **VHE emission** detected by **MAGIC**.

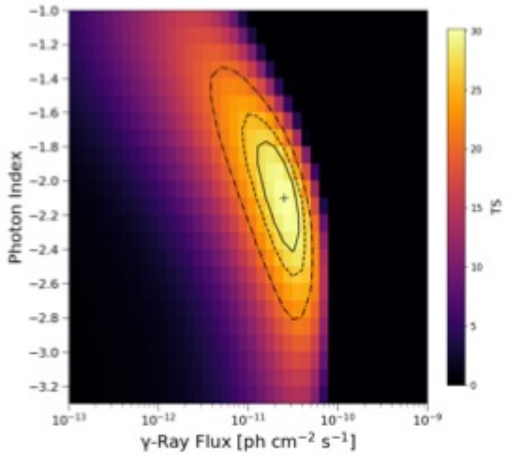
The ejection of **a new radio knot** and the **rotation of optical EVPA** were detected *close in time to VHE emission*.



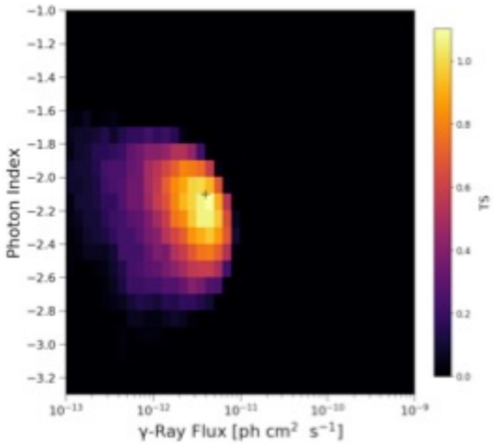
SED at different epochs around the VHE detection can be explained in **EC scenario on DT photons + SSC** with electron energy distribution limited by an interplay of acceleration, dynamic and cooling time scales.

Gamma rays from Fast Black-Hole Winds: Executive Summary

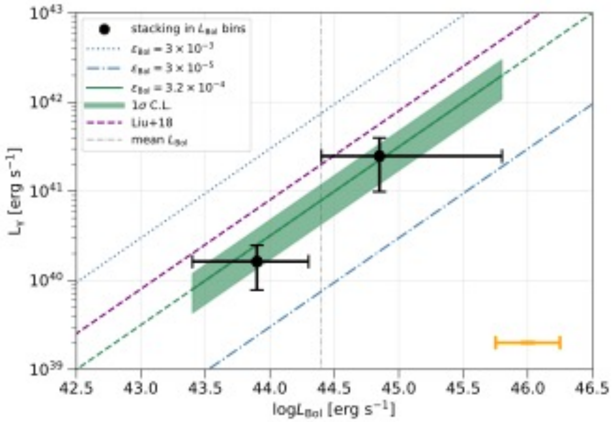
Chris Karwin



- **Benchmark sample**
- 11 UFOs with z<0.1 and v>0.1c
- Max TS: 30.1 (5.1 sigma for 2 dof)
- Best index = 2.1 ± 0.3
- Best flux = $2.51^{+1.47}_{-0.93} \times 10^{-11}$ ph cm^{-2} s

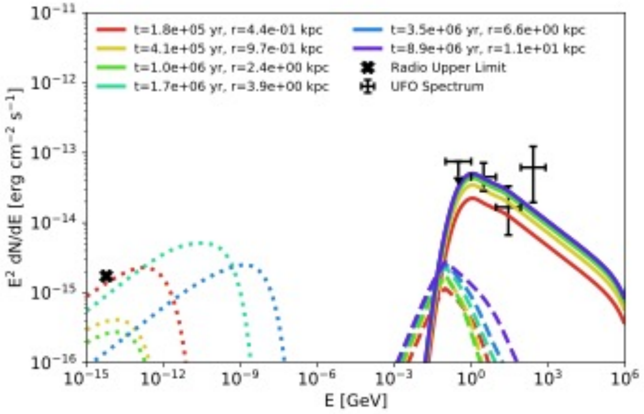


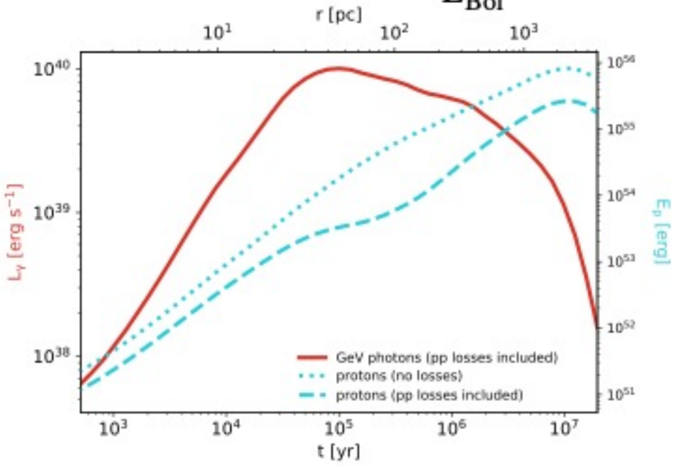
- **Control sample**
- Max TS: 1.1
- Signal also not dominated by star formation nor weak jets



- **Efficiency**: gamma-ray luminosity scales with the bolometric luminosity

$$\epsilon = \frac{L_\gamma}{L_{Bol}} = 3.2^{+1.6}_{-1.5} \times 10^{-4}$$





- **Model**: hadronic emission resulting from diffusive shock acceleration.
- On average, the forward shock has traveled 20-300 pc away from the SMBH.
- The max energy of protons accelerated at the shock is ~10^17 eV, making AGN winds a potential source of CRs beyond the knee of the CR spectrum (3e15 eV) and also likely contributors to the EGB and IceCube neutrino flux.

Gamma-ray emission from young radio galaxies and quasars

G. Principe[1,2,3] ,
L. Di Venere[4,5], M. Orienti[3], G. Migliori[3], F. D'Ammando[3]; on behalf of the *Fermi* Large Area Telescope Collaboration.
[1]University of Trieste, Department of Physics, Trieste, Italy; [2]INFN-Trieste, Trieste, Italy; [3]IRA-INAF, Bologna, Italy; [4]INFN-Bari and Politecnico-Bari, Bari, Italy.

Executive Summary

Motivation

According to radiative models, radio galaxies are predicted to produce gamma rays from the earliest stages of their evolution onwards.

The study of the high-energy emission from young radio sources is crucial for providing information on the most energetic processes associated with these sources, the actual region responsible for this emission, as well as the structure of the newly born radio jets.

Method

Taking advantage of more than 11 years of Fermi-LAT data:

- we perform the largest and deepest systematic search of gamma-ray emission from young radio galaxies and quasars using a sample of 162 sources and 11.3 years of Fermi-LAT data,
- we perform for the first time a stacking analysis on a sample of (undetected) young radio sources.

Outlook

We report the detection of significant gamma-ray emission from 11 young radio sources, including the discovery of significant gamma-ray emission from the compact radio galaxy PKS 1007+142.

Although the stacking analysis of below-threshold young radio sources does not result in a significant detection, it provides stringent upper limits to constrain the gamma-ray emission from these objects.

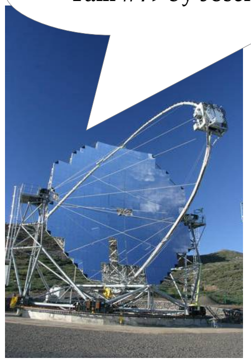
Gamma-ray signatures from pair cascades in recombination-line radiation fields

Christoph Wendel, Josefa Becerra González, Amit Shukla, David Paneque and Karl Mannheim

Multiwavelength campaign for Mrk 501 in July 2014:

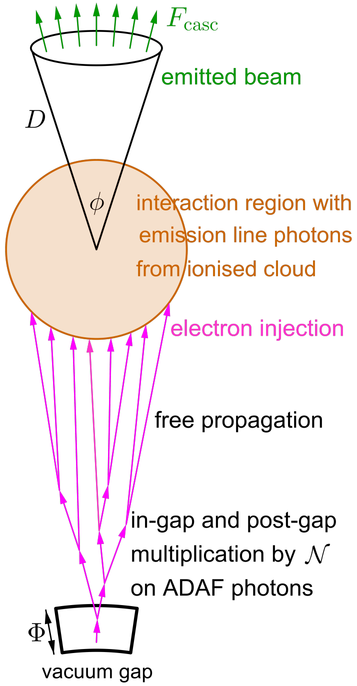
- Hints for additional narrow component at ~ 3 TeV
  - PL, LP and ELP fit inconsistent at > 3 σ
  - Broad + narrow LP preferred over single LP at 4 σ
- Talk #79 by Josefa Becerra González

Calls for alternative explanation

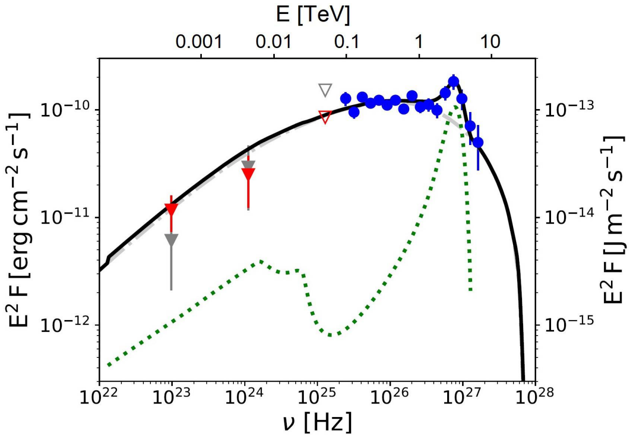


MAGIC Telescopes

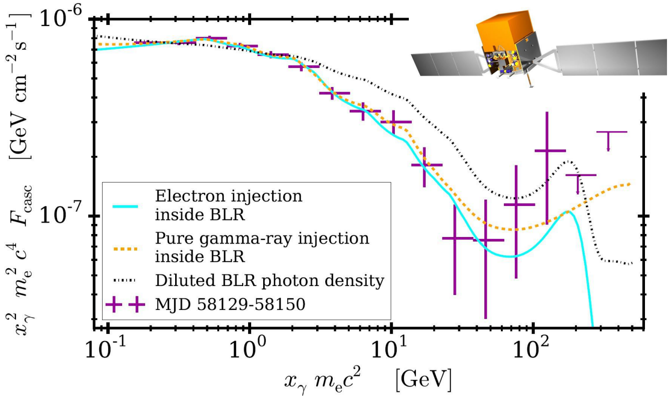
- 10^{10} K, low-accreting ADAF:
  - Pair materialisation in vacuum gap and subsequent multiplication by $\mathcal{N}=10^6$ → Electron beam
  - Ionisation of emission line clouds, that reprocess 0.01 of ADAF luminosity



- Electron beam + emission lines → IC pair cascade
- Escaping cascaded gamma rays can account for narrow SED feature



Blue: MAGIC data
Red and grey: *Fermi*-LAT
Grey line: SSC emission
Green dotted line: Cascaded emission
Black line: SSC + cascaded emission



Dip in SED of 3C 279 from flaring episode in January 2018:

- Apply IC pair cascade model similar to Mrk 501 case
- Emission from edge of BLR (cyan and orange) preferred toward outside of BLR (black dash-dotted)

High-precision gamma-ray observations reveal SED substructures beyond the predictions of spherical blob models, but in line with the predictions of IC pair cascade models in external radiation fields.

Drop me a mail
cwendel@astro.uni-wuerzburg.de

Discovery of TXS 1515-273 at VHE gamma rays and modelling of its Spectral Energy Distribution

Serena Loporchio – INFN Bari

serena.loporchio@ba.infn.it

On behalf of the Fermi-LAT and MAGIC collaborations

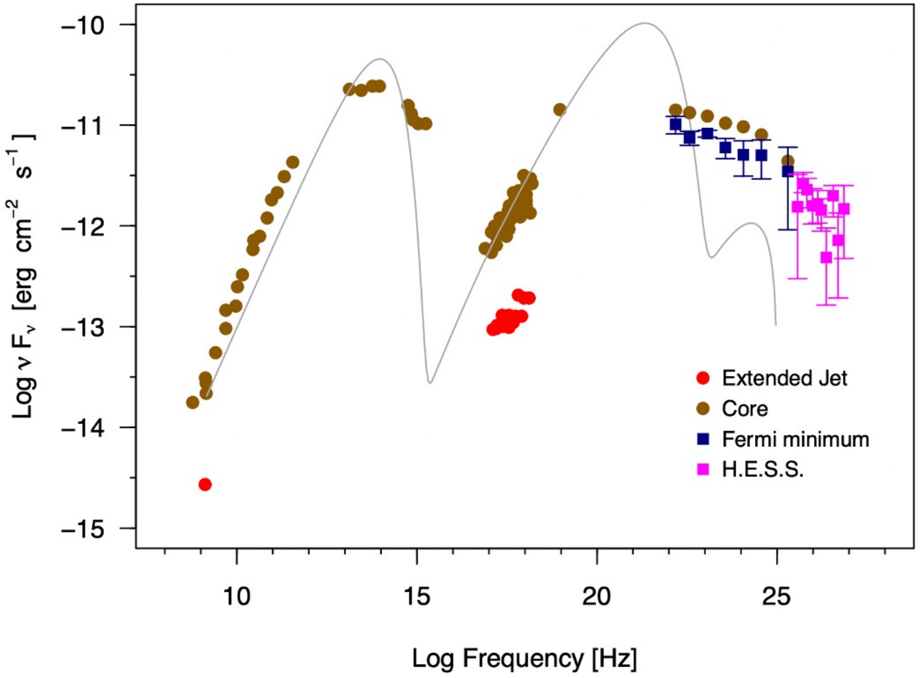
This contribution is focused on the discovery of the BL Lac object TXS 1515-273 at very high energies with the MAGIC telescopes, and the modelling of its spectral energy distribution.

The multi wavelength campaign organized in February 2019 during a flaring activity of this source, which had not been studied in detail before, had an excellent coverage in the X-rays, provided by different instruments.

We performed detailed studies on the variability of this source and used the results to constrain the parameters of the emission region, which were then used to model its SED, using the one-zone model and a two-component model.

Our studies allowed for a classification of this source among the BL Lac object sub-classes and showed the limits of the one-zone model, overcome by the introduction of a second emission region.

What is the origin of the VHE emission from AP Librae?



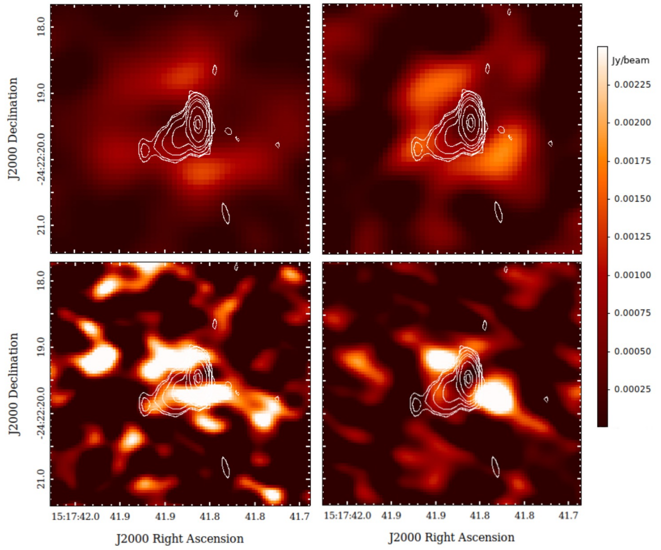
What is it about?

A very unusual LBL: 9 decade broad HE component.
Synchrotron self-Compton cannot produce TeV.
Hervet+ (15), Zacharias+ (16), Petropoulou+ (16): very contrasting jet physics.

Agniva Roychowdhury, Eileen T. Meyer, Markos Georganopoulos, Peter Breiding, Maria Petropoulou

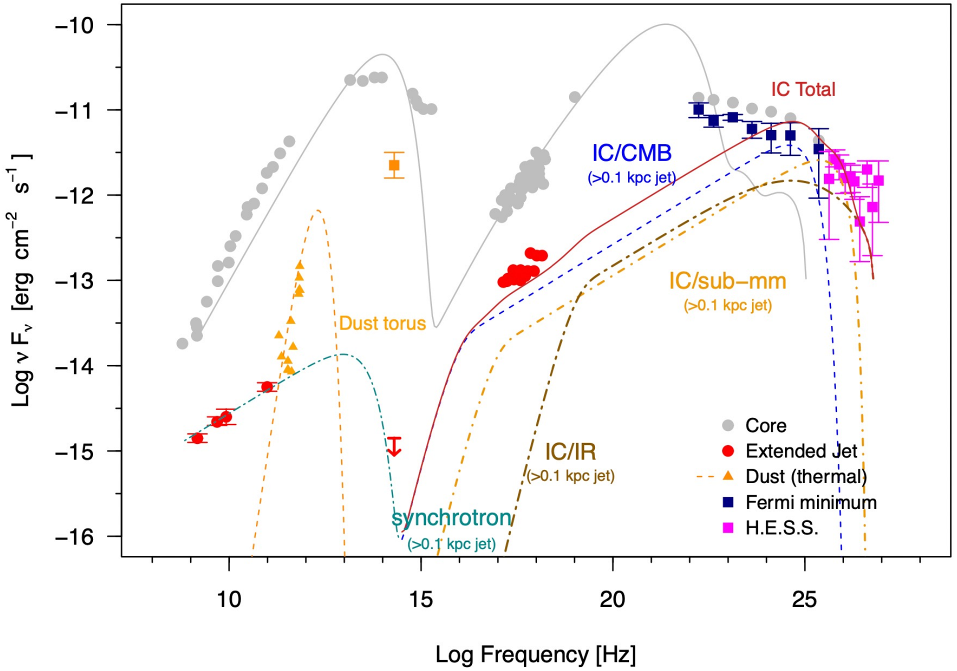
What did we do?

- Constrained the radio-IR synchrotron spectrum for the extended jet.
- Detected a large-scale torus in a BL Lac for the first time!
- Used a one-zone model for the spectral energy distribution (SED).



What did we find?

- IC/CMB model of Zacharias+ (2016) for the TeV ruled out.
- IC/CMB: GeV
- IC/torus: TeV in the >0.1 kpc jet.



Why is this interesting?

- Constraints on jet energetics and composition.
- Feasible constraints on origin *and* location of HE emission (X-ray to TeV) from AGN with dust lanes.
- RL-AGN unification paradigm: BL Lac with efficient accretion?

Question break (1)

MAGIC and H.E.S.S. detect VHE gamma rays from the blazar OT081 for the first time: a deep multiwavelength study

Subtitle: Twinkle twinkle little blazar: are you FSRQ or BL Lac?

What is this contribution about? We present the first detection of VHE gamma-rays from blazar OT081 (obtained by MAGIC and H.E.S.S. and its deep study in multiwavelength

Why is it relevant / interesting? This study is very exciting because the dataset is very challenging in terms of modeling of the emission scenario. The source is a transitional object between BL Lac and FSRQs. Also is very interesting how we could determine four different states of activity in a short period of observations.

What have we done? We had studied the multiwavelenght lightcurves from many instruments across the electromagnetic spectrum and built the broadband spectral energy distributions for four states of activity.

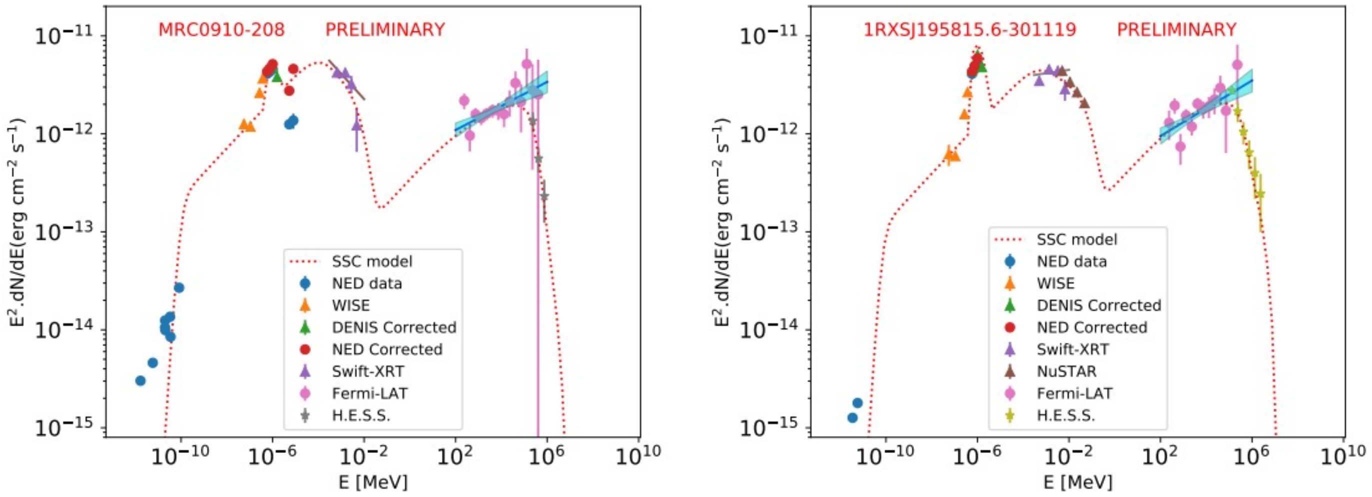
What is the result? We have constrained the high energy part of the broadband SED during the flare in VHE gamma rays and study the emission scenario in four different states of activity. This is a preliminary report, while the full study will be disclosed in a paper (in preparation for MAGIC, H.E.S.S. and *Fermi*-LAT collaborations).

12-23.07.2021 -- ICRC 2021 -- Executive summary -- Marina Manganaro (marina.manganaro@uniri.hr)

Detection of new Extreme BL Lac objects with H.E.S.S. and *Swift* XRT

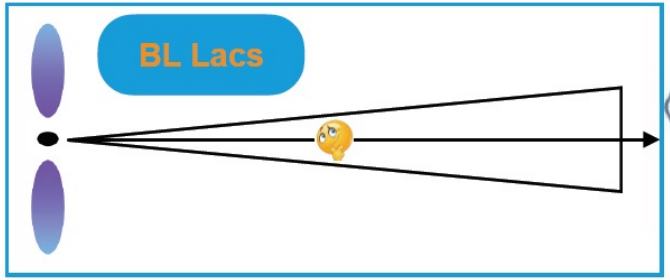
Mathieu de Bony de Lavergne, Tomas Bylund, Manuel Meyer, Angel Priyana Noel, David A. Sanchez

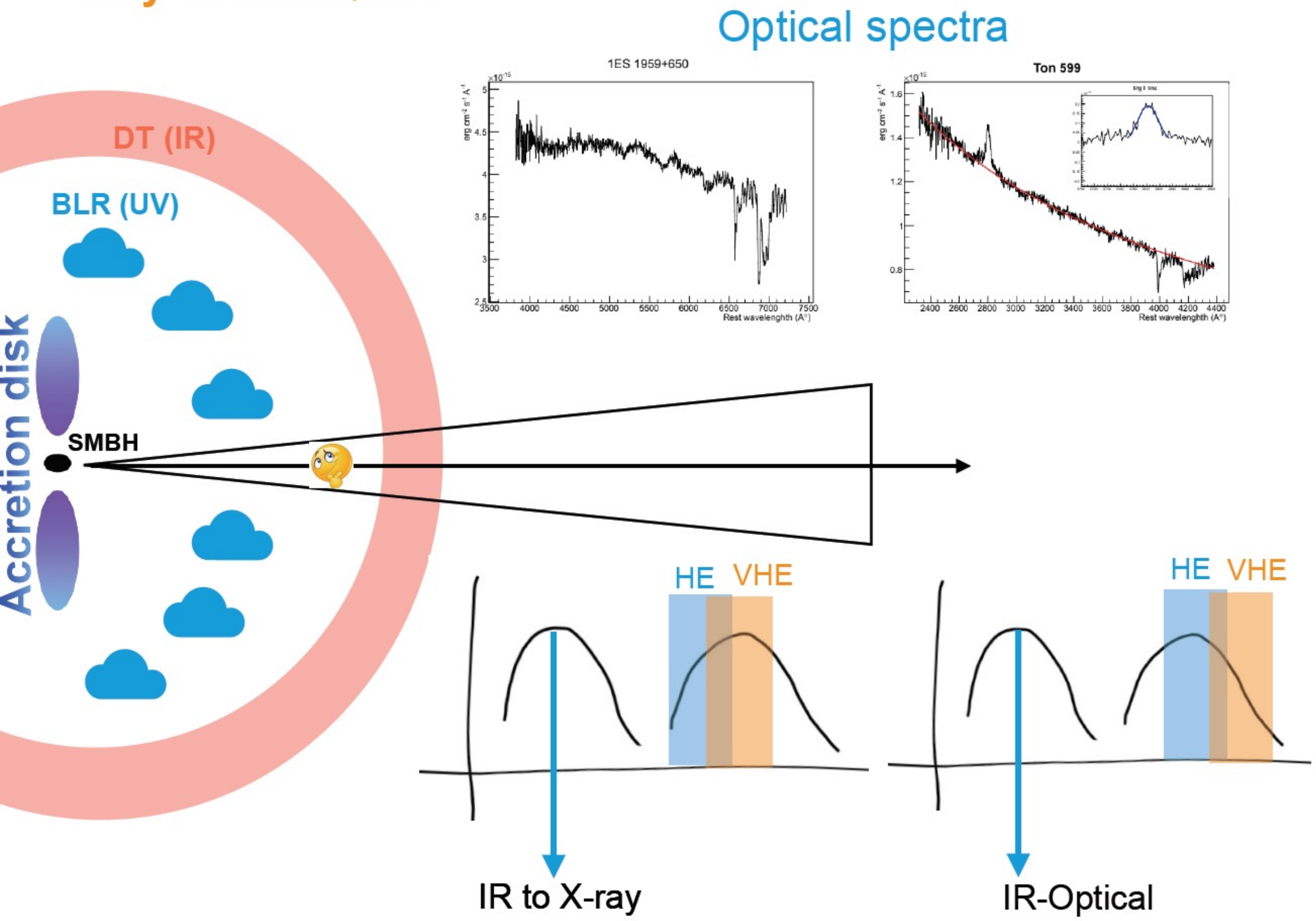
- We report the discovery at TeV energies of two new extreme high-synchrotron-peaked blazar candidates (EHBL), MRC 0910-208 and 1RXS J195815.6-301119.
- EHBLs are among the most powerful cosmic particle accelerators found in nature, making them good candidates for understanding the radiation mechanism in such high-energy ranges, and can be used to understand any hadron-initiated emissions in multi-TeV energies.
- We observed and detected MRC 0910-208 and 1RXS J195815.6-301119 using the H.E.S.S.-telescopes, and analysed data from Fermi-LAT and the XRT instrument onboard Neil Gehrels Swift observatory, and performed a simple SSC modelling. We also evaluated the synchrotron peak energy for both sources.
- **Results:** We detected TeV-emissions from MRC 0910-208 and 1RXS J195815.6-301119, confirm their nature as EHBL, and measured their intrinsic spectra to be hard (Γ∼2) and well fitted by simple SSC models.



Introduction

Why TeV FSQRs?





Motivation:

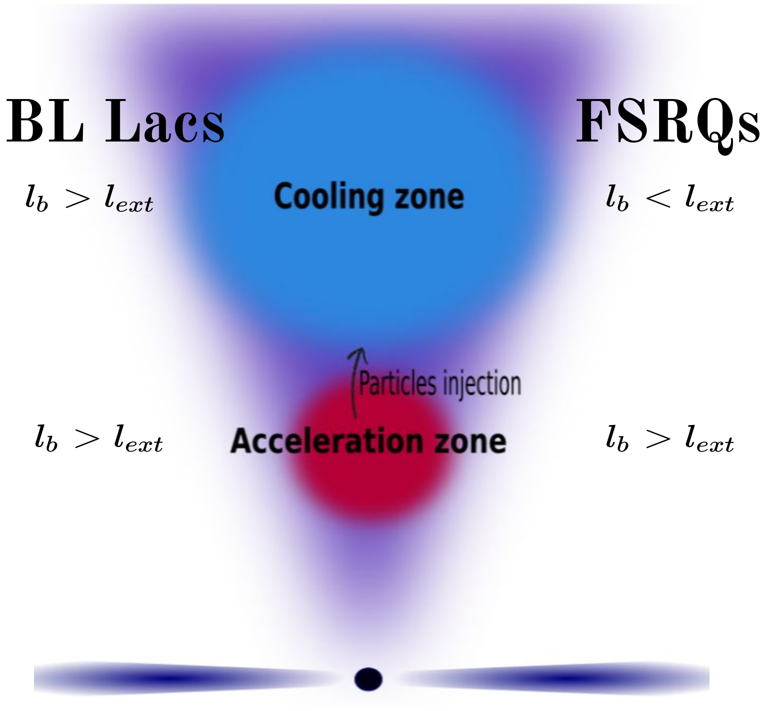
- Only 8 FSRQs @TeV
- All of them detected during high flux state (except PKS 1510-089)
- Generally located at larger distance

$$J(E_\gamma) = J_0(E_\gamma) \times e^{-\tau(E_\gamma, z)}$$

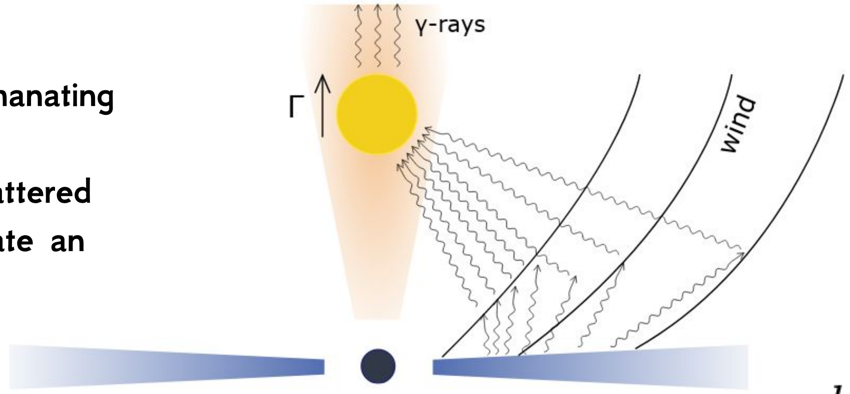
- Spectral cutoff due to external radiation field (~20 GeV; Stern & Poutanen 2014)
- Potential source of EeV-scale neutrino (Righi et al. 2020)

A two-zone emission model for blazars and the role of accretion disk MHD winds

Stella S. Boula, Apostolos Mastichiadis, Demosthenes Kazanas



1. Self-consistent MHD wind emanating from the AGN accretion disk
2. Accretion disk photons are scattered on the wind particles and create an isotropic external photon field.



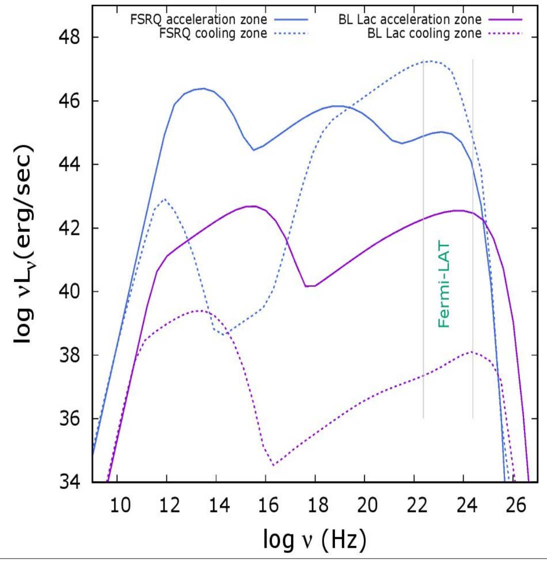
$$l_B = \frac{\sigma_T R_b U_B}{m_e c^2}, \quad l_{ext} = \frac{\sigma_T R_b U_{ext}}{m_e c^2}, \quad B \propto 1/z, \quad U_{ext} = constant$$

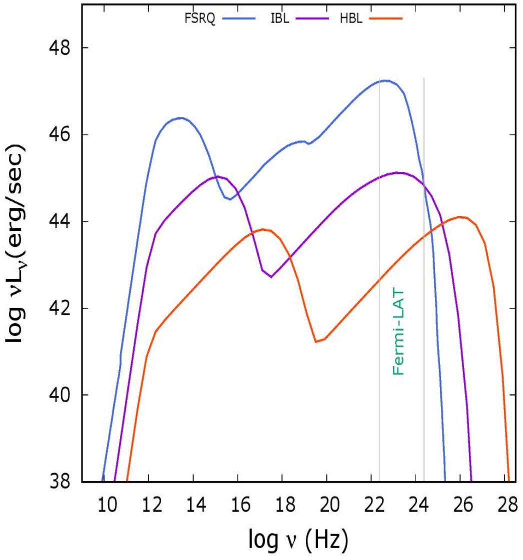
All parameters of the problem are related to the mass accretion rate:

$$U_{\rm B} \propto \frac{\dot{m}}{M},$$

$$U_{\rm ext} \propto U_{\rm sc} \propto \frac{\dot{m}^{\alpha+1}}{M} \quad (\alpha = 1 \text{ for } \dot{m} \geq 0.1 \text{ and } \alpha = 2 \text{ for } \dot{m} < 0.1),$$

1. We assume that particles accelerate into a zone close to the black hole and calculate their Spectral Energy Distribution (SED), by solving the integro-differential kinetic equations numerically.
2. We inject the escaping electrons from the Radiation zone into Cooling zone, which is at a larger distance and then we calculate the SED.
3. We add up the fluxes of the two zones and obtain the total spectrum and then the theoretical Blazar Sequence is reproduced.

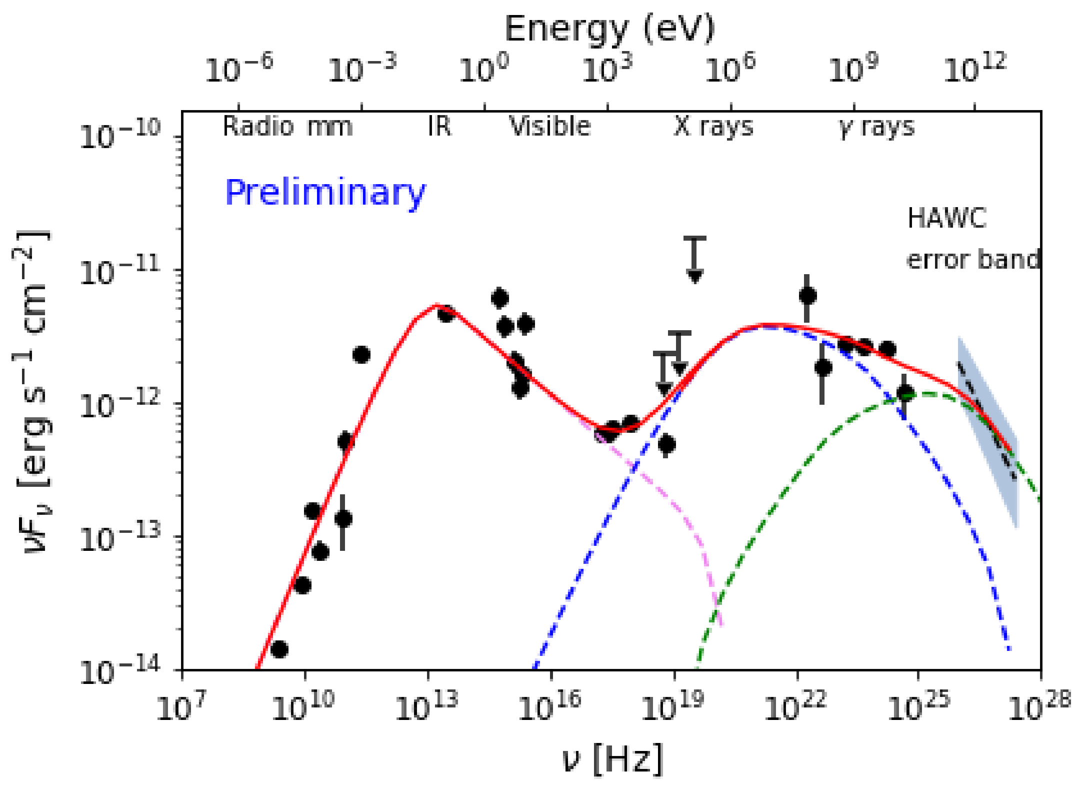




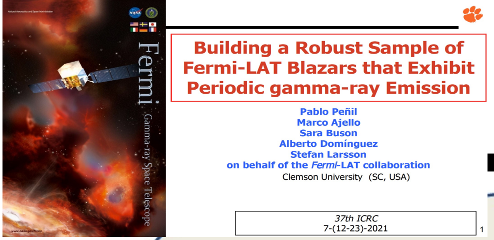
Modeling the non-flaring VHE emission from M87 as detected by the HAWC gamma ray observatory

Fernando Ureña-Mena[a], Alberto Carramiñana[a], Anna Lia Longinotti[b] and Daniel Rosa-González[a]
[a]INAOE, Mexico
[b]IA-UNAM, Mexico

- M87 is a supergiant elliptical galaxy with an active nucleus (AGN), which is a well-established MeV, GeV and TeV gamma-ray source.
- The High Energy Water Cherenkov (HAWC) gamma-ray observatory marginally detected this source at E > 0.5 TeV (Albert et al, 2021).
- In this work we fit a lepto-hadronic model to a SED built to include the HAWC observations for the first time.
- We conclude that this scenario could explain the M87 VHE emission, including the possible gamma-ray spectral turnover which is also seen in other objects such as Centaurus A



Lepto-hadronic model fitted to a M87 SED

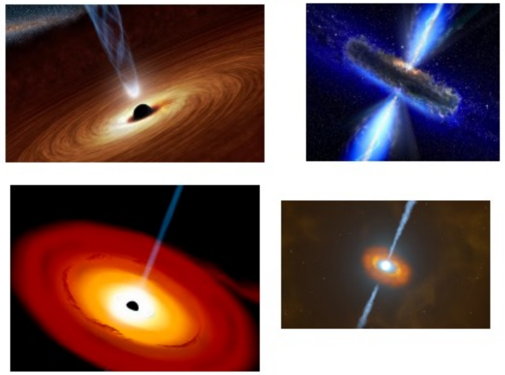

Building a Robust Sample of Fermi-LAT Blazars that Exhibit Periodic gamma-ray Emission

Pablo Peñil
Marco Ajello
Sara Buson
Alberto Domínguez
Stefan Larsson
on behalf of the *Fermi*-LAT collaboration
Clemson University (SC, USA)

37th ICRC
7-(12-23)-2021

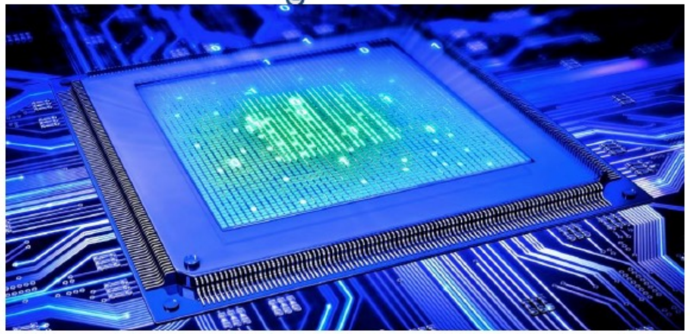
Project

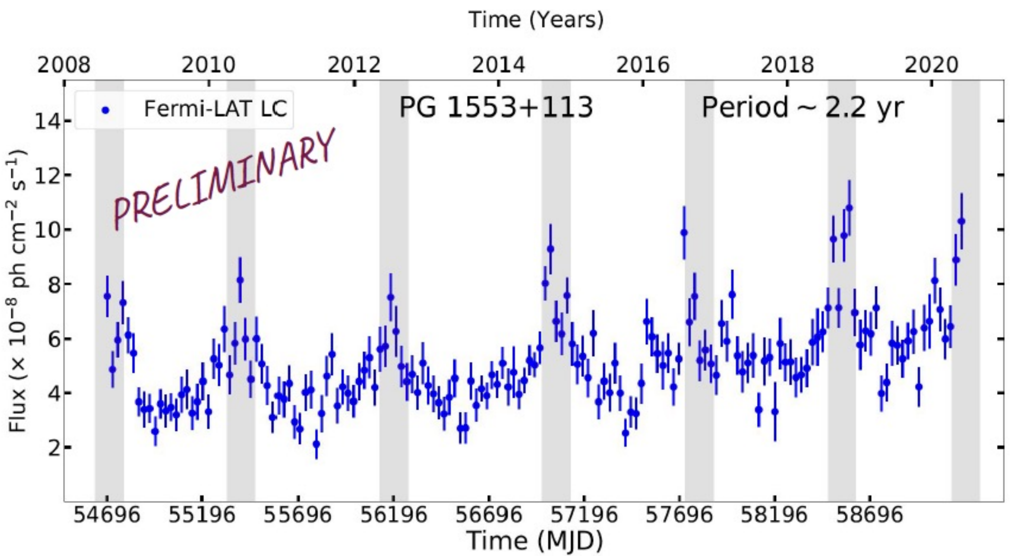
BLAZARS



***FERMI*-LAT OBSERVATIONS**

SYSTEMATIC SEARCH FOR PERIODICITY

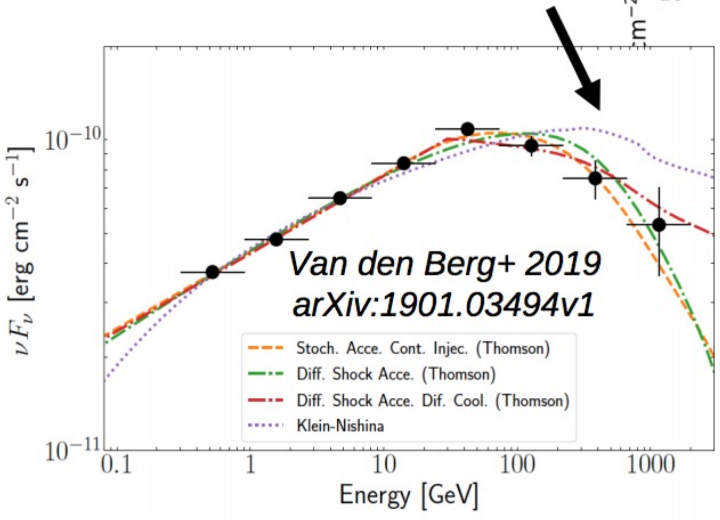


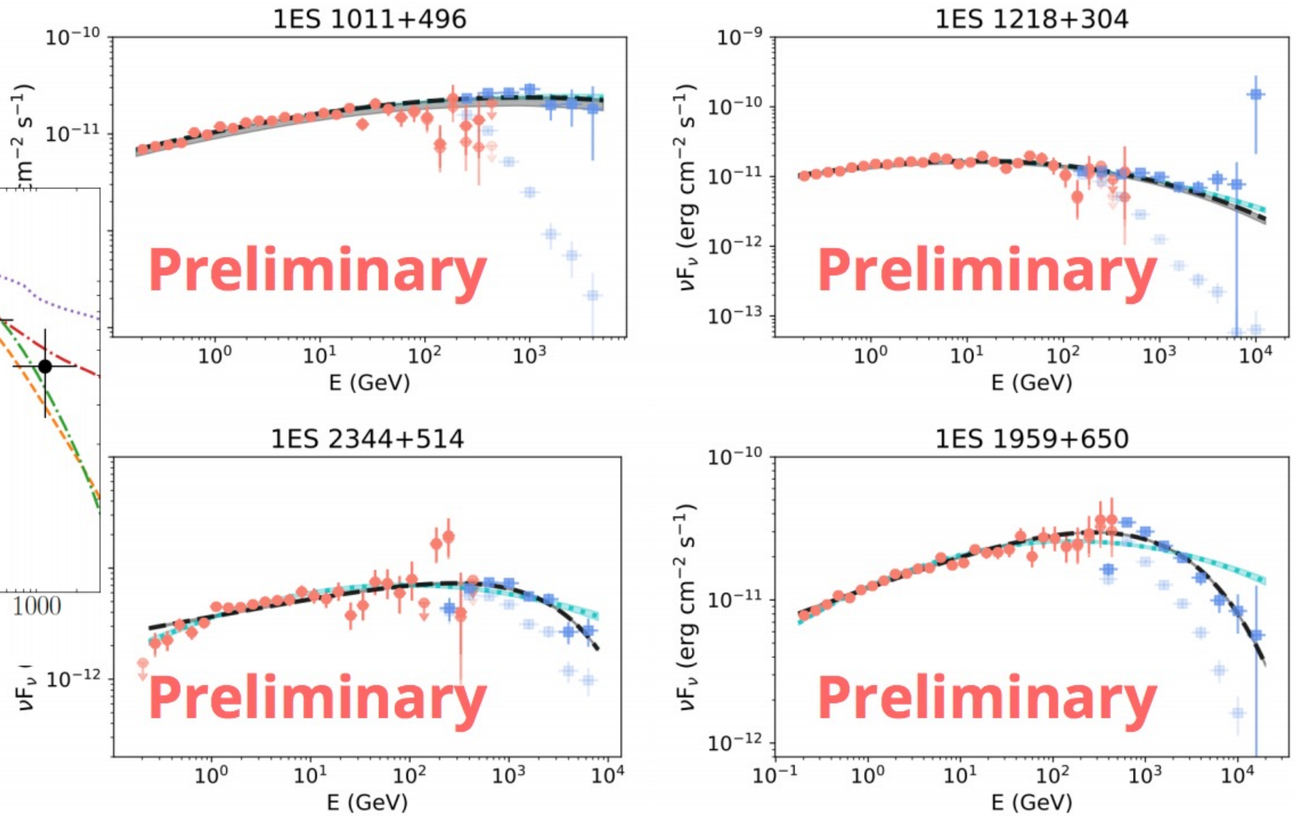


6 BLAZARS ≥ 5σ PERIODICITY

GeV/TeV γ-ray Spectrum of Blazars
→ Particle Acceleration and Cooling

- GeV-TeV spectra alone are useful!
- Fermi-LAT and VERITAS spectra to constrain models

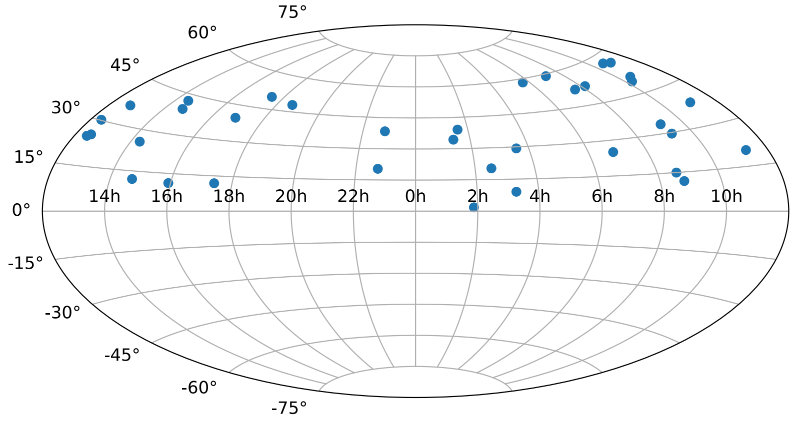




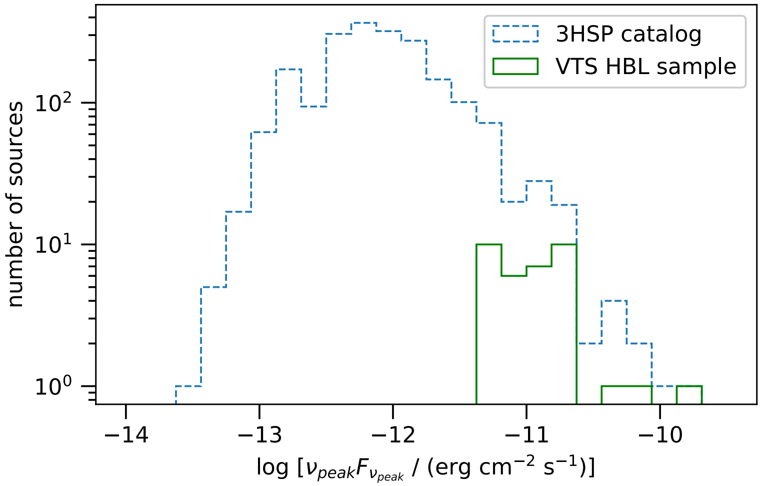
Observations of an HBL sample with VERITAS

Manel Errando (Washington University in St. Louis) on behalf of the VERITAS collaboration

- VERITAS is conducting an unbiased survey of TeV emission from 36 selected high-frequency-peaked BL Lacs.
- We have so far collected more than ~2,000h hours of data, including 155h of dedicated observations since 2019.
- Results will be used to derive the luminosity function of TeV-emitting HBLs.



The VERITAS HBL sample



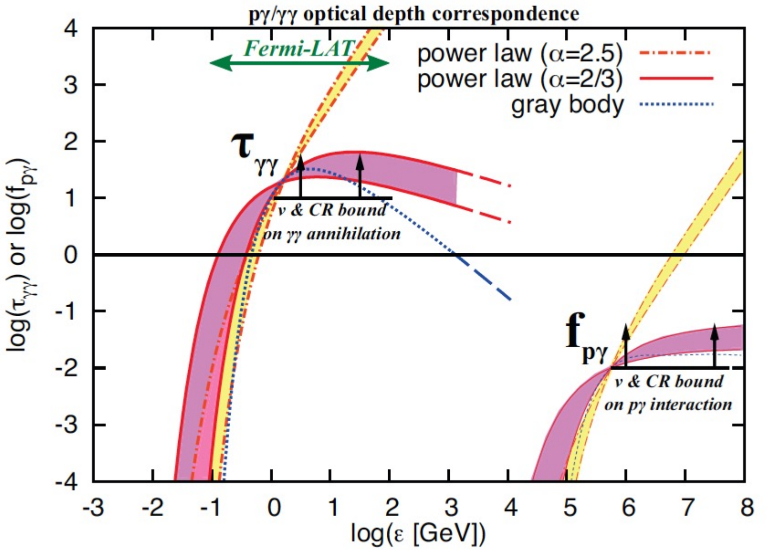
Question break (2)

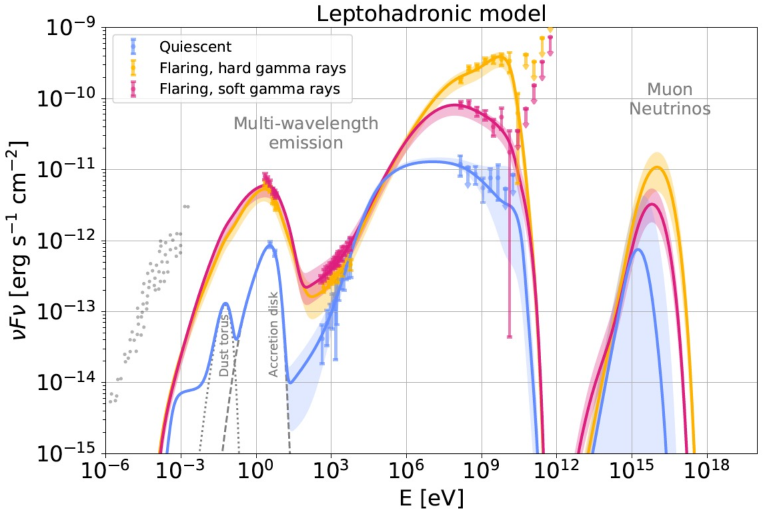
Discussion

- Robustness of physical interpretations? If I cannot describe multi-wavelength data, I add more d.o.f., but is that unique? How can different interpretations be disentangled?
- Selection effects: are certain object classes only selected by IACTs because they are observable in that energy range? What is special about these object classes?
- What drives flares? Increases injection, changing physical parameters, ...
- What can we learn from population and/or periodicity studies?

Discussion: leptonic vs. hadronic models

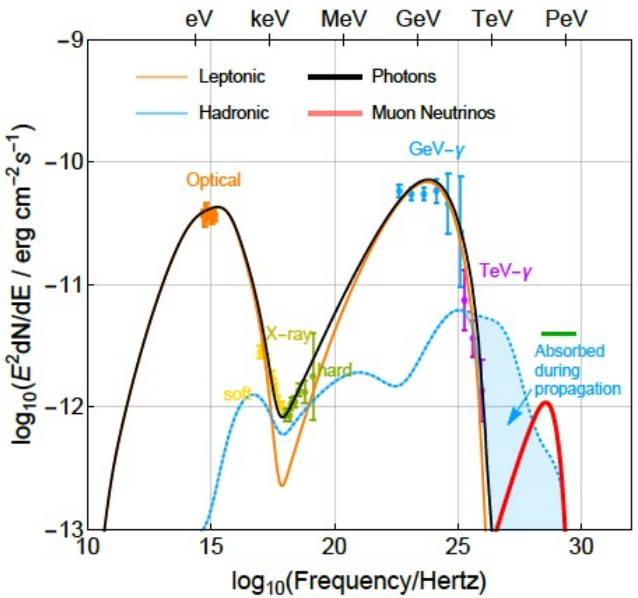
Murase, Guetta, Ahlers, 2016





Rodrigues et al, ApJ 912 (2021) 1, 54

- Leptonic versus hadronic models: Level of detail in models, e.g. re-processing of gamma-rays in source?
- Are gamma-ray emitters really neutrino emitters?
- Role of flare ramp-up vs. gamma-ray attenuation?
- Do re-processed gamma-rays show up in X-ray range, limiting the hadronic contributions?
- Can EBL effects be distinguished from internal absorption?



(example: TXS 0506+056, from Gao, Fedynitch, Winter, Pohl, *Nature Astron.* 3 (2019) 1, 88)

BACKUP

Executive summary contribution #277

16 July 2021

Title: Systematic X-ray study of GeV emitting radio galaxy

Authors: Hiroto Matake(matake@astro.hiroshima-u.ac.jp), Yasushi Fukazawa

・What is this contribution about?

We report about the contribution from jet and accretion disk to the X-ray spectra for gamma-ray emitting radio galaxies (RG).

・Why is relevant/interesting?

Previous work used under 10 gamma-ray RG. From 4FGL-DR2 catalog, we choose 21 RGs which has been observed 4 times in Swift/XRT. It is enough number to perform statistical analysis.

・What have we done?

We studied the relation between X-ray parameter which is result of Swift/XRT data and gamma-ray parameter which is from 4FGL-DR2 catalog, and we'll show the result of time variation and the relation between X-ray and Gamma-ray Photon Index.

・What is the result?

It is turn out that the RGs can be divide into 3 types, using the result of time variation, the relation between photon index of X-ray and Gamma-ray, and accretion rate. First is the objects class "Jet dominant type" which show strong harder-when-brighter trend, hard gamma-ray spectra, soft X-ray spectra, and low accretion rate. Second is the objects class "Accretion Disk dominant type" which show weak harder-when-brighter trend, soft gamma-ray spectra, hard X-ray spectra, and high accretion rate. Third, the objects class "Jet and AD dominant type" which show strong harder-when-brighter trend, soft gamma-ray spectra, hard X-ray spectra, and middle accretion rate.