An educational exploration of Cosmic Rays and Blazars: a PCTO experience

Introduction to astroparticle physics and data analysis

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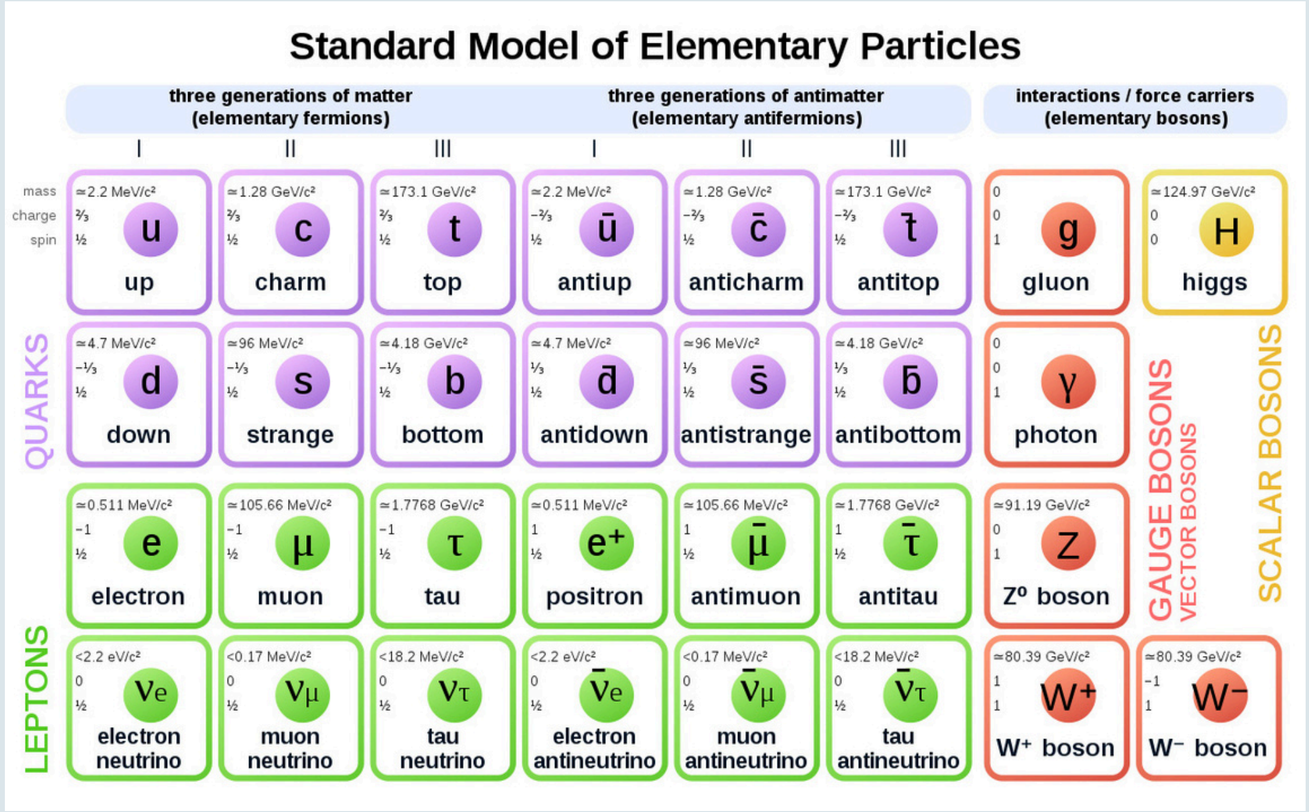
Elementary particles

At the base of the world around us are the so-called "elementary particles" that are not composed of other simpler particles, these are:

- quarks;
- leptons;
- bosons.



Cosmic rays

Cosmic rays are high-energy particles originating from outer space, which provide valuable insights into the high-energy universe.

Cosmic Rays can be revealed thanks to cutting-edge telescopes like the Pierre Auger observatory in western Argentina.

Cosmic Rays Cube

Cosmic Rays Cube measurements

DEGREES	R1	R2	R3	R4	R5	R6	MEDIA	MEDIA/50	ERRORS
0	50.0	48.0	49.0	51.0			49.5	0.99	0.03
15	48.0	48.0	47.0	48.0	49.0	52.0	48.7	0.97	0.05
27	39.0	38.0	50.0	50.0	39.0	39.0	42.5	0.85	0.12
45	39.0	39.0	34.0	34.0	32.0	34.0	35.3	0.71	0.07
59	19.0	19.0	19.0	19.0	22.0	22.0	20.0	0.40	0.03
87	10.0	10.0	8.0	8.0			9.0	0.18	0.02

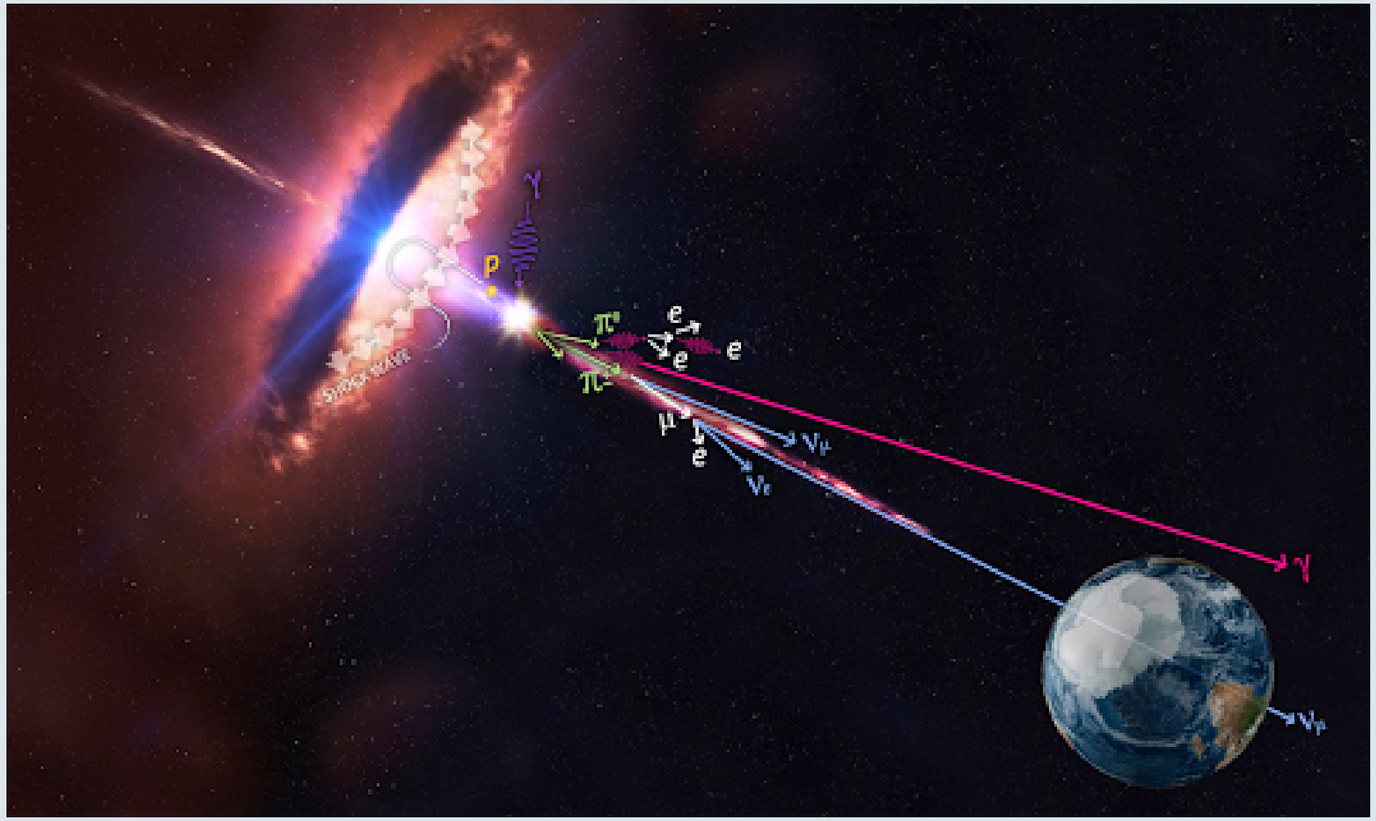
DEGREE		COS⊥2 θ
0	0	1.000
15	0.26167	0.933
27	0.471	0.794
45	0.785	0.500
59	1.02922	0.266
87	1.51767	0.003

DEGREES	Theoretical	Sperimental
0	1.00	0.99
15	0.93	0.97
27	0.79	0.85
45	0.50	0.71
59	0.27	0.40
87	0.00	0.18

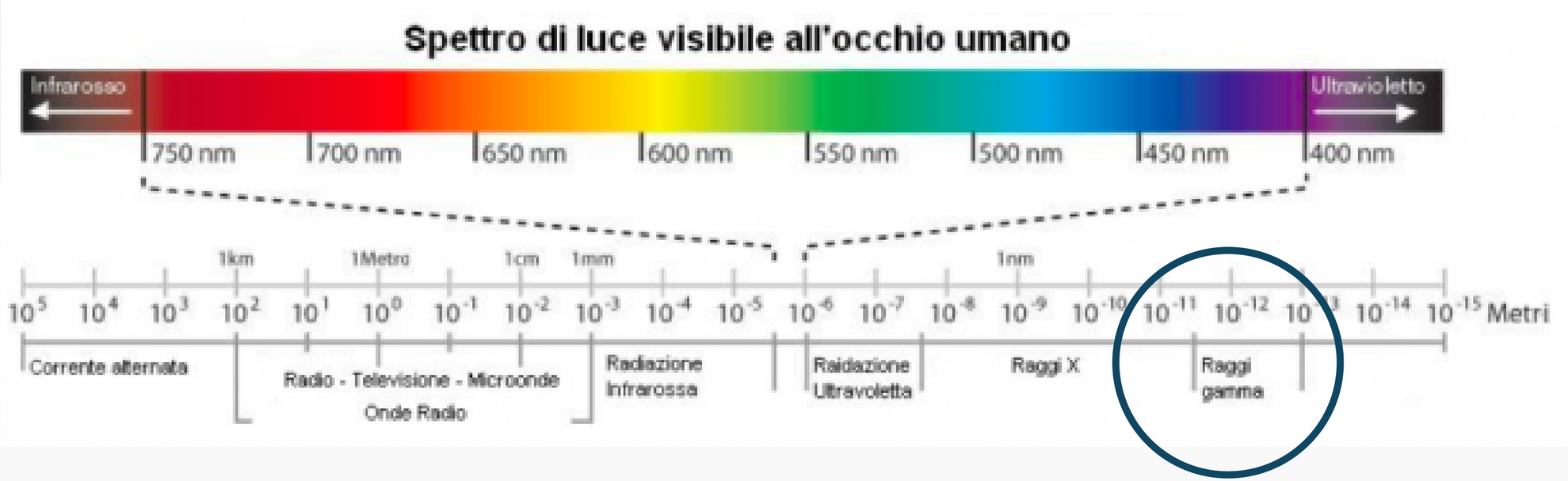
SOURCES

They are divided into:

- GALACTIC: stars (neutron, PULSAR), supernova, star interactions;
- EXTRAGALACTIC: stars, galaxy clusters, gamma-ray bursts

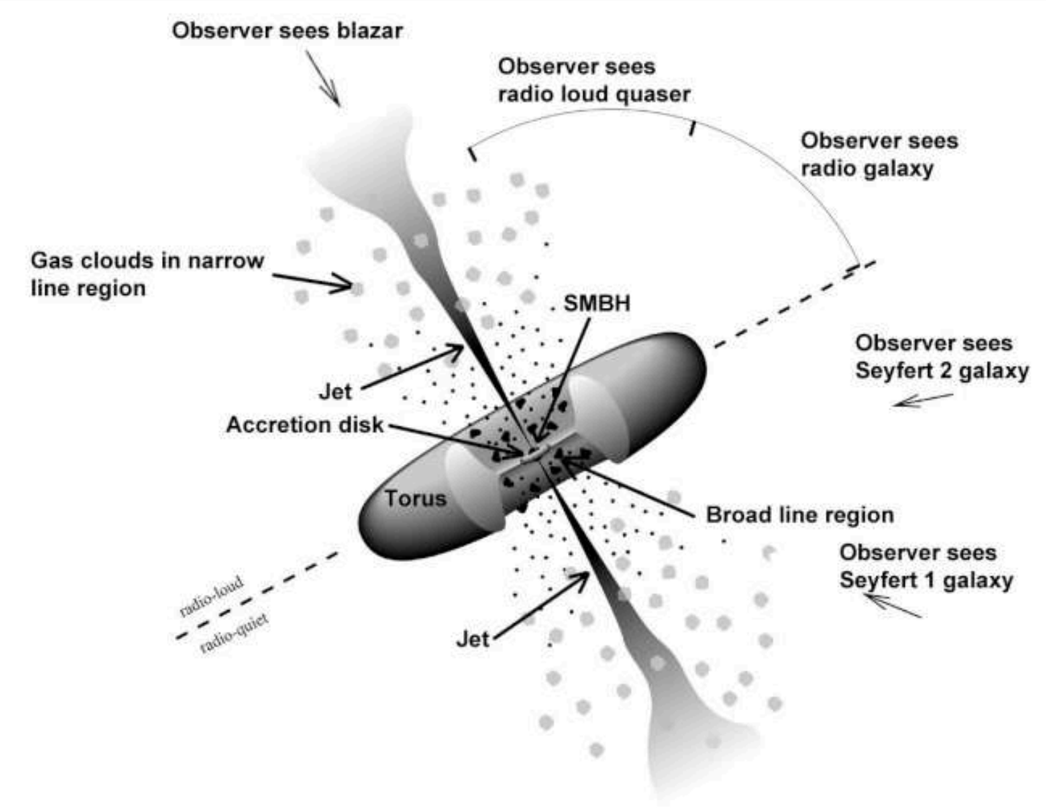


Blazar emission spectrum



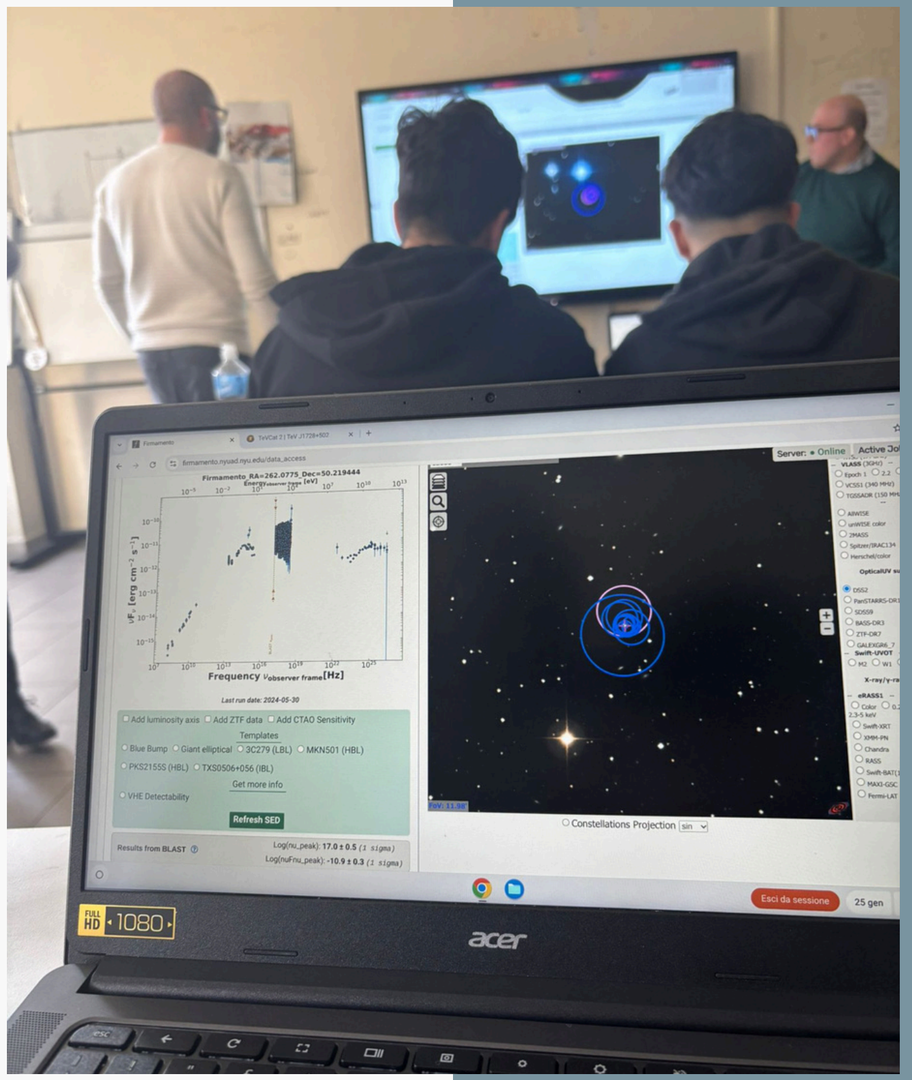
Blazar are part of the AGN, structures at the centre of several so-called active galaxies, powered by a supermassive black hole. The black hole accelerates the matter around it and shoots it out, and the accelerated particles in these jets can emit radiation up to the most energetic gamma rays.

In particular, the jet of particles from the blazars are directed towards the observer (earth).



How is an analysis carried out?

- collect data from portals accessible to all (Firmamento, Tevcat,...);
- analyze and represent data (in this case we used Python).

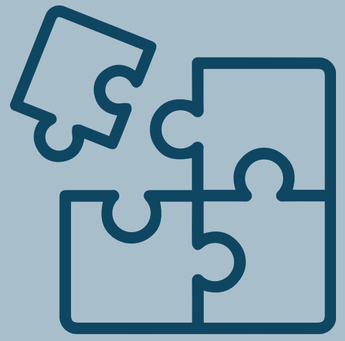


Performance of work

Open the SED in python

- First we asked python to open the file with pandas and convert it into dataframe

Visualize datas

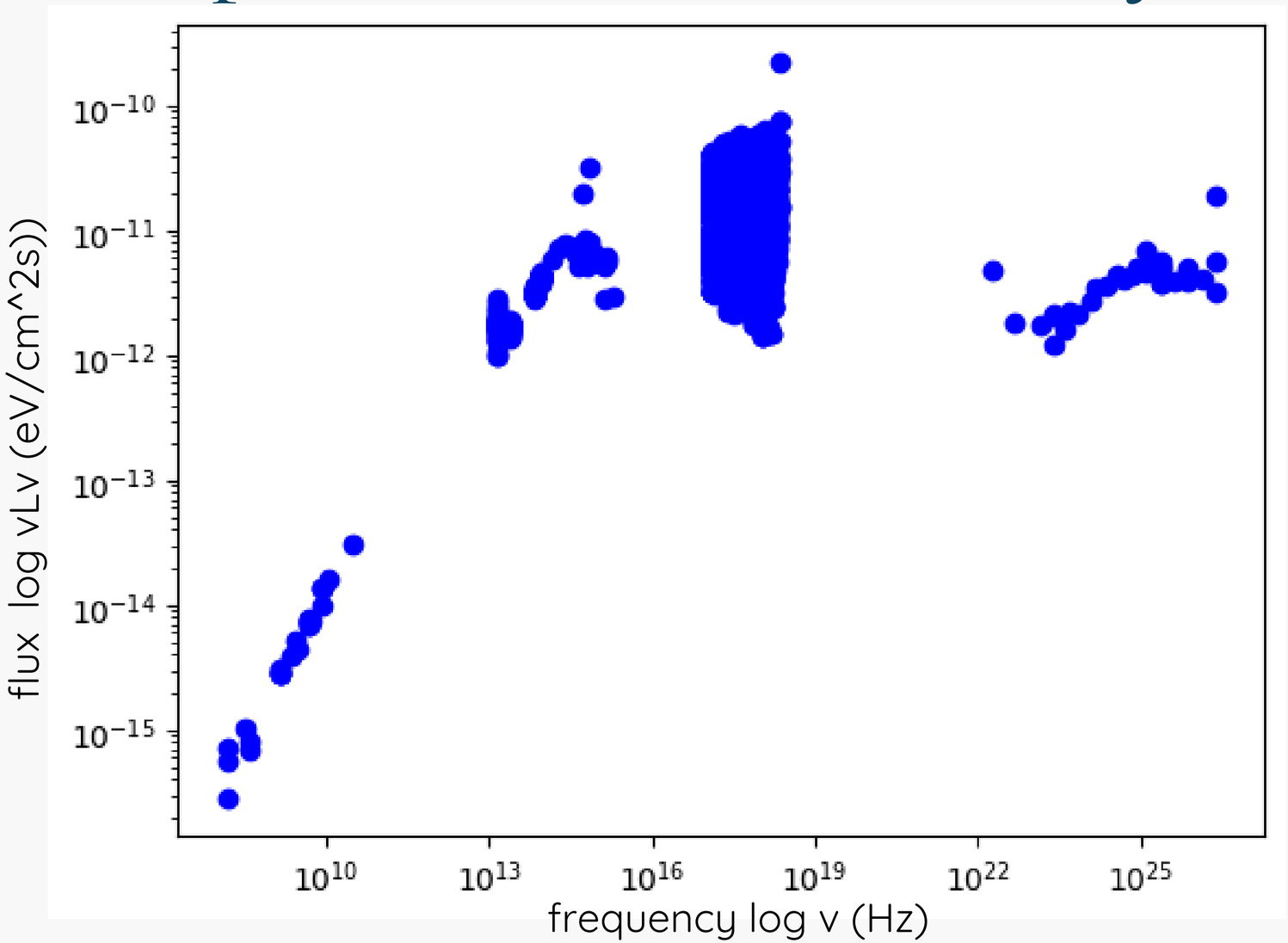


- then we asked python to describe the data
- number of events, flow(min and max), emission,density...

Graphical representation

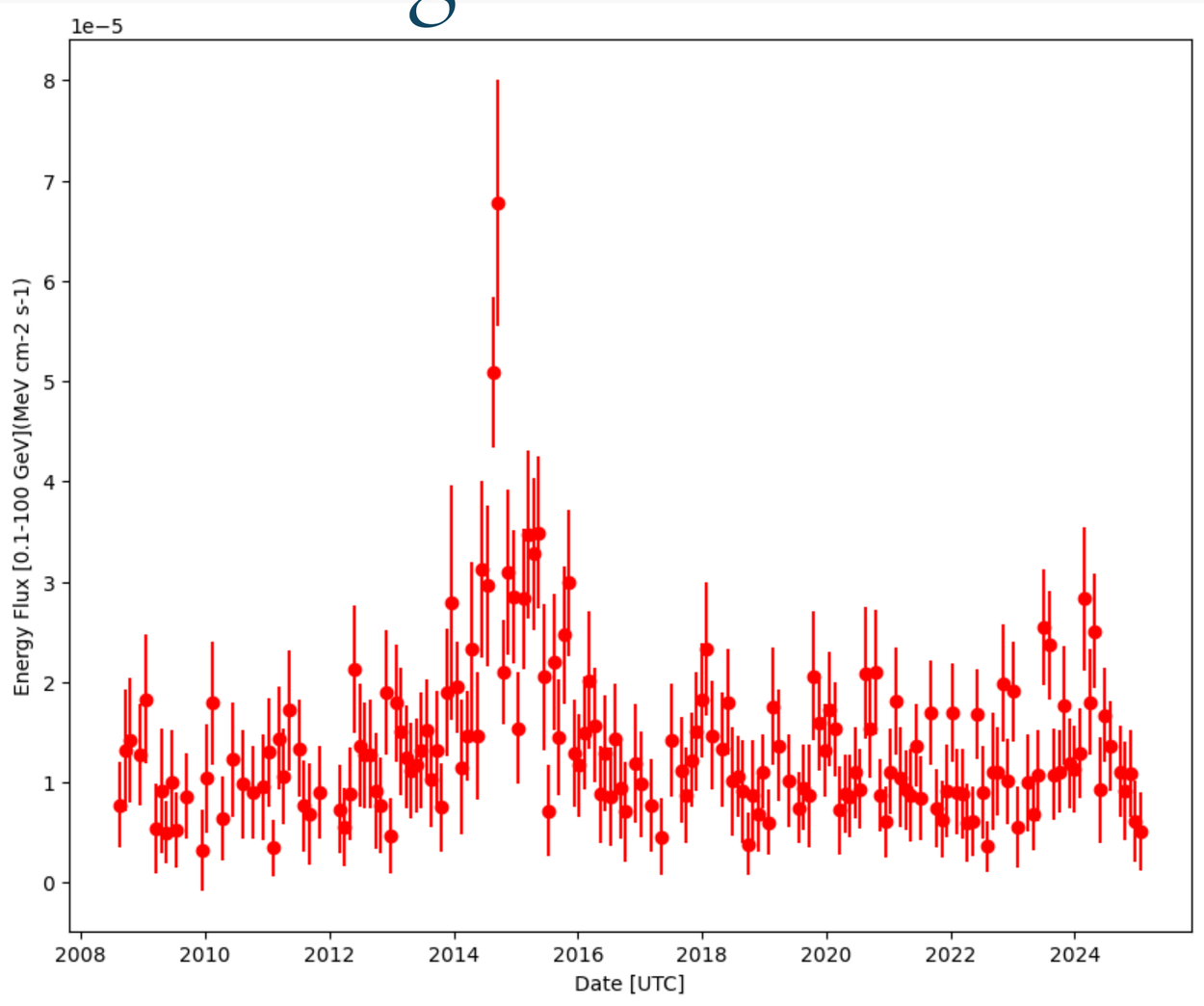
- Using a logarithmic scale we were able to display the multifrequency graph of our data
- **spectral emission density (frequency-flux) graphic**
- **light curve graphic (date-energy flux)**

Spectral emission density



This graphic shows the emission spectrum based on frequency (hertz) and flux (erg/cm2s), the figure clearly shows two peaks, known as sincroton light and inverse Compton, typical of a blazar.

Light curve



This figure shows the light curve of the source; it expresses values as a function of energy and time. The highest energy value has been registered in 2014, but it's necessary to consider the variability of uncertainty shown in the graph as vertical lines.

Thank you.