# Testing high energy neutrino emission from the Fermi Gamma-ray Space Telescope Large Area Telescope (4LAC) sources.

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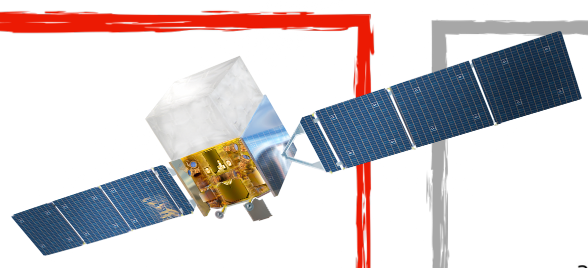
The detection of the high-energy neutrino IC-170822A in spatial (within the error region) and temporal flare activity correlation with the blazar TXS 0506+056 allowed these objects to be considered as progenitor sources of neutrinos. Besides this, no more detection of this kind was reported. Some other neutrinos detected by IceCube show a spatial correlation (within the error region) from other Fermi-LAT detected sources. However, these objects did not show a flare activity like TXS 0506+056. Assuming a lepto-hadronic scenario through pγ interactions, this work describes the SED in some objects from the fourth catalog of active galactic nuclei (AGNs) detected by the Fermi Gamma-ray Space Telescope Large Area Telescope (4LAC) sources, which are in spatial correlation with neutrinos detected by IceCube. Additionally, we estimate the corresponding neutrino flux counterpart from these sources.

## Messengers

The Fermi-LAT team released the 4LAC (4LAC-DR2) Catalog covering the first 10 years of operations. The catalog comprises 3125 Active Galactic Nuclei (AGNs) with high-energy emission at > 50 MeV [1].



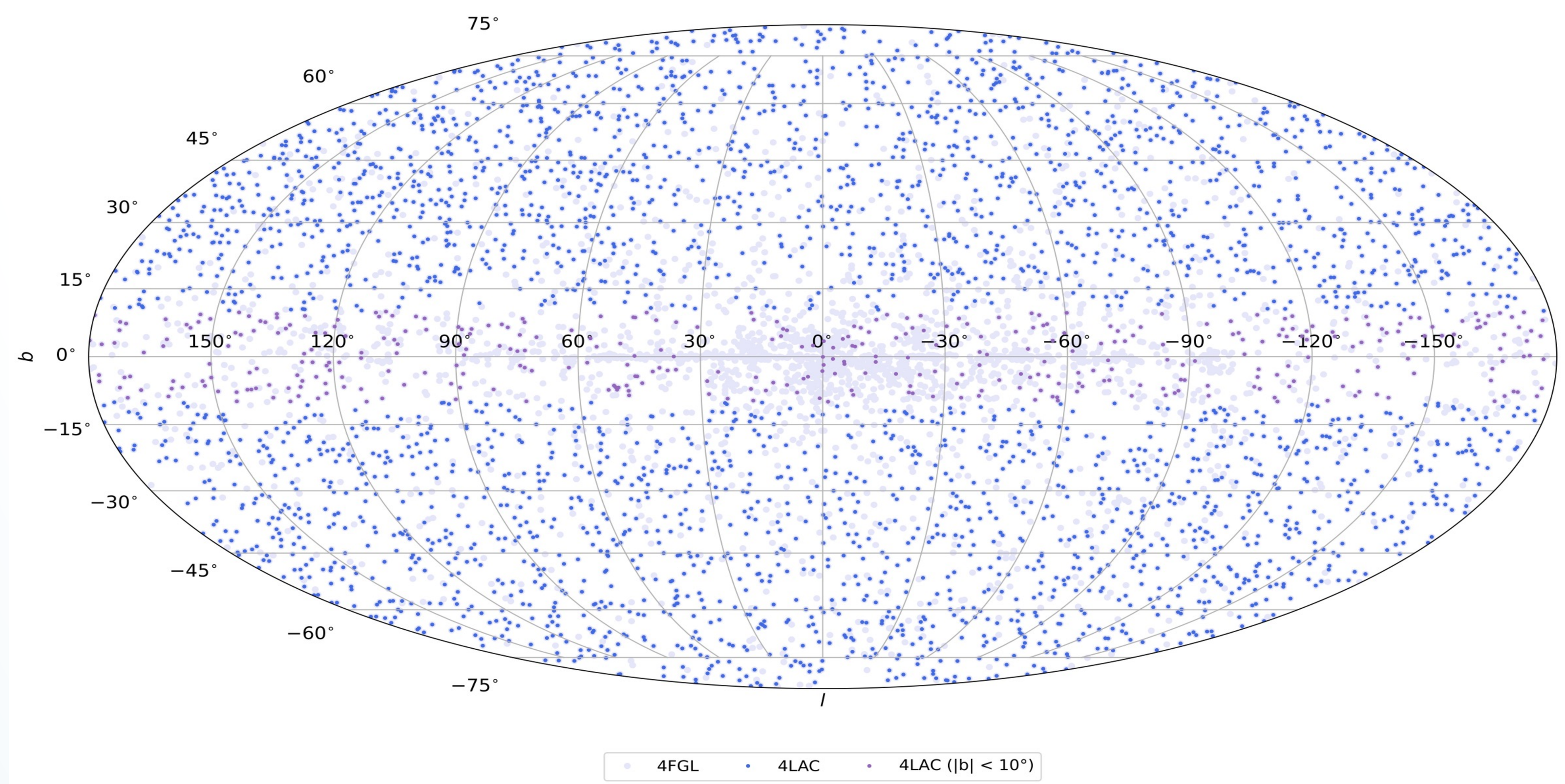
Credit: NASA

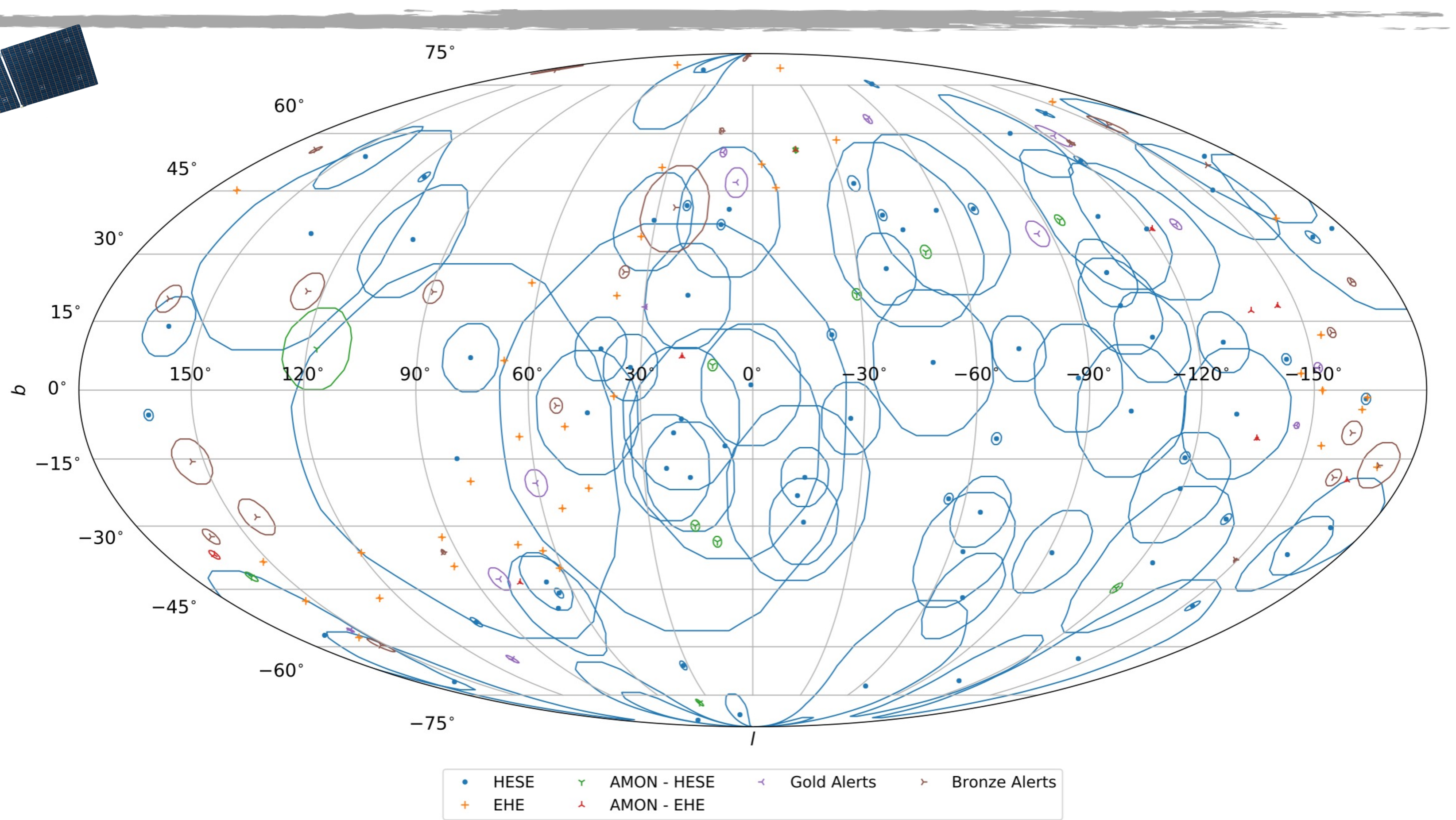
The population on the sample is conformed by:

- 694 FSRQ
- 1125 BL Lacs
- 1240 BCU
- 66 Non Blazars AGNs

Additionally, we take into consideration the low-latitude sample which contains:

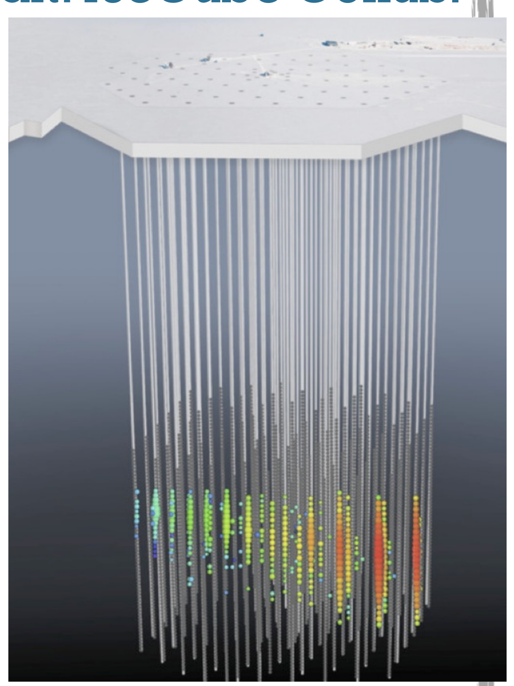
- 36 FSRQ
- 65 BL Lacs
- 260 BCU
- 6 Non Blazars AGNs



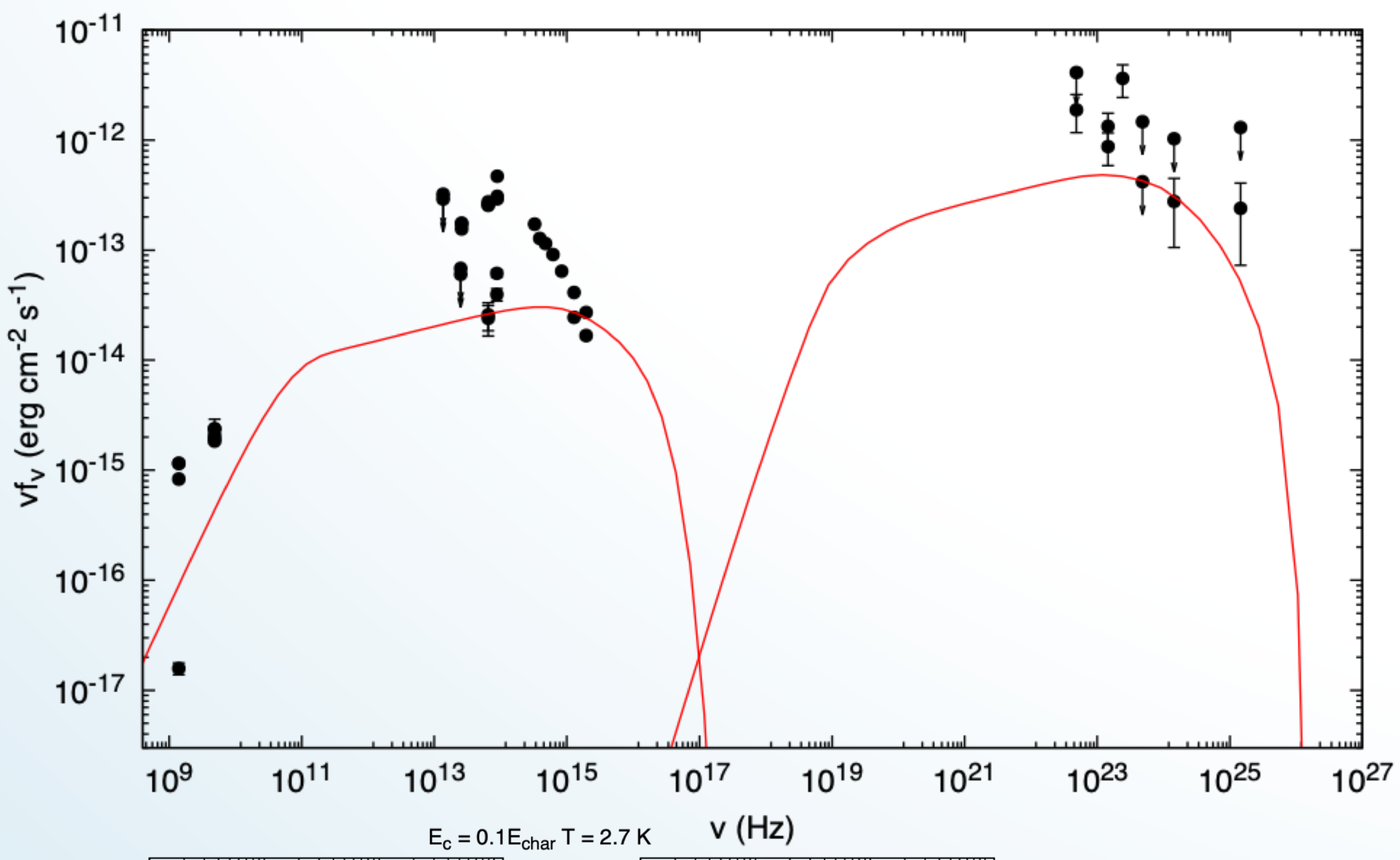

The IceCube Observatory has reported several detection of high-energy neutrinos. The HESE and EHE catalogs, the events HESE and EHE distributed via AMON and recently the Golden and Bronze alerts [2].

Credit: IceCube Collab.



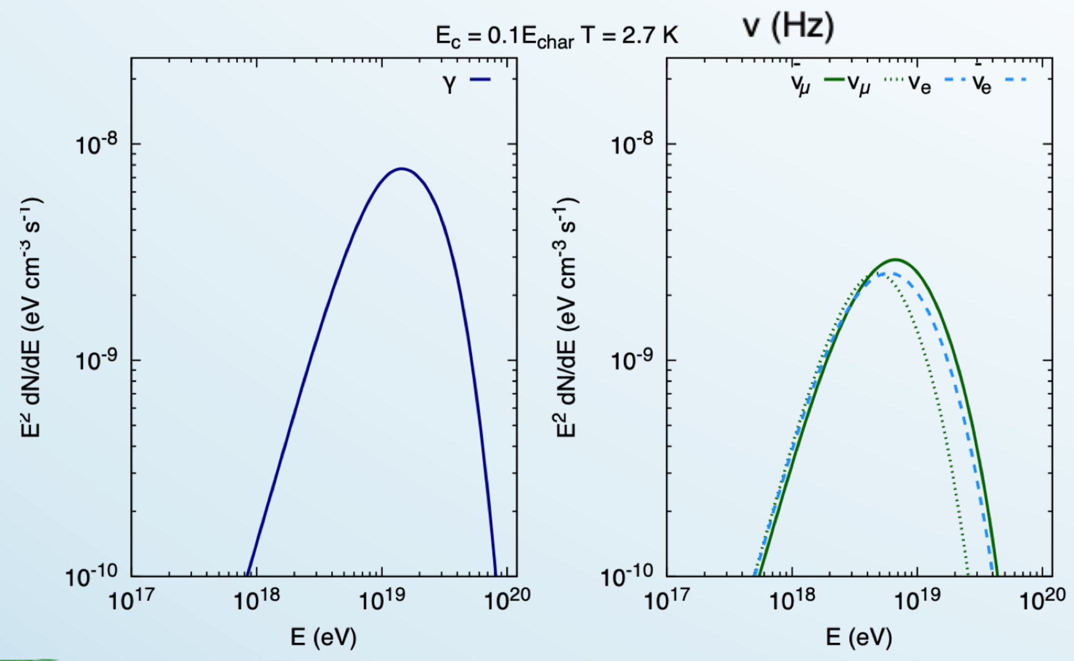
Only one event (IC 170922A) has been detected in temporal correlation with a source that emits γ-rays. This source is the blazar TXS 0506+056 that was in flare state when the neutrino was detected[3]. Posteriori observations performed by IceCube in this direction of the sky found a flare of neutrinos with no electromagnetic activity[4,5].

## The model framework




In this work, we explore the blazars reported in the 4LAC which are in spatial correlation (i.e. the blazar position is embedded into the 90% error of the neutrino localization) with the track events reported by IceCube. For those sources that satisfy the criterium, the broadband Spectral Energy Distribution (SED) will be built with quasi-simultaneous photons at the arrival time of the neutrino.

If the broadband SED of the candidate fits successfully to a leptonic model (as the SED from the left), we would not expect neutrinos from this source. We adopt the leptonic model derived and shown in [6].




In the case where the SED cannot be described assuming a leptonic model, an extra component it's proposed. This extra component have a hadronic origin. From this component it's expected a high energy γ-rays and neutrino flux from this. In this work we adopt the model proposed by [7].

We also explore the gamma-ray light curve of the sources in scale of months in order to find possible flares state of those objects.

[1] Fermi-LAT Collaboration 2020, apj, 892, 105.
[2] IceCube Collaboration. Data Releases. Data Access.
[3] IceCube Collaboration 2018, Science, 361, eaat1378.
[4] IceCube Collaboration 2018, Science, 361, 147.
[5] Fraija, N., Aguilar-Ruiz, E., Galván-Gámez, A. 2020, mnras, 497, 5318.
[5] Finke, J.D., Dermer, C.D., & Böttcher, M. 2008, apj, 686, 181.
[6] Kelner, S.R. & Aharonian, F.A. 2008, prd, 78, 034013.

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