Gamma ray source catalogs for the identification of the IceCube neutrino sources

Ryutaro Kanetani
Chiba University: International Center for HadoronPhysics (ICEHAP)
23wm2114@student.gs.chiba-u.jp

Motivation of the study

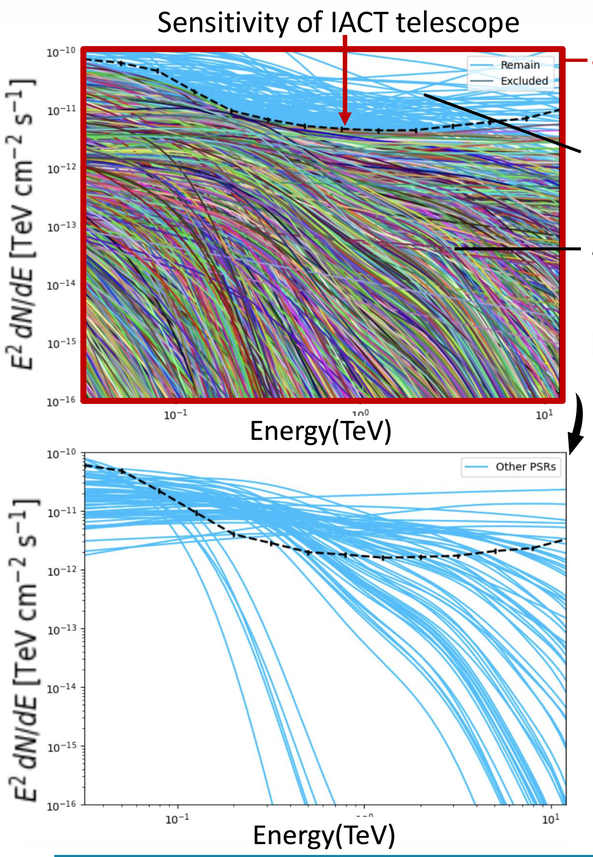
There is an IceCube alert channel called GFU, designed to identify new types of sources associated with IceCube's mutiplet event.
Unblazar, galactic sources, etc., with smaller energy than that of Singlet IC event are expected as new types of sources. For that, this study is for creating the γ sources list and If a IceCube's multiplet event is detected from the same direction as a source in the list we made with a significance of > 4σ, an alert will be sent to gamma-ray observatories, CTA.

Catalogues we started with

Previously 3FGL, GeV γ-rays source catalogue, was used and TeV galactic sources (e.g., Galactic Centre, Crab Nebula) were empirically added.
This time, we started with the updated version of 3FGL which is 4FGL-DR3 and the TeV γ catalogue, TeVCat, and selected sources with our own criteria.

Selecting 4FGL sources

Compared the IACT sensitivity to the γ fluxes of 4FGL sources, caluculated using Powerlaw, Logpara, PLcutoff model being multiplied by finke's EBL model.



4505 sources

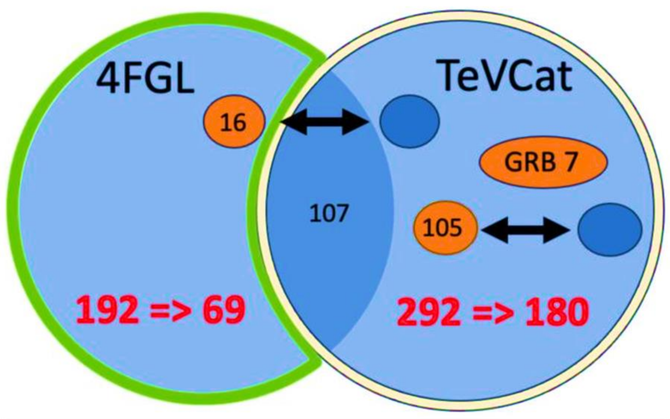
188 sources survived

4417 sources which were excluded since its flux doesn't reach the IACT sensitivity

- These 188 sources remained and 4 sources added later => 192 sources
- Excluded the 123 overlapping sources with TeVCat

=> 69 sources

Selecting TeVCat sources



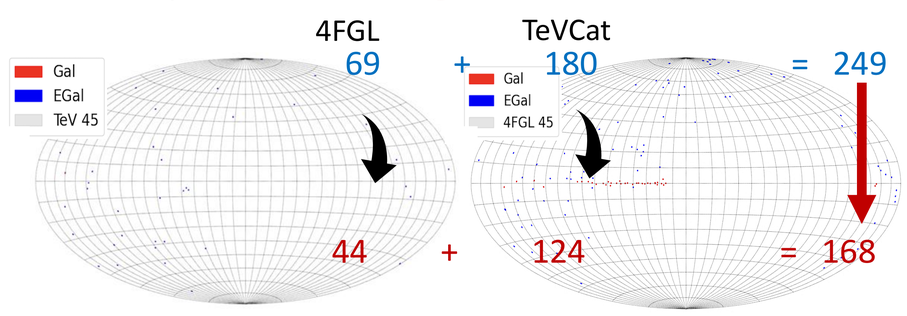
- Excluded GRB as it's bright only temporarily : -7
- Chose more important sources among pairs of nearby sources : -105

292 => 180 sources

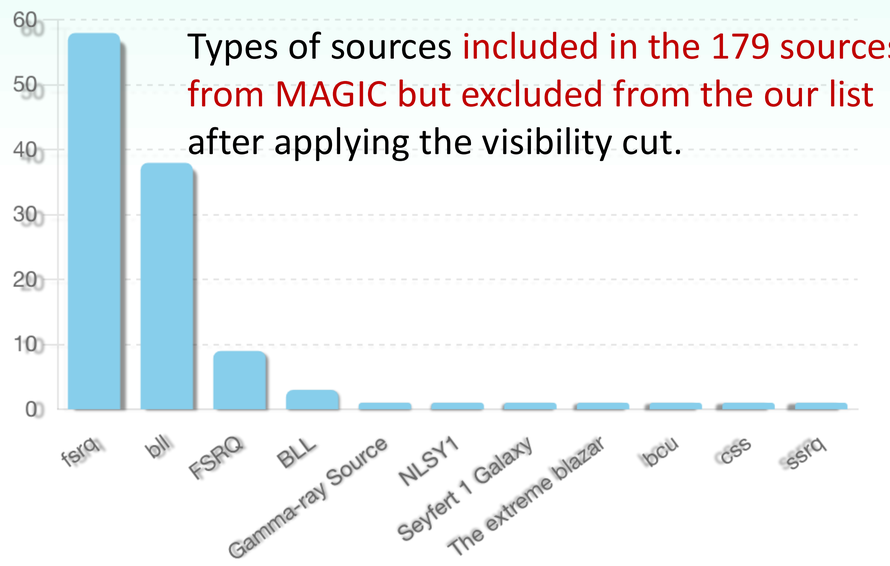
Visibility Cut

The sources in the previous list by MAGIC is subject to observational conditions.
For comparison, the following observational conditions were imposed to our list:

- La Palma
- At night
- Zenith angle < 45 degrees
- Moon separation = 30 degrees



Compared to the previous list by MAGIC

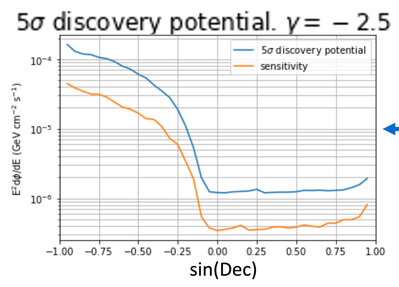


Types of sources included in the 179 sources from MAGIC but excluded from the our list after applying the visibility cut.

- Far FSRQs, which are too far to observe from IACT site, were excluded.
- Some transient blazars were excluded, as we included some of less transient sources, considering γ sources with less viriability are expected to contribute to ν spectral.

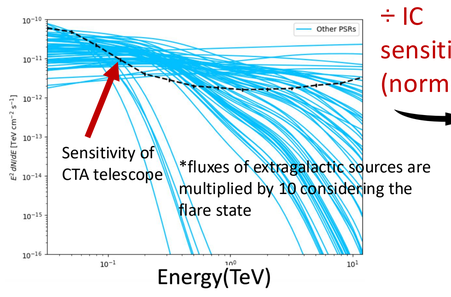
Considering the IceCube sensitivity

To reduce the number of sources in the list considerng the IC sensitivity, caluculated the FoM by dividing the γ flux by IC sensitivity

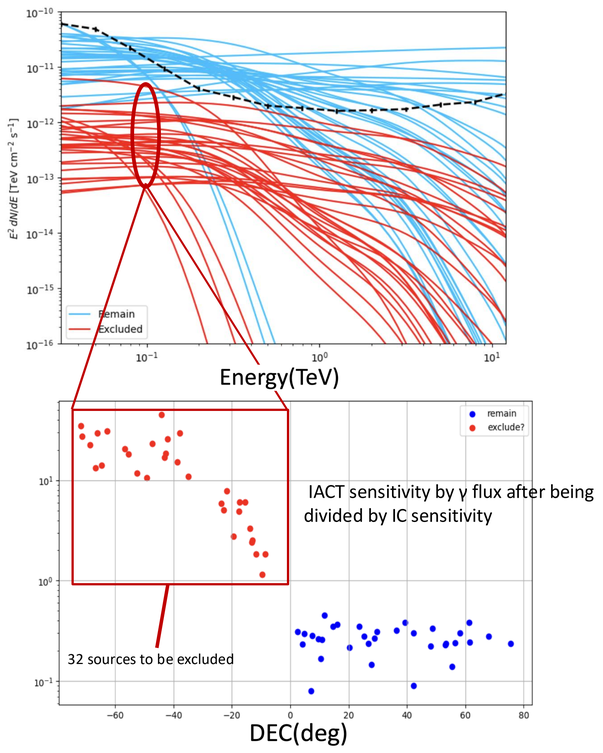


$$\text{FoM} = \frac{\text{Flux}}{\text{IC Sensitivity}}$$ (Flux → γ ray)

4FGL

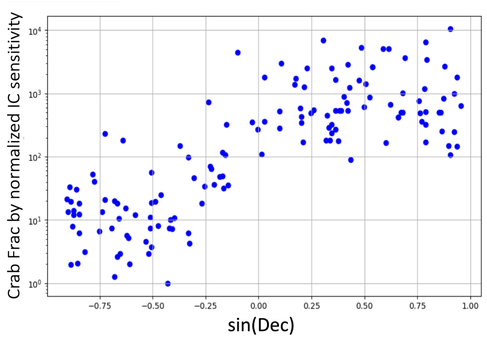


÷ IC sensitivity (normalized)



Excluding these 32 sources whose fluxes are the IACT sensitivity curve after being divided by IC sensitivity, the number of selected 4FGL sources will be 37.

TeVCat



- Since the Flux value is not written in the catalog, I used the Crab Frac value.
- Divided the Crab Frac of each source by the normalized IC sensitivity and defined them as FoM.
- The threshold of FoM is planned to set at 20.

Acknowledgements