Observation of gamma-ray sources with DAMPE

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DAMPE gamma-ray data

After more than five years' operation, DAMPE have collected more than 220,000 gamma-ray events above 2 GeV, selected from all events detected by DAMPE with gamma-ray photon selection algorithm[1]. We have carried out the calibration of boresight alignment for gamma-ray data, and derived the instrument response functions and developed a dedicated software named DmpST[2] for gamma-ray data analysis.

In this work, we select the first five years' gamma-ray data from 1 Jan. 2016 to 31 Dec. 2020 and remove the events when DAMPE travels through the South Atlantic Anomaly (SAA) and during the solar flare time.
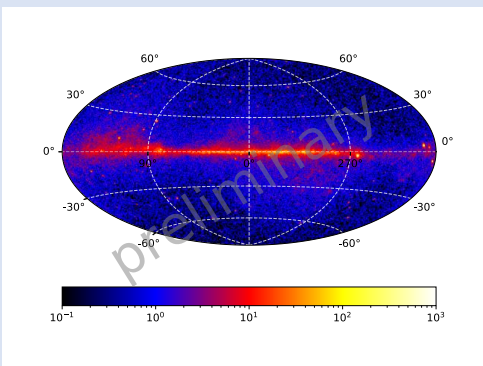

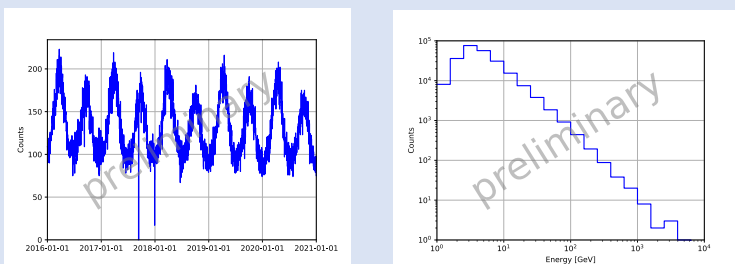Fig 1. Counts map of DAMPE five years gamma-ray data in galactic coordinate with Aitoff projection.

Fig. 2 Time and energy distribution of DAMPE five years gamma-ray data.

Method of blind search for source candidates

The gamma-ray data contains three parts: galactic diffuse emission, resolved sources and isotropic diffuse emission. For detecting the resolved sources effectively, we apply the Li-Ma method[3] to blind search the source candidates firstly. We binned the data into more than 3 million equal solid angle's pixels with N_{side}=512 in HEALPix projection and chose each pixel as well as its 8 neighbours as on region.
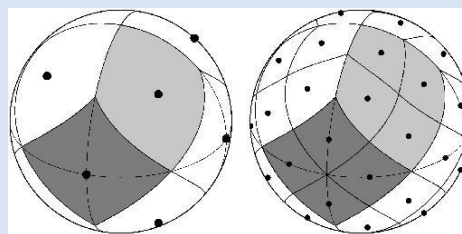

Fig 3. Examples of sky-pixels binned with N_{side}=1 and 2 in HEALPix projection.
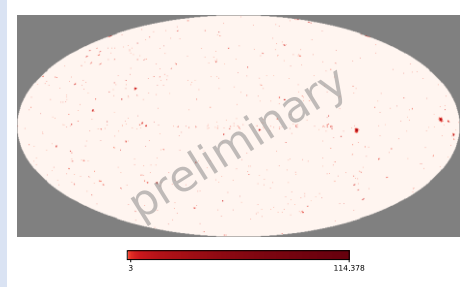

Fig 4. Significance map of DAMPE gamma-ray data with the Li-Ma method.

We select the data around each candidate in 5 degree, and binned the data into 15 energy bin in log scale and 0.05 degree spatial bins. We set a point source with PowerLaw spectrum in each candidate's direction, and use the galactic diffuse model from Fermi-LAT's observation and isotropic diffuse model with PowerLaw spectrum to fit the data and get the TS value of source. For reducing the effect of nearby sources, the sources in the 10 degree circle be included in the model to refit the data.
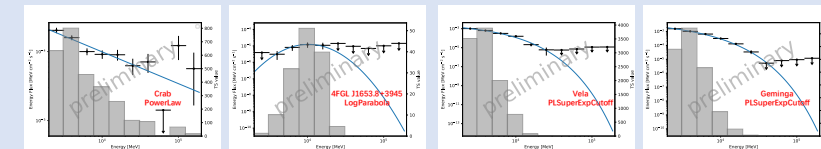
Results and Summary

Fig 5. Examples SED of sources with PowerLaw and curved spectra observed by DAMPE.

We detected 222 gamma-ray sources observed by DAMPE and determine the spectra of these sources. Most of sources favor PowerLaw spectrum, and 3 sources favors curved spectra. We associated these sources with Fermi-LAT's 4FGL[4] to determine the types of these sources.
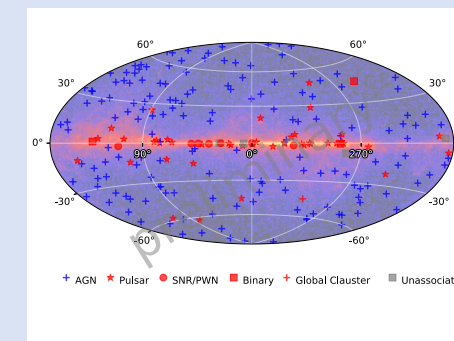

Fig 6. Spatial distribution of sources and their types associated with 4FGL.

AGN	Pulsar	SNR and/or PWN	Binary	Globular Cluster	Unassociated
163	44	7	3	1	4

Table1. The types of sources observed by DAMPE.

References:
[1] Z.-L. Xu, K.-K. Duan, et al., RAA, 18 (2018) 027.
[2] K.-K. Duan, W. Jiang, et al., RAA, 19 (2019) 132.
[3] T.-P. Li and Y.-Q. Ma, ApJ, 272 (1983) 317.
[4] S. Abdollahi, F. Acero, et al., ApJS, 247 (2020) 33.