Measurement of VHE diffuse gamma-ray emission from |b|<5 degree of Galactic plane with LHAASO-WCDA

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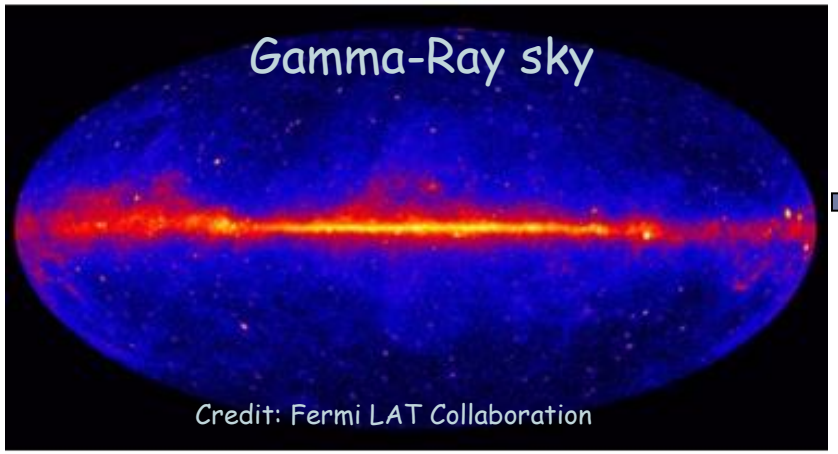
Diffuse Galactic γ-ray Emission (DGE)

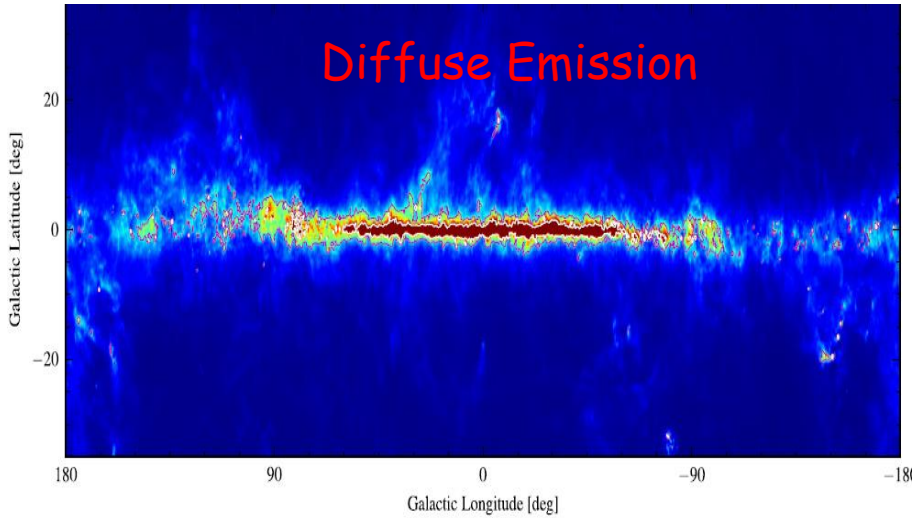
$p, \alpha + ISM \rightarrow \pi^0 \rightarrow 2\gamma$ π^0 decay

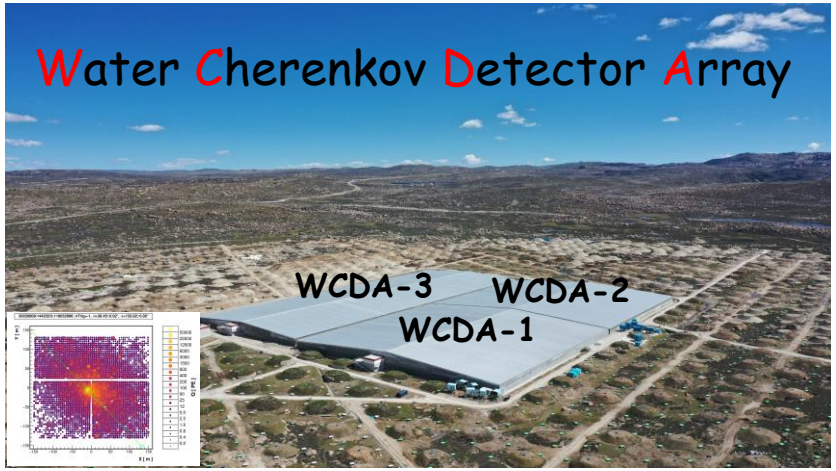
$e + ISM \rightarrow \gamma$ bremsstrahlung

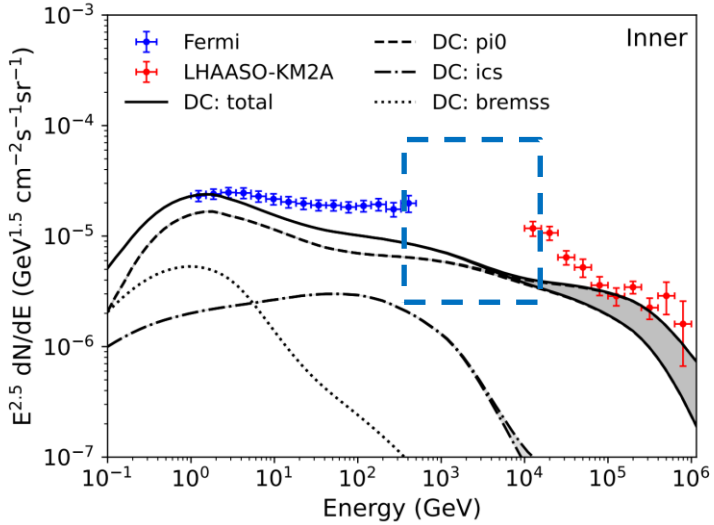
$e + ISRF \rightarrow \gamma$ Inverse Compton scattering

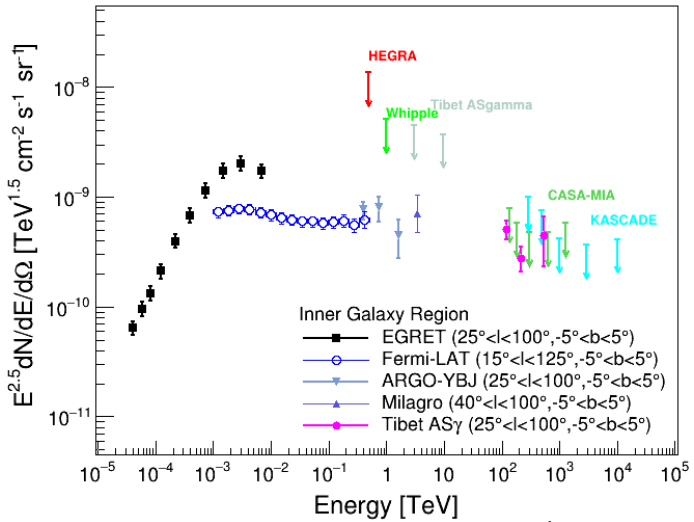


- Point Sources
- Large-scale extended sources
- Isotropic Background









- WCDA is sensitive to gamma rays from sub-TeV to 25 TeV, will bridge Fermi and KM2A.

R. Zhang et al.(2023), Z. Cao et al.(2023)

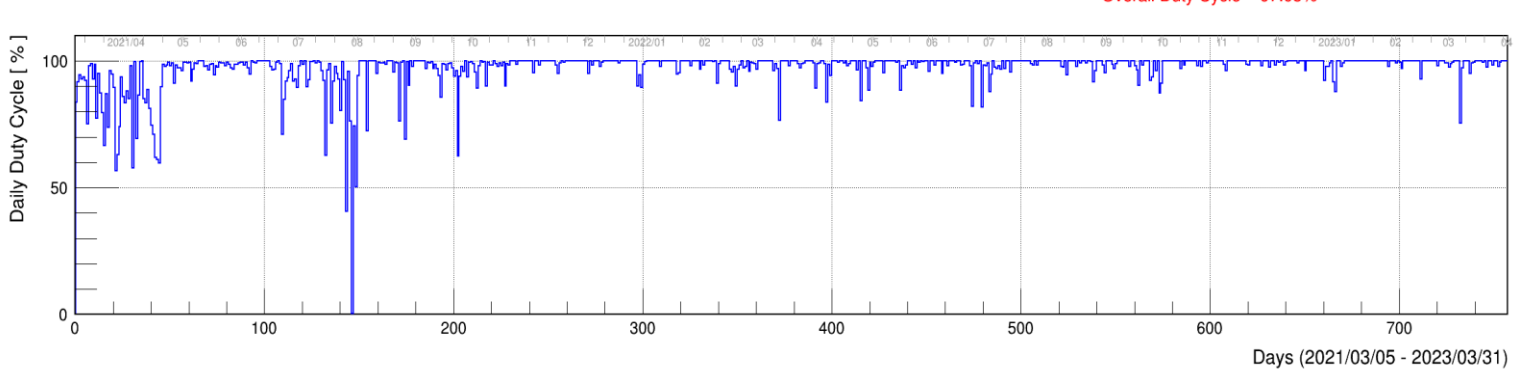
Data sample and Method

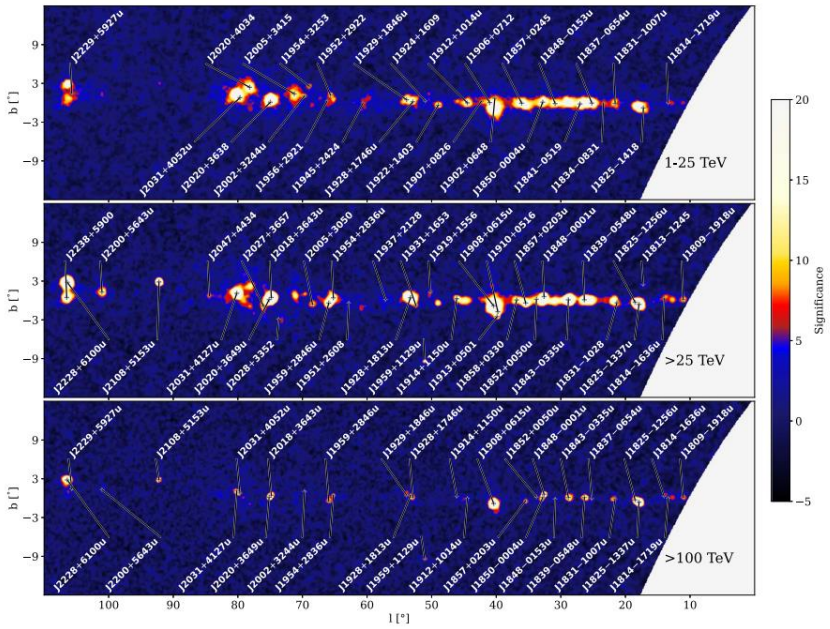
- Full array data
  - 20210305-20230331
  - Livetime: ~686 days
- Method
  - Direct integral
  - Integral time: 4 + 10 hours
  - SED：Froward-folding
  - Maximization: 3D likelihood

- Inner Galaxy Plane
  - (-5° <b<5° , 15° <l<125°)
- Outer Galaxy Plane
  - (-5° <b<5° , 125° <l<235°)
- Exceptions for extended sources
  - Cygnus cocoon： 6°
  - Geminga： 8°
  - Monogem： 8°

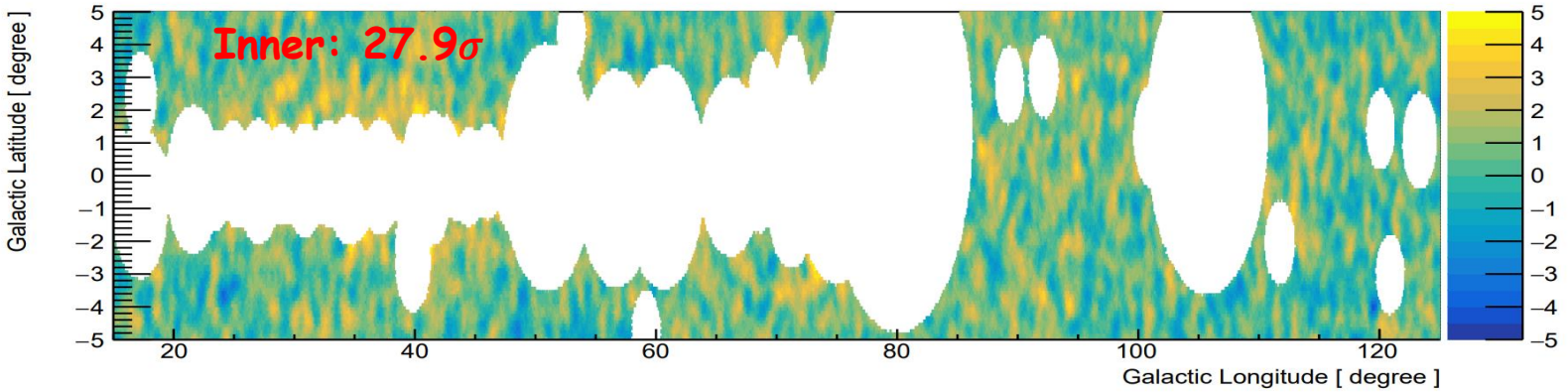
- Resolved source Mask：
  - WCDA Catalog + TeV Catalog
  - $R_{\mathrm{mask}} = 2.5 \times \sqrt{\sigma_{psf}^2 + \sigma_{ext}^2}$
  - $\sigma_{psf} = 0.5^\circ$ is chosen
  - σ_{ext}： the source extension

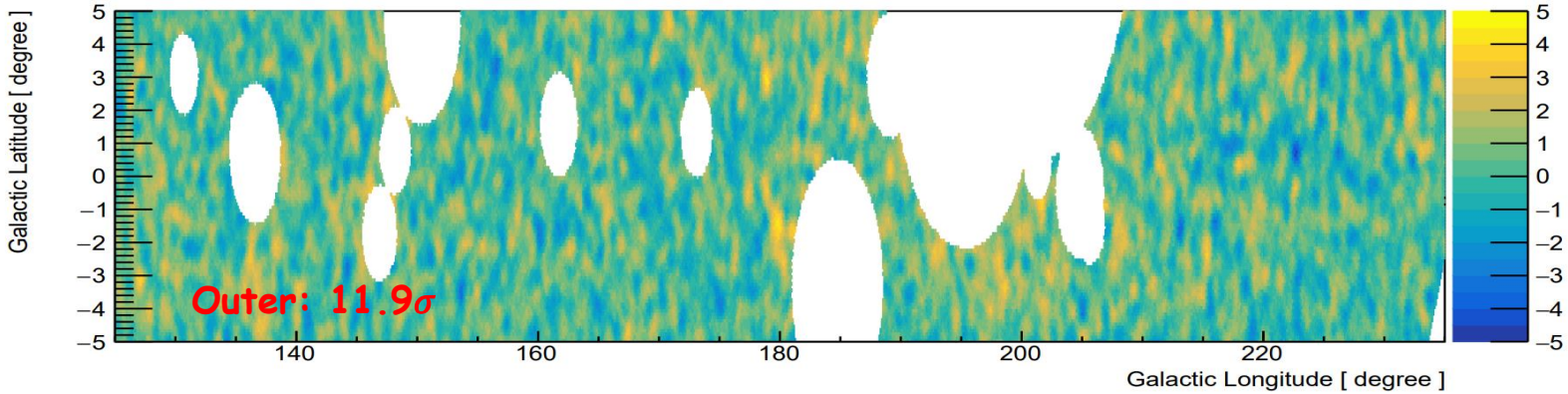
The first LHAASO Catalog
Zhen Cao *et al* ,2024, *ApJS,* **271,** 25

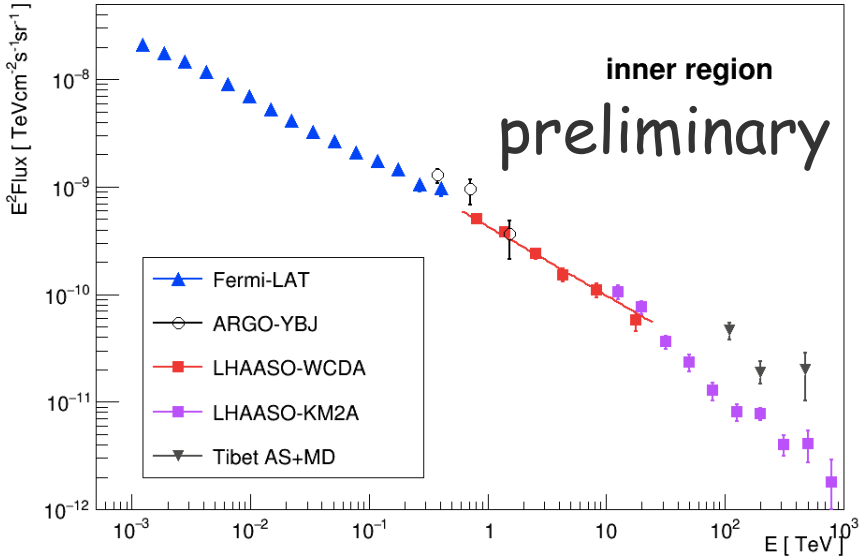


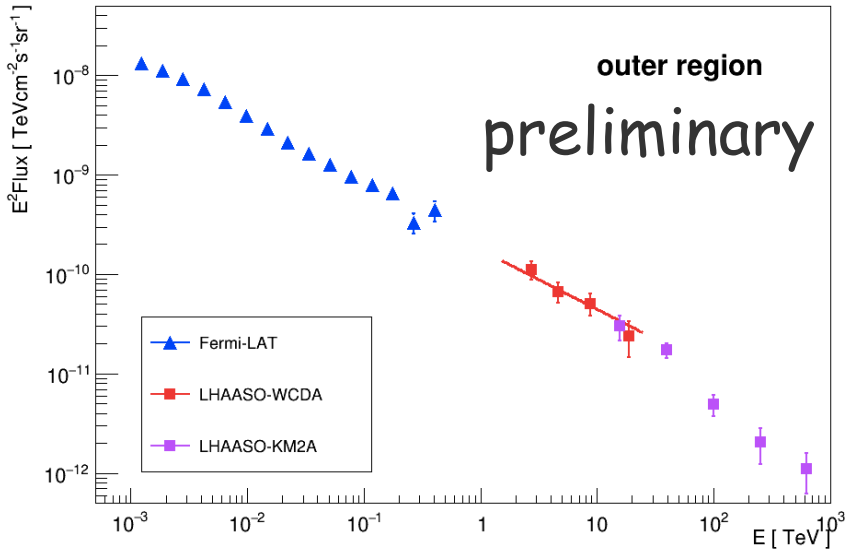


Results: Significance map & Spactral



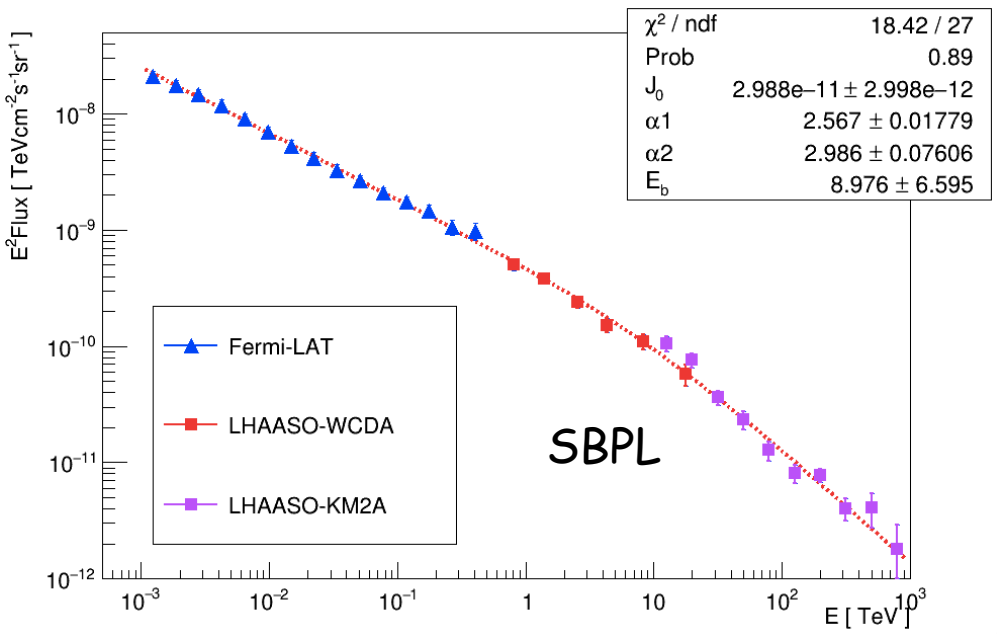


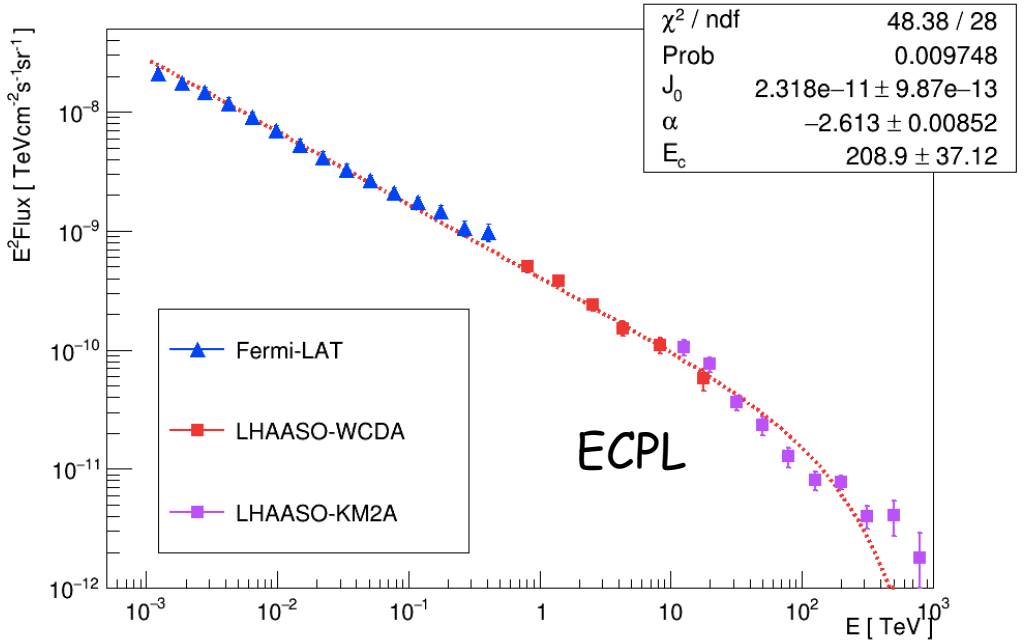




- The total significance of the inner (outer) Galaxy region is 27.9σ (11.9σ).
- After the mask, no significant point-like sources are present in the significance maps, except for some hot spots, which need more data to confirm whether they are point-like sources or diffuse emissions.
- The SED are consistent with Fermi-LAT and KM2A

Disussion: Broadband Spectral Fit





Spectral Model	Formula	Parameter values	χ^2 / ndf
SBPL	$N_0(E/E_0)^{-\gamma_1}(1+(E/E_b)^{\frac{\gamma_2-\gamma_1}{\beta}})^{\beta}$	$\gamma_1 = 2.57 \pm 0.02$ $\gamma_2 = 2.99 \pm 0.08$ E_b (TeV) $= 9.0 \pm 6.6$	18.4/27
ECPL	$N_0(E/E_0)^{-\gamma}\exp(-E/E_c)$	$\gamma = 2.61 \pm 0.008$ E_c (TeV) $= 208.9 \pm 37.1$	48.4/28

The SBPL model is therefore favored over when statistical and systematic errors are considered.

Summary

- Diffuse gamma emission from two regions of Galactic plane is measured with high significance by LHAASO-WCDA.
- The WCDA measurements fill the gap between Fermi and KM2A.
- The diffuse emission from the outer Galactic plane is for the first time detected in the multi-TeV energy range.
- Broadband Spectral Fit: The SBPL model is favored.

Thank you!