Search for diffuse $\gamma$-ray emission from galactic plane with YBJ-HA

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outline

• Diffuse gamma-ray emission
• YBJ-HA (YangBaJing Hybrid Array)
• Data analysis
• Estimation of signal and background
• Result and summary
Diffuse gamma rays

Diffuse galactic gamma-ray

Undetected faint point sources

Extragalactic background
Galactic interstellar $\gamma$-rays

1. $\pi^0$ decay

2. Bremsstrahlung

3. Inverse Compton

4. Annihilate or decay

For the sduy of:
1. Galactic CRs
2. ISM
3. ISRF
4. DM
115 EDs: plastic scintillator
16 MDs: water Cherenkov
Energy range: TeV to hundred TeV
Location: 4300m a.s.l. Tibet/China
Experiment data:
- Duration: 01/2017-06/2018 (~160 days)
- Number of events: \( \sim 7.6 \times 10^8 \)

Monte Carlo samples:
- Corsika_v74005:
  - CRs:
    - Hadronic model: QGSJET2+GHEISHA
    - Energy range: 1TeV-10PeV
    - Zenith range: 0° – 60°
    - Location: YBJ (4300m)
    - Component: p He Fe CNO MgAlSi
    - Scale model: Giasser/Horandel Model
    - Number of CRs samples: \( \sim 3.5 \times 10^8 \)
- Gamma-rays:
  - Spectrum index: -2.59
  - Number of \( \gamma \)-ray samples: \( \sim 1.5 \times 10^7 \)

Reconstruction:
- Arrival time \( \rightarrow \) Direction
- Detected charge \( \rightarrow \) Energy proxy
- The same procedure are used for both data and monte carlo samples
Inside the array

Energy estimator

zenith < 45°

Normalized Counts [Hz]

\[ \log_{10}(\Sigma p/[m^2]) \]

zenith < 45°

Normalized Counts

Zenith [Degree]

Ratio

Muon

N_{\text{Muon}} = 0

Exp

MC-CR\text{~s}

MC-gamma

Data

MC_Gaisser

MC_Horandel

MC_Coore_Soft

MC_Coore_Soft + Po

D_{\text{LHAASO-HMENA}}
Energy estimation

Primary Energy of Gamma

- Median Energy: \( \sim 20 \text{TeV} \)
- Number of selected data samples: \( \sim 1.3 \times 10^6 \)

- Median Energy: \( \sim 50 \text{TeV} \)
- Number of selected data samples: \( \sim 3.0 \times 10^5 \)
Estimation of signal and background

All-distance equi-zenith angle method

\[ I = \frac{N_{\text{obs}}}{N_{\text{bkg}}} \]

\[ I_{\text{on}}, N_{\text{on}} \]

\[ I_{\text{off}}, N_{\text{off}} \]

\[ \text{Sign}_{ij} = \frac{I_{ij} - 1}{\Delta I_{ij}} \]

Large-scale CRs anisotropy

Adopted from the talk of Yingying Guo

~15 TeV
Diffuse gamma-ray

Significance Map

Relative Intensity

outer galactic plane: $140^\circ \leq gl < 225^\circ$

inner galactic plane: $20^\circ \leq gl < 105^\circ$

$\pm 3^\circ$

Galactic longitude [degree]
## Significance Distribution

### All Sky

- **Number of bin**
  - 0
  - 100
  - 200
  - 300
  - 400
  - 500

- **Significance**
  - -6
  - -4
  - -2
  - 0
  - 2
  - 4
  - 6

- **Consistent with Gaussian function**
- **No significant gamma-ray excess**

### Inner galactic plane

- **Entries**
  - 135
- **Mean**
  - 0.1324
- **Std Dev**
  - 1.071
- **χ² / ndf**
  - 15.85 / 45
- **Constant**
  - 12.57 ± 1.32
- **Mean**
  - 0.1324 ± 0.0922
- **Sigma**
  - 1.071 ± 0.065

### Outer galactic plane

- **Entries**
  - 140
- **Mean**
  - 0.05964
- **Std Dev**
  - 0.8773
- **χ² / ndf**
  - 12.9 / 45
- **Constant**
  - 15.92 ± 1.65
- **Mean**
  - 0.05964 ± 0.07415
- **Sigma**
  - 0.8773 ± 0.0564
90% CL upper limit on flux

When the primary energy is ~50 TeV

Helene, O. NIM. A300 (1991) 132-136
90% CL upper limit

![Graph showing 90% CL upper limit with various data points and labels for different experiments.](image-url)
No significant diffuse $\gamma$-ray excess in the galactic plane is observed by YBJ-HA in energy range of several dozens of TeV in the first 160 days.

90% CL upper limits on flux are obtained.

More data are being collected by the YBJ-HA, and LHAASO-KM2A are under-construction.

Thank you for your attention!
backups
Subtraction of anisotropy
Group shot of moon and sun