The Cosmic-ray Anisotropy Observed by YBJ-HA Experiment

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Outline

- Some observations of anisotropy
- YBJ-HA(YangBaJing Hybrid Array)
- Data selection & Background estimation
- Summary
Experiment Observation

a) 1997-2001

Dec. (deg) 60 40 20 0
Tail-in Loss-cone Cygnus

b) 2001-2005

Dec. (deg) 60 40 20 0
Tibet Air Shower Array

Tibet 5TeV

ARGO-YBJ

c)

Rel. intensity

R.A. (deg) 300 200 100 0
1.001 1 0.999
1997-2001
2001-2005

Ice Cube 13TeV

Super-Kamiokande-I

HAWC

Tibet Air Shower Array

https://doi.org/10.1126/SCIENCE.1131702  https://doi.org/10.3847/1538-4357/aad90c
https://doi.org/10.1016/j/ppnp.2017.01.004  https://doi.org/10.1103/PhysRevD.75.062003
No time dependence of Sidereal anisotropy

The Tibet III Air Shower Array

Argo-YBJ

https://doi.org/10.3847/1538-4357/aac6cc
https://doi.org/10.1088/0004-637X/711/1/119
### YBJ-HA Array / testing Array of LHAASO-KM2A

<table>
<thead>
<tr>
<th></th>
<th>YBJ-HA</th>
<th>LHAASO-KM2A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Altitude</strong></td>
<td>4300m</td>
<td>4400m</td>
</tr>
<tr>
<td><strong>Detector type</strong></td>
<td>ED &amp; MD</td>
<td>same</td>
</tr>
<tr>
<td><strong>Separation</strong></td>
<td>15m</td>
<td>same</td>
</tr>
<tr>
<td><strong>time synchronization system</strong></td>
<td>white rabbit clock</td>
<td>same</td>
</tr>
<tr>
<td><strong>electronics</strong></td>
<td>ED</td>
<td>MD</td>
</tr>
</tbody>
</table>
YangBaJing Hybrid Array (YBJ-HA)

Detector types: (115EDs + 16MDs)

- 115 Electromagnetic particle Detectors (EDs)
- 16 Muon Detectos (MDs)

**Muons lateral density distribution**

Diffuse γ rays upper limits on flux

Data phase and the their respective number of events for analysis

<table>
<thead>
<tr>
<th>Phase</th>
<th>Time (days)</th>
<th>Number of Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>68</td>
<td>$1.081 \times 10^8$</td>
</tr>
<tr>
<td>2</td>
<td>74</td>
<td>$1.361 \times 10^8$</td>
</tr>
<tr>
<td>3</td>
<td>135</td>
<td>$2.701 \times 10^8$</td>
</tr>
<tr>
<td>4</td>
<td>119</td>
<td>$2.886 \times 10^8$</td>
</tr>
</tbody>
</table>
ED charge calibration & electronics stability

- **Single particle peak**
  - Peak: 193 × 0.064PC
  - Width: 35 × 0.064PC
- **The ratio of anode charge to dynode**
  - Anode saturated
  - Anode Charge/Dynode Charge = 32.6
- **The stability single particle peak**
  - Day (1 denotes the first day in operation)
- **The stability of the ratio**
  - Day (1 denotes the first day in operation)
Data selection

Criteria:

on array

The number of EDs > 4
the zenith angle <60°

Monte Carlo agrees with data
The simulated primary energy distribution
Background estimation

All-Distance Equi–Zenith Angle Method

$I$ indicates the relative intensity in some direction

Sidereal Anisotropy

Significance map

Relative intensity map

The projection on R.A. axis

Tail-in

Loss-cone
No time dependence of sidereal anisotropy

Phase 1: 68 days
Phase 2: 74 days
Phase 3: 135 days
Phase 4: 119 days
Systematic checks

- **solar anisotropy**
- **anti-sidereal anisotropy**
- **extended-sidereal anisotropy**

**Systematic error**
summary

- We observed the sidereal anisotropy of cosmicray at the median energy of 15 TeV.
- No time-dependence of the Large-structure anisotropy.
- The anti/extended-sidereal anisotropy is $\sim 10^{-5}$, which ensured the reliability of sidereal anisotropy.
- The YBJ-HA is running, LHAASO-KM2A is under construction.