Studies on Helium flux with DAMPE

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Outline

- Scientific case
- DAMPE experiment
- Helium analysis
- Efficiency and background studies
- Preliminary results

The launch of DAMPE
December 17th, 2015
Scientific case: hardening of cosmic-ray flux?

Many possible hypotheses:
- CRs from other galactic sources
- unknown acceleration mechanisms
- different propagation effects
**DAMPE experiment**

Scientific satellite project of Chinese Academy of Science (CAS)

Goals:
- Detection up to 100 TeV cosmic rays
- High energy $\gamma$-ray telescope
- Detection of $e/\gamma$ (5 GeV – 10 TeV)

Four Sub-Detectors
- **PSD:** gamma anticoincidence, $Z$ measurement ($Z \propto \sqrt{E}$)
- **STK:** tracking, gamma conversion, $Z$ measurement ($Z \propto \sqrt{ADC}$)
- **BGO:** thick calorimeter (32 radiation and 1.6 nuclear lengths), $e/\gamma$ – hadron separation
- **NUD:** $e/\gamma$ – hadron separation

Collaboration: Inst. High Energy Physics, Inst. Modern Physics, National Space Center, Purple Mountain Observatory, University of Science and Technology

Bari, Lecce, Perugia (Universities and INFN)

Geneva University

arXiv:1706.08453

04/14
Here a data sample collected in 1 year is analyzed looking for events induced by Helium nuclei

Stable data acquisition very soon after the satellite launch (December 17, 2015)
Real event in both views

Helium candidate

54.7 GeV collected in BGO

Matching of STK track with PSD and BGO hits
Analysis steps

Trigger

- High Energy Trigger (requirement on the energy release on the first four BGO layers)

Pre-selection

- $E > 20$ GeV in BGO
- South Atlantic Anomaly removed
- Rejection of side tracks

Geometry

- Match of PSD hits and BGO fired bars with STK track

Charge

- Agreement of charge measurement on both PSD planes and $1^{st}$ STK layer
- Proper PSD range to select $Z = 2$
The cut \( Z \sim 2 \) on the STK 1\textsuperscript{st} layer signal reduces the proton contamination

\[ E_{\text{BGO}} < 500 \text{ GeV}, \]  a residual of Lithium is visible at this step of the analysis
Helium selection on the basis of PSD signal

Data-MC agreement in all BGO-energy ranges and in both the PSD views

yz view

xz view
HET and STK efficiency

The data-MC differences have been taken into account to estimate the systematic error (15.8% essentially due to HET)

\[ \varepsilon_{\text{HET}} = \frac{N(\text{HET | unbias})}{N(\text{unbias})} \]

Poster CRD097 by S. Vitillo for details on STK
PSD - charge reconstruction efficiency

Also in this case the systematic error (14%) has been estimated looking at the data-MC differences.
The proton contamination in the Helium sample is very small (< 1.5 %)

The Lithium pollution at low energies has been studied and it results negligible

The range accepted for Helium is shown by the vertical dashed lines
Helium acceptance

\[ A_{EFF} = A_{GEN} \frac{N_{SURV}}{N_{GEN}} \]

(the proton background has been multiplied by 10)

Estimate of primary energy

DAMPE -> black dots

Systematic uncertainty 21%

Energy uncertainty to be estimated
Conclusions

- The DAMPE detector works properly at 500 km above the Earth's surface.

- The Helium flux has been measured in the range 5 GeV/nucleon – 2.5 TeV/nucleon (talk CRD082 by Chuan YUE for protons).

- The hardening of the Helium has been observed.

- More studies and systematics check (energy scale, unfolding ...) are necessary to confirm this measurement.

- The data sample shall be extended. Presently more than 1.5 years data are available and the acquisition is going on.

- In the next future the He-flux measurement will be extended up to 25 TeV/nucleon.
Backup slides
Energy resolution for protons

Monte Carlo resolution is after spectral unfolding

Beam Test at CERN - Energy deposit in PSD

2 MeV expected for $Z=1$

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