Precision Measurement of the Monthly Fluxes in Cosmic Rays with the Alpha Magnetic Spectrometer on the ISS

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On behalf of the AMS Collaboration

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AMS Measurement Period

AMS is a TeV precision, multipurpose, magnetic spectrometer, on the ISS since May 2011. AMS is measuring GCR fluxes and their time variation. AMS will study the solar modulation effect and the short-term solar activity in the present (24th) and next solar cycle for the live-time of the ISS.

Daily sunspot number: http://www.sidc.be/silso/datafiles
AMS Detector and Particles and Nuclei Identification

Transition Radiation Detector
- e+ e- identification

Time-of-Flight counter
- Trigger
- Velocity
- Particle flight direction
- Charge

Silicon Tracker + Magnet
- Rigidity
- Charge & sign

Ring Imaging Cherenkov detector
- Velocity
- Charge

Electromagnetic Calorimeter
- e+ e- identification
- e+ e- Energy

See A. Kounine Highlight Talk CRD, Saturday July 15th / Other AMS talks on parallel CRD July 13th - 14th
AMS Contribution to Solar Modulation

- Simultaneous multi-particle measurements.
- Fine rigidity resolution.
- Total uncertainty at the percentage level.
- Short integration time.
- Continuous particle measurement over one solar cycle.

Detailed time evolution of GCR during both periods of maximum and minimum of solar activity.

AMS measurements will help to understand the propagation of charged particles in heliosphere and to test diffusion and drift models.

See V. Bindi Highlight Talk SH, Monday July 17th
AMS Proton Flux vs. Time & Rigidity

May 2011 - May 2016

Preliminary Data. Please refer to the AMS forthcoming publication in PRL.
AMS Proton & Helium Monthly Fluxes

Each color corresponds to an integration time of 27 days

Flux \times R^{2.7} \text{ [m}^{-2} \text{ sr}^{-1} \text{ sec}^{-1} \text{ GV}^{1.7}]$

- **Proton**
- **Helium**

Preliminary Data. Please refer to the AMS forthcoming publication in PRL.
Normalized Proton Flux Evolution

Proton
May 2011

Preliminary Data.
Please refer to the AMS forthcoming publication in PRL

Flux Normalized to Average

Rigidity [GV]

Preliminary Data. Please refer to the AMS forthcoming publication in PRL

<table>
<thead>
<tr>
<th>Proton Flux Range</th>
<th>Corresponding Energies</th>
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</thead>
<tbody>
<tr>
<td>2.15-2.40 GV</td>
<td>5.37-5.90 GV</td>
</tr>
<tr>
<td>1.16-1.33 GV</td>
<td>1.51-1.71 GV</td>
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Normalized Proton Flux Evolution

Preliminary Data. Please refer to the AMS forthcoming publication in PRL.
Normalized Proton Flux Evolution

Preliminary Data. Please refer to the AMS forthcoming publication in PRL

See M. Palermo Talk on parallel session SH039, Monday July 17th
Normalized Proton Flux Evolution

Proton
Jul2012

Preliminary Data. Please refer to the AMS forthcoming publication in PRL
Normalized Proton Flux Evolution

Proton
May 2013

Preliminary Data. Please refer to the AMS forthcoming publication in PRL

Normalized Proton Flux

Flux Normalized to Average

Rigidity [GV]

Preliminary Data. Please refer to the AMS forthcoming publication in PRL

Normalized Proton Flux

1.16-1.33 GV 1.51-1.71 GV 3.29-3.64 GV 41.90-45.10 GV

2.15-2.40 GV 5.37-5.90 GV 10.10-11.00 GV
Normalized Proton Flux Evolution

Proton
Feb2014

Preliminary Data.
Please refer to the AMS forthcoming publication in PRL

Flux Normalized to Average

Rigidity [GV]

Normalized Proton Flux

Preliminary Data. Please refer to the AMS forthcoming publication in PRL

2.15-2.40 GV  5.37-5.90 GV  10.10-11.00 GV
1.16-1.33 GV  1.51-1.71 GV  3.29-3.64 GV  41.90-45.10 GV
Normalized Proton Flux Evolution

Proton
Mar2015

Preliminary Data. Please refer to the AMS forthcoming publication in PRL

1.16-1.33 GV
1.51-1.71 GV
3.29-3.64 GV
41.90-45.10 GV

2.15-2.40 GV
5.37-5.90 GV
10.10-11.00 GV
Normalized Proton Flux Evolution

Proton
Nov 2015

Preliminary Data. Please refer to the AMS forthcoming publication in PRL

Flux Normalized to Average

Rigidity [GV]

Preliminary Data. Please refer to the AMS forthcoming publication in PRL

2.15-2.40 GV  5.37-5.90 GV  10.10-11.00 GV

1.16-1.33 GV  1.51-1.71 GV  3.29-3.64 GV  41.90-45.10 GV

Normalized Proton Flux

Normalized Proton Flux Evolution

Proton May2016

Preliminary Data. Please refer to the AMS forthcoming publication in PRL

2.15-2.40 GV
5.37-5.90 GV
10.10-11.00 GV
1.16-1.33 GV
1.51-1.71 GV
3.29-3.64 GV
41.90-45.10 GV

Normalized Proton Flux

Rigidity [GV]
Helium Normalized Flux & Time Profile

Helium
May2011-Feb2014
Preliminary Data. Please refer to the AMS forthcoming publication in PRL

Helium
Feb2014-May2016
Preliminary Data. Please refer to the AMS forthcoming publication in PRL

Preliminary Data. Please refer to the AMS forthcoming publication in PRL

Helium

41.90-45.10 GV
10.10-11.00 GV
5.37-5.90 GV
3.29-3.64 GV
2.15-2.40 GV
1.51-1.71 GV
Electron and Positron Monthly Fluxes

Electron
Preliminary Data. Please refer to the AMS forthcoming publication in PRL

Positron
Preliminary Data. Please refer to the AMS forthcoming publication in PRL
Monthly e+ and e- flux Time profile

Preliminary Data.
Please refer to the AMS forthcoming publication in PRL
Monthly e+ and e- flux Time profile

Preliminary Data. Please refer to the AMS forthcoming publication in PRL.
Monthly e+ and e- flux Time profile

Preliminary Data.
Please refer to the AMS forthcoming publication in PRL
Monthly $e^+$ and $e^-$ flux Time profile

Preliminary Data.
Please refer to the AMS forthcoming publication in PRL
Monthly e+ and e- flux Time profile

Preliminary Data.
Please refer to the AMS forthcoming publication in PRL
**Particle Drift**

- A<0 e- are less modulated than e+
- A>0 e- are more modulated than e+

**Polarity Inversion:**
- Nov 2012 - Mar 2014

**Drift direction:**
- Positrons in A>0 epochs or electrons A<0
- Positrons in A<0 epochs or electrons A>0


AMS Positron over Electron Charge-sign dependent modulation

Preliminary Data. Please refer to the AMS forthcoming publication in PRL

Polarity Inversion: Nov2012-Mar2014

Summary & Conclusions

- AMS $p$, $He$, $e^+$, $e^-$ monthly fluxes were measured during the ascending phase of solar cycle 24 through its maximum and descending phase.
- All particles show sub-structures related to the short-term solar activity.
- AMS $e^+/e^-$ ratio clearly shows the charge-sign dependence of solar modulation.
- AMS will measure all GCR nuclei and anti-proton fluxes in the present (24th) and next solar cycle.