GOBIERNO DE ESPAÑA | MINISTERIO DE CIENCIA E INNOVACIÓN

Ciemat — Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

cfp CIEMAT física de partículas

The Latest Time Variation Measurements with AMS

M. A. Velasco, CIEMAT, Madrid (Spain)

on behalf of the AMS Collaboration

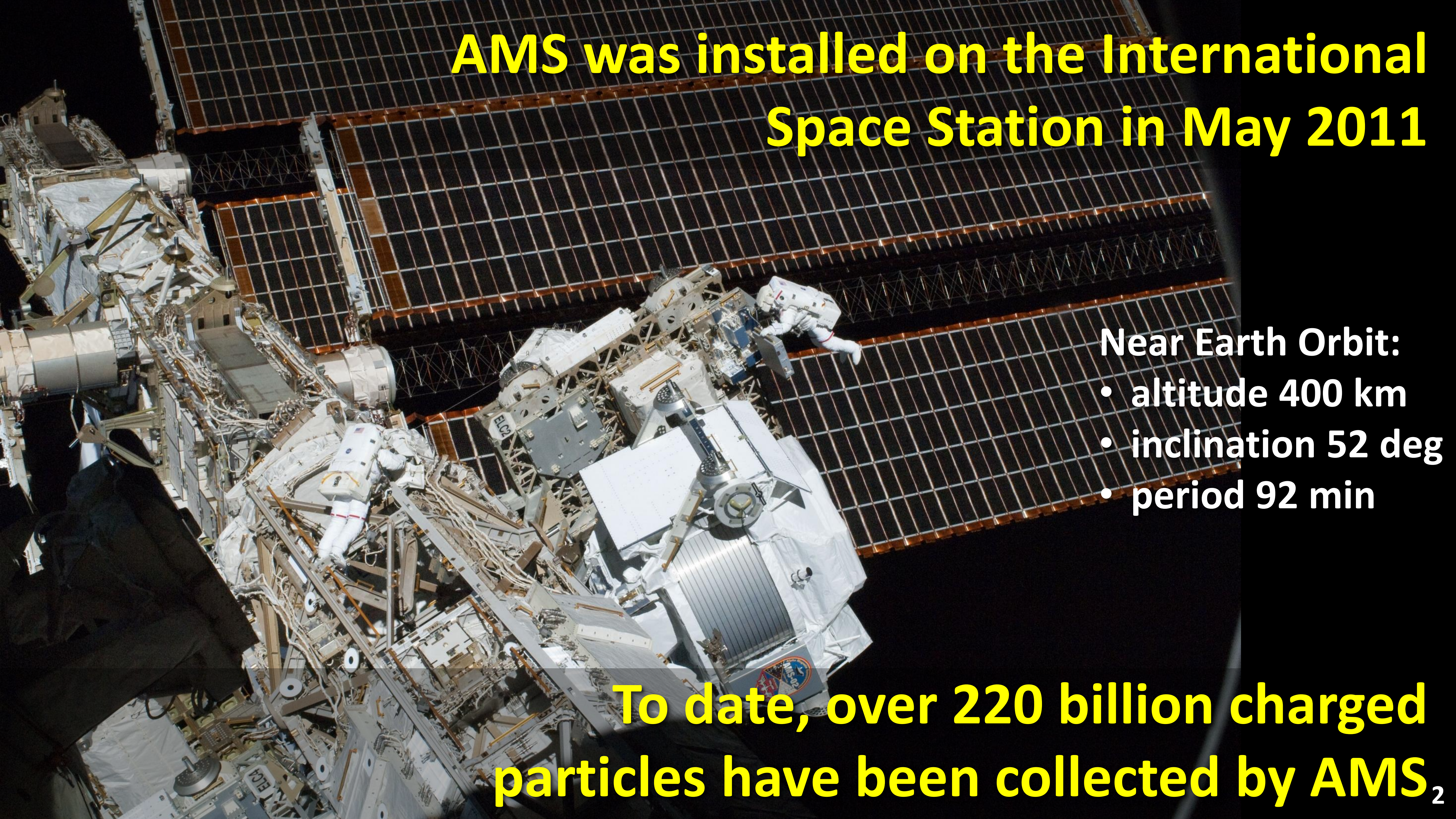
3rd Workshop on Trasgo detectors

Facultad de Física, Universidad de Santiago de Compostela

June 27, 2023

Proyecto trasgo Project

AMS was installed on the International Space Station in May 2011



Near Earth Orbit:

- altitude 400 km
- inclination 52 deg
- period 92 min

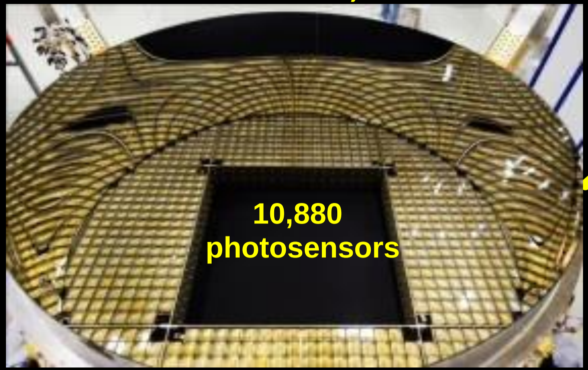
To date, over 220 billion charged particles have been collected by AMS

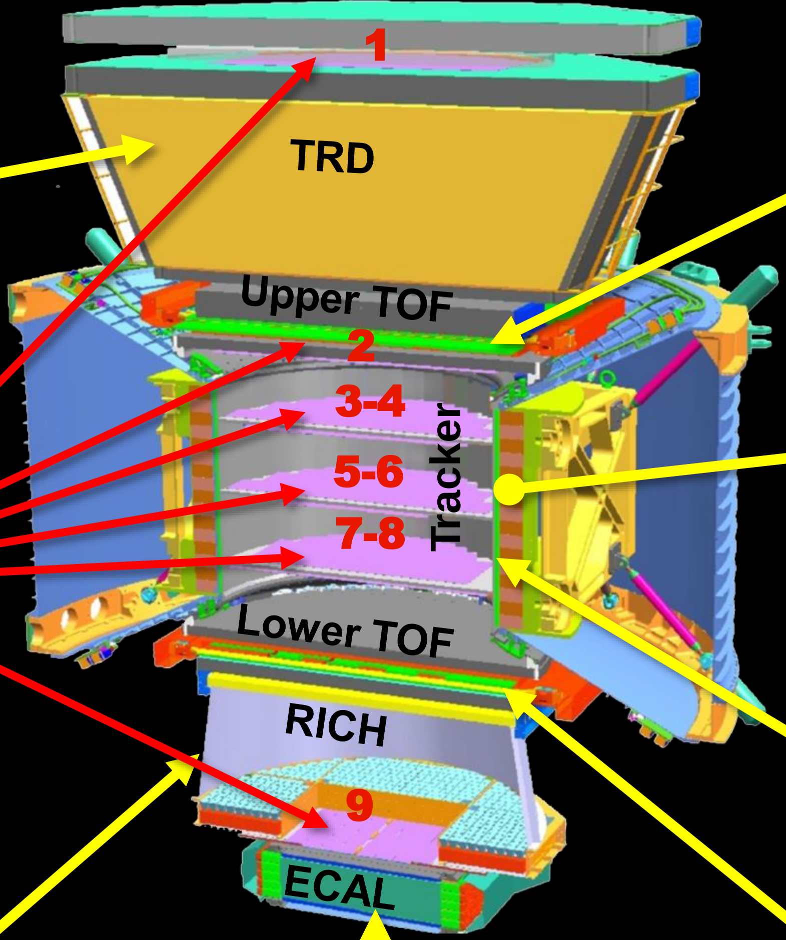
AMS is a space version of a precision detector used in accelerators

Transition Radiation Detector (TRD)
identify e^+, e^-

Silicon Tracker
measure Z, P

Ring Imaging Cerenkov (RICH)
measure Z, E

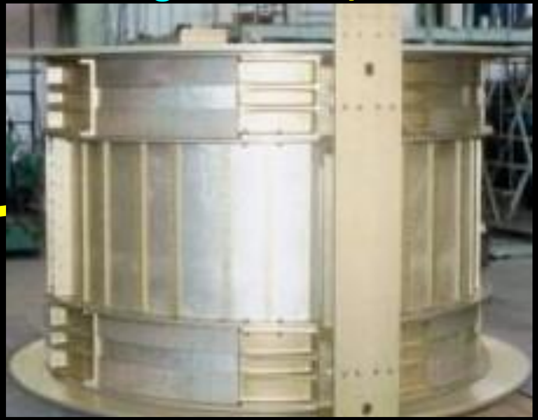




Electromagnetic Calorimeter (ECAL)
measure E of e^+, e^-

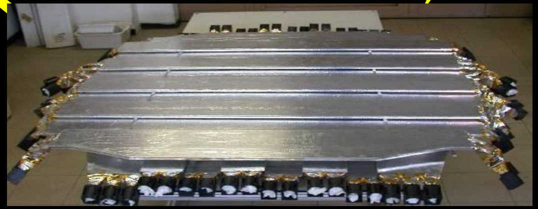
Upper TOF measure Z, E

Magnet identify ±Z, P

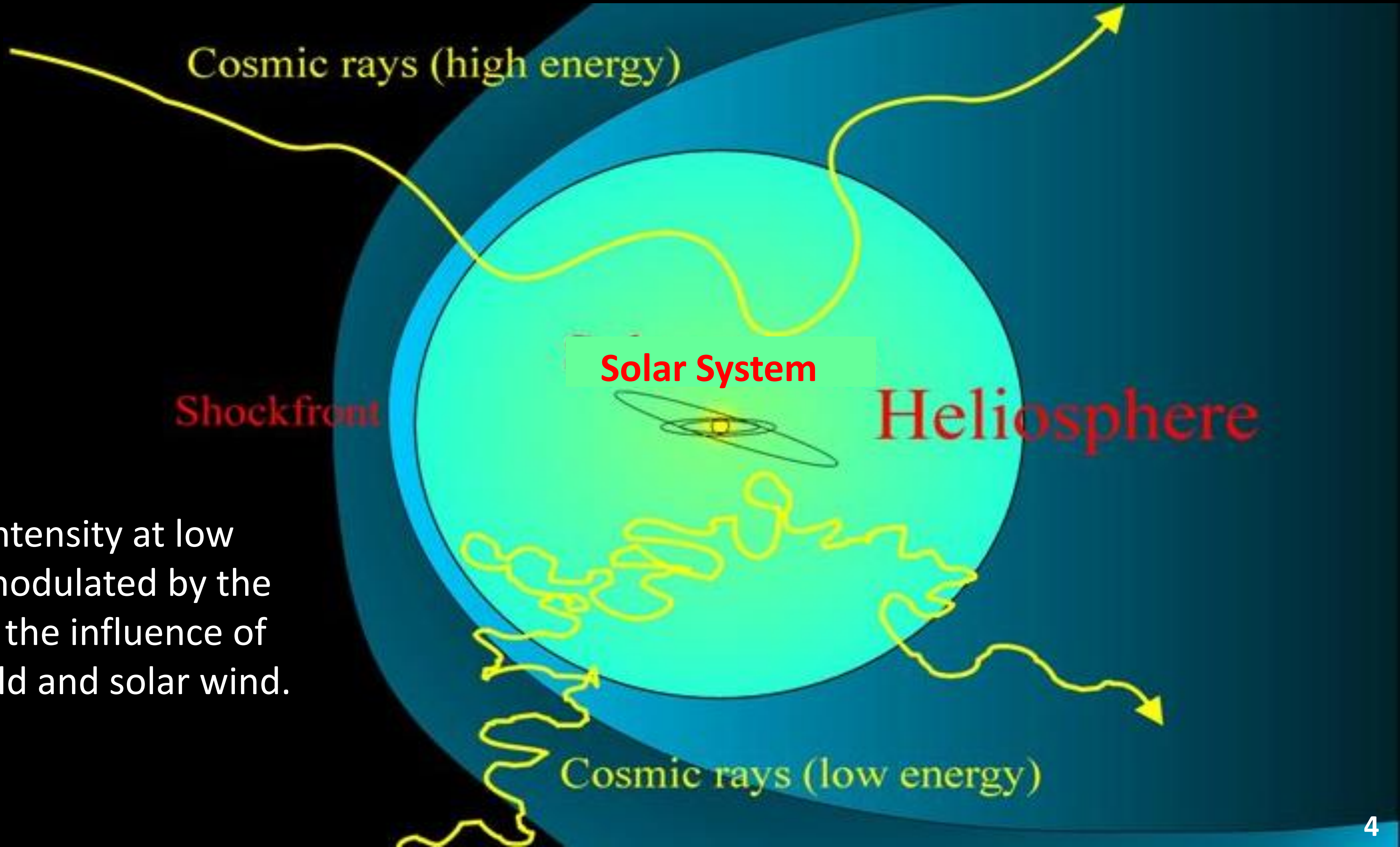


Anticoincidence Counters (ACC)
reject particles from the side

Lower TOF measure Z, E

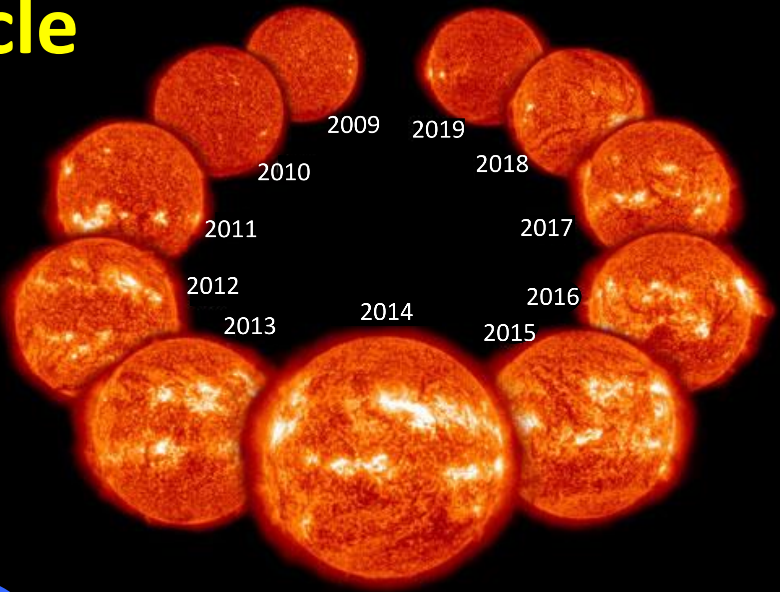


Solar Modulation of Cosmic Rays



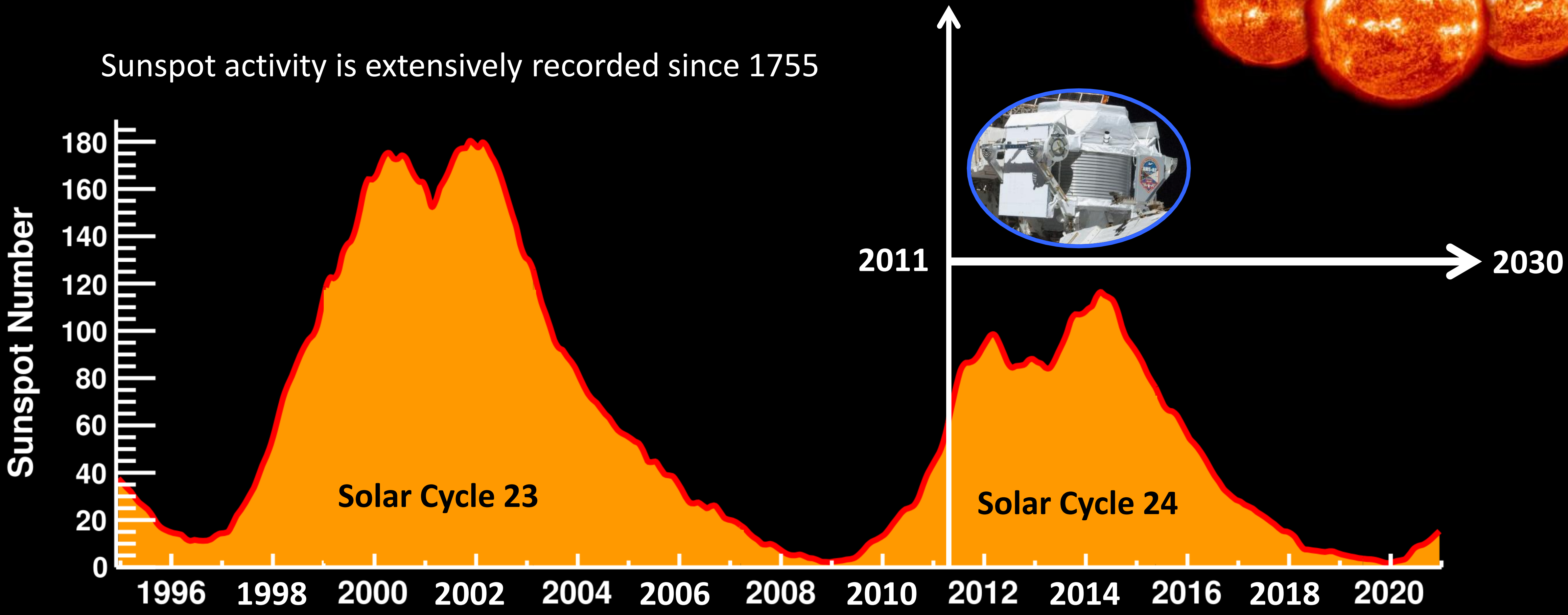
Cosmic ray intensity at low energies is modulated by the Sun through the influence of magnetic field and solar wind.

Long Term Variation: Solar Cycle



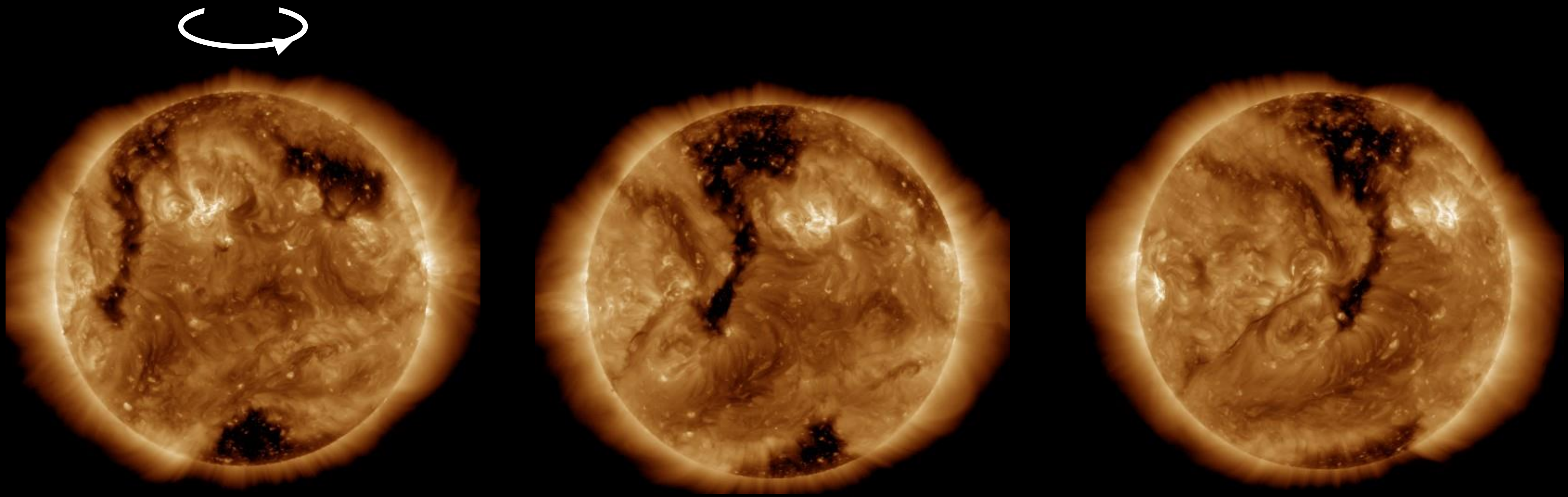
The most significant long-term scale variation of cosmic rays is related to the 11-year solar cycle.

Sunspot activity is extensively recorded since 1755



Cosmic Ray Recurrent Variation in Short Scale

Short scale variation of cosmic rays are related to Sun's rotation (Bartels' rotation: 27 days).



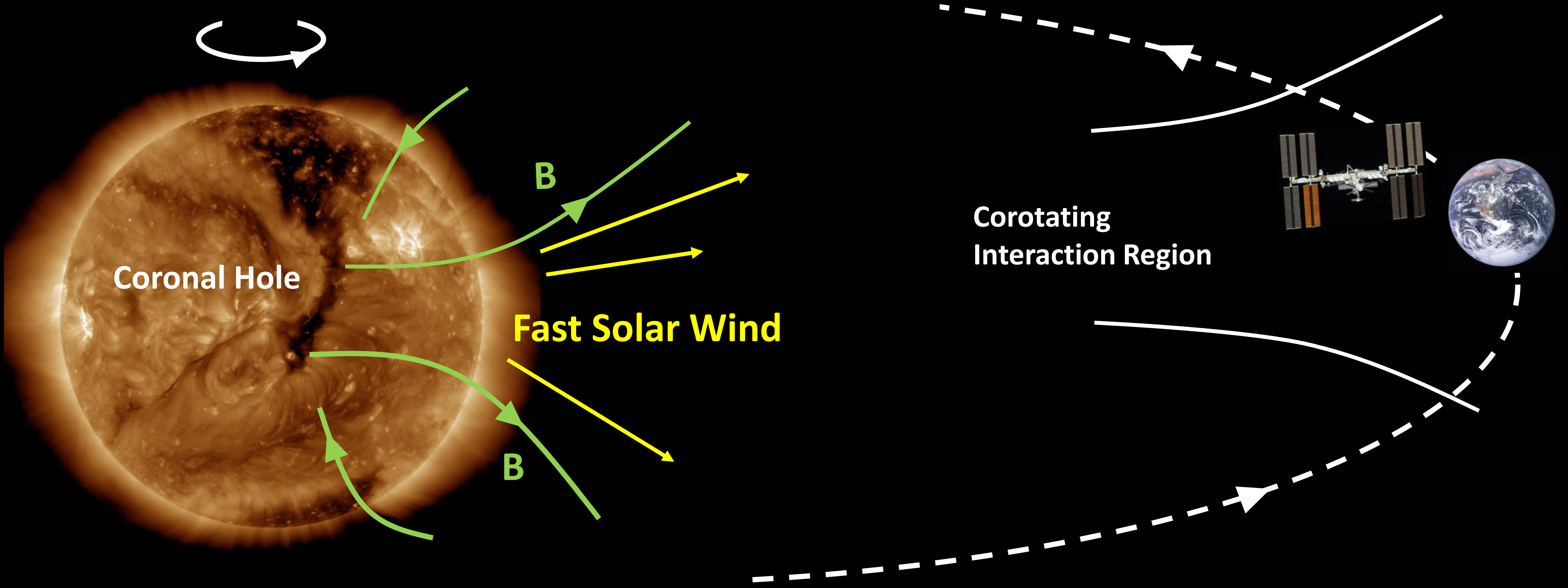
2016-03-22 **2016-03-24** **2016-03-26**

Image taken by Dynamics Observatory (SDO), NASA

Coronal holes are regions where plasma density and temperature are lower, so they appear darker in images.

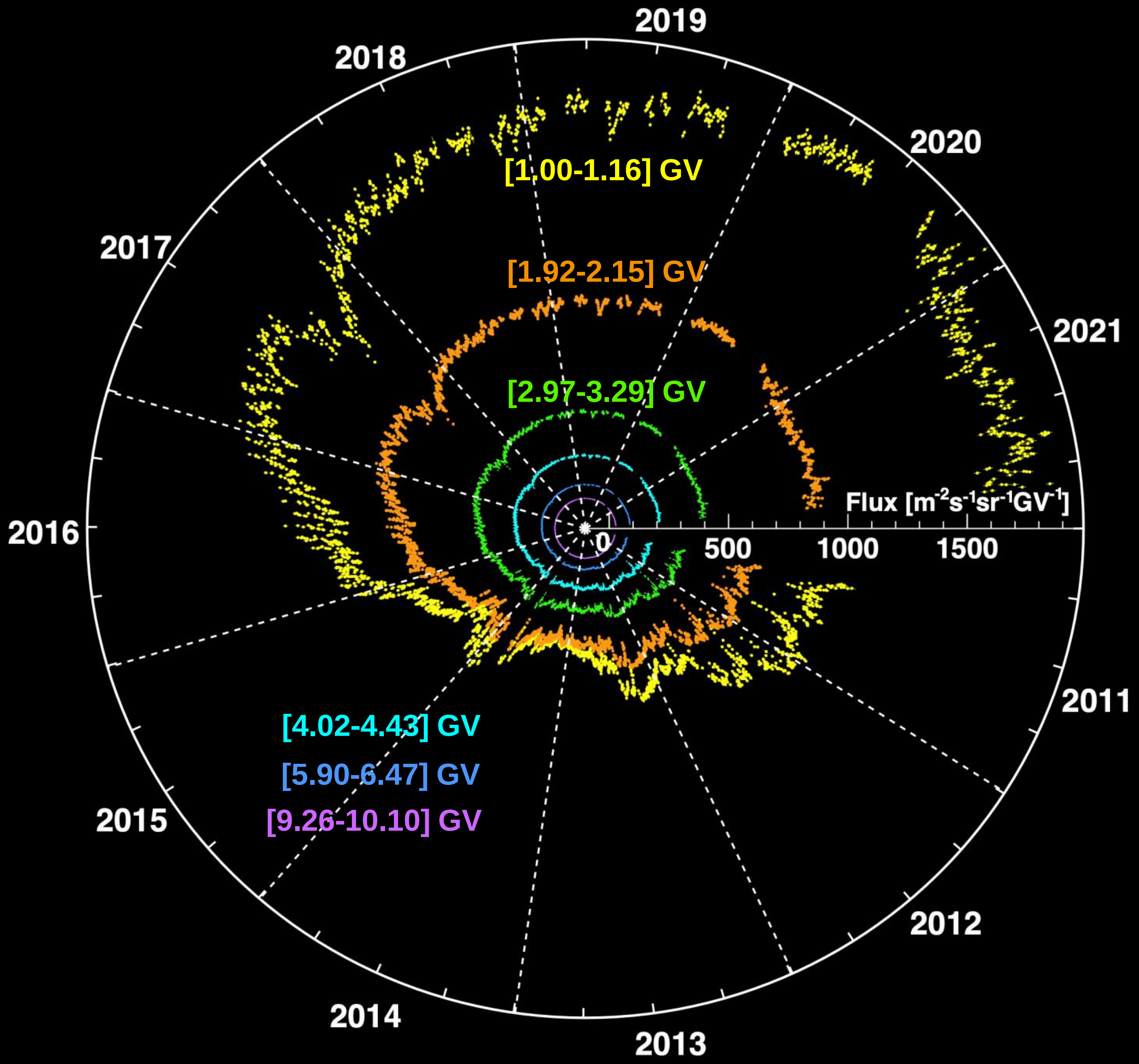
Cosmic Ray Recurrent Variation in Short Scale

Coronal Holes are sources of high speed solar wind affecting Earth.



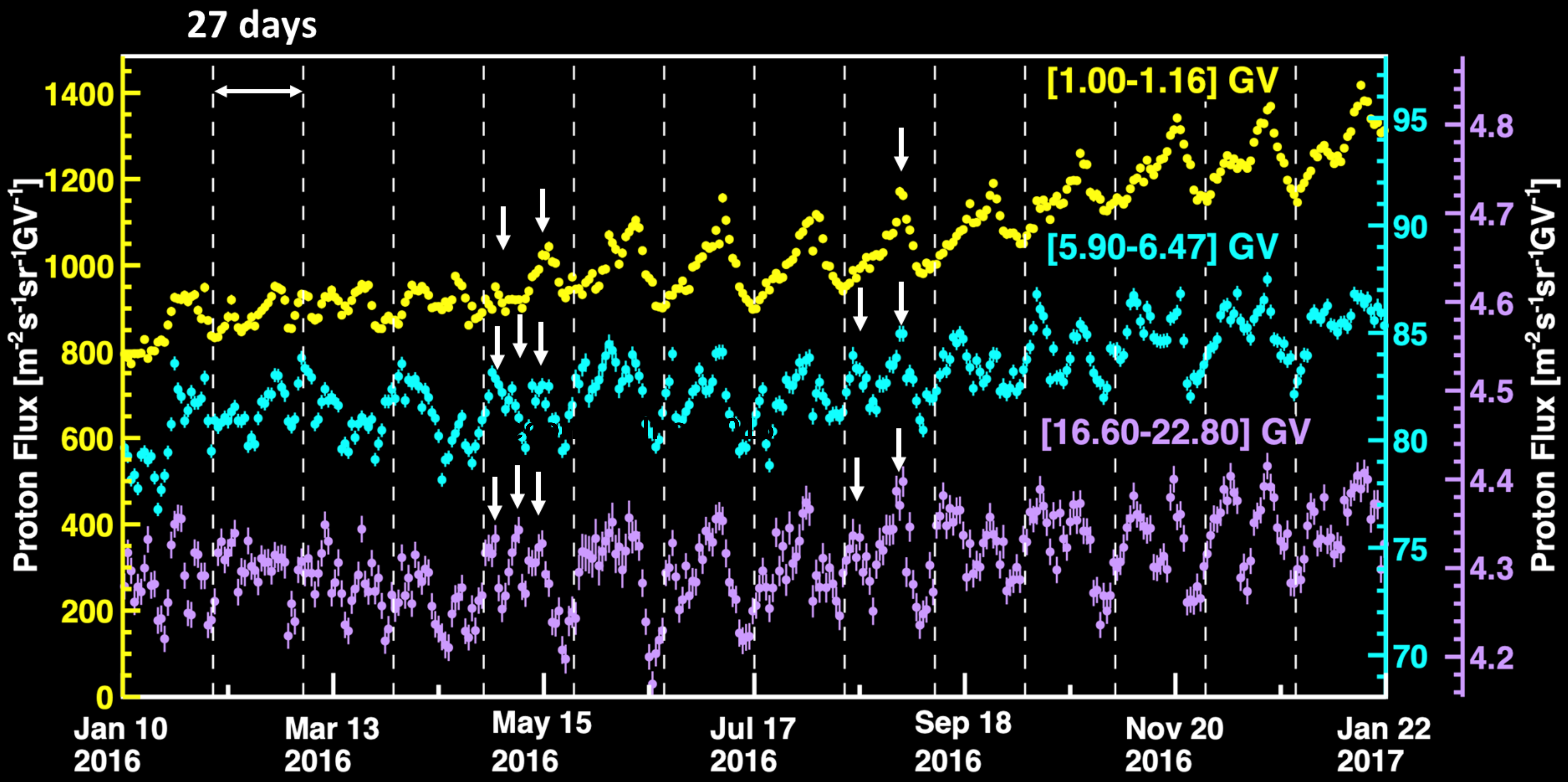
Precision measurements of the individual species of cosmic rays in a solar cycle provide unique inputs for the understanding of cosmic rays in the heliosphere.

AMS Daily Proton Flux

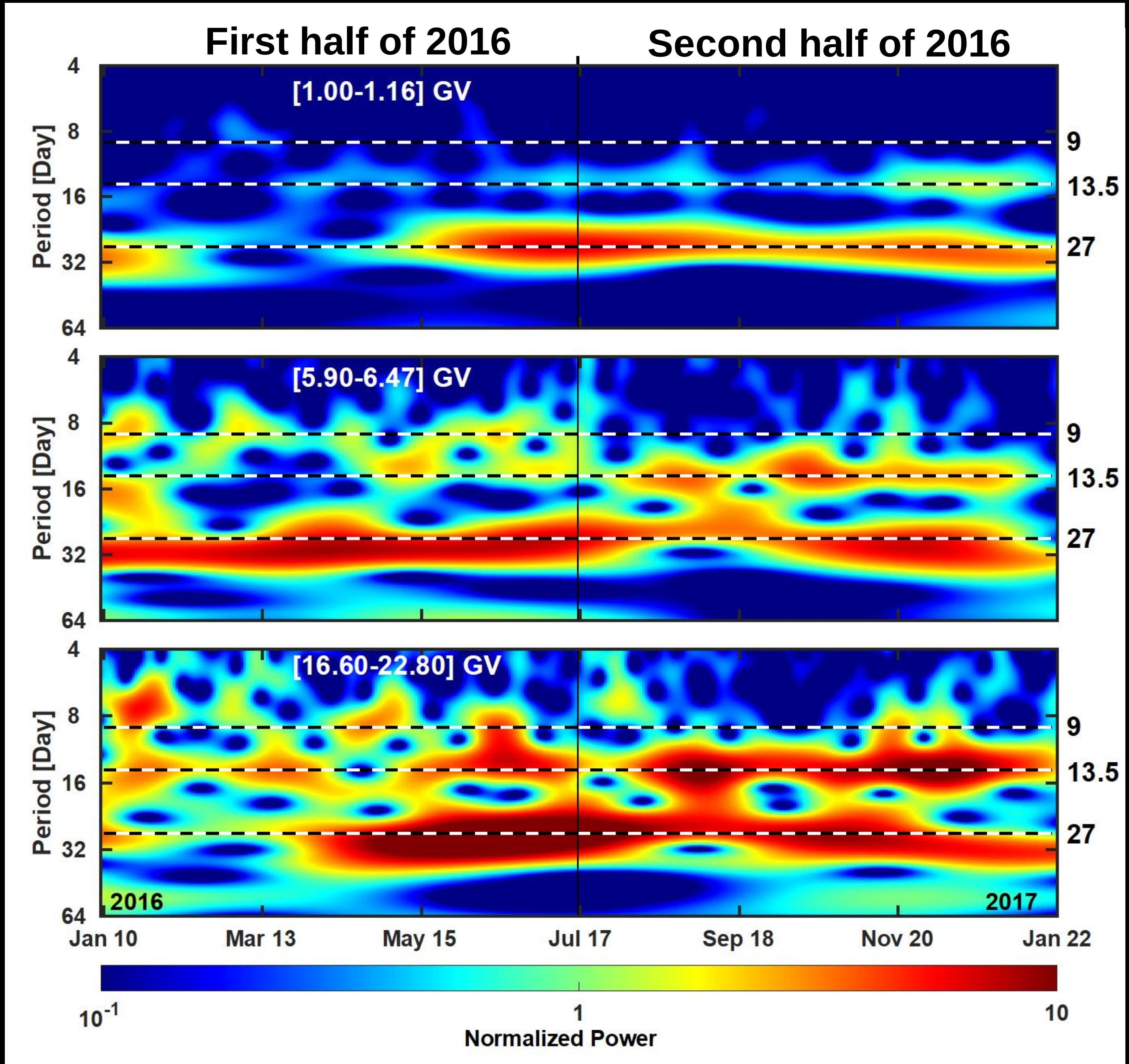


Recurrent Proton Flux Variation in 2016

Double-peak and triple-peak structures are visible in different Bartels rotations



Wavelet Analysis of Proton Fluxes in 2016



To study the recurrent time variations in the daily proton fluxes, a **wavelet time-frequency** technique was used.

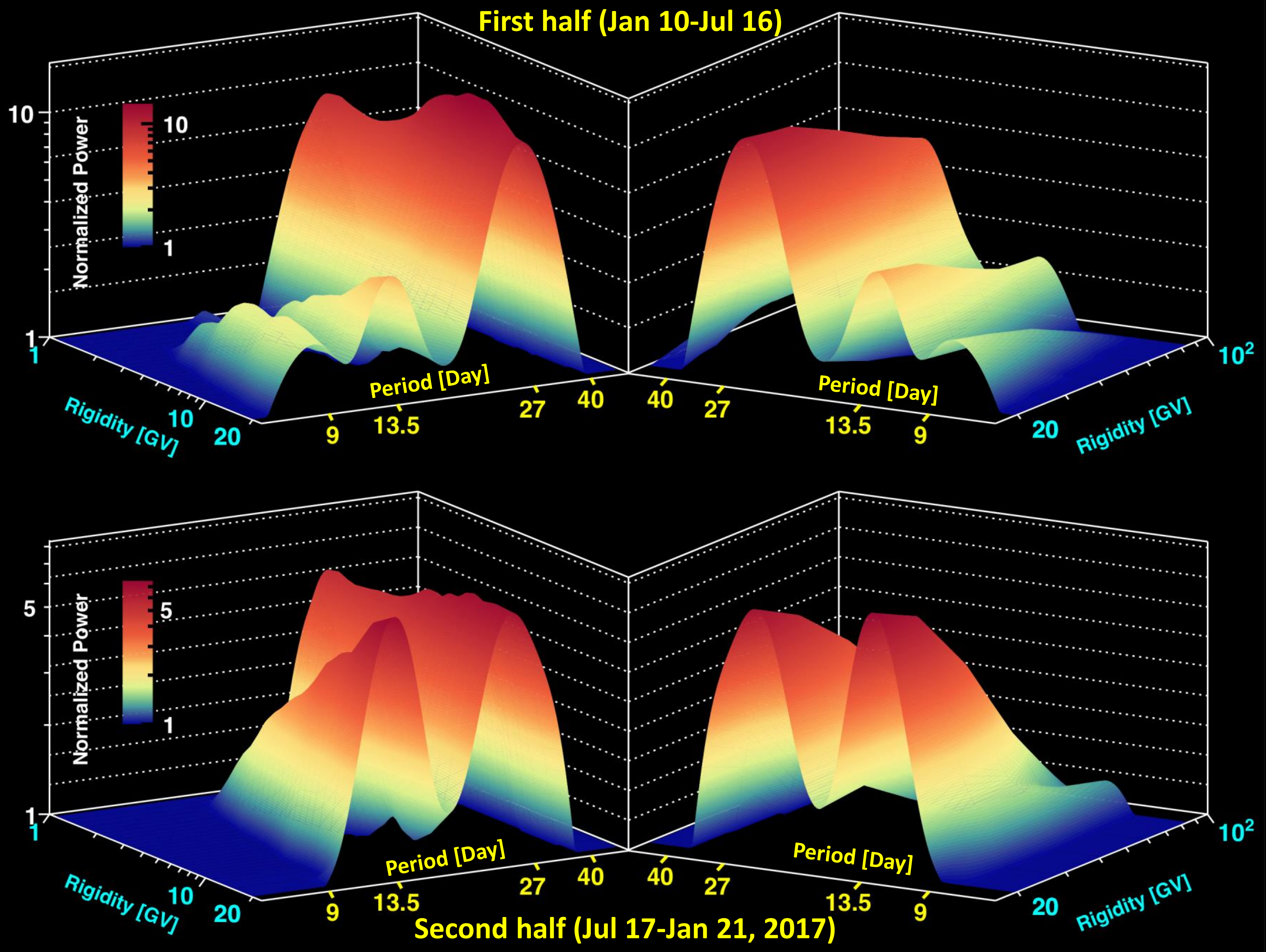
To show the strength of the periodicity, **the normalized power** is defined by the power divided by **the variance** of the time series.

Periods of 9, 13.5, and 27 days are observed in 2016.

The strength of all three periodicities changes with time and rigidity.

In particular, shorter periods of 9 and 13.5 days, when present, are more visible at 6 GV and 20 GV compared to 1 GV.

Periodicities of Daily Proton Fluxes in 2016



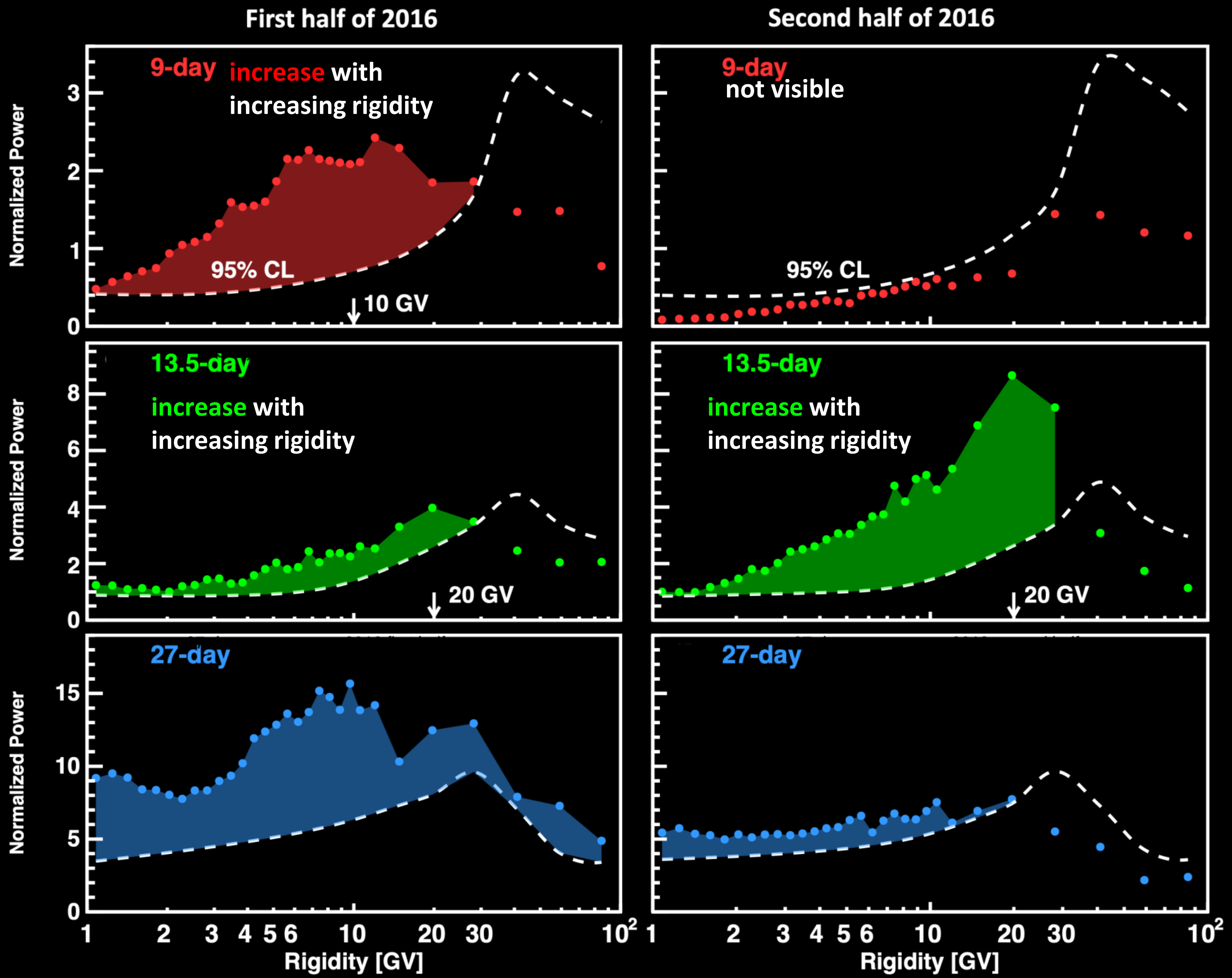
Highlight #1

Unexpectedly, the strength of **9-day and 13.5-day periodicities** increases with increasing rigidity up to **∼10 GV** and **∼20 GV,** respectively. Then the strength decreases with increasing rigidity up to **100 GV.**

Thus, the AMS results do not support the general conclusion that the strength of the periodicities always decreases with increasing rigidity

Phys. Rev. Lett. 127, 271102 (2021)

Rigidity Dependence of 9-day, 13.5-day, and 27-day periods of protons

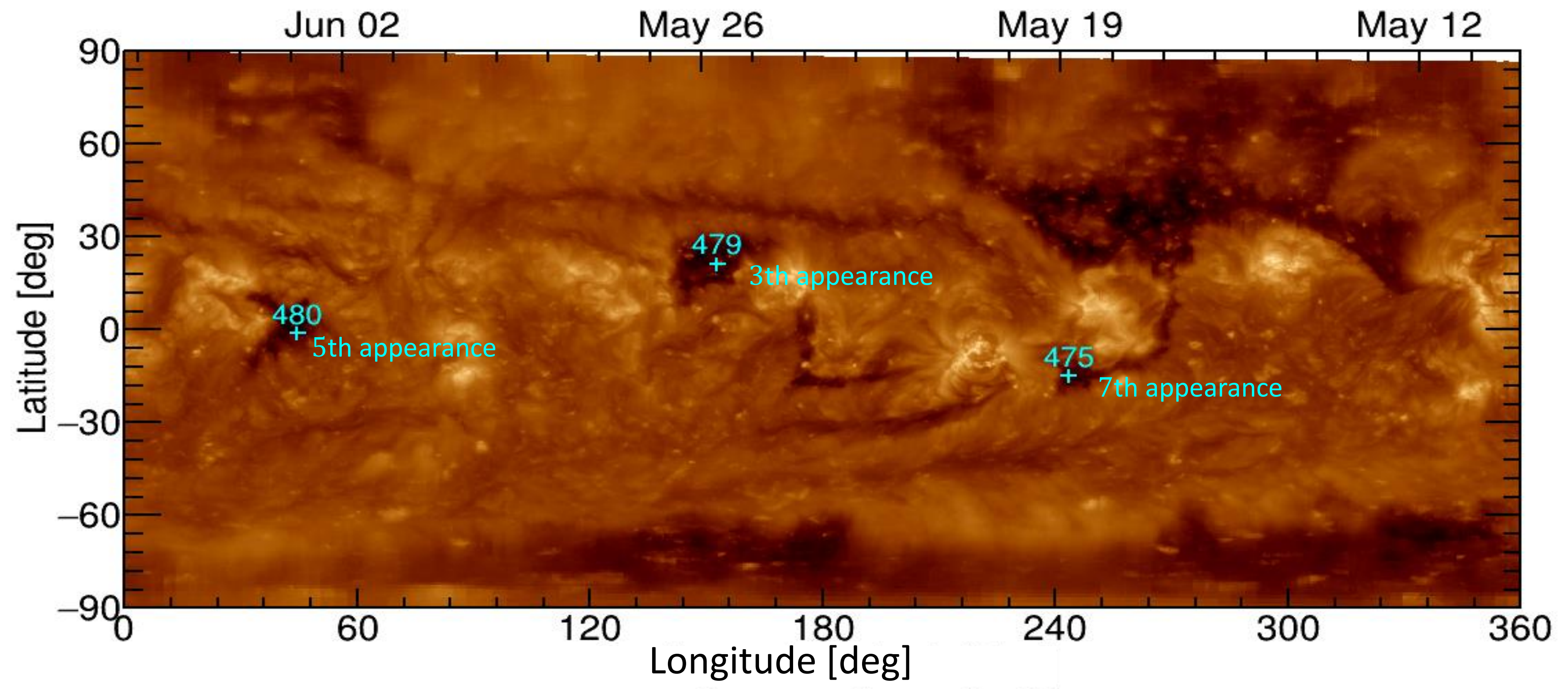


Shaded areas are the rigidity intervals where the periodicity is prominent

Cosmic Ray Periodicities and the Rotation of the Sun

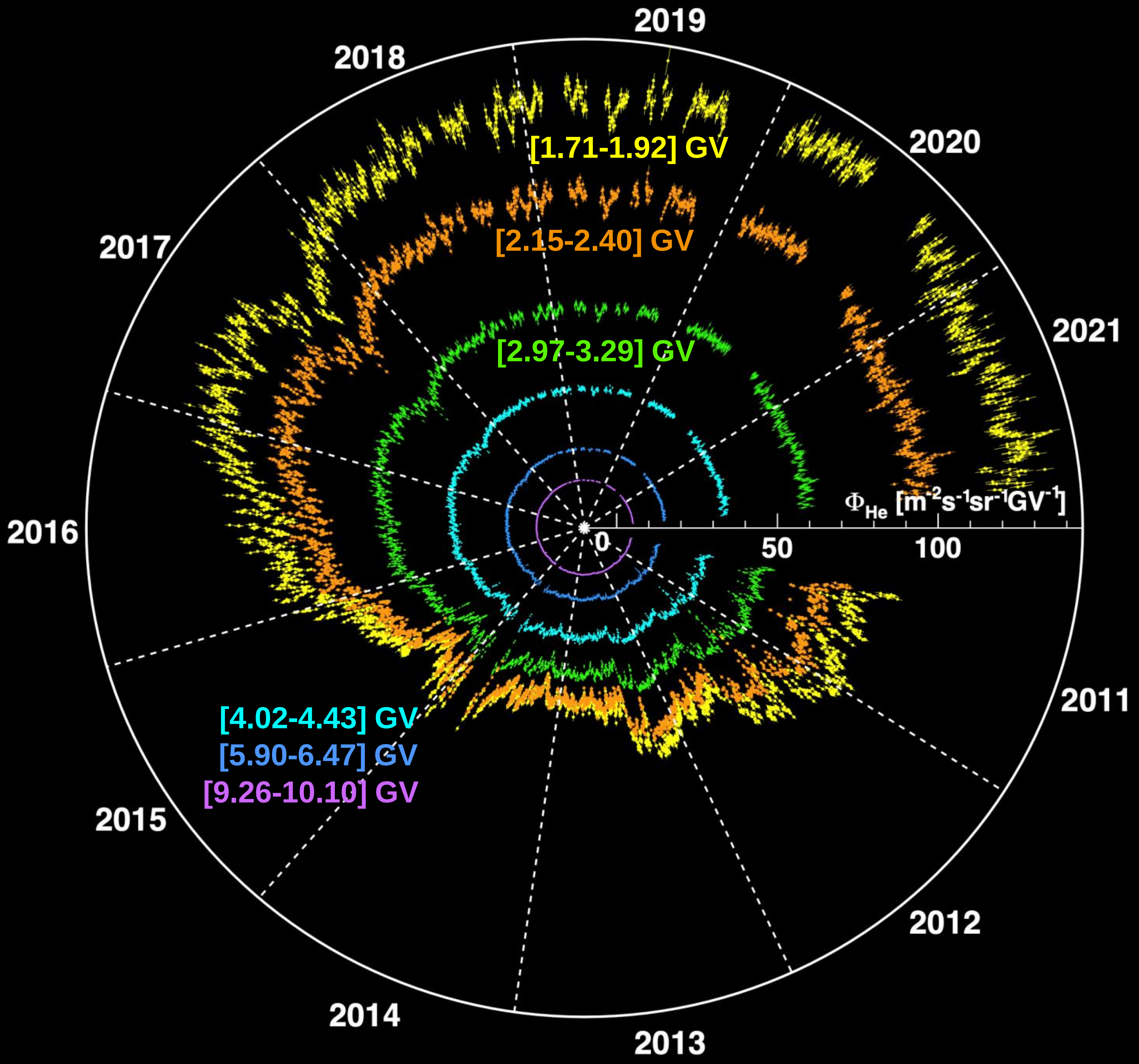
Coronal Holes are sources of high speed solar wind affecting Earth. The rotation of the Sun causes multiple periods in the flux:

0 coronal hole:	⟶	No apparent periods
1 coronal hole	⟶	**27-day** period (a Bartels rotation)
2 coronal holes separated by 180º	⟶	**13.5-day** period
3 coronal holes separated by 120º	⟶	**9-day** period

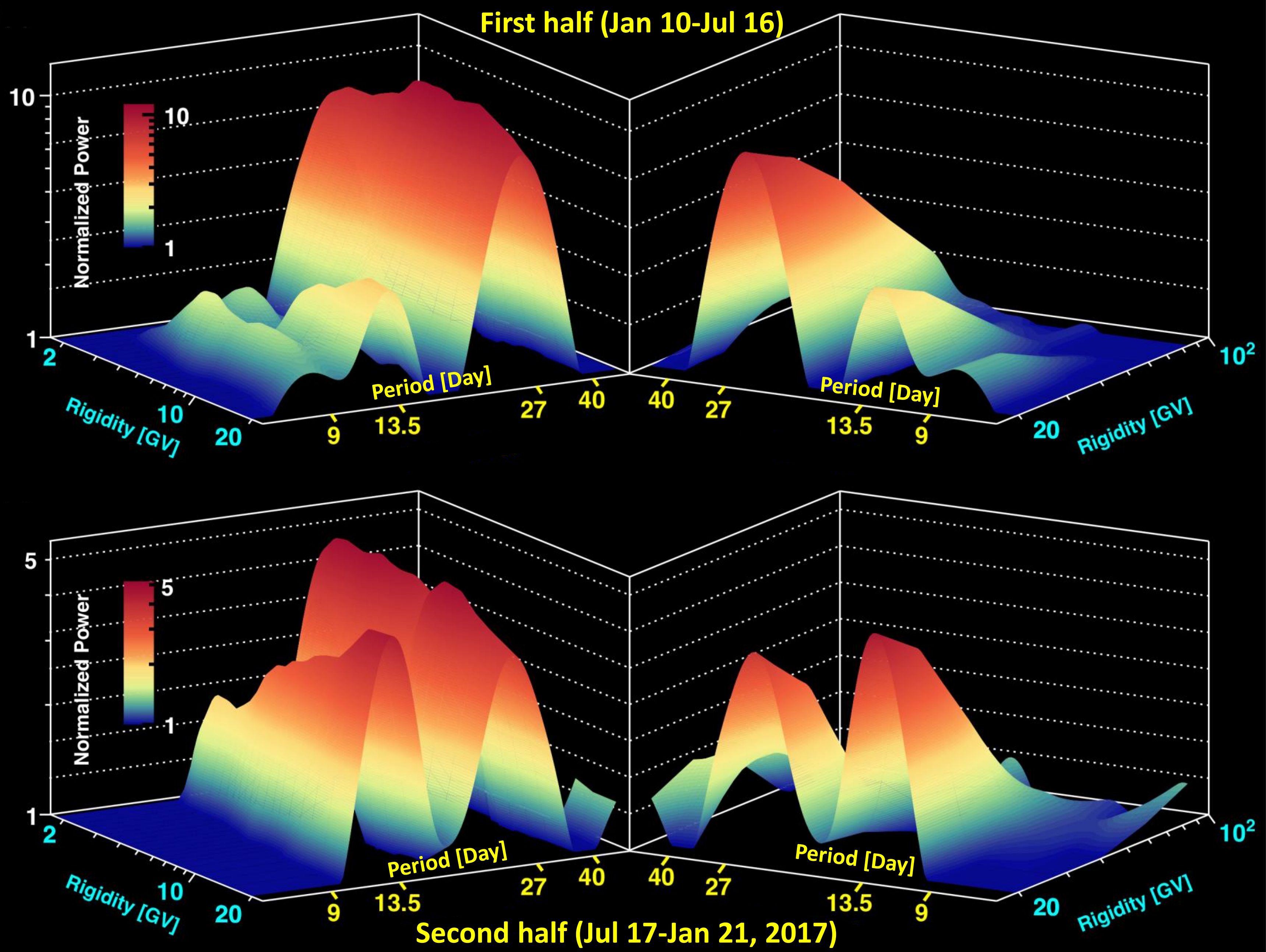


(May 10, 2016-Jun 06, 2016) Image taken by Solar Dynamics Observatory (SDO), NASA

AMS Daily Helium Flux



Periodicities of Daily Helium Fluxes in 2016



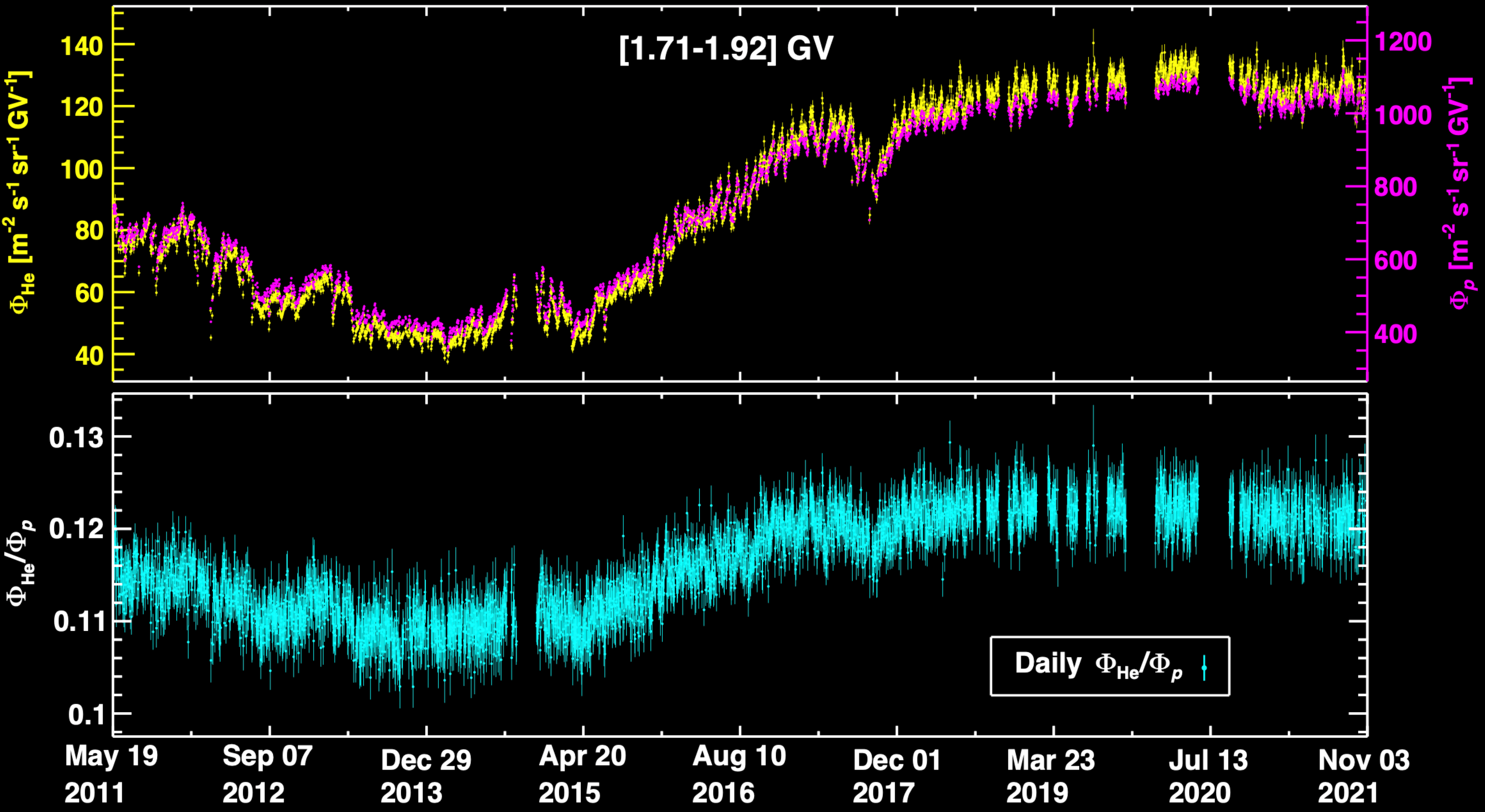
Similar periodic structures are observed for helium.

The AMS results do not support the general conclusion that the strength of the periodicities always decreases with increasing rigidity

Phys. Rev. Lett. 128, 231102 (2022)

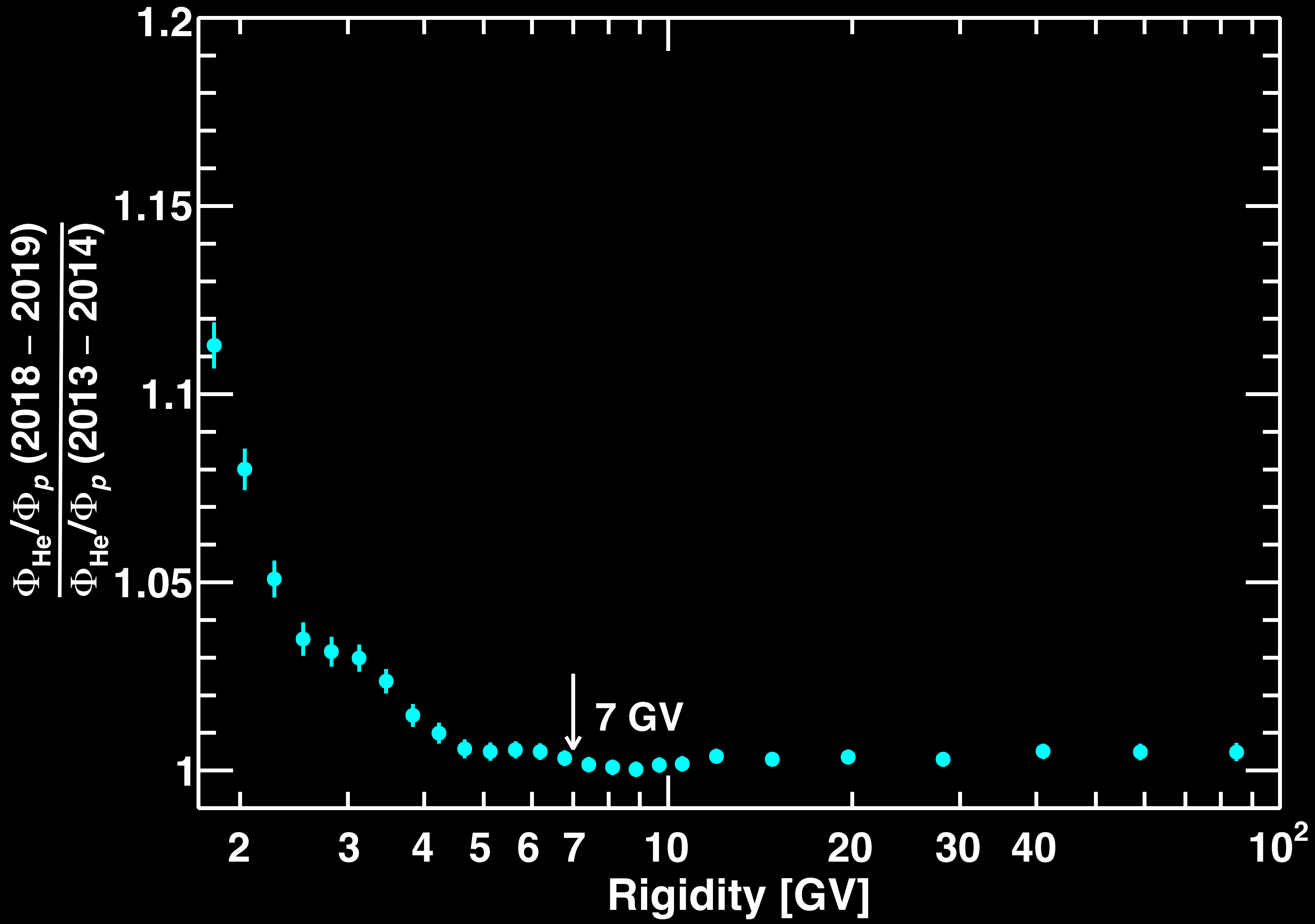
Daily Φ_{He}, Φ_p and $\Phi_{\mathrm{He}}/\Phi_p$

$\Phi_{\mathrm{He}}/\Phi_p$ exhibits variations on multiple timescales



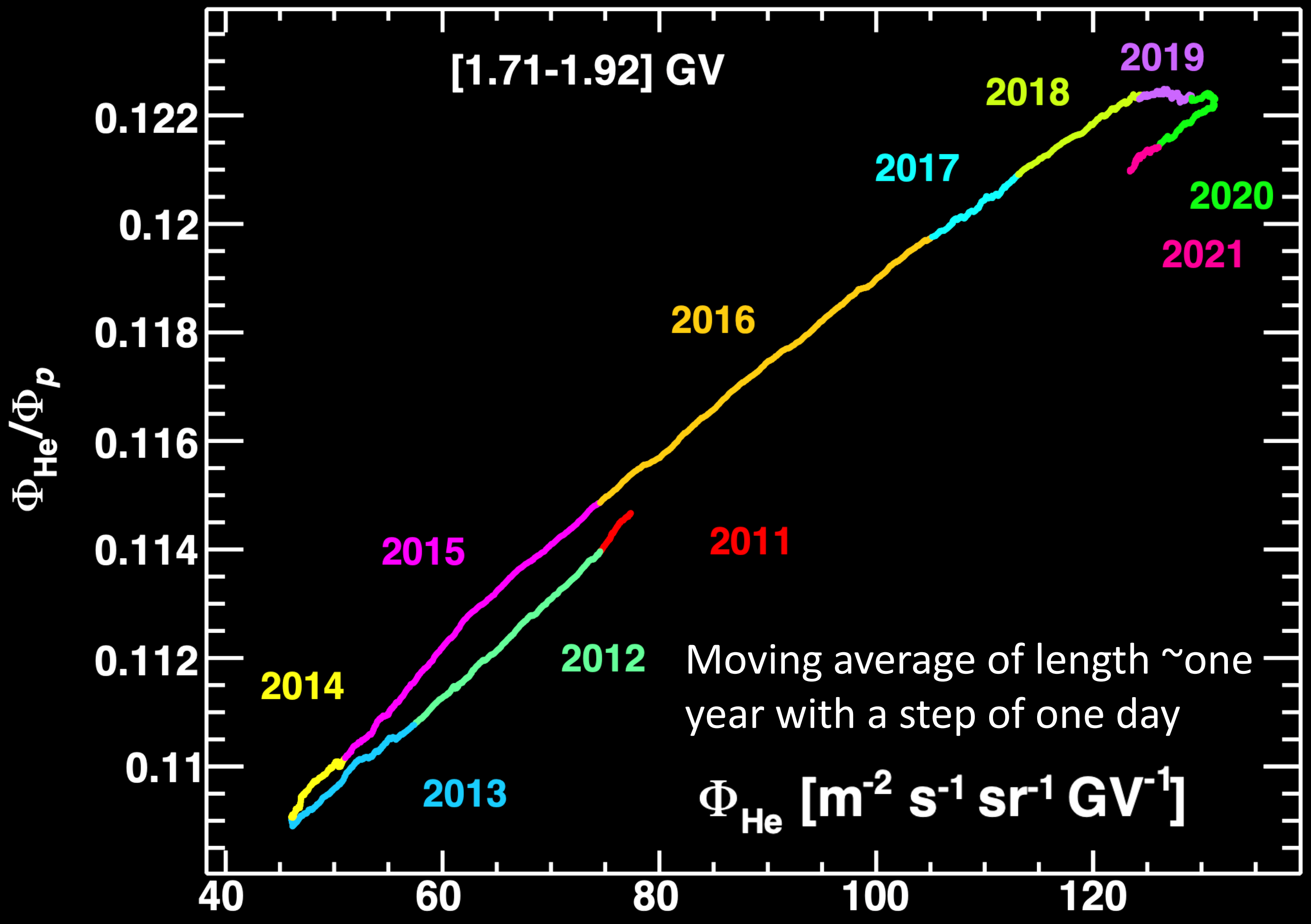
Daily Φ_{He}, Φ_p and $\Phi_{\mathrm{He}}/\Phi_p$

Below ~7 GV, Φ_{He} exhibits larger time variations than Φ_p



A hysteresis between $\Phi_{\mathrm{He}}/\Phi_p$ and Φ_{He}

At low rigidity the modulation of the helium to proton flux ratio is different before and after the solar maximum in 2014



A hysteresis between $\Phi_{He}/\ \Phi_p$ and Φ_{He}

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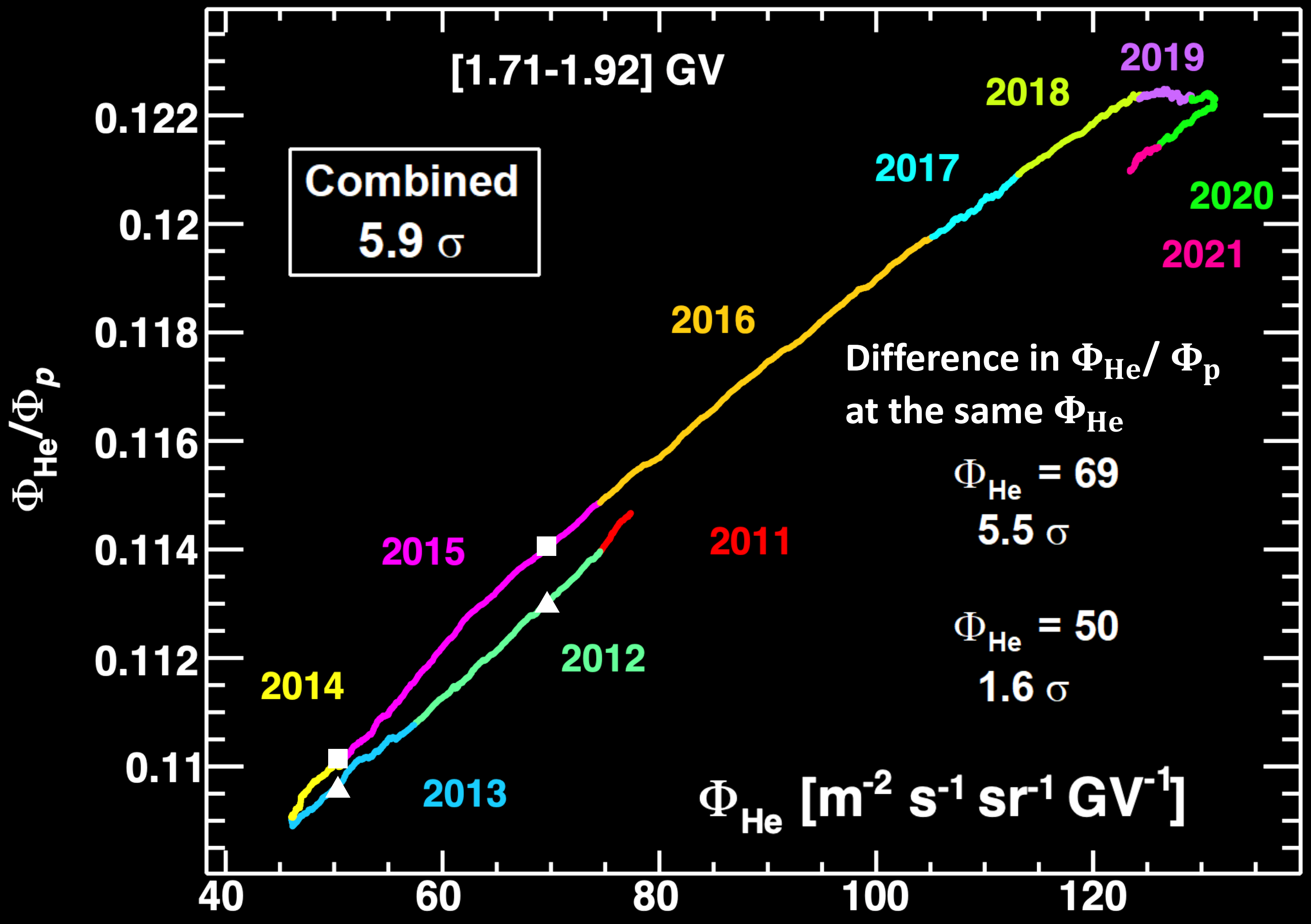


We study the significance of the difference of $\Phi_{He}/\ \Phi_p$ at the same Φ_{He} but different solar conditions:

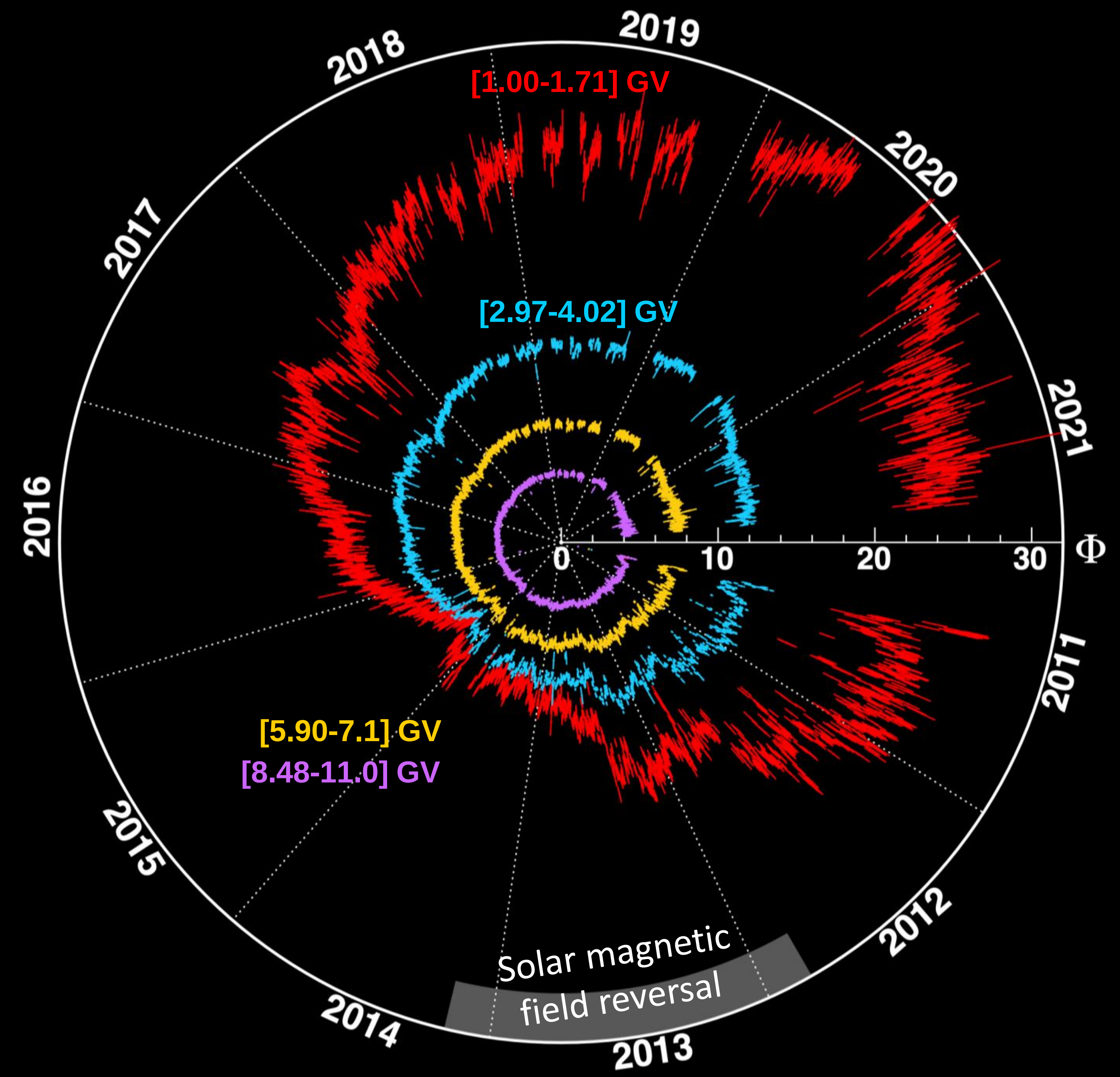
- ▲ : Φ_{He}/Φ_p before the solar maximum 2014
- ■ : Φ_{He}/Φ_p after the solar maximum 2014

Highlight #2

The hysteresis is observed with an overall significance >7σ below 2.4 GV

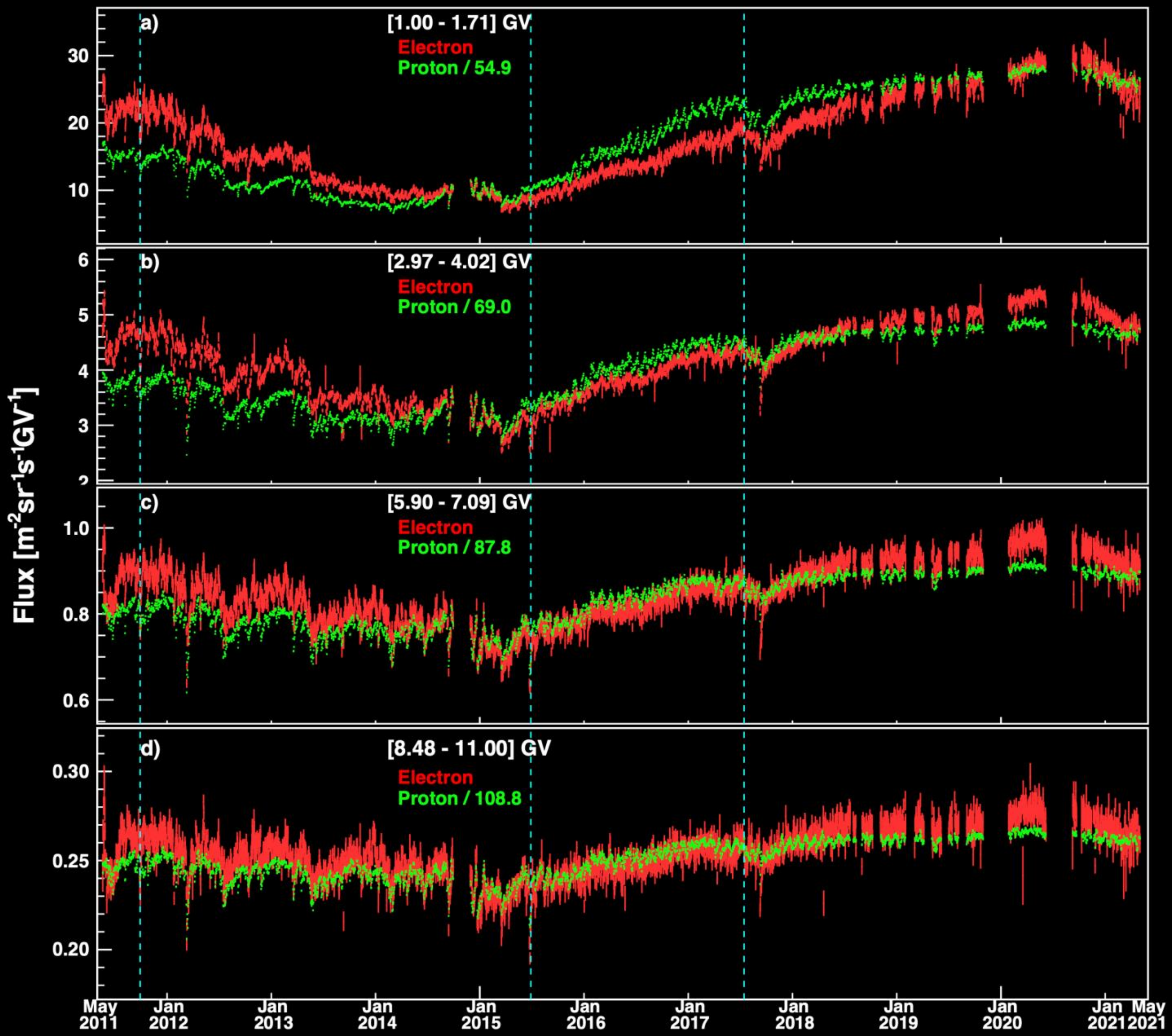
Phys. Rev. Lett. 128, 231102 (2022)

AMS Daily Electron Flux

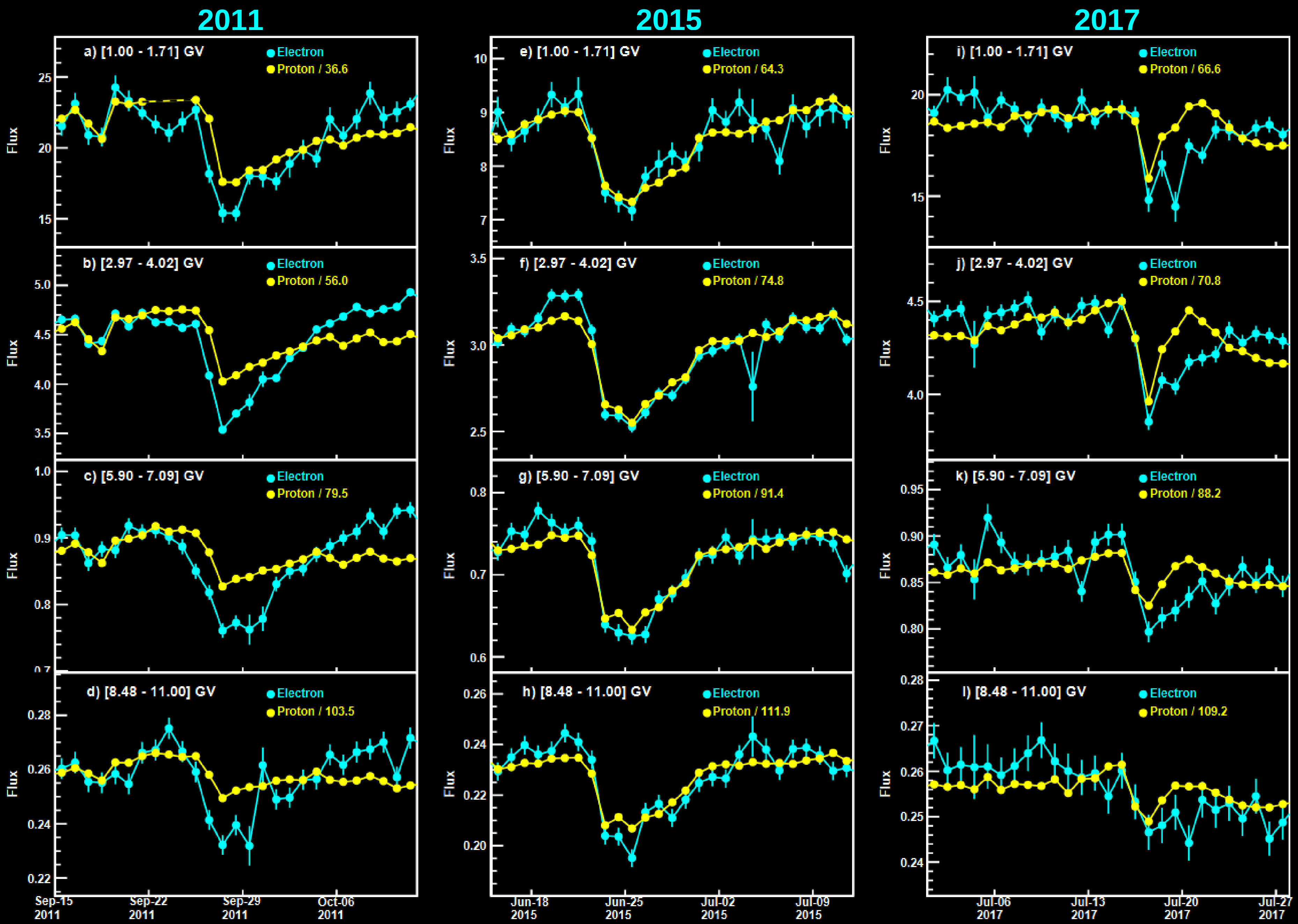


AMS Daily Electron and Proton Fluxes

The time-dependent behavior of the Φ_{e^-} and Φ_p is distinctly different



Non recurrent variations of Electron and Proton Fluxes

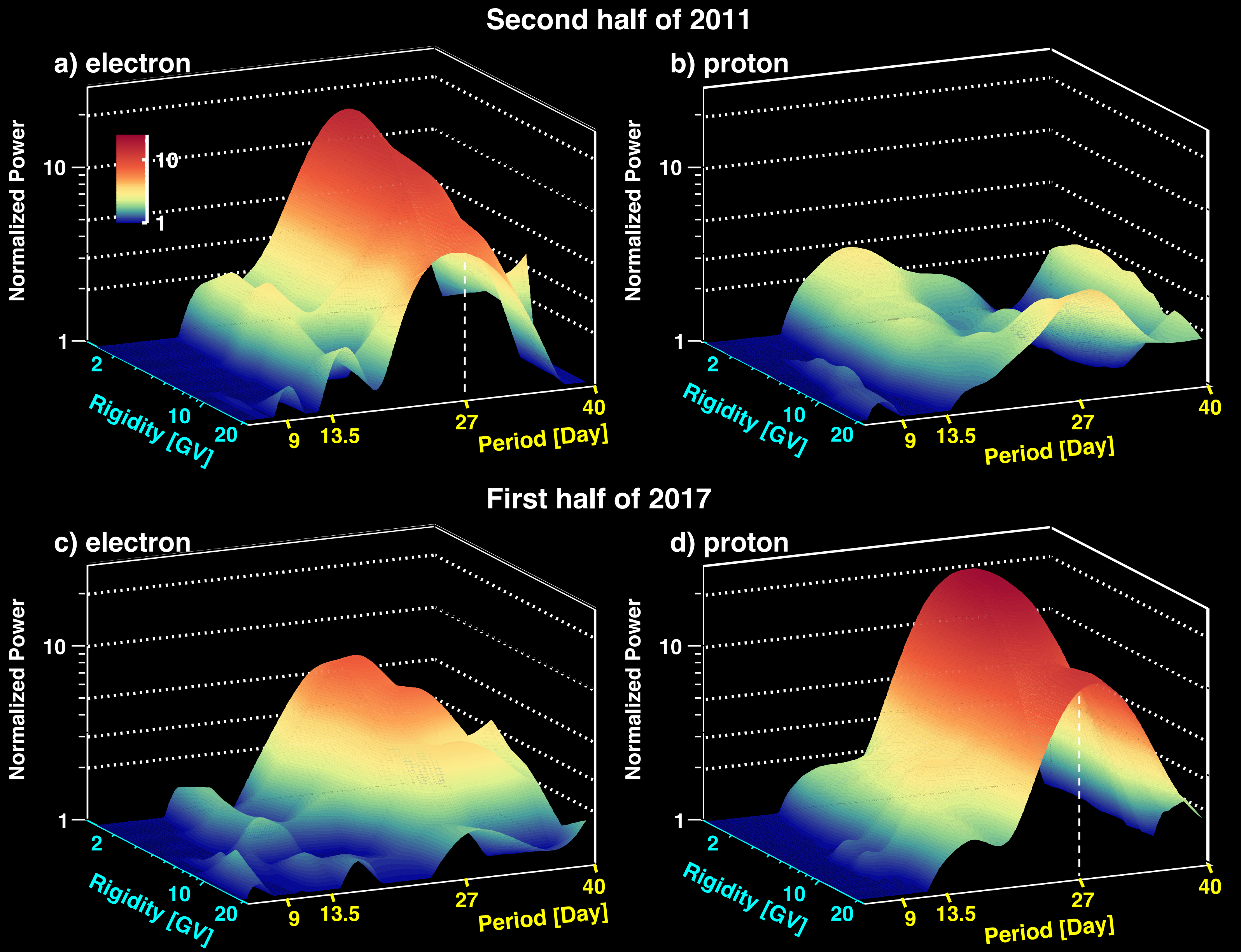


During **lower solar activity** in 2011 and 2017, a **difference between the short-term evolution of electrons and protons** is observed, while during the **solar maximum** in 2015 the **difference vanishes**.

These observations indicate a charge-sign dependence in nonrecurrent solar modulation.

Periodicities of Daily Electron Fluxes

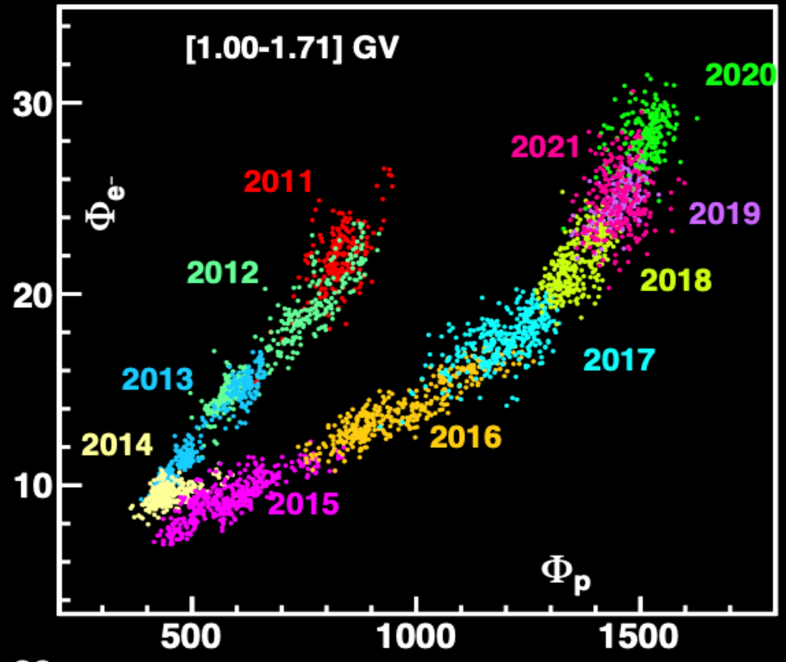
The rigidity dependence of the electron periodicities is different from that of protons

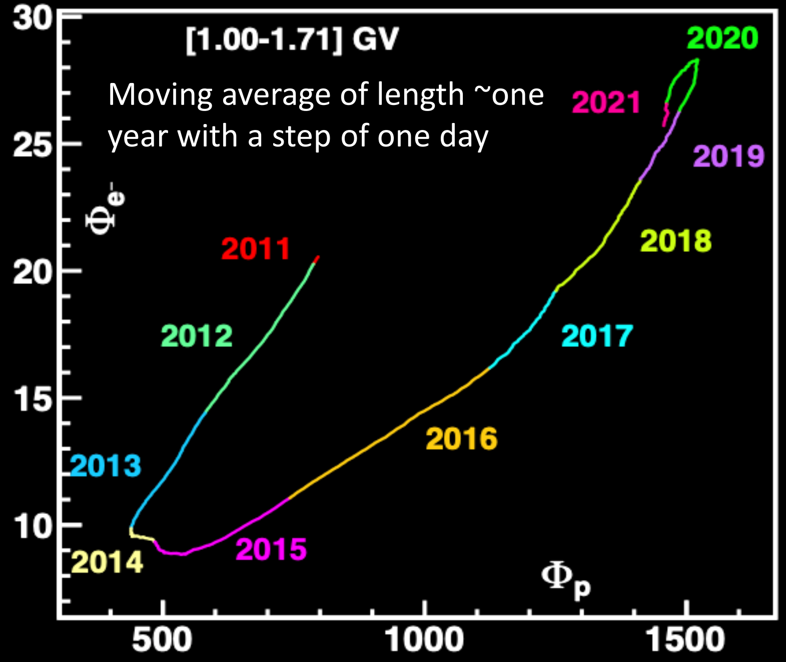


In the second half of 2011 the strength of the 27-day period of electrons is greater than that of protons.

In the first half of 2017 the strength of the 27-day period of electrons is less than that of protons.

A Hysteresis between Φ_{e^-} and Φ_p



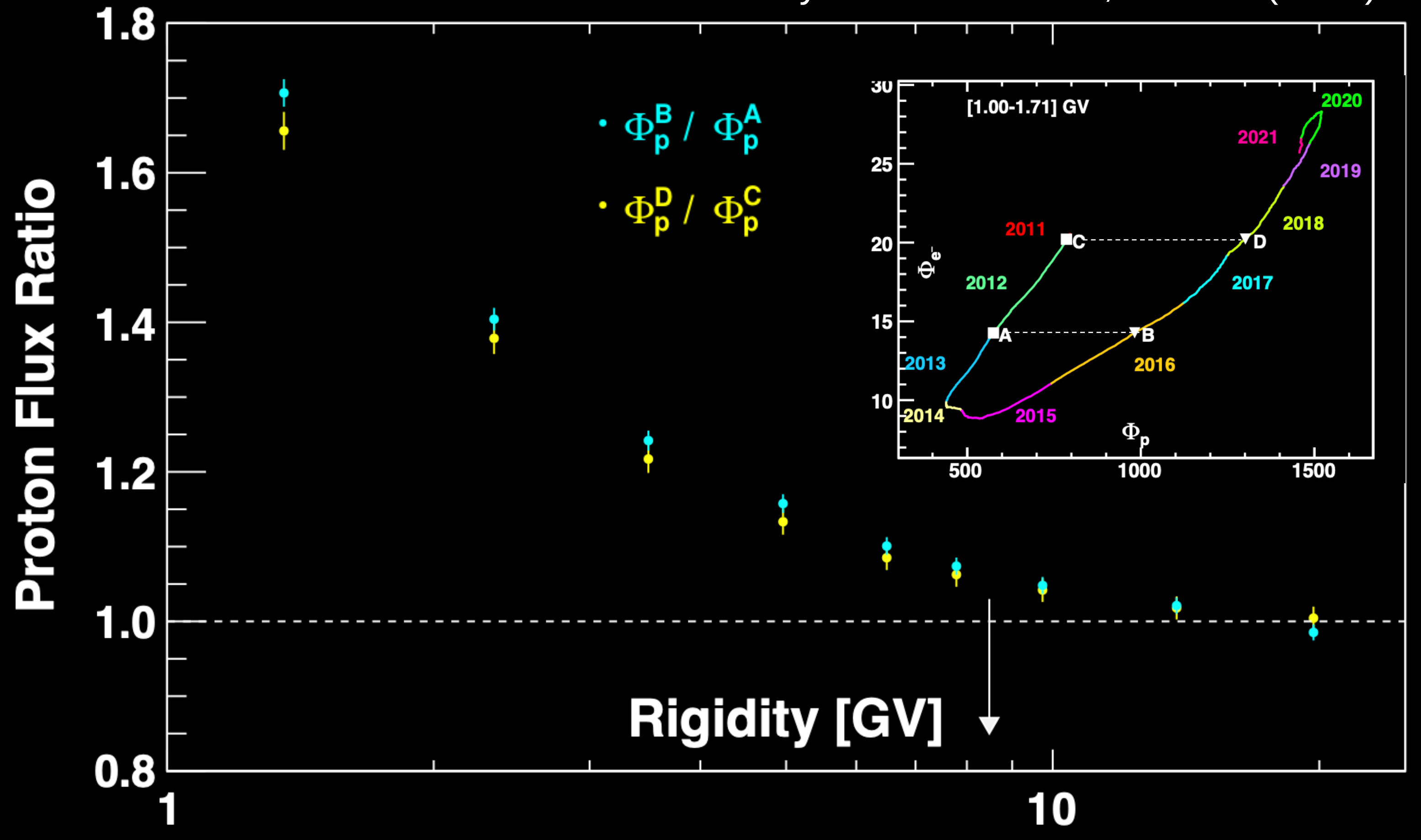


To assess the significance of the hysteresis we study, at different solar conditions, the values of Φ_p at the same Φ_{e^-}

Highlight #3

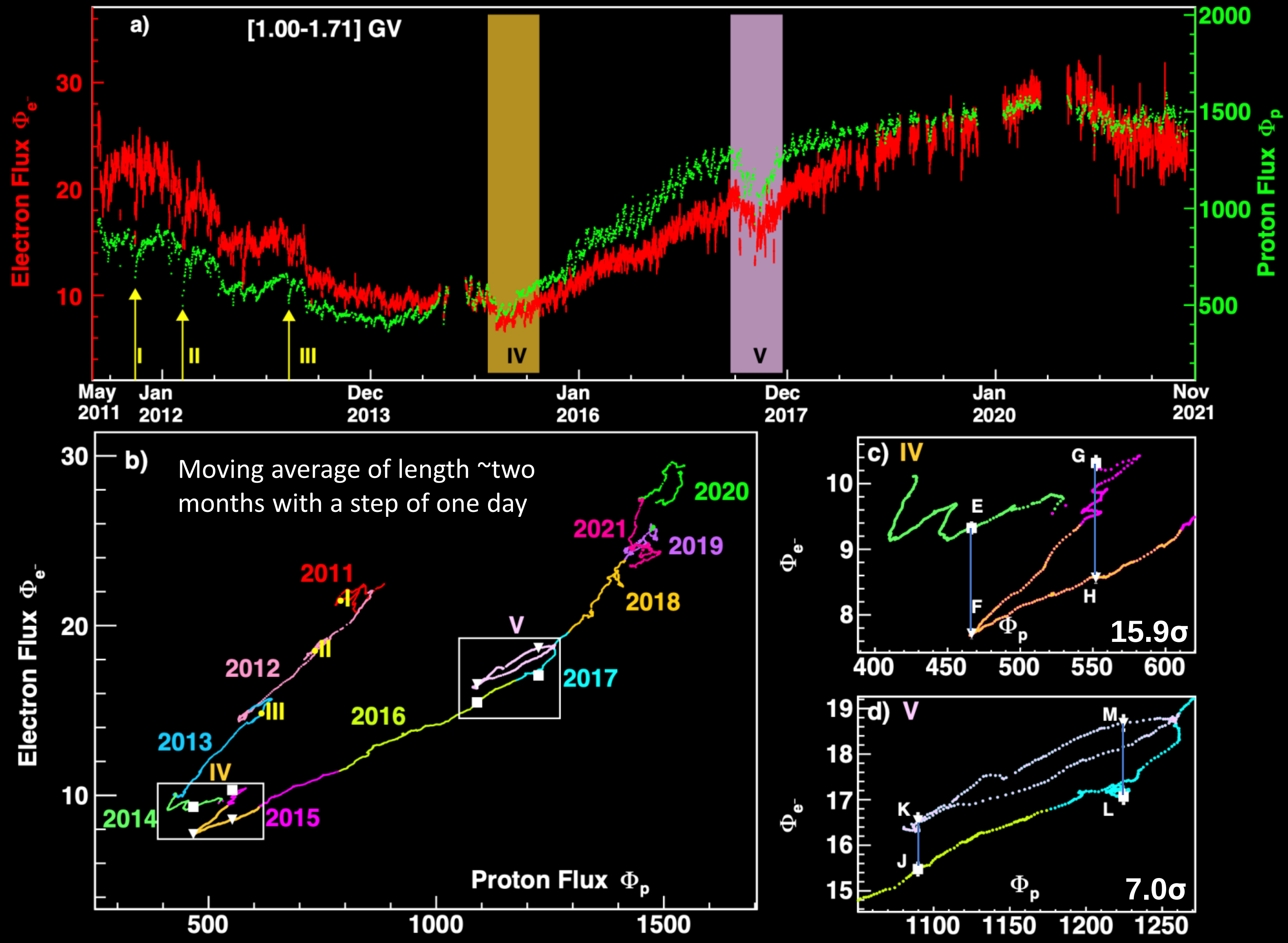
The hysteresis is observed with a significance > 6σ at rigidities below 8.5 GV

Phys. Rev. Lett. 130, 161001 (2023)



Structures in the Electron-Proton Hysteresis

Significant structures in the electron-proton hysteresis are observed corresponding to sharp variations in the fluxes



AMS Publications on Cosmic Rays in the Heliosphere

1) PRL 121, 051101 (2018) Monthly p, He

2) PRL 121, 051102 (2018) Monthly e+, e- Editors' Suggestion

3) PRL 127, 271102 (2021) Daily p

4) PRL 128, 231102 (2022) Daily He

5) PRL 130, 161001 (2023) Daily e- Editors' Suggestion, Featured in Physics, Viewpoint in *Physics (APS announcement)*

6) To be submitted to PRL Daily e+

7) To be submitted to PRL Cosmic antiprotons

AMS Publications on Cosmic Rays in the Heliosphere

PHYSICAL REVIEW LETTERS **127,** 271102 (2021)

Periodicities in the Daily Proton Fluxes from 2011 to 2019 Measured by the Alpha Magnetic Spectrometer on the International Space Station from 1 to 100 GV

PHYSICAL REVIEW LETTERS **128,** 231102 (2022)

Properties of Daily Helium Fluxes

PHYSICAL REVIEW LETTERS **130,** 161001 (2023)

Editors' Suggestion

Featured in Physics

Temporal Structures in Electron Spectra and Charge Sign Effects in Galactic Cosmic Rays

AMS Daily Data: 1) Tables from PRL Supplemental Material

TABLE S1: May 20, 2011.

Rigidity [GV]	Φ_p	$\sigma_{stat.}$	σ_{time}	$\sigma_{syst.}$	
1.00 – 1.16	(9.998	0.157	0.100	0.293)	$\times 10^2$
1.16 – 1.33	(9.749	0.075	0.071	0.222)	$\times 10^2$
1.33 – 1.51	(9.144	0.067	0.050	0.171)	$\times 10^2$
1.51 – 1.71	(8.404	0.058	0.038	0.135)	$\times 10^2$
1.71 – 1.92	(7.394	0.049	0.031	0.107)	$\times 10^2$
1.92 – 2.15	(6.302	0.041	0.025	0.084)	$\times 10^2$
2.15 – 2.40	(5.489	0.036	0.022	0.069)	$\times 10^2$
2.40 – 2.67	(4.628	0.030	0.018	0.056)	$\times 10^2$
2.67 – 2.97	(3.927	0.025	0.015	0.046)	$\times 10^2$
2.97 – 3.29	(3.278	0.021	0.012	0.037)	$\times 10^2$
3.29 – 3.64	(2.749	0.018	0.010	0.031)	$\times 10^2$
3.64 – 4.02	(2.249	0.014	0.008	0.025)	$\times 10^2$
4.02 – 4.43	(1.844	0.011	0.007	0.020)	$\times 10^2$
4.43 – 4.88	(1.500	0.009	0.006	0.016)	$\times 10^2$
4.88 – 5.37	(1.218	0.008	0.005	0.013)	$\times 10^2$
5.37 – 5.90	(9.897	0.063	0.037	0.108)	$\times 10^1$
5.90 – 6.47	(7.975	0.052	0.030	0.087)	$\times 10^1$
6.47 – 7.09	(6.481	0.042	0.024	0.071)	$\times 10^1$
7.09 – 7.76	(5.183	0.035	0.019	0.057)	$\times 10^1$
7.76 – 8.48	(4.123	0.029	0.015	0.046)	$\times 10^1$
8.48 – 9.26	(3.392	0.025	0.013	0.038)	$\times 10^1$
9.26 – 10.1	(2.669	0.021	0.010	0.030)	$\times 10^1$

Example #1: daily proton flux

2824 tables with daily measurements from May 20, 2011 to October 29, 2019

In the following tables we present the daily proton flux Φ_p as a function of rigidity at the top of AMS. The fluxes are in units of $[\mathrm{m}^2 \cdot \mathrm{sr} \cdot \mathrm{s} \cdot \mathrm{GV}]^{-1}$. The errors include statistics ($\sigma_{stat.}$), time-dependent systematic errors (σ_{time}) and the total systematic error ($\sigma_{syst.}$). Contributions to the time-dependent systematic errors (σ_{time}) are from: the trigger efficiency and the reconstruction efficiencies. Contributions to the total systematic error ($\sigma_{syst.}$) are from: the time-dependent systematic error, the background evaluation, the geomagnetic cutoff, the acceptance calculation, the rigidity resolution function, and the absolute rigidity scale.

Similar tables for daily Helium flux and for the He/p flux ratio

AMS Daily Data: 1) Tables from PRL Supplemental Material

These tables in pdf format are available at

PRL webpage

Open Access

Periodicities in the Daily Proton Fluxes from 2011 to 2019 Measured by the Alpha Magnetic Spectrometer on the International Space Station from 1 to 100 GV

M. Aguilar *et al.* (AMS Collaboration)
Phys. Rev. Lett. **127**, 271102 – Published 27 December 2021

More

Article | References | Citing Articles (12) | Supplemental Material | PDF | HTML | Export Citation

Supplemental Material

AMS detector description, details of event selection, details of wavelet analysis and figures, and the tabulated daily proton fluxes as functions of rigidity.

SM-Daily-P-REV.pdf

SM-Daily-P-Tables-REV.pdf

AMS-02 webpage

Go to https://ams02.space/publications

Published on June 10, 2022

Properties of Daily Helium Fluxes

Phys. Rev. Lett. **128**, 231102 (2022) , Citations: **6** , View supplemental material and data

Properties of Daily Helium Fluxes

Phys. Rev. Lett. **128**, 231102 (2022)
Published on: June 10, 2022

Abstract

We present the precision measurement of 2824 daily helium fluxes in cosmic rays from May 20, 2011 to October 29, 201
based on 7.6×10^8 helium nuclei collected with the Alpha Magnetic Spectrometer (AMS) aboard the International Spac
to proton flux ratio exhibit variations on multiple timescales. In nearly all the time intervals from 2014 to 2018, we obse
a period of 27 days. Shorter periods of 9 days and 13.5 days are observed in 2016. The strength of all three periodicitie
entire time period, we found that below ~7 GV the helium flux exhibits larger time variations than the proton flux, and
ratio is time independent. Remarkably, below 2.4 GV a hysteresis between the helium to proton flux ratio and the heliu
the 7σ level. This shows that at low rigidity the modulation of the helium to proton flux ratio is different before and afte

Supplemental Material

SM-Daily-He-REV.pdf
SM-Daily-He-Tables.pdf

AMS Daily Data: 2) Tables in CSV format

In the previous AMS-02 webpage…

AMS-02 webpage

Go to https://ams02.space/publications

Published on June 10, 2022

Properties of Daily Helium Fluxes

Phys. Rev. Lett. **128**, 231102 (2022) , Citations: **6** , View supplemental material and data

Scroll down

Supplemental Material

SM-Daily-He-REV.pdf
SM-Daily-He-Tables.pdf

Download AMS Data

Table-S1-S2824 Download the table

Table of *Properties of Daily Helium Fluxes*

YYYY-MM-DD	Rigidity	Flux	σ_{stat}	σ_{time}	σ_{sys}
2011-05-20,	1.71,1.92,	8.770e1,	0.180e1,	0.046e1,	0.176e1
2011-05-20,	1.92,2.15,	8.071e1,	0.153e1,	0.040e1,	0.128e1
2011-05-20,	2.15,2.40,	7.360e1,	0.134e1,	0.036e1,	0.101e1
2011-05-20,	2.40,2.67,	6.613e1,	0.113e1,	0.031e1,	0.083e1
2011-05-20,	2.67,2.97,	5.754e1,	0.094e1,	0.026e1,	0.069e1
2011-05-20,	2.97,3.29,	4.802e1,	0.081e1,	0.020e1,	0.056e1
2011-05-20,	3.29,3.64,	4.218e1,	0.070e1,	0.018e1,	0.049e1
2011-05-20,	3.64,4.02,	3.556e1,	0.056e1,	0.015e1,	0.041e1
2011-05-20,	4.02,4.43,	2.966e1,	0.045e1,	0.012e1,	0.034e1
2011-05-20,	4.43,4.88,	2.474e1,	0.038e1,	0.010e1,	0.028e1

AMS Daily Data: 3) External databases

In the previous AMS-02 webpage…

AMS-02 webpage

Go to https://ams02.space/publications

Published on June 10, 2022

Properties of Daily Helium Fluxes

Phys. Rev. Lett. **128**, 231102 (2022) , Citations: **6** , View supplemental material and data

Scroll down

Download AMS Data

Table-S1-S2824 Download the table

Table of *Properties of Daily Helium Fluxes*

External Databases

AMS Data at CRDB (Cosmic-ray DataBase)

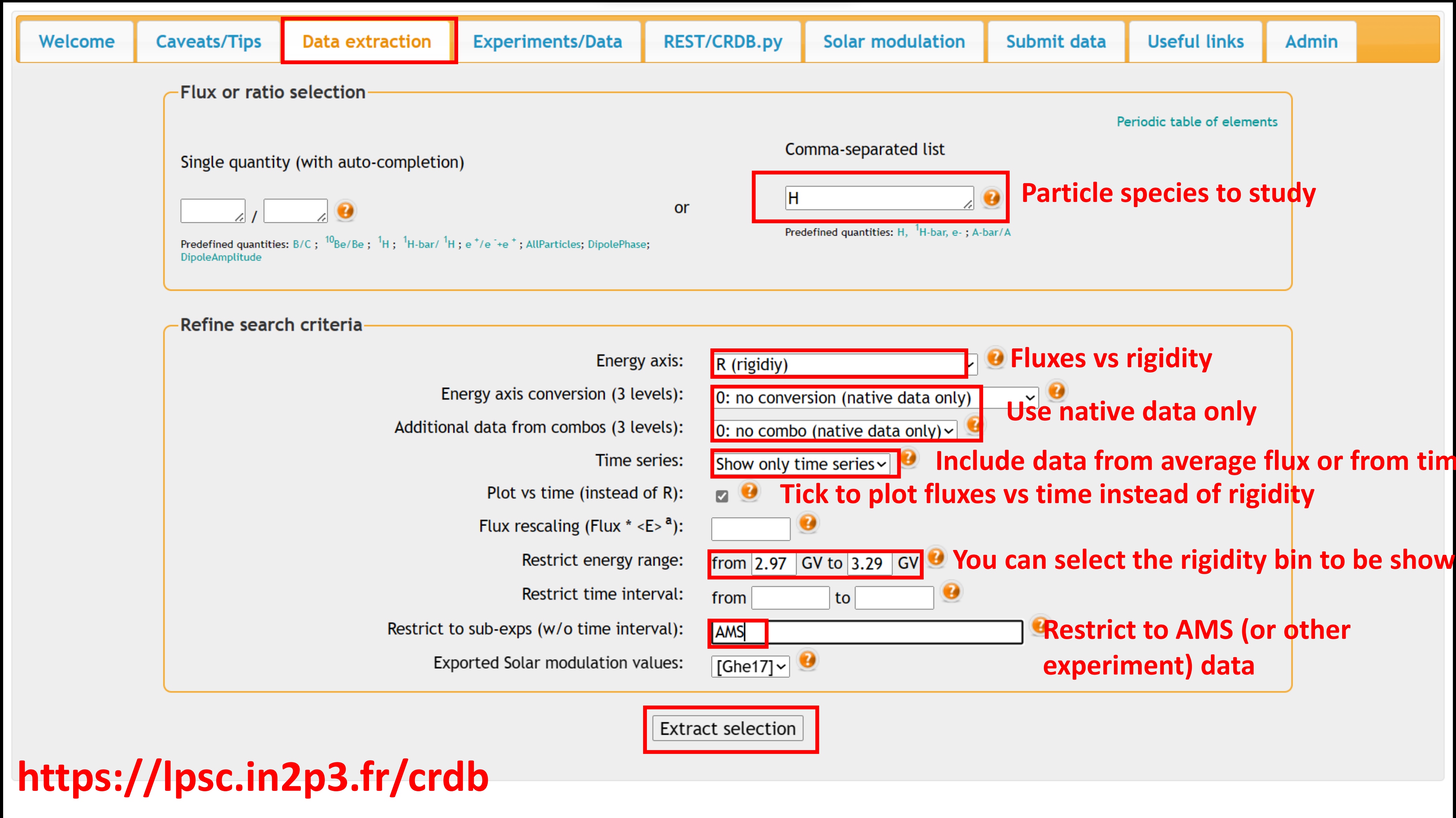
The CRDB at LPSC/IN2P3/CNRS , online since 2013, is fully described in Maurin et al. (2014 , 2020)

AMS Data at Cosmic Ray DataBase (CRDB) © SSDC

The CRDB © SSDC is developed at the **S**pace **S**cience **D**ata **C**enter, a facility of the Italian Space Agency (ASI).

AMS Daily Data: 3) External databases

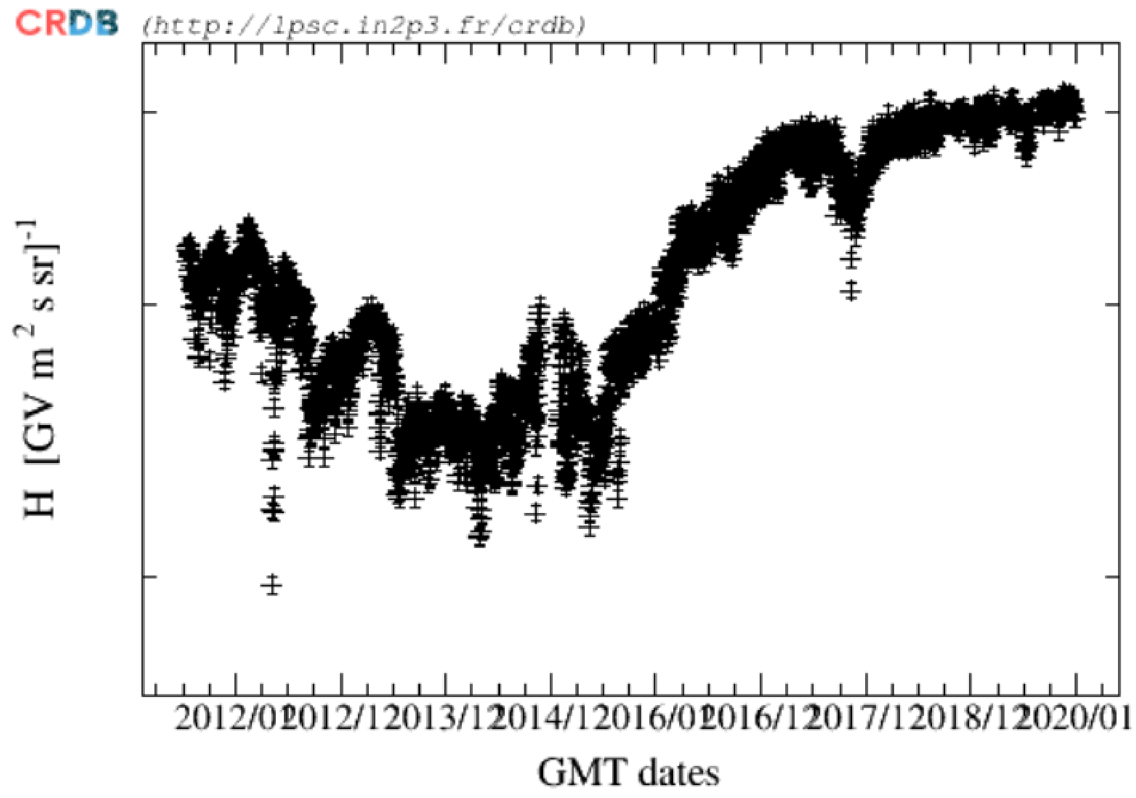
AMS Data at Cosmic-ray Database (LPSC/IN2P3/CNRS)



AMS Daily Data: 3) External databases

AMS Data at Cosmic-ray Database (LPSC/IN2P3/CNRS)

Plot & exports - Hide



Be careful! This data includes daily and monthly data
You can uncheck monthly measurements from the Replot option

Replot (with options)

Retrieve plot: .png - .pdf - .root - .C

Retrieve data: USINE - GALPROP - CSV - ASCII - CSV (as import)

AMS Daily Data: 3) External databases

AMS Data at Cosmic-ray Database (LPSC/IN2P3/CNRS)

#AMS02

Monthly flux

# Qty	<t>	tlo	tup	y	ystat_lo	ystat_up	ysyst_lo	ysyst_up	yerrtot_lo	yerrtot_up
H	1311847200	1166400	1166400	3.231000e+02	8.000000e-01	8.000000e-01	5.500000e+00	5.500000e+00	5.557877e+00	5.557877e+00
H	1311155999	43199	43200	3.278000e+02	2.100000e+00	2.100000e+00	3.700000e+00	3.700000e+00	4.254409e+00	4.254409e+00
H	1311242399	43199	43200	3.257000e+02	1.800000e+00	1.800000e+00	3.600000e+00	3.600000e+00	4.024922e+00	4.024922e+00
H	1311328799	43199	43200	3.203000e+02	1.800000e+00	1.800000e+00	3.500000e+00	3.500000e+00	3.935734e+00	3.935734e+00
H	1311415199	43199	43200	3.273000e+02	1.500000e+00	1.500000e+00	3.600000e+00	3.600000e+00	3.900000e+00	3.900000e+00
H	1311501599	43199	43200	3.281000e+02	2.000000e+00	2.000000e+00	3.600000e+00	3.600000e+00	4.118252e+00	4.118252e+00
H	1311587999	43199	43200	3.279000e+02	1.600000e+00	1.600000e+00	3.700000e+00	3.700000e+00	4.031129e+00	4.031129e+00
H	1311674399	43199	43200	3.256000e+02	1.700000e+00	1.700000e+00	3.700000e+00	3.700000e+00	4.071855e+00	4.071855e+00
H	1311760799	43199	43200	3.244000e+02	1.800000e+00	1.800000e+00	3.700000e+00	3.700000e+00	4.114608e+00	4.114608e+00
H	1311847199	43199	43200	3.222000e+02	1.700000e+00	1.700000e+00	3.700000e+00	3.700000e+00	4.071855e+00	4.071855e+00
H	1311933599	43199	43200	3.132000e+02	1.800000e+00	1.800000e+00	3.600000e+00	3.600000e+00	4.024922e+00	4.024922e+00
H	1312019999	43199	43200	3.158000e+02	1.500000e+00	1.500000e+00	3.700000e+00	3.700000e+00	3.992493e+00	3.992493e+00
H	1312106399	43199	43200	3.158000e+02	1.400000e+00	1.400000e+00	3.700000e+00	3.700000e+00	3.956008e+00	3.956008e+00

Daily flux

<t>
(Unixtime)

Flux

σ_{stat}

σ_{sys}

$\sigma_{tot} = \sqrt{\sigma_{stat}^2 + \sigma_{sys}^2}$

AMS Daily Data: 3) External databases

AMS Data at Cosmic-ray Database (LPSC/IN2P3/CNRS)

arXiv > astro-ph > arXiv:2306.08901

Search...

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Astrophysics > High Energy Astrophysical Phenomena

[Submitted on 15 Jun 2023]

A cosmic-ray database update: CRDB v4.1

D. Maurin, M. Ahlers, H. Dembinski, A. Haungs, P.-S. Mangeard, F. Melot, P. Mertsch, D. Wochele, J. Wochele

The cosmic-ray database, CRDB, has been gathering cosmic-ray data for the community since 2013. We present a new release, CRDV v4.1, providing many new quantities and data sets, with several improvements made on the code and web interface, and with new visualisation tools. CRDB relies on the mySQL database management system, jquery and tsorter libraries for queries and sorting, and php web pages and ajax protocol for displays. A REST interface enables user queries from command line or scripts. A new (pip-installable) CRDB python library is developed and extensive jupyter notebook examples are provided. This release contains cosmic-ray dipole anisotropy data, high-energy $\bar{p}/p$ upper limits, some unpublished LEE and AESOP lepton time series, many more ultra-high energy data, and a few missing old data sets. It also includes high-precision data from the last three years, in particular the hundreds of thousands AMS-02 and PAMELA data time series (time-dependent plots are now enabled).All these data are shown in a gallery of plots, which can be easily reproduced from the public notebook examples. CRDB contains 314902 data points from 487 publications, in 4092 sub-experiments from 126 experiments.

Check more details and other measurements on https://arxiv.org/pdf/2306.08901.pdf

AMS Daily Data: 3) External databases

AMS Data at Cosmic-ray Database @ SSDC (ASI)

SSDC SPACE SCIENCE DATA CENTER

COSMIC RAY Database

Database for Charged Cosmic Ray measurements.

Version 3.2

https://tools.ssdc.asi.it/CosmicRays/

Login

Feedback and contacts

Looking for cosmic ray data?

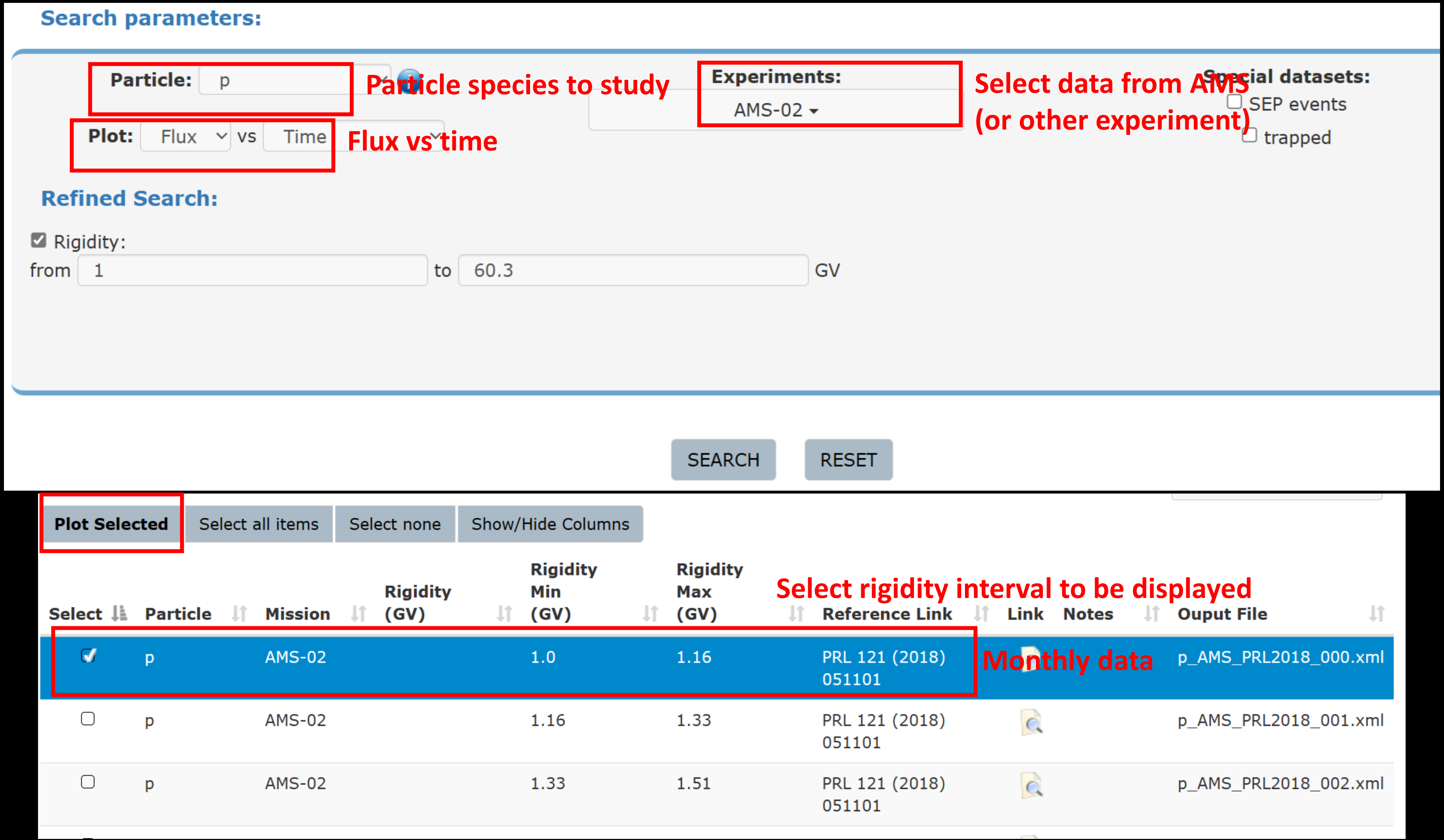
The present Cosmic Ray DataBase (CRDB) provides access to published data from missions dedicated to charged cosmic-rays measurements.
Have a look to our current (not comprehensive but in expansion) **data-set** here!
Data are organized in a SQL database and can be searched through **queries** based on particle species, measurement of interest and/or name of the mission. A refined search is also available.
Query results are accessible through a table, ready to be plotted, exported and downloaded in various formats. The set of returned information comprehends the published data points with associated uncertainties, and some meta-data. When, aside original data, more information are provided (e.g. the corresponding data obtained after some manipulation, as energy-rigidity conversion, change of units or similar), this is reported in the output file. Please, always consult the original publication before using the data.
Feel free to contact us for any comment, query, suggestion, for adding new data or signalling any possible inaccuracy.
Thank you for citing us when using the CRDB for your works!

Currently, only p and He daily fluxes are available in CSV format

Most recent time-dependent AMS data available here!

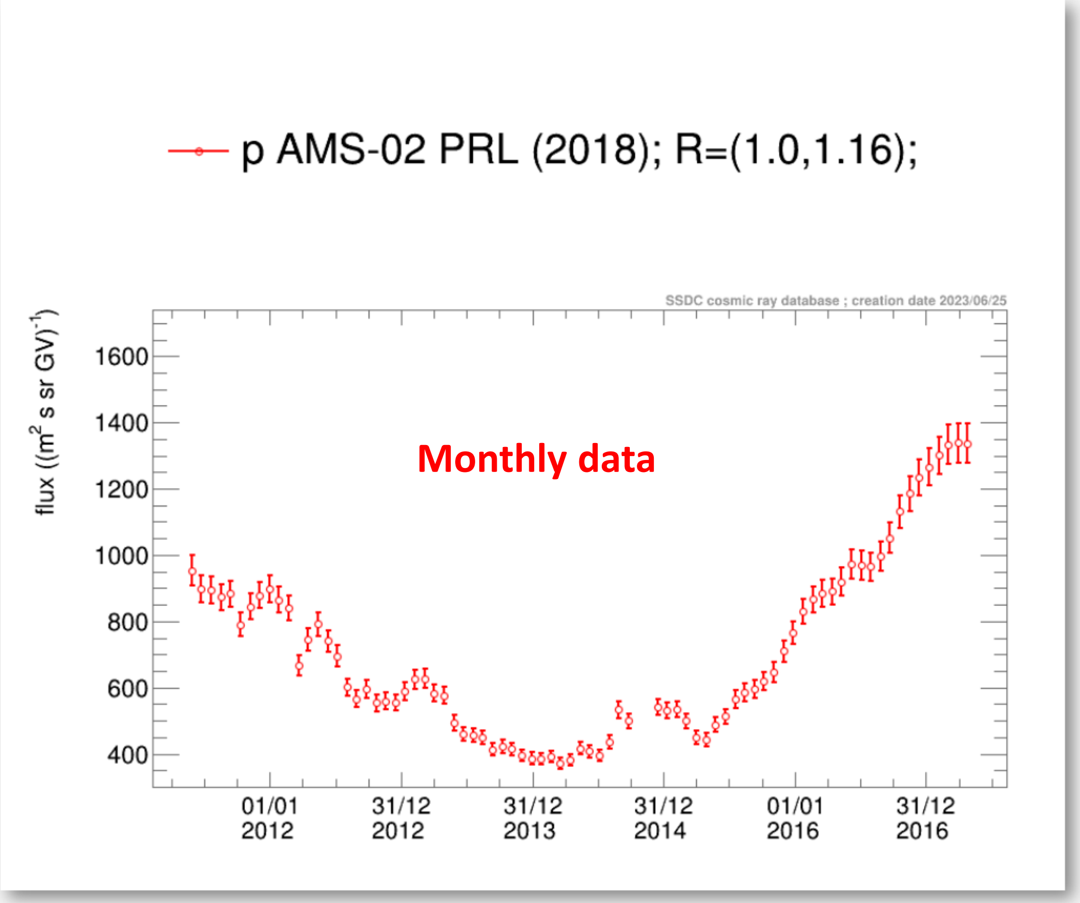
AMS Daily Data: 3) External databases

AMS Data at Cosmic-ray Database @ SSDC (ASI)



AMS Daily Data: 3) External databases

AMS Data at Cosmic-ray Database @ SSDC (ASI)



Any modification to the display option will affect only the ROOT and the PNG file. XML files will not be modified by these actions (for example: fluxes written in the XML file will be compliant to the published ones and will not be multiplied by E^s). Please always consult the original publication.

Default axis are logarithmic

☐ **Show more labels (only valid if log axis)**

☐ **X linear scale**

☐ **Y linear scale**

☐ **Show grid**

☐ **Show horizontal bins**

Set X range:

from ____ **to** ____

Set Y range:

from ____ **to** ____

Multiply Y by E^s

s= ____

Update Plot | Reset Options

Export Format:

☑ png ☑ root ☑ xml ☑ txt

Download

Cosmic Ray DataBase (CRDB) © SSDC

Privacy Policy Visits: 18853

AMS Daily Data: 3) External databases

AMS Data at Cosmic-ray Database @ SSDC (ASI)

```
# Data from SSDC cosmic rays database www.ssdc.asi.it
# File generated today 20230625
# Errors may contain statistic and systematic depending on the options set when drawing the graph
# Fluxes are multiplied by a power of Energy (or Rigidity) if the option is set when drawing the graph
# Horizontal errors usually are not uncertanties of the measurement but correspond to binning. See publication.
#
# GraphTitle: p AMS-02 PRL (2018); R=(1.0,1.16);
# XLabel: time (UTC)
# YLabel: flux ((m^{2} s sr GV)^{-1})
#
# Columns: X, XErrorLow, XErrorHigh, Y, YErrorLow, YErrorHigh
1.306584e+09  0.000000e+00 0.000000e+00  9.531000e+02  4.615246e+01 4.615246e+01
1.308917e+09  0.000000e+00 0.000000e+00  8.981000e+02  4.088276e+01 4.088276e+01
1.311250e+09  0.000000e+00 0.000000e+00  8.940000e+02  4.103084e+01 4.103084e+01
1.313582e+09  0.000000e+00 0.000000e+00  8.726000e+02  3.942436e+01 3.942436e+01
1.315915e+09  0.000000e+00 0.000000e+00  8.827000e+02  3.944617e+01 3.944617e+01
1.318248e+09  0.000000e+00 0.000000e+00  7.898000e+02  3.579679e+01 3.579679e+01
1.320581e+09  0.000000e+00 0.000000e+00  8.450000e+02  3.817814e+01 3.817814e+01
1.322914e+09  0.000000e+00 0.000000e+00  8.790000e+02  3.939353e+01 3.939353e+01
1.325246e+09  0.000000e+00 0.000000e+00  8.982000e+02  4.012044e+01 4.012044e+01
1.327579e+09  0.000000e+00 0.000000e+00  8.648000e+02  3.875061e+01 3.875061e+01
1.329912e+09  0.000000e+00 0.000000e+00  8.394000e+02  3.751386e+01 3.751386e+01
```

Monthly data

<t>
(Unixtime)

Flux

$\sigma_{tot} = \sqrt{\sigma_{stat}^2 + \sigma_{sys}^2}$

Thanks to its large acceptance, identification capabilities and long-term mission in space, AMS is a unique experiment to carry out precise studies on the time variability of the individual species in cosmic rays

By 2030, AMS will cover two solar cycles, and more unexpected results are yet to come