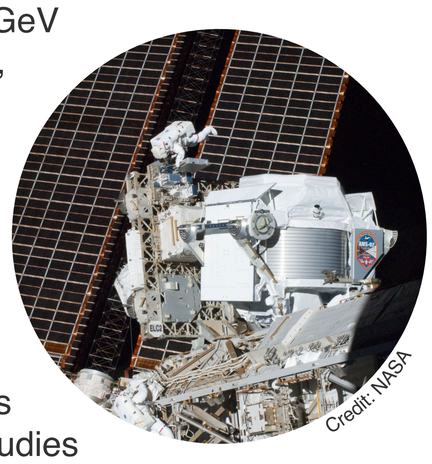
LOW-ENERGY RESULTS FROM THE ALPHA MAGNETIC SPECTROMETER ON THE INTERNATIONAL SPACE STATION AND THEIR INTERPRETATION

MIGUEL REIS ORCINHA (ON BEHALF OF THE AMS COLLABORATION)
ISTITUTO NAZIONALE DI FISICA NUCLEARE, PERUGIA
UNIVERSITÀ DEGLI STUDI DI PERUGIA

1 The AMS detector

Alpha Magnetic Spectrometer (AMS) is a state-of-the-art particle physics detector installed on the **International Space Station (ISS)** that allows for high precision cosmic rays measurements in the GeV to TeV energy scale. In operation since May 2011, AMS has detected more than **233 000 000 000** particles thanks to its high acceptance (~0.5 m^2sr) and long exposure time.



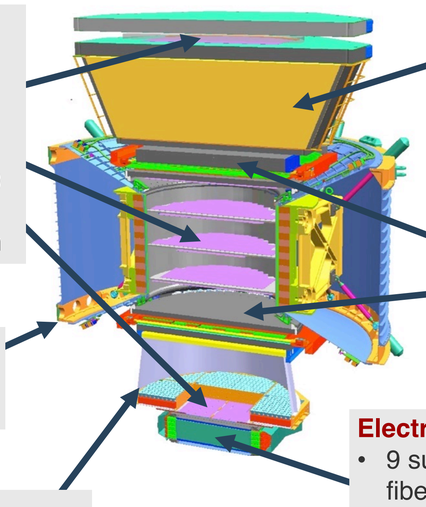
Physics Goals

- ✓ Search for primordial antimatter
- ✓ Search for dark matter signals
- ✓ Search for strange quark matter particles
- ✓ Astrophysics of Galactic cosmic rays & γ-rays
- ✓ Magnetospheric physics & space radiation studies
- ✓ **Solar Physics (long-term cosmic ray modulation & solar events)**

Sillicon Tracker
- 9 layers of double-sided silicon sensors
- Spatial accuracy in bending direction: ~10μm
- Measurement of rigidity (p/q) up to ~2 TV for protons
- Measurement of charge-sign

Permanent Magnet
- 6000 Ne-Fe-B magnets
- Magnitude: 0.15 T

Ring Imaging Cherenkov
- Aerogel and NaF radiators
- Precise measurement of β=v/c with ~0.1% uncertainty



Transition Radiation Detector
- 20 layers of proportional chambers filled with Xe/CO_2 gas mixture
- p/e rejection ~10^2-10^4

Time-of-Flight Detector
- 4 layers of scintillation counters
- AMS' main trigger
- Measurement of β=v/c with ~1% uncertainty

Electromagnetic Calorimeter
- 9 super-layers of lead and scintillating fiber (17 X_0)
- Measurements of e± and γ energy ($\Delta E/E$~2% - 100GeV)
- p/e rejection >10^4

2 Solar modulation of cosmic rays

The Sun emits a continuous stream of highly conductive plasma known as **solar wind** that permeates the entire solar system and transports the **solar magnetic field** within it. This magnetic field changes the **direction** and **energy** of cosmic rays inside the Solar system, creating an effect known as **Solar modulation**.

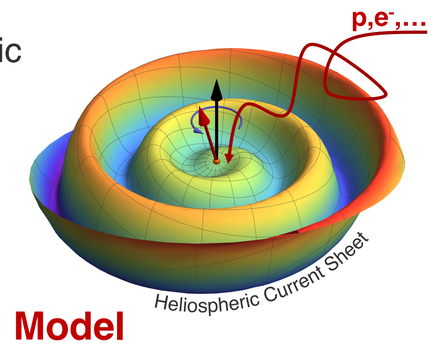
Solar activity enhances this effects by changing the shape, density and velocity of the solar wind over time, thus introducing **time dependence** to this effect.

Variations of several time scales can be observed in the cosmic-ray flux which are directly correlated with solar activity:

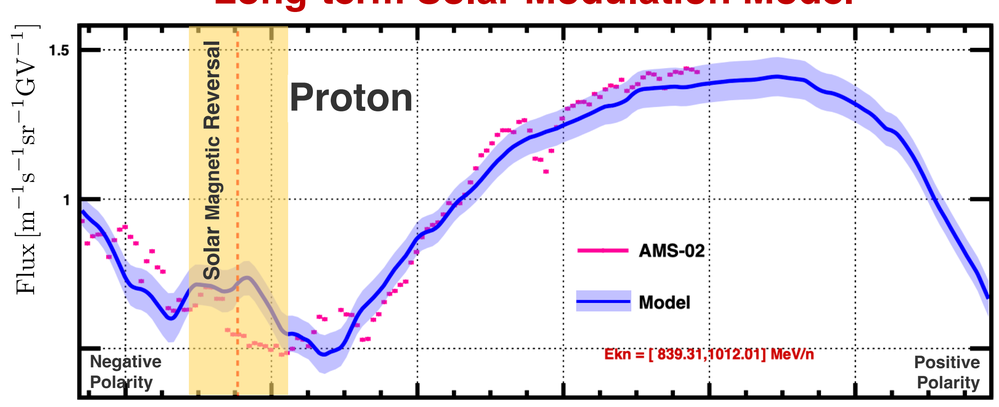
Temporal Variability

- ❑ **Long time scale (~ 11 years)**
  - Change of cosmic-ray intensity
  - Charge-sign effects (related to magnetic field polarity)
- ❑ **Solar rotation (~ 27 days)**
- ❑ **Short time scale (~ few days)**
  - Forbush decrease
  - Solar energetic particles (SEP)

The **Solar activity cycle** is characterized by periodic changes in solar observables as it evolves. Solar activity is at a maximum during the **solar magnetic reversal**. A **1D solution to Parker's TPE** was developed in which solar activity is parametrized using the number of sunspots.



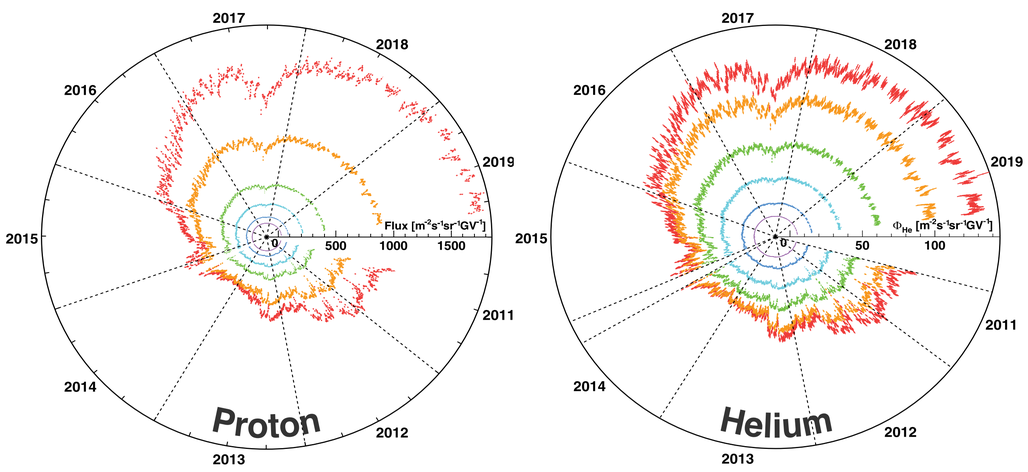
Long-term Solar Modulation Model



3 AMS Daily Proton and Helium fluxes

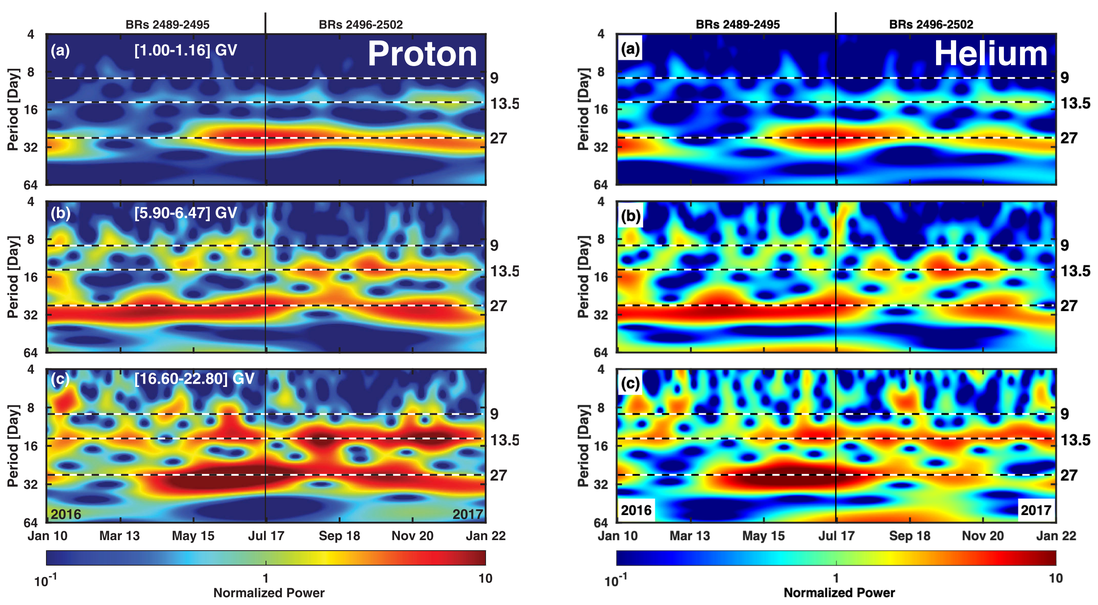
Based on **5 500 million proton events** and on **760 million helium events**, the proton and helium fluxes were precisely measured from **May 2011** to **October 2019**, on a daily time resolution.

Proton & Helium Daily Fluxes



Proton and helium fluxes show common **short-term time structures** to each other and share some with the proton and helium fluxes.

Periodicities in Proton & Helium

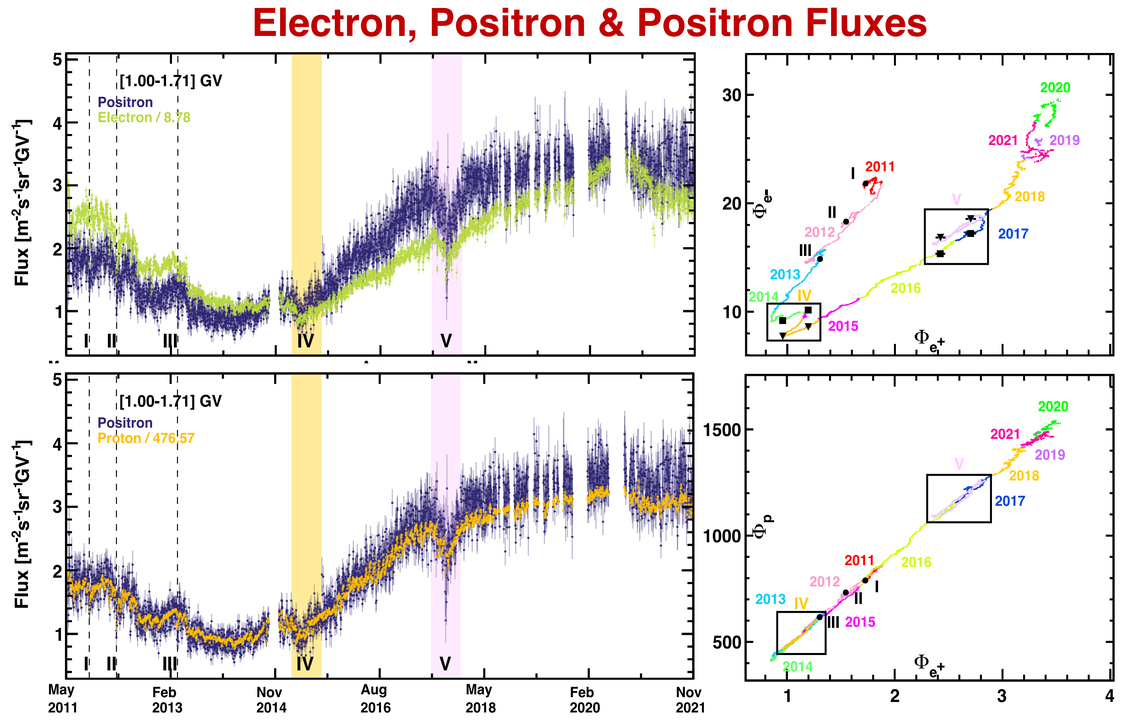


4 AMS Daily Electron and Positron fluxes

Based on **200 million electron events** and **3.4 million positron events**, from **May 2011** to **November 2021**, AMS made precise measurements of the electron and positron fluxes on a daily time resolution.

Positron and electron fluxes showcase the **charge-sign effect**, while proton and positron fluxes exhibit very similar temporal behaviours.

Electron, Positron & Positron Fluxes



Contributions: D. Pelosi, M. Orcinha, N. Tomassetti, F. Barão, B. Bertucci, E. Fiandrini, F. Faldi

Recent AMS Publications

1. **Daily Proton**, PRL 127, 271102, 2021
2. **Daily Helium**, PRL 128, 231102, 2022
3. **Daily Electron**, PRL 130, 161001, 2023
4. **Daily Positron**, PRL 131, 151002, 2023

We acknowledge support from the CAESAR project, ASI-INAF n.2020-35-HH.0, from the ASI-UniPG agreement 2019-2-HH.0, and by acknowledged people and institutions in references above.