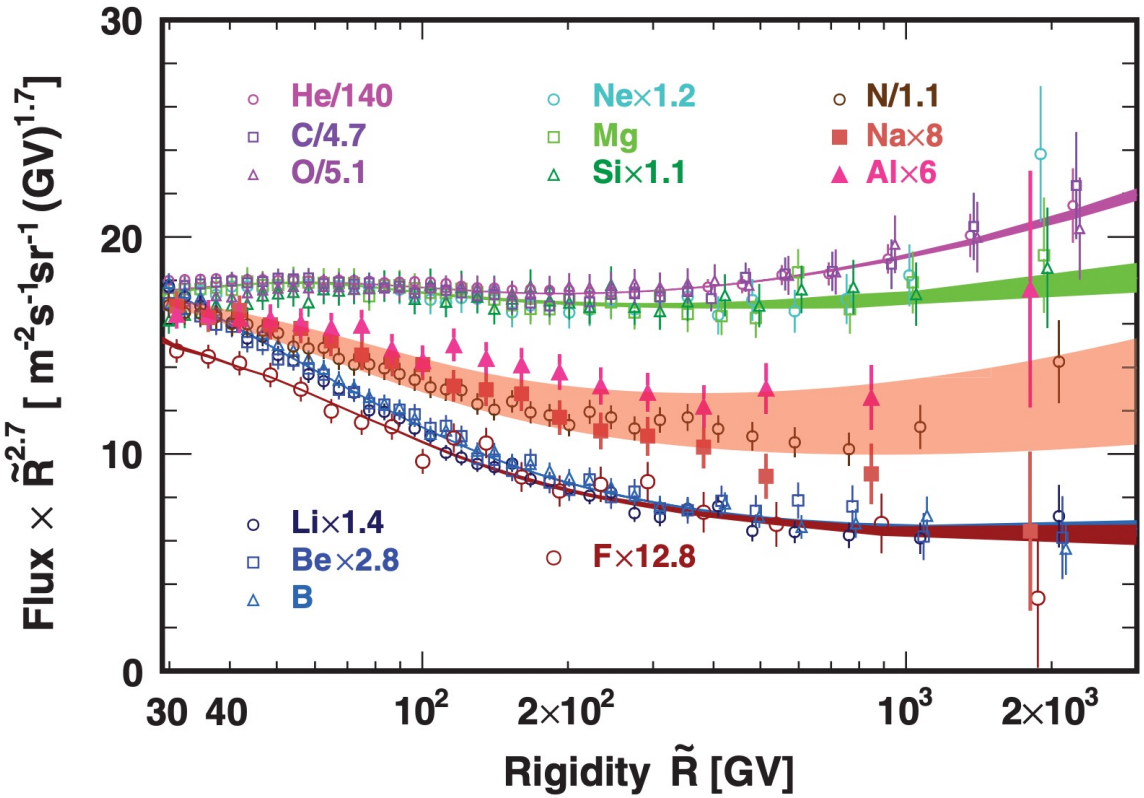
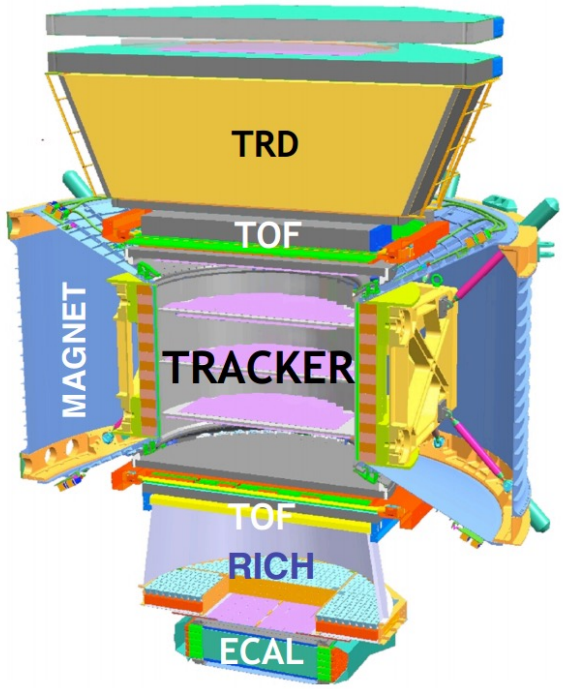
Alpha Magnetic Spectrometer

The **Alpha Magnetic Spectrometer** (AMS-02) is a state-of-the-art cosmic-ray detector installed on the ISS, continuously measuring the cosmic-ray flux. AMS has collected more than **199,500,000,000 cosmic ray events** up to this day, at a rate of about **45 million events per day**.

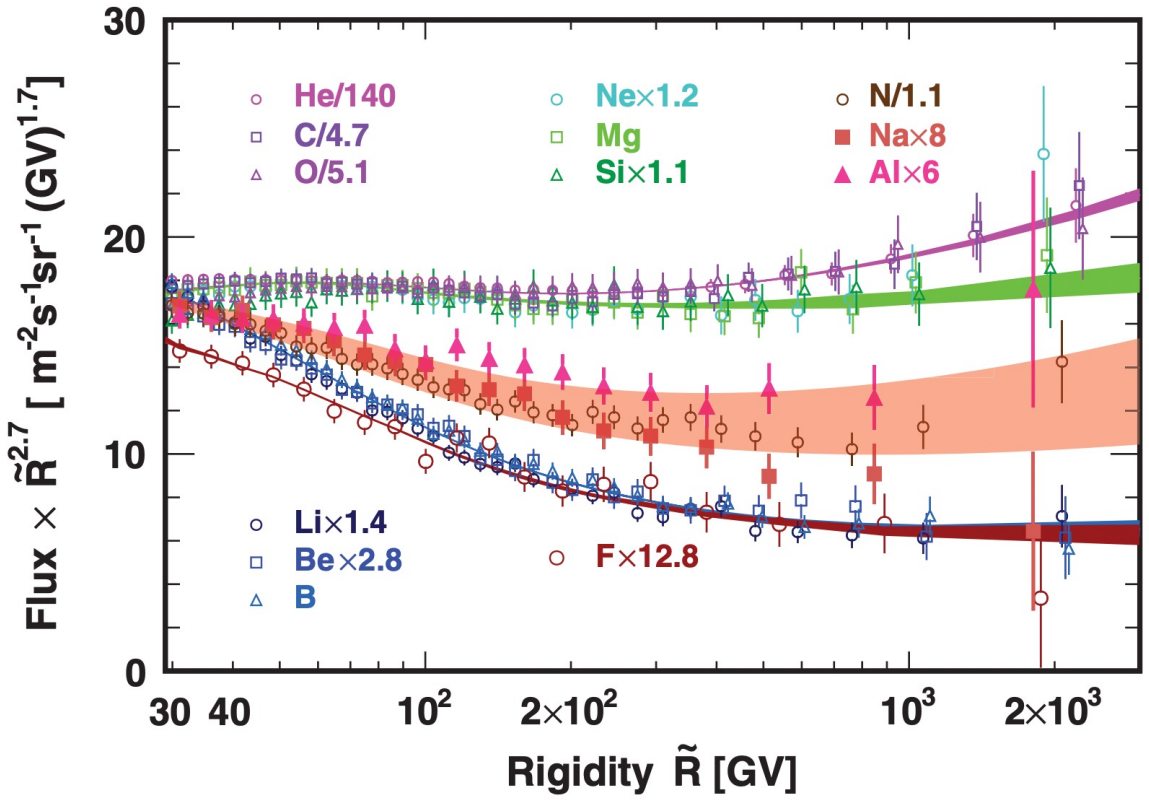


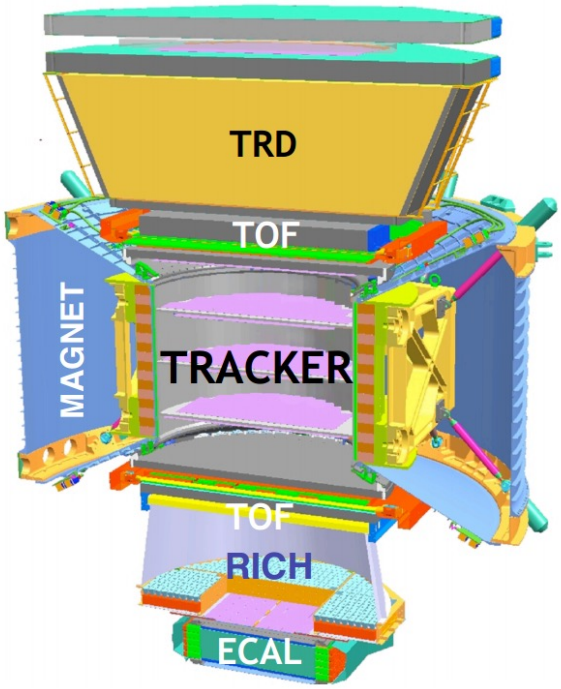


Alpha Magnetic Spectrometer

AMS physics goals:

- Direct detection of cosmic ray antimatter
- Search for evidences of dark matter
- Precise measurement of the cosmic-ray flux
  - Nuclei, leptons, isotopes and gamma-rays
  - Antimatter

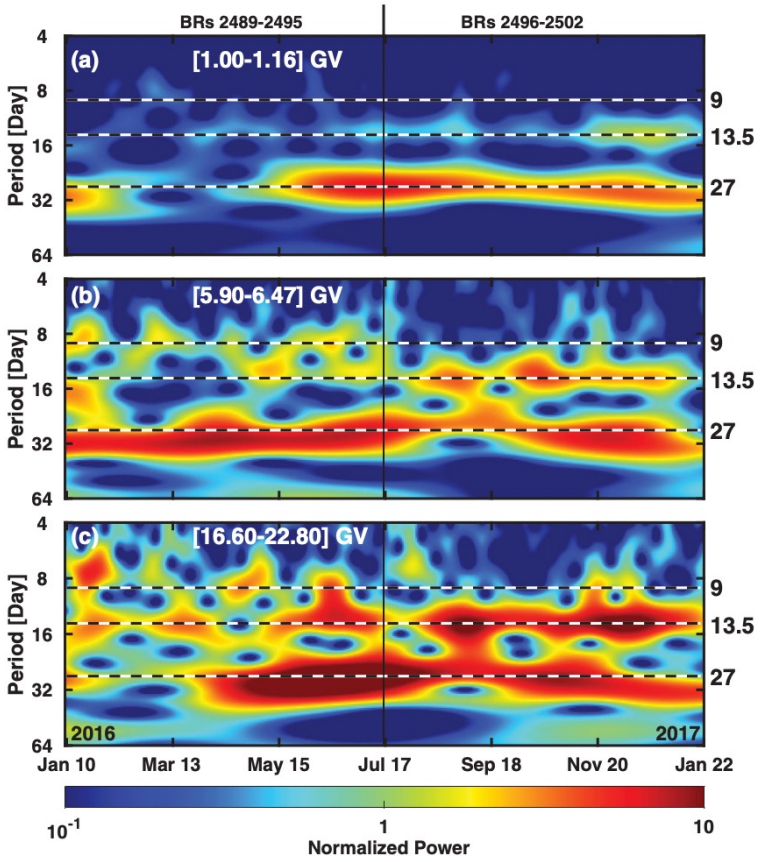




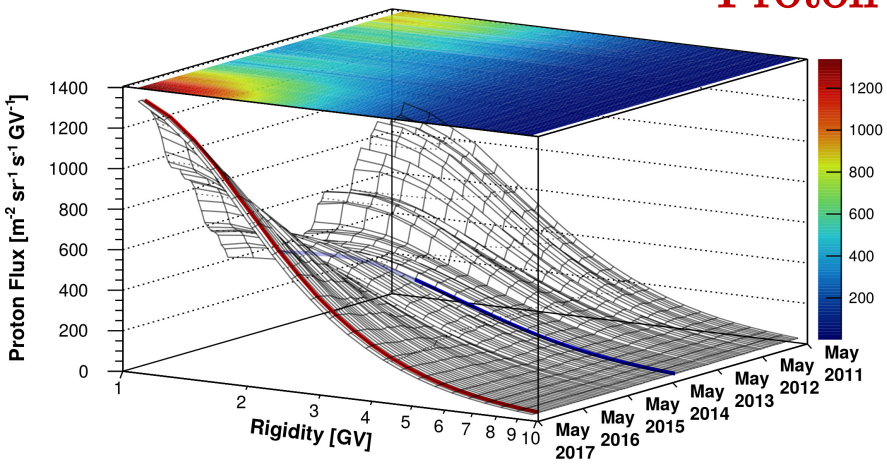
Time Variability

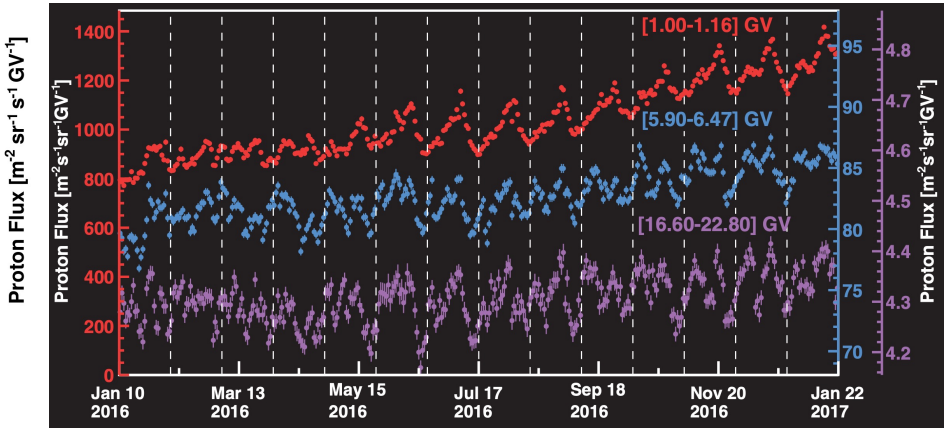
Physics channels

- Time-resolved CR fluxes
  - Daily (solar events)
  - Bartel (solar rotation)
  - Yearly (solar activity cycle, solar magnetic reversal)
- Flux ratios (p/He, e^+/e^-, $^3He/^4He$,...)
- Long-term observations
  - Neutron monitors
  - Satellites (Voyager, Parker probes, balloon, ...)

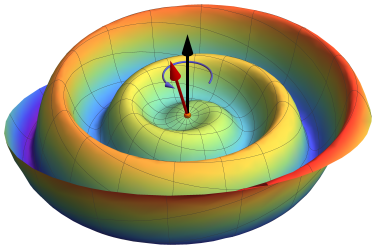


Proton





Low Energy Physics

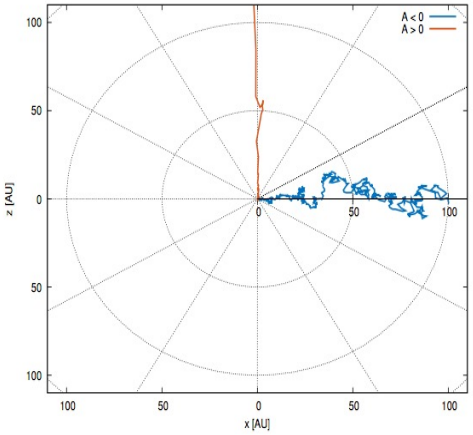


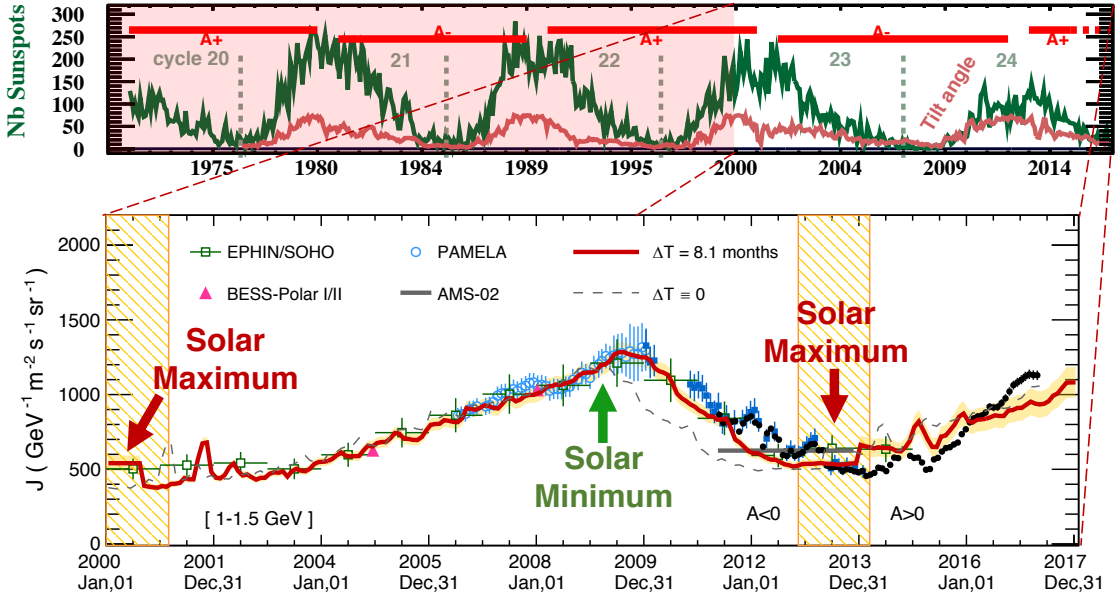
CR transport equation

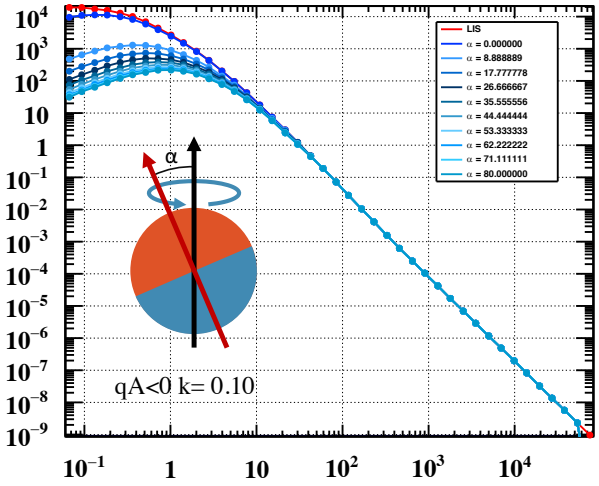
- Parker's equation

$$\frac{\partial f}{\partial t} = \underbrace{\nabla \cdot (\mathbf{K}_s \cdot \nabla f)}_{\text{diffusion}} - \underbrace{(\mathbf{V} + \langle \mathbf{v}_{dr} \rangle) \cdot \nabla f}_{\text{convection and drift}} + \underbrace{\frac{1}{3} (\nabla \cdot \mathbf{V}) \frac{\partial f}{\partial \ln P}}_{\text{adiabatic energy loss}} + \underbrace{Q(r, P, t)}_{\text{source/LIS}}$$

- Solar wind & heliospheric magnetic field
- Numerical & Stochastic resolution of the equation
  - 1D, 2D, Stochastic, Force-Field, ...







Deuteron separation

Isotopic separation

- Grants insight on galactic mass distribution
- Requires accurate mass separation
- Enables the exploration of advanced statistical tools and estimators

$$M^{\mathrm{Total}}(1/m) = f_1 M_p + \underbrace{f_2 M_d + f_3 M_{d\to p}}_{M_d^{\mathrm{Total}}} + \underbrace{f_4 M_{\mathrm{He}\to d} + f_5 M_{\mathrm{He}\to p} + f_6 M_{\mathrm{He}\to t}}_{M_{\mathrm{He}\to X}}$$