AMS observation of complex time structures
in the cosmic-ray electron and positron Fluxes

The Alpha Magnetic Spectrometer (AMS) project

AMS is a particle physics experiment for high precision cosmic ray measurements at GeV-TeV energy. Here is the main 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)**

…and here is how it will fulfill these goals:

- International collaboration: 16 countries, 60 institutes, 500+ scientists
- Same concept (design, precision, capability) as particle detectors at LHC
- Compact design to fit the space shuttle & no human intervention after installation
- Long-term operation above the atmosphere: onboard the ISS at ~400 km altitude since may 2011
- Large collection power: geometrical factor (~0.5 m^2sr) X exposure time (= ISS lifetime)

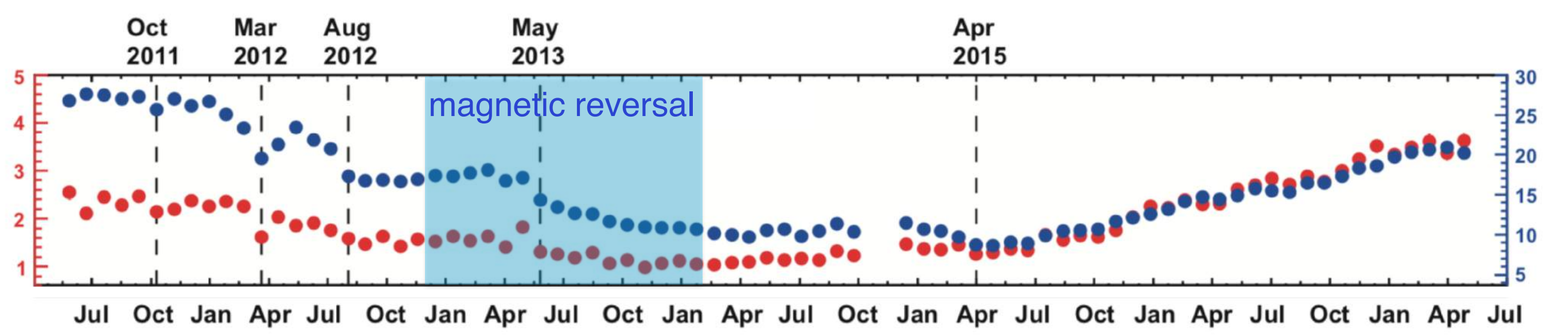
Solar modulation of cosmic particles and antiparticles

When entering the Heliosphere, Galactic cosmic rays interact with the turbulent **magnetic fields** of the Sun dragged out by the **solar wind**. As a result, the intensity of the cosmic radiation near-Earth changes with time, following the 11-year solar activity cycle. This effect is known as **solar modulation of cosmic rays.**

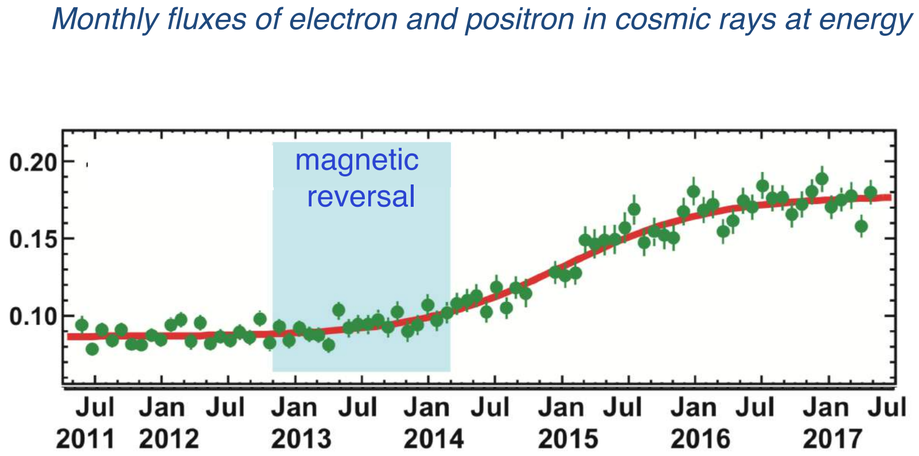
The rare **antimatter** components of the cosmic radiation bring precious information on the physics of solar modulation. In fact, we know that particles and antiparticles are deflected to opposite directions by the Sun's magnetic field, and thus they reach the Earth's vicinity after sampling different regions of the Heliosphere. Moreover, the role of particles and antiparticles **interchanges** at each solar cycle due to **magnetic reversal**: a spectacular event, occurring every 11 years, where the Sun's magnetic north and south **flip**.

AMS measurements of electron and positron in cosmic rays

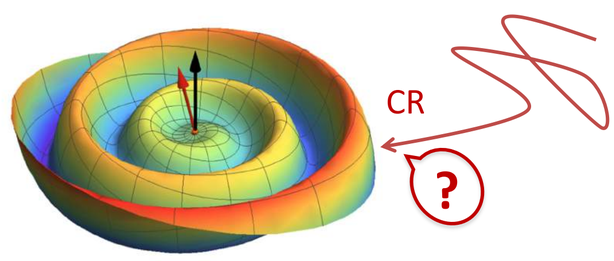
Based on 23.5 million events collected from May 2011 to May 2017, AMS has measured the time variations in the electron and positron fluxes on monthly time scale. This period includes the 2013 magnetic reversal.



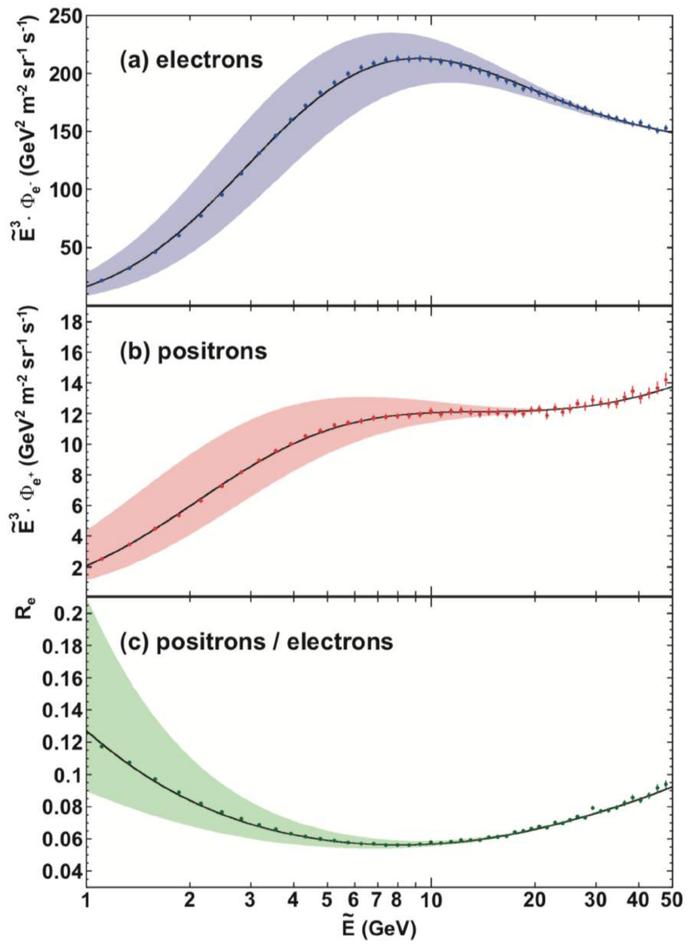
Monthly fluxes of electron and positron in cosmic rays at energy E~1 GeV between May 2011 and May 2017



Time-evolution of the positron/electron ratio at 1 GeV of energy



When cosmic rays enter the heliosphere, they drift across the spiral structure of the solar magnetic field



Observed time-variation range of cosmic-ray electrons, positrons, and positron/electron ratio as function of energy.

The electron and positron fluxes are found to show common short-term structures. In the electron/positron ratio, short-term structures are canceled out, while a remarkable long-term dependence appears after the 2013 magnetic reversal. An explanation for this feature involves **drift motion** of cosmic rays along the regular spiral structure of the heliospheric magnetic field. Due to drift, cosmic positrons and electrons behave differently over the solar cycle, and they role interchanges after each magnetic reversal. Calculations are being carried out.

Multichannel Investigation of Solar Modulation Effects in Galactic Cosmic Rays
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