AMS observation of complex time structures
in the cosmic-ray proton and helium 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:

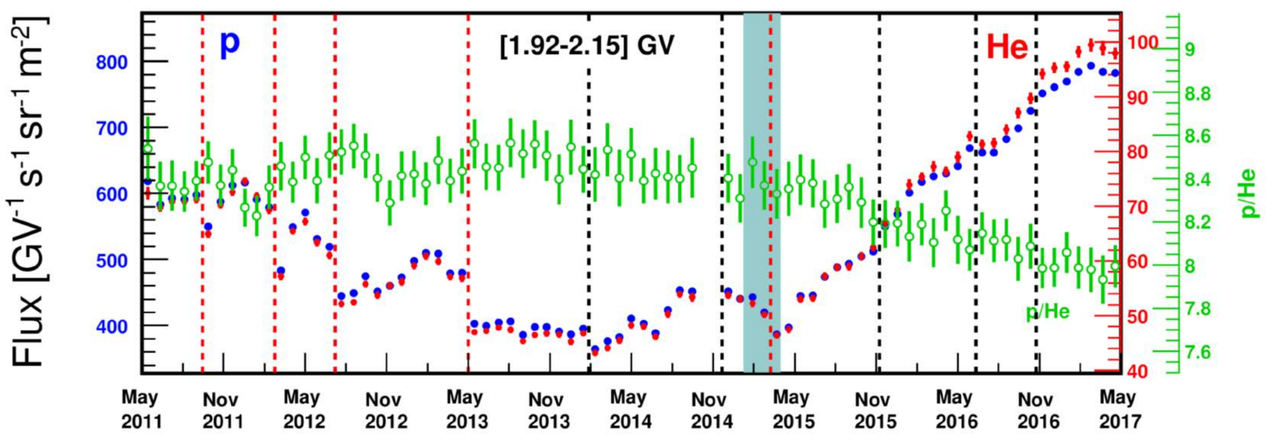
- International collaboration: 16 countries, 60 institutes, 500+ scientists
- Same concept (design, precision, capability) as particle detectors at LHC
- Compact design to fit the space shuttle & no human intervention after installation
- Long-term operation above the atmosphere: onboard the ISS at ~400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

Solar modulation of cosmic-ray nuclei in the heliosphere

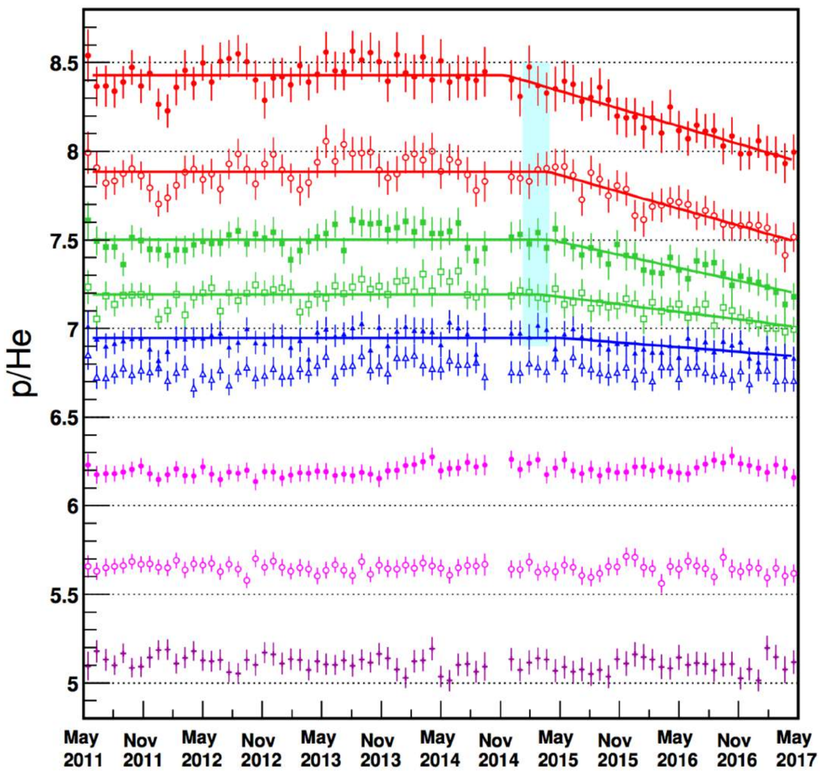
When entering the Heliosphere, Galactic cosmic rays interact with the turbulent **magnetic fields** of the Sun dragged out by the **solar wind**. As a result, the intensity of the cosmic radiation near-Earth changes with time, following the 11-year solar activity cycle. This effect is known as **solar modulation.** Multichannel and time-resolved measurements of cosmic-ray nuclei are well suited to study their transport in the Heliosphere.

AMS measurements of proton and helium fluxes

Based on 958 million events collected from May 2011 to May 2017, AMS has measured the time variations of the proton and helium fluxes on monthly time scale at rigidity between 1 GV and 60 GV.

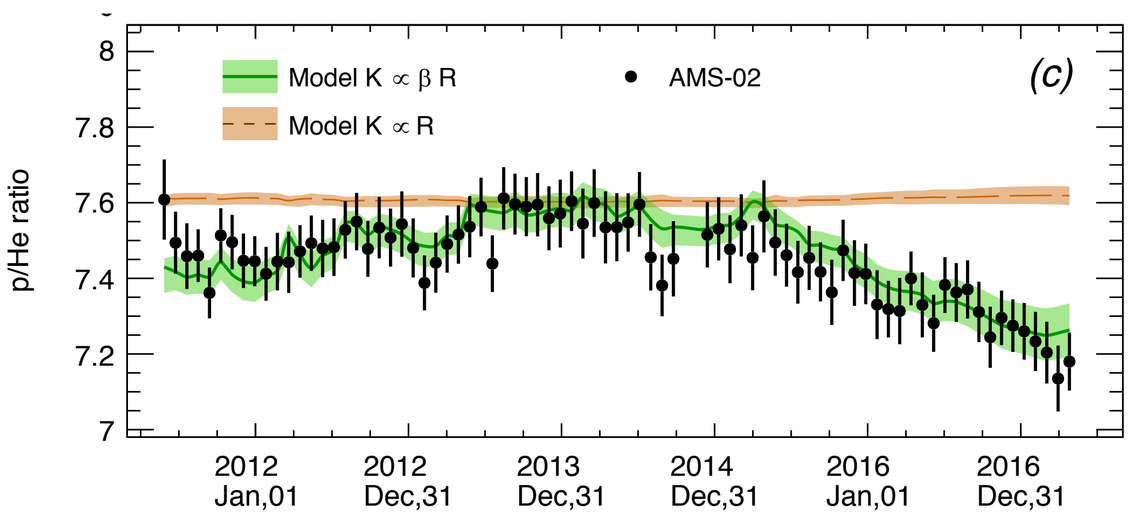


Time dependence of proton and helium fluxes in cosmic rays at rigidity R~2 GV measured between May 2011 and May 2017. The p/He ratio is also shown.



Time dependence of the p/He ratio at rigidity from 2 GV to 22 GV (top to bottom). Below 3 GV, the ratio is not constant

The proton and helium fluxes are found to show identical short-term structures.In the p/He ratio, these structures are canceled out. Below 3 GV, however, the time dependence of the p/He ratio shows a long-term structure. In particular, the p/He time variation is appreciable during the flux recovery phase after May 2015.



Interpretations

Possible explanations for the long-term dependence of the p/He ratio may involve various physical effects, such as (1) differences in their rigidity spectra ouside heliosphere, (2) velocity dependence effects of cosmic-ray diffusion in the heliosphere, (3) the effects of ^{3}He and ^{4}He isotopes in the total helium flux.

Multichannel Investigation of Solar Modulation Effects in Galactic Cosmic Rays
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