



Study of Charged Cosmic Rays in Space

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Cosmic rays are energetic particles traveling through the space. They were discovered in 1912 by Victor Hess. Since then, many experiments were conducted to determine the composition and spectra of the cosmic rays. Charged cosmic rays with energies below ~ 100 TeV are absorbed by the atmosphere and cannot be measured by ground-based instruments. Above 100 TeV, showers induced by collisions with the atmosphere can be observed on ground, but the charge and mass information are lost. Detectors carried by high-latitude balloons or satellites are built to measure lower energy cosmic rays directly. These experiments can determine the particle energies and charges. Furthermore, if a magnetic spectrometer is used, the charge sign and mass of the passing particle can be measured, which provide a complete particle identification. In particular, such a detector can separate anti-particles from their corresponding particles in the cosmic rays.

AMS is currently the only operational space-borne magnetic spectrometer. The detector has a large acceptance and can determine the energy, momentum, velocity, and charge of a cosmic ray particle precisely in the energy range from 0.5 GeV to a few TeV. It measures the spectra of cosmic ray protons, antiprotons, electrons, positrons, deuterons, as well as nuclei from Helium ($Z=2$) to Nickel ($Z=28$), with percent level accuracy. The capability to measure the antiparticles in the cosmic rays allows AMS to explore fundamental physics related to the dark matter and anti-matter in the universe. In addition, the precision spectra of the nuclei show unexpected features. They challenge the current theories of the source, the acceleration processes, and the propagation of the cosmic rays.

In this presentation, I will introduce the design concept and the actual hardware of the AMS detector. A few examples explain how simple physics considerations lead to specific detector designs. The constraints due to the requirements to operate the detector in space are discussed. Finally, some of the most important results of the AMS experiment after 11 years of operation onboard the International Space Station are reported.