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Cover Story (Issue 11, 2025): The Earth-Magnet Assists DAMPE in Studying Cosmic Anti-Electrons

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The recent paper titled "*Measurement of Separate Electron and Positron Spectra from 10 GeV to 20 GeV with the Geomagnetic Field on DAMPE*" [1] presents a new contribution to cosmic-ray physics by utilizing the Earth's magnetic field to distinguish between electrons and their anti-particles, i.e., positrons in data collected by the DAMPE satellite. This approach is necessary given that DAMPE, a calorimeter like Fermi-LAT, lacks an onboard magnet, unlike other experiments such as AMS-02 or PAMELA, the so-called magnetic spectrometers. The study focuses on the energy range of 10–20 GeV, where previous measurements on separate spectra of electrons and positrons were all obtained with spectrometers; however, at higher energies the measurements from Fermi-LAT and spectrometer experiments have large discrepancies.

The DAMPE Collaboration employs a well-validated geomagnetic field model (IGRF-12) to trace the trajectories of cosmic-ray particles, separating electrons and positrons based on their deflection patterns. This technique, known as the east-west effect, has been previously used by Fermi-LAT, but DAMPE's implementation benefits from improved detector performance and a more detailed treatment of systematic uncertainties. The analysis carefully accounts for background contamination, primarily from residual protons, and demonstrates that secondary particles from atmospheric interactions are negligible in the selected energy and angular ranges. The resulting electron and positron spectra show excellent agreement with AMS-02 and PAMELA, reinforcing the reliability of these earlier measurements while suggesting that Fermi-LAT's results at higher energies may have systematic offsets.

The energy range covered by DAMPE in this analysis is relatively narrow (10–20 GeV), constrained by the satellite's zenith-pointing orientation. This prevents the investigation of the positron fraction's intriguing rise above 20 GeV, which has been linked to potential dark matter annihilation or astrophysical sources such as pulsars. The authors acknowledge this limitation and propose a future observational campaign with an inclined detector orientation, though this would require several additional years of data collection. Another challenge is the high background contamination in the positron sample, particularly from protons, which reaches up to 65% at the highest energies. While the background subtraction is handled carefully, the large uncertainties in the positron flux at higher energies highlight the difficulties inherent in calorimeter-based charge separation.

The techniques developed here could inform the design of future missions, such as the High Energy cosmic-Radiation Detection (HERD) facility, which aims to extend cosmic-ray measurements to even higher energies with its 3-D calorimeter and is thus five-side (top and four lateral sides) sensitive to incident cosmic rays. To be placed on the top of the China Space Station in 2028-2029, the primary orientation of HERD is also zenith-pointing; however, the shadows of cosmic rays with different charges, beautifully shown in Figure 1 of the current paper [1], will be well sampled with the lateral sides of HERD with large acceptance, broad energy bands, good energy resolution and excellent electron/proton discrimination power.

References

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