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Formation and Evolution of Radiation Belt Electron Reversed Energy Spectra

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Earth's radiation belts are a torus-shaped region in geospace, filled with electrons and ions at energies of tens of keV to hundreds of MeV that are stably trapped by the terrestrial magnetic field. Delicate competition among the processes of acceleration, loss and transport of the particles lead to a subtle dynamic equilibrium, which controls the overall structure of the radiation belts.

Enabled by NASA's Van Allen Probes launched in August 2012, we can obtain the high-resolution precision measurements of energetic particles, leading to a newly unveiled observation of the reversed energy spectra with abundant high-energy electrons but fewer low-energy electrons between hundreds of keV and ~2 MeV in the inner magnetosphere, which revokes the traditional recognition of radiation belt electron energy spectra as steeply falling fluxes with increasing energy.

Through a combination of observational data analyses and numerical simulations, we have comprehensively studied the reversed energy spectrum of radiation belt electrons, including its spectral characteristics, statistical distribution properties, and the formation and evolution mechanisms. Our results indicate that the reversed energy spectrum of radiation belt electrons has important implications for unveiling the sophisticated energy-dependent nature of wave-particle interactions and energetic particle dynamics in geospace, and also has potential practically applied values to be used for further verification of the empirical models of radiation belt electrons.

References

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