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Editorial: The loss and acceleration mechanisms of energetic electrons in the Earth's outer radiation belt

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Editorial on the Research Topic
The loss and acceleration mechanisms of energetic electrons in the Earth's outer radiation belt

The Earth's outer radiation belt is occupied by different energy electrons (10 s keV – 10 s MeV). The outer radiation belt during geomagnetic storms is extremely variable due to different loss and acceleration mechanisms. Losses mechanisms of electrons mainly include magnetopause shadowing with subsequent enhanced outward radial transport and scattering into the atmospheric loss cones (drift or bounce) via wave-particle interactions with electron cyclotron harmonic (ECH) waves, chorus waves, plasmaspheric hiss, and electromagnetic ion cyclotron (EMIC) waves, etc. Acceleration mechanisms of electrons mainly include local acceleration via gyroresonant interactions with whistler mode chorus waves and inward radial diffusion by ultralow-frequency (ULF) waves. The solar wind and magnetospheric processes have important effects on the evolution of electrons in the outer radiation belt. Other magnetized planets with radiation belts also experience above physical mechanisms.

This Research Topic, "*The Loss and Acceleration Mechanisms of Energetic Electrons in the Earth's Outer Radiation Belt*," aims in advancing the understanding of the loss and acceleration mechanisms of radiation belt electrons and improve the capability to model and forecast the evolution of electrons in the outer radiation belt. This Research Topic collected 9 research articles to address a wide range of topics in the loss and acceleration mechanisms of the electrons in the outer radiation belt.

Yu et al. investigated the influences of latitude-dependent wave power spectrum on the scattering effects of chorus waves on electrons. Compared with the latitude-dependent model, traditional latitudinally constant model introduces great errors in the diffusion coefficients, especially for electrons with small to intermediate pitch angles. Their simulations demonstrate that the latitude distribution of wave power spectrum plays an important role in controlling the dynamics of radiation belt electrons.

Foster et al. examined the consequences of an upstream motion of the chorus wave generation region based on Van Allen Probes observations and nonlinear theory. The findings underscore the importance of considering source region motion in models to enhance the accuracy of predictions related to radiation belt electron behavior.

He et al. investigated the long-duration transpolar arcs (TPA) observed by Fengyun-3D and Defense Meteorological Satellite Program (DMSP) satellites on 17 January 2019, an exceptionally quiet period (AE<30 nT). The TPA initially appeared at the poleward boundary of the auroral oval in the dawn sector and gradually migrated towards the dusk sector. The observations underscore the complex field and particle dynamics in the high-latitude reconnection region and the twisted tail plasma sheet.

Chen et al. studied the ultra-relativistic electron dynamics during continuous geomagnetic storm events based on Van Allen Probe observations. Compared to an isolated geomagnetic storm, electrons are accelerated to higher energies and larger flux levels in continuous geomagnetic storm events. These results are helpful to understand the dynamics of ultra-relativistic electrons in the Earth's outer radiation belt during continuous geomagnetic storm events.

Silva et al. introduced a new method called "*Invariant Matching*" to quantify adiabatic motions. They presented adiabatic motion at different storm phases using the TS05 magnetic field model. This new method can be applied to both outer radiation belt and ring current populations. To remove the influence of adiabatic motion, the observed electron fluxes are usually transferred to phase space densities. Silva et al. reviewed the calculation steps of phase space densities with different implementation options and showed the calculation results. Their analysis reveals that variations in magnetic field models can lead to significant discrepancies in PSD estimations.

Liu et al. examined how variations in wave normal angles, as well as the velocities and temperatures of proton ring and shell distributions, influence the growth rates of magnetosonic (MS) waves based on a full wave dispersion relation solver, the study. These results provide new insights into the excitation of MS waves in Earth's magnetosphere.

Hosseini et al. developed a backward test particle numerical model to investigate energetic electrons distribution interacted with coherent whistler mode waves. Nonlinear interaction features are shown in the simulation results, suggesting the important role of nonlinear phase trapping in driving the amplification of whistler mode waves. These results contribute to a more comprehensive understanding of radiation belt dynamics.

Chakraborty et al. investigated the near-equatorial pitch angle distributions (PADs) of relativistic electrons in the outer belt based on 7 years' observations of Van Allen Probe B. The distribution of three PADs types (pancake, butterfly, flattop) are presented by calculating a pitch angle anisotropy index (PAI). Their results suggest that a simplified formula can capture PADs of outer radiation belt relativistic electrons.

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