Acceleration and Loss of Ultra-relativistic Electrons in the Earth Van Allen Radiation Belts

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Measurements from the Van Allen Probes mission clearly demonstrated that the radiation belts cannot be considered as a bulk population above approximately electron rest mass. Ultra-relativistic electrons (~>4MeV) form a new population that shows a very different morphology (e.g. very narrow remnant belts) and slow but sporadic acceleration.

We show that acceleration to multi-MeV energies can not only result of a two-step processes consisting of local heating and radial diffusion but occurs locally due to energy diffusion by whistler mode waves. Local heating appears to be able to transport electrons in energy space from 100s of keV all the way to ultra-relativistic energies (>7MeV). Acceleration to such high energies occurs only for the conditions when cold plasma in the trough region is extremely depleted down to the values typical for the plasma sheet.

There is also a clear difference between the loss mechanisms at MeV and multi MeV energies. The difference between the loss mechanisms at MeV and multi-MeV energies is due to EMIC waves that can very efficiently scatter ultra-relativistic electrons, but leave MeV electrons unaffected.

We also present how the new understanding gained from the Van Allen Probes mission can be used to produce the most accurate data assimilative forecast. Under the recently funded EU Horizon 2020 Project Prediction of Adverse effects of Geomagnetic storms and Energetic Radiation (PAGER) we will study how ensemble forecasting from the Sun can produce long-term probabilistic forecasts of the radiation environment in the inner magnetosphere.