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Remarkable new results for high-energy protons and electrons in the inner Van Allen belt regions

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Early observations indicated that the Earth's Van Allen radiation belts could be separated into an inner zone dominated by high-energy protons and an outer zone dominated by high-energy electrons. Subsequent studies showed that electrons of moderate energy (less than about one megaelectronvolt) often populate both zones, with a deep 'slot' region largely devoid of particles between them. The two-belt radiation structure was explained as arising from strong electron interactions with plasmaspheric hiss just inside the plasmapause boundary with the inner edge of the outer radiation zone corresponding to the minimum plasmapause location.. Recent Van Allen Probes observations have revealed an unexpected radiation belt morphology, especially at ultrarelativistic kinetic energies (more than several megaelectronvolts). The data show an exceedingly sharp inner boundary for the ultrarelativistic electrons right at L=2.8. Additional, concurrently measured data reveal that this barrier to inward electron radial transport is likely due to scattering by powerful human electromagnetic transmitter (VLF) wave fields. We show that weak, but persistent, wave–particle pitch angle scattering deep inside the Earth's plasmasphere due to manmade signals can act to create an almost impenetrable barrier through which the most energetic Van Allen belt electrons cannot migrate. Inside of this distance, the Van Allen Probes data show that high energy (20 -100 MeV) protons have a double belt structure with a stable peak of flux at L$\sim$1.5 and a much more variable belt peaking at L$\sim$2.3.