Particle transport and energisation in Earth's Radiation Belts

Oliver Allanson[1,2,3]

[1] *Space Environment and Radio Engineering (SERENE); Electronic, Electrical and Systems Engineering; School of Engineering; University of Birmingham; Birmingham; UK*

[2] *Environmental Mathematics; Department of Earth & Environmental Sciences; University of Exeter; Penryn; UK*

[3] *Department of Mathematics; University of Exeter; Exeter; UK*

Understanding the dynamics of energetic electron populations in the Earth's outer radiation belt[1,2] presents unique opportunities to grapple with the fundamental physics of relativistic charged particle trapping, loss, and acceleration in our own 'back-yard'. On the one hand, our understanding of radiation belt dynamics has evolved a great deal in the 60+ years since their discovery. However (and perhaps as ever?), there are many aspects whose basic description and importance in this domain are yet to be fully understood, incorporated, or effectively parameterized and incorporated into system-scale scientific and operational models.

We present a survey of fundamental theory and modelling approaches, focusing on: best current understanding of wave-particle interactions; and some key milestones in the 21st century. We will focus on developments pertaining to wave-particle interactions[3,4,5], and outline future directions. These will include understanding and incorporation of: quasilinear and nonlinear interactions[6,7]; stochastic parameterization[8]; fast and spatially-dependent radial transport[9]; the existence (or otherwise) of an upper limit to electron fluxes[10]; and new modelling paradigms such as combinations of stochastic partial differential equations for particle scattering, with fluid-based approaches[11,12].

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