PAP301 Abstract
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Fast transport of equatorially trapped electrons in the Earth’s radiation belts

Ultra-low frequency (ULF) waves in the Pc4-Pc5, 2–25 mHz range have been observed to accelerate trapped 1–10 MeV electrons in the Earth's radiation belts. This acceleration leads to particle losses and injections that occur on timescales comparable to the particle drift periods. Current models of radiation belt intensity are diffusion models written as Fokker-Planck equations, which fail to capture fast temporal variations in the particle distribution function. This omits any drift-periodic signatures, such as drift echoes and drift resonance, from the models. Furthermore, several existing radiation belt models use electromagnetic fields that violate Liouville’s theorem and yield unphysical results.

This thesis is a study of fast transport of equatorially trapped electrons in the Earth’s radiation belts. We look at solutions for the time evolution of the linear part of the perturbed distribution function using both analytical and numerical methods. Based on this work we build a simple model of fast transport in the radiation belts using a spectral PDE framework called Dedalus. The resulting program is a computationally inexpensive, simple approach to modeling drift-periodic signatures on fast timescales.

The behavior of the distribution function is investigated in three systems: a simple system without a ULF wave, and systems with a single non-resonant and resonant ULF wave. The wave solutions are evaluated with magnetic field perturbations of different magnitudes. The Earth's magnetic field is modeled with the Mead field.

The numerical solution of the perturbed differential equation is studied for 3 MeV equatorially trapped electrons. The results show phase-mixing in the distribution function regardless of field fluctuations or resonance. The non-resonant wave solution shows time-delayed, localized structures in the presence of large magnetic field fluctuations. These transients are also seen in the analytical solution. Due to the nature of the wave solution we do not observe signatures of drift resonance in the simulations, even though drift resonance is present in the analytical solution.