From injection to diffusion: modeling the effect of radial transport on radiation belt intensity

Dr. Solène Lejosne (she/her), solene@berkeley.edu
Space Sciences Laboratory, University of California, Berkeley

Measured radiation belt intensity can present transient fluctuations at trapped particles' drift frequency. While indicative of the occurrence of non-diffusive radial transport events, these drift-periodic fluctuations tend to be viewed as playing little to no role in large-scale radiation belt dynamics. In fact, an essential assumption in radiation belt science is that the typical effect of trapped particle transport on radiation belt intensity is well represented by a purely diffusive model, namely, the radial diffusion equation. This talk will provide observational and theoretical reasons that call into question this consensus.

Drift-periodic fluctuations have been reported in the Earth's inner radiation belt, in the outer belt, and even at Saturn. Their observations have become more and more common over the last decade, facilitated by the use of instruments with high-energy resolution channels. Thus, drift-periodic fluctuations may be a ubiquitous radiation belt feature. Yet, because drift-periodic fluctuations are expected to dissipate rapidly once generated, their contributions to large-scale radiation belt dynamics have been discarded in traditional radiation belt modeling efforts.

I will show that the drift-periodic fluctuation lifetime is in fact much longer than expected (measured in hours in the Earth's radiation belts). I will also explain why the observed magnitude and lifetime of a drift-periodic fluctuation is always an underestimation of the natural magnitude and lifetime of the structure. From the theoretical standpoint, these findings call into question the applicability of the standard, drift-averaged formulation of radial diffusion used to model the effect of radial transport on radiation belt intensity. I will propose a way forward by introducing a drift-diffusion model capable of retaining drift phase information and rendering drift-periodic fluctuations. By using this model in a systematic way, it will be possible to determine the role played by non-diffusive radial transport events in radiation belt acceleration, transport and loss.