Revisiting Langeving Modeling of ISR Spectra: Applications to Parameter Estimation

Brian La Rosa[1], Marco Milla[1], Enrique Rojas[2], Elías Huaripuma[3]

[1]Pontificia Universidad Católica del Perú, [2]Cornell University, Universidad Tecnológica del Perú

Abstract: An incoherent scatter spectral model for collisional and magnetized F-region plasma has been developed by Milla and Kudeki (2011) [1], based on single-particle statistics and a nonlinear Langevin equation that captures the physics of Coulomb collision at small aspect angles. The stochastic differential equation (SDE) resulting from this model was solved using a first-order approximation known as Euler-Maruyama. Furthermore, the statistics needed to perform the autocorrelation function (ACF) were estimated by Monte Carlo experiments. Numerical stiffness progressively deviates the simulation from its exact value when the algorithm is not accurate as required for complex particle dynamics. Therefore, we propose a higher-order numerical algorithm for SDEs that can deal with this difficulty to model the influence of Coulomb collisions in ISR spectra. Benchmarks like computational execution time and weak convergence are covered. In addition, we evaluate and test whether the velocity and displacement distributions deviate from Gaussian. Finally, we will present the results on the design and implementation of simple surrogate models that capture the most salient features of the auto-correlation functions required for parameter estimation.

References:

[1] M. A. MILLA and E. KUDEKI, "Incoherent scatter spectral theories—Part II: Modeling the Spectrum for Modes Propagating Perpendicular to B" IEEE Trans. Geosci. Remote Sens., vol. 49, no. 2, Feb. 2011. [Online]https://ieeexplore.ieee.org/document/5595000

Session: Ionosphere and high atmosphere

Oral or Poster: Oral session