The effects of Coulomb collisions on H^+ and He^+ plasmas for topside incoherent scatter radar applications at Jicamarca

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Abstract

The need for considering the effects of Coulomb collisions in modeling the spectrum measurements at Jicamarca was first suggested by Sulzer and González [1999]. Motivated by this work, Milla and Kudeki [2011] developed a collisional spectrum model that takes into account Coulomb collision effects at all magnetic aspect angles including the direction perpendicular to B as needed for Jicamarca applications. The model has been applied in preliminary fittings of radar data providing encouraging results. However, the model was developed only for O+ plasmas, which limits its application to F-region measurements between 200 km and 600 km. As an extension of this work, we have recently started the development of a new multi-component collisional incoherent scatter spectrum model that considers O+, H+, and He+ plasmas as needed for topside perpendicular-to-B observations at Jicamarca. The development of the spectrum model is being carried out based on the simulation of charged particle trajectories embedded in a collisional magnetized plasma. Coulomb collision effects on the particle motion are modeled by friction and diffusive forces with parameters taken from the standard Fokker-Planck model of Rosenbluth et al. [1957]. As the simulation process is a very demanding computational task, we are working on a CUDA-based simulation program to run the simulations in an NVidia Tesla GPU system. The detailed study of the statistics of the simulated trajectories will give us further insight into the physics of Coulomb collisions, which is needed for the interpretation of incoherent scatter measurements. In this presentation, we will report on our advances on the development of this new spectrum model. The model will be used in the simultaneous estimation of drifts, densities, and temperatures of the topside equatorial ionosphere in perpendicular-to-B experiments at Jicamarca. This experimental evaluation will have a broader impact since the accuracy of the Fokker-Planck collision model will be tested.

References

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