GEC17-2017-000268

Abstract for an Invited Paper
for the GEC17 Meeting of
the American Physical Society

Modeling streamer discharges in strong magnetic fields: from particle to fluid[1]

JANNIS TEUNISSEN, Centre for Mathematical Plasma Astrophysics, KU Leuven, Belgium

In atmospheric air, streamer discharges become magnetized in a magnetic field of a few tens of Tesla. Such strong magnetic fields are experimentally hard to realize, but they can easily be incorporated in a particle model. However, particle-in-cell simulations are computationally expensive, in particular when they need to be performed in 3D. Therefore, I have developed a plasma fluid model for discharges in external magnetic fields. This open-source model uses multi-dimensional electron transport data tables, generated by a Monte Carlo Boltzmann solver. It furthermore includes adaptive mesh refinement and a parallel Poisson solver, making use of the Afivo framework. Two- and three-dimensional numerical simulations show that positive streamers preferably grow parallel to the magnetic field. If the background electric and magnetic field are parallel, the magnetic field accelerates streamers while reducing their radius. For a perpendicular field configuration, deterministic streamer branching parallel to the magnetic field is observed. Surprisingly, the $\vec{E} \times \vec{B}$ drift plays no major role for positive streamers, whereas it does affect negative streamers. One application of the results is the understanding of sprite discharges on Jupiter, which could well be magnetized due to the stronger planetary magnetic field.

[1]Research performed in collaboration with A. Sun and U. Ebert. JT is supported by FWO postdoctoral fellowship 12Q6117N.