ELECTRON TRANSPORT, TRANSIENT PLASMAS AND HIGH-ENERGY PHENOMENA IN PLANETARY ATMOSPHERES

SAŠA DUJKO[1], DANKO BOŠNJAKOVIĆ[1], ILIJA SIMONOVIĆ[1] and CHRISTOPH KÖHN[2]

[1]*Institute of Physics Belgrade, University of Belgrade, Pregrevica 118, 11080 Belgrade, Serbia*
E-mail sasa.dujko@ipb.ac.rs

[2]*Technical University of Denmark, National Space Institute (DTU Space), Elektrovej 328, Kgs Lyngby 2800, Denmark*

Abstract. Lightning on Earth is a complex natural phenomenon bridging several lengths, time, and energy scales ranging from the scattering and motion of the lower-energy electrons in streamer discharges to the emission of MeV leptons, hadrons, and photons by kilometer long lightning leaders. Lightning, and other types of transient plasmas in our atmosphere are responsible for the production of nitrogen oxides, ozone, and other greenhouse gases. Likewise, the Miller-Urey experiment has shown that the electrical discharges in the atmosphere of Primordial Earth may have catalyzed the production of amino acids as a precursor of life on our planet (Köhn et al. 2019, 2022).

In this work, we study the properties of electron transport in gas mixtures that reflect diverse planetary atmospheres, keeping in mind that lightning is not limited to our planet only. Using a numerical multi term solution of the Boltzmann equation and a Monte Carlo simulation approach (Dujko et al. 2010), calculations were carried out over a range of planetary atmospheric conditions relevant for the modeling of electrical discharges and transient plasmas such as sprites and elves. Thermalization of high-energy electrons produced by cosmic rays in Earth's atmosphere and the impact of a planetary magnetic field on the transport properties of the electrons in atmospheres of the gas and ice giants are also examined. We also discuss electron avalanches and avalanche-to-streamer transitions in the atmospheres of Primordial Earth and Titan (the largest satellite of Saturn), by modeling the electron dynamics with the fluid and particle models.

References

Köhn, C., Dujko, S., Chanrion, O., Neubert, T.: 2019, *Icarus*, **333**, 29.
Köhn, C., Chanrion, O., Bodker Enghoff M., Dujko, S.: 2022, *Geophys. Res. Lett.*, **49**, e2021GL097504.
Dujko, S., White R.D., Petrović, Z.Lj., and Robson, R.E.: 2010, *Phys. Rev. E*, **81**, 046403.