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The influence of Bremsstrahlung induced photoionization for the streamer motion in various gas mixtures

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Streamers, the beginning stages of electric discharges, evolve differently depending on their polarity and on the ambient gas composition. One of the well-known supporting mechanisms is “UVphotoionization” where, in air, excited nitrogen emits a UV photon subsequently ionizing oxygen. In pure nitrogen, however, this mechanism is suppressed because of the lack of oxygen; hence this mechanism strongly depends on the ambient gas medium.
In this paper we introduce Bremsstrahlung induced photoionization: In the ambient electric field,electrons gain energy and produce Bremsstrahlung photons through the collision with the ambient gas molecules; similarly to “UV-photoionization”, the Bremsstrahlung photons ionize the gas molecules and, as such, create electron populations detached from the initial electron patch. For the study of this process we implemented the electron-nucleus Bremsstrahlung process as well as the photoionization by individual photons into an already existing 2.5 D Monte Carlo particle code for the simulation of streamers. We initiated plasma patches of electrons and ions with varying initial electron energies and peak densities in different ambient fields in air and pure nitrogen. We will compare the temporal evolution of the electron densities as well as of the electric field with and without modelling Bremsstrahlung. In air we will test the influence of Bremsstrahlung induced photoionization against “UV-photoionization”. We will show that the influence of Bremsstrahlung is negligible in air, but plays a significant role in pure nitrogen at standard temperature and pressure.