3D particle simulations and analysis of streamer discharge in atmospheric air

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Streamers are thin ionized channels that can propagate into non-ionized regions, due to the electric field enhancement at their tips. They typically form at higher pressures (e.g., atmospheric pressure) and are strongly non-linear, as they propagate due to space charge. They play an essential role in the early stage of many discharges, such as lightning discharges, sparks and sprites, in addition, streamers are widely used for many industrial applications, such as plasma assisted ignition/combustion, water/gas cleaning and ozone generation. We have recently developed a 3D particle model to simulate streamer discharges. In this talk, some advanced techniques that are used in the code will be presented in detail, for instance, adaptive mesh refinement (AMR), adaptive particle management and code parallelization. These techniques might be of general interest for researchers doing particle simulations, especially those who have to consider space charge effects. Photoionization and electron detachment from natural background ionization in the form of O2- are included in the simulation. Selected results will be represented, i.e., overlapping avalanches in an overvolted gap, splitting of positive streamers induced by external background ionization or magnetic field, streamer formation from a positive needle electrode. Our results help to answer fundamental questions about inception of pulsed discharges in atmospheric air.

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