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Towards quantitative modeling of multi-streamer processes in 3D

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Based on the work of several PhD students in Amsterdam, we now have a verified model for positive streamers in air. For streamer propagation a fluid model is sufficient, while for branching the discreteness of the photo-ionization events has to be taken into account. The model results on propagation and branching have both been validated on experiments in Eindhoven, and hence a few streamers can now be modeled quantitatively in 3D. However, bursts or coronas with hundreds and more streamers are computationally not feasible. Instead of this, models of dielectric breakdown type should be developed, but based on the now known microscopic basis. We present two results in this direction: 1. The identification of steady positive and negative streamers and a revision of the concept of the stability field. 2. The analysis of streamer heads as coherent structures which allows a macroscopic characterization of the streamer head dynamics by few parameters such as radius, velocity, maximal and minimal field, ionization degree etc. (up to now only for positive streamers). Together with the branching simulations, these are stepping stones towards a reduced model of dielectric breakdown type for multi-streamer structures.

The models were developed and evaluated by the PhD students Dennis Bouwman, Hani Francisco, Baohong Guo, Xiaoran Li and Zhen Wang under the supervision of Jannis Teunissen and Ute Ebert in Amsterdam, and the experiments used for model validation were performed by Ph.D. students Siebe Dijcks and Yihao Guo under the supervision of Sander Nijdam in Eindhoven. For the reduced model, we collaborate with Alejandro Luque in Granada, Spain.