3-D Modeling of Two Interacting Streamers

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Streamers are filamentary plasmas and exist in many natural plasma discharges in the Earth's atmosphere (Bazelyan and Raizer, 2000). They play important roles in the initiation and propagation of lightning. They are the precursors of lightning leader initiation, and they are also the main components of the streamer zone of a propagating leader (Rakov and Uman, 2003). However, the interaction of streamers has not been fully studied and well understood.

Our previous 2-D modeling study on the properties of relatively long streamers shows they exponentially accelerate and expand in reasonable thundercloud electric fields (Shi et al., J. Geophys. Res. Atmos., 121, 7284–7295, 2016). It is also found that the streamers at thundercloud altitudes radiate in the high frequency and very high frequency range of the EM spectrum.

In this talk, we will report the simulation results from a recently developed 3-D streamer model. Our study focuses on the interactions of two streamers initiated simultaneously in an overbreakdown field of $1.5E_k$, which may be found during the corona flash stage of negative leader stepping (Bazelyan and Raizer, 2000). The results show that the peak field in the streamer head determines the propagation direction of the streamer, and the propagation directions of the streamers are no longer along the direction of the ambient field. We also find that the two interacting streamers grow exponentially just as a single isolated streamer does. Assuming that each streamer continues to grow exponentially with a constant growth rate, it can be shown that the two streamers will propagate along their own paths at a fixed angle and will not merge.