PROBLEMS OF CONVENTIONAL BREAKDOWN THEORY OF SPRITES

Victor Pasko

CSSL Laboratory, Penn State University, University Park, PA 16802, USA Email: vpasko@psu.edu

In this talk we will discuss a limited set of problems in current sprite theory emphasizing a relationship of physical processes in sprites and in other thunderstorm related transient luminous events in the middle atmosphere to high-pressure lightning discharges at lower altitudes. It is well established by now that sprites commonly consist of large numbers of needle-shaped filaments of ionization [1] and typically initiate at altitudes 70-75 km in a form of upward and downward propagating streamers [2-5]. Many of the small-scale features observed in sprites can be interpreted in terms of corona streamers, which, after appropriate scaling with air density, are fully analogous to those, which initiate spark discharges in relatively short (several cm) gaps at near ground pressure [6,7, and references therein], and which constitute building blocks of streamer zones of conventional lightning leaders in long gaps [8]. We note that the understanding of ambient gas heating processes initiated by streamers embedded in originally cold air represent a long standing problem, which is of interest for studies of long laboratory sparks and natural lightning discharges [8]. The visual appearance of a subset of the recently observed transient luminous events in the middle atmosphere, which originate from thundercloud tops [9, and references therein], indicate that these events may be related to conventional lightning leader processes and therefore are associated with significant heating of the air in the regions of atmosphere through which they propagate. The recent reports of infrasound bursts originating from sprite altitudes [10-12], provide an additional motivation for studies of the heating of the ambient air and associated chemical effects caused by streamers in transient luminous events. In this talk we will discuss similarity properties of electrical discharges and scaling properties of physical processes involved in the air heating in streamer channels as a function of air pressure and will report the most recent results from a model allowing investigation of effective time scales of air heating in streamer channels.

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