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Identifying single electron avalanches in streamer discharges

GIDEON WORMEESTER, CWI Amsterdam, NL, SANDER NIJDAM, Eindhoven Univ. Techn., NL, UTE EBERT, CWI A'dam and Eindhoven UT — Although some properties of positive streamers in nitrogen-oxygen mixtures, such as velocity and diameter, are remarkably insensitive to the $N_2 : O_2$ -ratio of the background gas, the visible structure can be quite different. In particular, experiments in high purity nitrogen have demonstrated that streamers can exhibit a feather-like structure, with small hairs connecting to the main streamer channel. Such structures were not observed in mixtures with higher oxygen density, such as air. We hypothesize that these hairs are avalanches started by single electrons that move towards the positively charged streamer head. Using results from numerical simulations, the presence or absence of these hairs can be explained: In air, the electron density outside the streamer channel is high and avalanches overlap, while in high purity nitrogen, the electron density is sufficiently low that avalanches are distinct and visible individually.

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