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Attraction of positive streamers to surfaces and free electrons

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Positive streamers require two ingredients to propagate: a sufficiently high external electric field and a constant supply of (free) electrons in front of the developing streamer head. In air, the electrons are usually provided by photo-ionization, producing free electrons in all directions around the streamer head. However, in cases with reduced photo-ionization, for example in pure gasses, the local external field direction does not necessarily coincide with the direction of sufficient electron density. One way to create such a condition is by using a laser beam to ionize a path. Depending on parameters this can lead to a guided streamer moving almost perpendicular to the field direction. Alternatively, a preceding discharge can have left a specific electron distribution and thereby guide the path of following discharges. This effect is very important for pulsed plasma jets or plasma bullets in pure nitrogen. We have studied this by looking at the development of the discharge during the first few pulses after ignition. Finally, a dielectric surface close to the streamer path can have a large influence on both the electric field distribution, as well as the electron density distribution and thereby can lead to specific paths that the streamer follows or avoids.