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Fractal properties of long sparks

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Two methods have been utilised to study the fractal nature of long laboratory sparks. The first method based on a statistical technique uses the variation in angle between consecutive steps to deduce the fractal nature in segments. The second method is based on the sandbox technique to calculate the fractal dimension of long sparks.

The variation in step size was found to be exponential. The direction change followed a Gaussian distribution with a standard deviation of 12.1°. The average tortuosity of laboratory sparks was found to be 10.5°±0.6°. This is about 1° smaller than the values reported for fixed segment length. Thus, the tortuosity values reported in literature for natural and triggered lightning flashes may be a slight over estimate of the actual tortuosity.

The average fractal dimension of laboratory sparks was found to be 1.71±0.14. This value agrees with the commonly accepted 1.7 value for complex laboratory discharges. Surprisingly, the fractal dimension showed a dependency on the magnitude of the applied voltage. This is due to the brightness variations in the sparks caused by channel currents. Thus the fractal dimension not only depends on the channel complexity but also on the channel thickness. This feature can be extended to calculate the currents in natural lightning channels. However, this is a disadvantage when calculating the parameters such as channel tortuosity through fractal methods.

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