Analysis of tortuosity of long laboratory sparks

D I Amarasinghe and D U J Sonnadara*
Department of Physics, University of Colombo, Colombo 03

Channel tortuosity of 50 cm long laboratory sparks were measured by processing a series of images taken by 3 cameras placed at a radial distance of 200 cm from the sparks with the angle between two cameras being 120°. The sparks were generated between a rod and a plane electrode. The measurements were taken at the Division for Electricity and Lightning Research at the Uppsala University Sweden.

Channel tortuosity was determined by using a method similar to a method used to determine the scattering of nuclear particles which has also been applied successfully to natural lightning channels. The distribution of the direction change of the channels was found to be Gaussian with a standard deviation of 15.4°. The average tortuosity of the channels was 12.1° which is smaller than the values reported for natural lightning channels but larger than the values reported for triggered lightning channels. The data showed a polarity-dependency on the width of the distribution of the direction change as well as the magnitude of the tortuosity of the sparks. The geometrical errors due to the cameras contribute an error of less than ±2.5°, which can be further reduced by applying camera corrections. The average tortuosity is strongly dependent on the segment length used in calculating the channel orientation. A Monte Carlo simulation program was used to determine the optimum segment length to extract the channel tortuosity. The investigation of the tortuosity variation with the channel sections indicated a decrease in tortuosity with the height of the sparks which has also been seen for triggered lightning channels.

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