

Does the Magnetic Field from the Leader Channel Influence the Fine Geometrical Structure of the Lightning Channel?

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Abstract— Two-dimensional images of lightning channels generally exhibit geometrical fine structure that can be described as oscillations around approximately straight path sections. In this paper, we use a simplified model to explore the possible influence of the magnetic field produced by the leader current on the leader geometry.

Keywords-lightning; leader; channel geometry

I. INTRODUCTION

Pictures of lightning channels show geometrical oscillations around approximately straight path sections as shown in Figure 1.

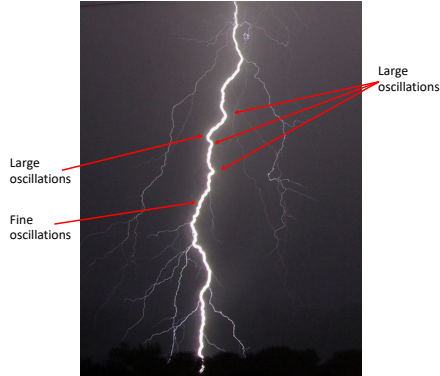


Figure 1. Lightning channel.

The zigzagging behavior has been ascribed to randomness in branching (e.g., [1], [2]). In this paper, we consider the effect of the magnetic field from the leader itself on the observed geometry.

II. SIMPLIFIED MODEL

The stepped leader channel progression is complex, with step formation involving corona streamers and bidirectional propagation. Here, we propose to use a simple model consisting of a continuously extending leader carrying a current of several hundred Amps which produces

a magnetic field through which future leader sections propagate. The magnetic field produces a force on the leader segments that could influence the shape of the leader. The basic schematic model is shown in Fig. 2a.

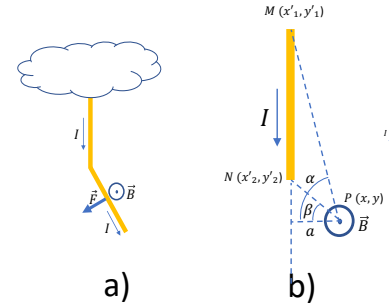


Figure 2. Simplified mode of the leader channel.

The magnetic flux density B is generated by the vertical section of the leader and the force is exerted on the current of the tilted leader section. Expressions for the magnetostatic field and force are readily obtained for the assumed simplified model:

$$\|\vec{B}\| = \frac{\mu_0 I}{4\pi a} (\sin \alpha - \sin \beta) \quad (1)$$

$$\|\vec{F}\| = q \|\vec{B}\| \|\vec{v}\| \quad (2)$$

where a , α and β are defined in Fig. 2b.

Assumptions on the mechanisms that lead to a change in leader propagation direction can be used to investigate the validity of the hypothesis that this magnetic force has an influence on the leader geometry.

REFERENCES

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