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Innovative Insights into Mechanical Properties of Electromagnetic Fields in Conical Cavities: A Unified SI Units Approach (*Invited*)

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This study introduces a novel approach to electromagnetic field analysis in conical cavities, employing a revised format of Maxwell's equations in SI units which aligns the dimensions of electric (E) and magnetic (H) field vectors as inverse meters [1]. The primary objective is to derive evolutionary equations for electromagnetic fields within conical structures, laying a foundation for future research into their mechanical properties, including mass and momentum.

The study leverages the *Evolutionary Approach to Electrodynamics (EAE)* [2, 3], also known as the *method of modal basis* [4], which was utilized for the analysis of electromagnetic fields in regular cavities and waveguides. The *EAE* allows for directly determining transient electromagnetic fields without resorting to Fourier transform techniques.

Recently, the *EAE* has been upgraded with the novel format of Maxwell's equations in SI units [5, 6]. This modification is appropriate for the analysis of the energetic and mechanical characteristics of electromagnetic fields. Herein, we applied the *upgraded EAE* to study the transient electromagnetic fields in conical cavities. It involves expanding the fields over a basis of frequency-independent eigenmodes inherent to the structure. The paper emphasizes the development of the modal basis, followed by the detailed formulation of evolutionary equations tailored to determine the modal amplitudes specific to this problem. In addressing electromagnetic challenges in conical geometries within the time domain, our approach employs a modal representation of transient electromagnetic fields. This approach transforms the initial space-time electrodynamic problem into a set of evolutionary equations, where the unknown modal amplitudes are dependent on radial coordinates and time.

This novel approach not only enriches our understanding of electromagnetic field dynamics in specialized structures but also sets the stage for future studies in the field to study the mechanical properties [7] of the electromagnetic fields in these conical-shaped structures. The applications of this particular problem will be discussed at the Conference. This study was supported in part by TUBITAK (Project No: 120E390).

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