

ABSTRACTS (MASTER THESIS)

Study on Beltrami field in microwaves

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Beltrami field is a vector field parallel to its curl. Beltrami field in an electromagnetic field has some interesting properties; however, there are very few applications using Beltrami field. This is because there is no established theory about Beltrami field. The first objective of this study is to obtain the general mathematical expression and the boundary condition of Beltrami fields, establishing basic theory about Beltrami field. The second objective is to develop applications exploiting the properties of Beltrami fields. The mathematical expression of a general Beltrami field was derived by an angular spectrum method. The mathematical representation of a general electromagnetic field with electric and magnetic field in parallel, $\mathbf{E} \parallel \mathbf{B}$ field, was obtained. It was shown that for any Beltrami field B^+ there exists another Beltrami field B^- such that, the superposition $B^+ + B^-$ becomes $\mathbf{E} \parallel \mathbf{B}$ field. It was also shown that any $\mathbf{E} \parallel \mathbf{B}$ field is expressed in the superposition of two Beltrami fields (Fig.1). The method of obtaining the Beltrami field using a familiar expression of an electromagnetic field was proposed. By using the method the mathematical expression of the Beltrami field in the rectangular waveguide was derived. The boundary condition of the Beltrami field in the waveguide was obtained. The use of a grating was proposed to achieve the boundary condition. The rectangular waveguide with a grating is designed to generate the Beltrami field. Full wave simulations were carried out and the Beltrami field and $\mathbf{E} \parallel \mathbf{B}$ field were generated in the waveguide. In this study, the application exploiting Beltrami field was investigated to achieve the second purpose. A novel length independent resonator with two corrugated reflectors was proposed. The operating principle and resonant condition of the resonator was theoretically obtained. Full wave simulations were carried out to verify the theory. It was confirmed that the length independency of the proposed resonator and the generation of one-dimensional Beltrami standing wave in the resonator (Fig.2).

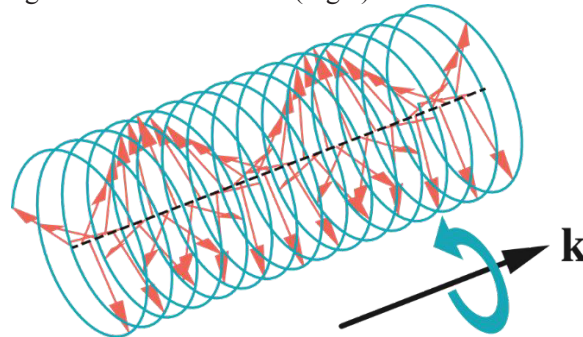


Fig.1 Beltrami field created by created front two circular electromagnetic waves

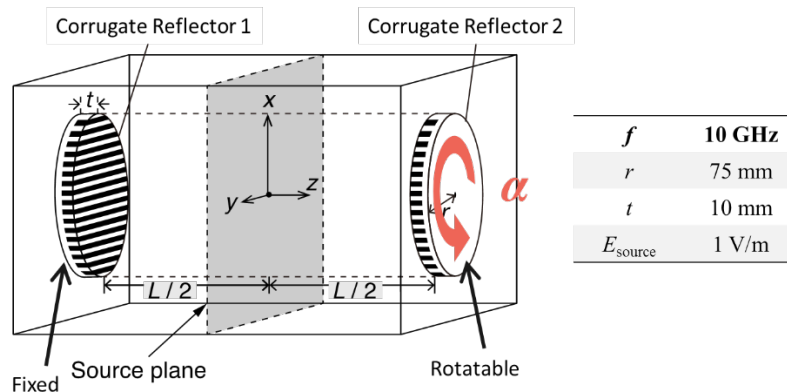


Fig.2 Proposed resonator and the generation of one-dimensional Beltrami standing wave and its simulation parameters