THE UNIVERSITY OF MICHIGAN

COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Radiation Laboratory

FOCUSING EFFECT OF A DIELECTRIC SPHERE ON THE PATTERN OF SIMPLE ANTENNAS

Interim Report (1 April 1971-1 October 1971)

By
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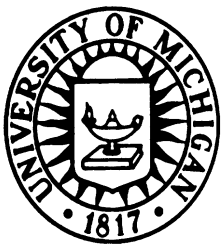

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Summary

For the period 1 April 1971 to 1 October 1971, the research under NASA Grant NGR 23-005-477 has been devoted to studying the focusing effect of a dielectric sphere on the fields of point sources located on its surface. Most of the work has been concentrated in the following areas:

(1) geometrical optical method,

(2) expressions for the fields as obtained by an exact formulation (boundary value problem),

(3) numerical evaluation.

Discussion of Research

A computer program was written utilizing geometrical optics ray-tracing and Snell's law to study the importance of the index of refraction on the focusing effect of the sphere. For various deviation criteria the dielectric constants which minimized the deviation of the rays from the forward direction were determined.

Expressions for the fields radiated from various small antennas located on the surface of a dielectric sphere were derived using the method of Green's dyadic. It was confirmed that the same results could be obtained if the excitation were allowed to approach the surface from either the inside or outside of the sphere as it should be. The three forms of excitation which have been investigated so far are the infinitesimal electric dipole, magnetic dipole and the Huygen source. The Huygen source was selected to approximate the fields present at a waveguide aperture.

A computer program was written to calculate the scattering coefficients; directivity in the forward direction; and the normalized electric field magnitude, angle and intensity in both the horizontal and vertical planes for each source. The program also produces Calcomp polar plots of the normalized field intensity. The result thus far obtained compares very favorably with the

experimental data gathered at NASA Langley Research Center by William F. Croswell and Jnan Saran Chatterjee.

Future Research

Many computer runs will be made to determine the effect of sphere size and dielectric constant on the shape and bandwidth of the field patterns.

The simple Huygen point source will be modified to obtain a better model for a sphere excited by a waveguide aperture.

Personnel

NASA Grant NGR 23-005-477 was awarded to The University of Michigan Radiation Laboratory. The Project Director is Professor Chen-To Tai. Mr. V. Bradford Mason, a graduate student under Professor Tai's supervision, is working on a thesis supported by this Grant.