THE UNIVERSITY OF MICHIGAN

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INTERIM SCIENTIFIC REPORT

Grant No. 72-2262, 1 June 1972 - 31 May 1973

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AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
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STUDIES IN DIFFRACTION

This interim scientific report summarizes the work carried out under the Air Force Office of Scientific Research Grant No. 72-2262 during the period 1 June 1972 to 31 May 1973.

The main objective was the development of improved methods for predicting scattered fields and the initial focus was on the high frequency regime. For bodies whose dimensions are much greater than the wavelength, a highly effective tool is the geometrical theory of diffraction (GTD) which is an extension of geometrical optics through the introduction of the concept of diffracted rays. However, GTD does have certain disadvantages, e.g., its prediction of infinities at places where an infinity of rays come together (i.e., caustics), requiring the introduction of caustic matching functions, and the abrupt discontinuity produced when a flash point becomes shadowed. One way to remove this discontinuity is to incorporate "transition" functions into the GTD prescription and in the particular case of back-scattering from a right circular cone it was found possible to develop an expression for the transition function by likening each generator of the cone to the generator of a half plane or wedge whose edge is at the base of the cone. Some of these results are briefly discussed in a paper by Senior and Uslenghi (1973a) which provides a rather accurate prescription for the backscattering from a right circular cone, incorporating diffraction effects through the second order. In addition, the fact that the rays diffracted by an edge are confined to the surface of the "Keller cone" was verified experimentally (Senior and Uslenghi, 1973b).

Recent years have seen a growing interest in transient or short pulse scattering phenomena and though it is true that these solutions can be deduced from an adequate knowledge of the cw scattering behavior, it may be more effective to seek the time domain solutions directly. A survey of recent developments in transient diffraction and scattering was presented (Senior, 1972) to the XVIIth General Assembly of URSI. The preparation of this invited talk as well as the attendance of the project director at the Assembly were supported in part by the subject Grant, and prompted a subsequent investigation of the impulse responses

of a metallic half plane (Mohsen and Senior, 1973). This particular geometry is one for which the impulse responses for plane, cylindrical and spherical wave excitations are, in fact, simpler than the cw solutions.

The final area of investigation was the low frequency scattering behavior of acoustically hard and soft bodies. It was shown how the first two terms in the low frequency expansions of the far field could be related to the dipole moments for the corresponding perfectly conducting bodies, and numerical results were presented for a variety of geometries (Senior, 1973). The possibility of bounding these terms geometrically was discussed and in the electromagnetic case this question is still under investigation in collaboration with Professor Kleinman of the University of Delaware.

Publications

The following publications resulted from the Grant, and copies have already been forwarded to the Sponsor.

"Experimental Detection of the Edge-Diffraction Cone", Proc. IEEE 60 (11), 1448, (1973) (with P. L. E. Uslenghi).

"Further Studies of Backscattering from a Finite Cone", Radio Science 8, 247-249, (1973) (with P. L. E. Uslenghi).

"Transient Diffraction and Scattering", invited paper presented at the XVIIth General Assembly of URSI, Warsaw, Poland (25 August, 1972). A brief summary was published in Radio Science 8 (6), 599-607 (1973).

"The Impulse Responses of a Half Plane", IEEE Trans. AP-21, 254-255 (1973) (with A. Mohsen).

"Low Frequency Scattering", J. Acoust. Soc. Amer. 53, 742-747 (1973).

Personnel

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13. ABSTRACT

This report briefly summarizes the work carried out under the subject Grant with main emphasis on the high frequency (cw) scattering of electromagnetic waves by perfectly conducting bodies, but containing also some results on transient (time domain) phenomena and low frequency acoustic scattering as well.

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