THE UNIVERSITY OF MICHIGAN

COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRICAL ENGINEERING
Radiation Laboratory

SCATTERING OF ELECTROMAGNETIC WAVES BY MOVING BODIES

First Annual Report

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PART I

For the period from 15 August 1966 to 15 August 1967, most of the research under the National Science Foundation grant No. GK-1213 has been devoted to the following two problems:

(i) The scattering of a plane wave by a uniformly moving perfectly conducting sphere, and

(ii) The scattering of a plane wave by an infinite perfectly conducting sheet moving with hyperbolic motion-the relativistic solution for the motion of a body being acted on by a constant force (Møller, The Theory of Relativity, pp. 74-75).

The research on the first of these problems has been successfully giving insight into the effect of uniform motion on the electromagnetic scattering by a finite body. Although its results apply to scattering by a special shape, namely a sphere, it appears that they may be extended to the treatment of other bodies.

Progress has been made on the second problem; however, it is not completed. The partial results which we have obtained indicate that it is possible to give a meaningful interpretation of the nature of the scattered field as a result of the acceleration.

PART II

Problem (i) The determination of the field scattered by a given moving object is, in principle, straightforward provided that the scattered field is known for the case where the object is stationary. For a stationary conducting sphere with an incident plane wave the well-known Mie solution completely represents the scattered wave. To consider the case when the sphere is undergoing uniform motion one transforms the incident field components to those seen by an observer moving with the sphere by invoking the respective transformation laws which are consequences of the invariance of the Maxwell equations and of the speed of light in inertial reference systems. The problem, now reduced to that of a plane wave incident on a stationary sphere, is solved and the scattered field components can be transformed back to the original system of reference.

It was found, however, a direct application of the above procedure resulted in an extremely awkward expression for the scattered field giving little insight of the problem. By considering only the far-zone field and expressing the results in a "retarded system" an easily interpreted but quite general solution was obtained. The solution still contained the Mie series to which analytic techniques such as the Watson transformation can be applied. It also allowed the calculation of such quantities as the total and differential cross sections. The electromagnetic to mechanical energy exchange processes can also be interpreted.

Problem (ii) Unlike the case of uniformly moving, inertial, systems; accelerating, non-inertial, systems are not elements of the Lorentz group. Their motion is observable by physical experiments and in such systems the classical Maxwell equations do not have the usual interpretation. However, invariant forms do exist for the indefinite Maxwell-Minkowski equations and these, along with constituitive relations depending on the acceleration, do represent the electromagnetic fields in arbitrary systems.

For the case of hyperbolic motion the resulting equations were separable and the separated equations were solvable in terms of Bessel functions and exponential functions. The incident field was transformed to the inertial system and written as an infinite series of the above functions. By means of the boundary condition on the infinite sheet and the causality requirements the solution corresponding to the scattered field can be expressed in an infinite series. The series, however, is very slowly convergent. We are at the present time attempting to obtain an asymptotic expression for it.

PART III

We have published, during this period, an internal memo, The University of Michigan Radiation Laboratory, No. 8266-501-M, 10 January 1967, and have presented, at the URSI Spring Meeting in Ottawa, Ontario, Canada, on 25 May 1967, a paper entitled "Scattering of a Plane Wave by a Moving Perfectly Conducting Sphere" by R. C. Restrick and C-T Tai.

The National Science Foundation grant GK 1213 has been awarded to The University of Michigan Radiation Laboratory which is under the direction of Professor Ralph E. Hiatt. The principal investigator on this project is Professor Chen-To Tai who is, at present, assisted by one graduate student, Robert C. Restrick, III.