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This Grant has been used to support two lines of research: the microwave conductivity of slightly ionized gases, and in scintillation of radio waves from astronomical sources.

For the first, research had been previously started on generalyzing the Lorentz approximation to the Boltzmann collision operator. The motivation for this was that the Margenau[1] calculation for the conductivity of a slightly ionized gas was valid only if the gas were in equilibrium (i.e., in a Maxwellian distribution). Since the gas (the upper atmosphere) around a re-entry vehicle could involve a shock wave, it seemed desirable to ascertain if a strongly non-Maxwellian distribution function would significantly change the conductivity. The previous analysis[2] used a method quite different from Margenau's to develop the conductivity: it involved an expansion of the Boltzmann collision operator (of the electron distribution function, involving the neutral gas-electron interactions) in powers of the electron-gas mass ratio.

It was found that the new method described above could be used for an arbitrary gas distribution function. The collision operator comes out as a series in $(m/M)^n$, with the first (n=o) term being the quiescent-gas result; the n=1 term involves the difference between the gas pressure tensor and that for a quiescent (Maxwellian) gas. This result was published.[3] This collision operator was then used to develop an expression for the a.c. conductivity in a slightly-ionized gas, such as that to be expected in a high-Mach number shock wave. This work formed the basis for the Ph.D. dissertation of Mr. Larry G. Evans[4]; after some further work, it is expected that these results will be published. The results are as might be expected on physical grounds: since the motion of the gas "specifies"

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a direction, and the electric field specifies another direction, the conductivity becomes a tensor (rather than a scalar as in the quiescent-gas case). The deviations from the Margenau (scalar) conductivity are proportional to the electron-gas mass ratio, so that the effect would be noticeable only for very strong shocks; however, calculations are continuing to determine if the consequences are experimentably verifiable.

The second main line of research (started in the middle of the second year of the Grant) was to investigate what could be learned about the interplanetary medium by the scintillations of radio stars. Research of a similar character (though for underwater-sound propagation) suggested lines of analysis which had not been made use of in the astrophysical literature. It was decided to focus on the problem of a radio wave through the interplanetary medium, taking account of the decreasing plasma density with distance from the sun. This would allow both for the refraction of the wave and for us to estimate the errors in the usual phase-screen approximation. As of this date, a paper is being prepared on the results, and, although this is a Final Report, will be sent to the Contract Monitor in the near future.

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