AN INVESTIGATION OF RADIO-WAVE SCATTERING IN THE INTERPLANETARY MEDIUM.

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SUMMARY

This thesis contains a study of the outer corona and interplanetary medium based on observations of the effect of the scattering of radio waves by irregularities of electron density in the medium.

Chapter 1 provides a review of our current knowledge of conditions in the corona and interplanetary medium, with an emphasis on those aspects related to the present study. The basic theory relevant to radio-wave scattering studies is outlined in Chapter 2 together with a brief review of the results of previous studies of coronal broadening and interplanetary scintillation.

A system of three receivers located at the apex of a triangle of side ~100km North of Adelaide has been constructed to measure the solar wind velocity using interplanetary scintillations. The base station for this system was brought into operation during 1972 and the full system completed late in 1974. A description of the design and construction of this system is presented in Chapter 3. Scintillation observations were also recorded with the C.S.I.R.O. Radioheliograph at Culgoora, NSW. Details of the data recording and analysis procedures for both systems are discussed in Chapter 4. This chapter also presents the preliminary results available from the full spaced-receiver system.

By observing a "grid" of scintillating radio sources spaced around the sky it is possible to investigate the propagation of large-scale, flare-produced disturbances into the ambient interplanetary medium. In Chapter 5 the daily variations of a number of sources have been combined with spacecraft observations of the interplanetary plasma to derive a picture of the large scale expansion pattern of five such disturbances. Each of the

events can be related to a specific solar flare which exhibits evidence for both shock-wave and energetic plasma ejection into the corona. Each of the disturbances extended over a wide area of the interplanetary medium by the time the shock wave had reached 1AU, but exhibited marked deviation from the spherical symmetry suggested by some spacecraft observations. Evidence for distortion of the shock front, resulting from propagation into an inhomogeneous ambient medium containing large-scale, corotating structures, is also presented.

Much of the interpretation of interplanetary scintillation data has in the past been based on the scintillation index and power spectrum of the intensity fluctuations. Recently there has been some examination of the probability density functions (p.d.f.) of the intensity fluctuations. In Chapter 6 the p.d.f's for scintillation observations at 80, 111.5 and 160MHz are compared with the two theoretical forms predicted by radio-wave scattering theory. It is found that at these frequencies the p.d.f. is generally intermediate in form between the Rice-squared and lognormal forms but with a tendency to be more nearly Rice-squared than lognormal.

The power spectrum of the intensity fluctuations can, in the case of weak scattering, be directly related to the nature of the electron density irregularities in the interplanetary medium. Chapter 7 presents an investigation of the power spectra of interplanetary scintillations recorded at 80, 111.5 and 160MHz. The effects of a three-dimensional scattering medium and uncertainties in the structure of the radio sources make it difficult to distinguish between Gaussian and power-law forms for the irregularities in electron density with the observational data available.

Fresnel structures, which have been reported only rarely in the literature, have been found in some records. It is shown that these only occur where a strong perturbation in the density of the interplanetary plasma exists close to the Earth. Under normal conditions the effect of scattering along an extended line of sight is to "fill-in" these structures.

Chapter 8 presents a discussion of coronal broadening observations of the Crab Nebula made with the C.S.I.R.O. Radioheliograph during June 1972 to 1974. These results continue previous two-dimensional 80MHz observations into the decreasing phase of the solar cycle and extend the technique to 160MHz. The results are in agreement with previous interferometer observations and reveal a marked decrease in axial ratio of the density irregularities with the decreasing activity.

A summary of the results presented in the thesis and suggestions for future work in these areas are discussed in the final chapter.