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ENHANCED BACKSCATTERING FROM ROUGH SURFACES

Principal Investigator: J C Dainty
Contractor: Imperial College
Contract Number: DAJA45-87-C-0039

2nd Periodic Report

September-December 1987
(Report Date: 18th January 1988)

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1 Progress During Reporting Period

Andrew Sant (graduate student employed on Contract from 10/87) has started a bibliography on surface and volume enhanced backscattering: the current version is appended. Minor upgrades to the scatterometer have been made (e.g. purchase of half-wave plate for 10.6 μm and a quarter-wave plate for 633 nm) and the options for extending the wavelength coverage to the 1-4 μm range are being evaluated in detail. Some two-dimensional surfaces (random gratings) have been made and are currently being measured.

Some preliminary measurements of the Stokes' parameters as a function of scattering angle have been made for surface #83 at normal incidence and $\lambda = 633 \text{ nm}$ (used by O'Donnell and Mendez¹, Fig 9). Figure 1 shows these results, for s-polarisation incident. The physical interpretation of the four Stokes' parameters is:

S_0 : total intensity, I_{tot}

S_1 : 'intensity of horizontal/vertical linear component'

S_2 : 'intensity of 45°/135° linear component'

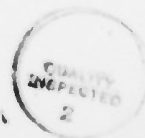
S_3 : 'intensity of RH/LH circularly polarised component'

The intensity of the polarised component is $I_{\text{pol}} = \sqrt{S_1^2 + S_2^2 + S_3^2}$ and therefore that of the unpolarised component is $I_{\text{unpol}} = I_{\text{tot}} - I_{\text{pol}}$. In Fig 1, S_2 and S_3 are small: we have not yet evaluated whether these values are "real" or whether they are a residual error of the measurement technique. If S_2 and S_3 are indeed negligible, then this means that the scattered light consists of a linearly polarised component (S_1) along the same direction as the incident linear polarisation, plus an unpolarised component equal to $(S_0 - S_1)$ in this case. Figure 2 plots these two quantities using data measured earlier in the co- and cross-polarised directions (I_{ss} and I_{sp}): assuming that S_2 and S_3 are ≈ 0 , it follows that $I_{\text{pol}} = I_{\text{ss}} - I_{\text{sp}}$ and $I_{\text{unpol}} = 2I_{\text{sp}}$. Note that the enhanced backscatter peak is almost entirely unpolarised.

During calibration of the scatterometer we measured a freshly prepared Magnesium Oxide surface, which is frequently claimed to be a good approximation to a Lambertian scatterer². As the results in Fig 3 show, it exhibits the enhanced backscatter peak! The energy in this peak is small and the scattering is quite Lambertian for incident angles $< 30^\circ$.

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2 Research Plans

During the next six months we hope to characterise and measure a number of two-dimensional surfaces (random gratings) for comparison with the numerical calculations of Nieto-Vesperinas and Soto-Crespo³. A more detailed study of the Stokes' parameters from three-dimensional surfaces will be carried out. We shall also extend the wavelength range of the scatterometer.

3 Administrative Actions

Dr A T Friberg has been appointed a Research Assistant for the period 1/1/88 to 31/3/88.

4 Other

J C Dainty is Chairman of the Topical Area on "Imaging, Propagation and Scattering through Random Media", at the ECOOSA Conference, Birmingham, UK, 22-25th March, 1988 and this Area includes a Session on "Enhanced Backscattering".

References

- 1 K A O'Donnell and E Mendez, *JOSA A*, **4**, 1194 (1987)
- 2 See, e.g., R S Longhurst, *Geometrical and Physical Optics*, 3rd Edition, Longman, 1973 §18-2.
- 3 M Nieto-Vesperinas and J Soto-Crespo, *Opt Lett*, **12**, 979 (1987)

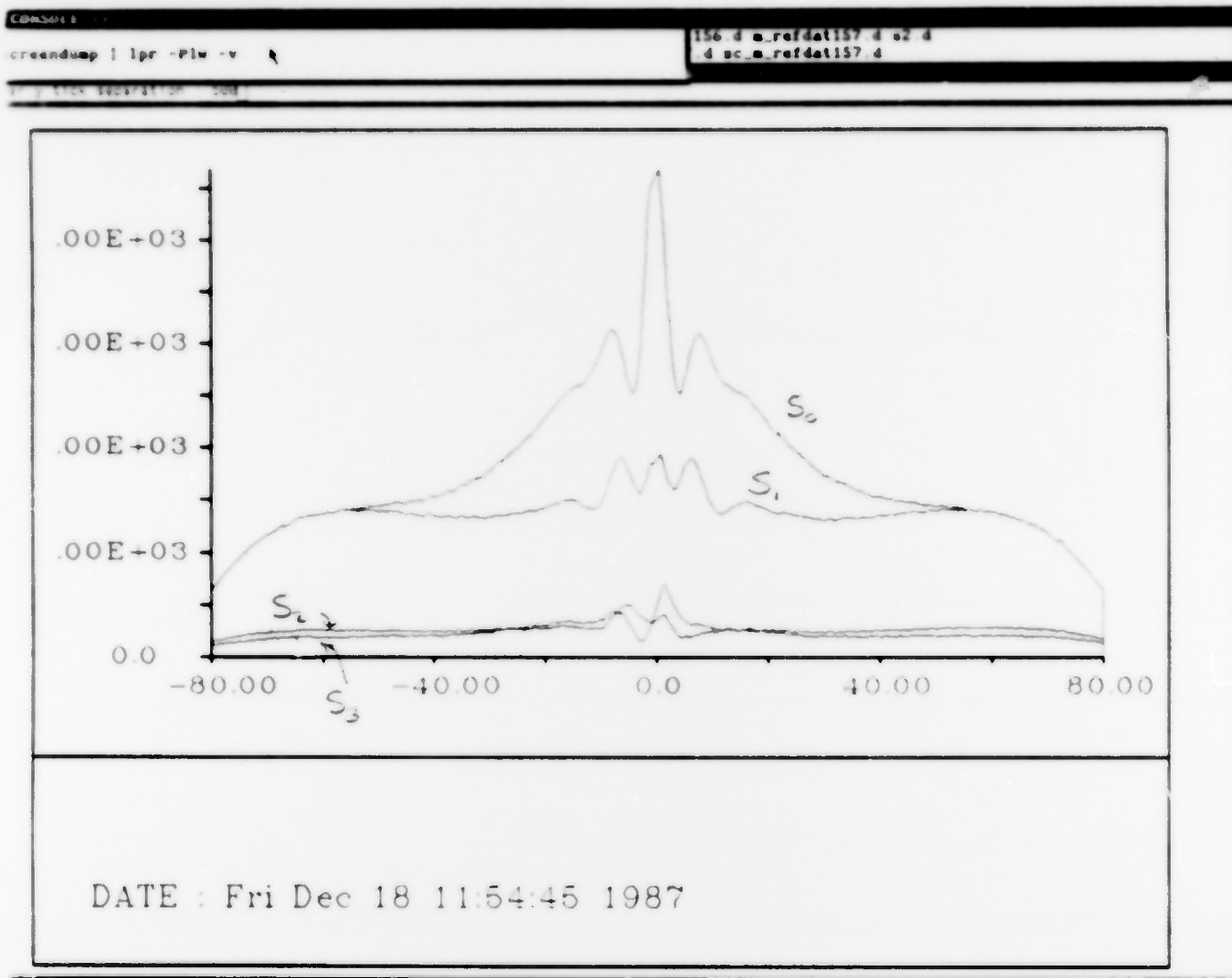


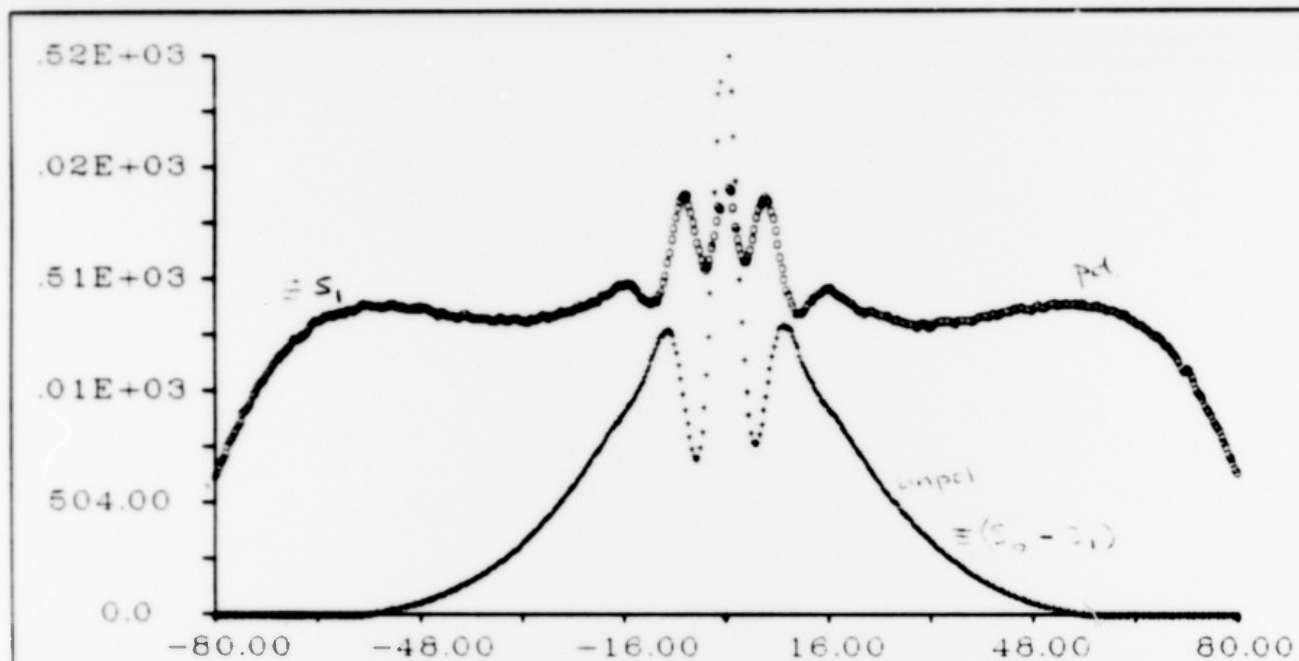
Figure 1

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Figure 2

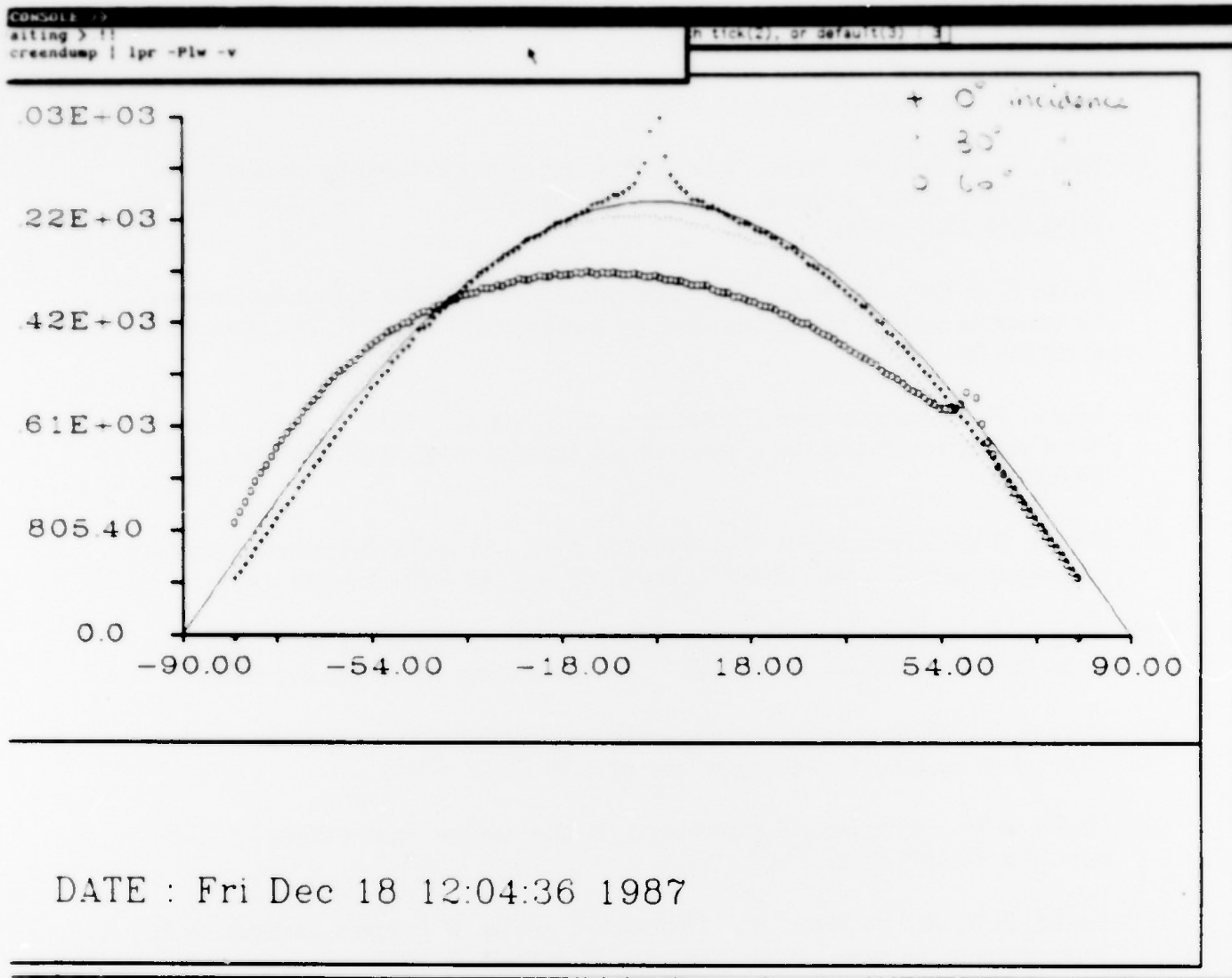


Figure 3

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