APPLICATION OF NUMERICAL METHODS TO PLANETARY RADIOWAVE SCATTERING

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Continued advances in computer technology make numerical solution of certain scattering problems feasible. Our work includes investigation of existing techniques to determine those which might be applicable to planetary surface studies, with the goal of improving the interpretation of radar data from Venus, Mars, the moon, and icy satellites.

Numerical scattering models currently require that the surface be approximated by flat, perfectly conducting facets -- as shown in the figure. Each facet is described in some standard way, such as by its unit surface normal and its area. Facet dimensions are limited to fractions (typically one-tenth) of the probing wavelength. The total field is found by simultaneously solving the boundary condition problem on all the facets which make up the approximation to the surface. These equations relate the incident field, the reradiated (scattered) field, and the currents.

Because the complexity of the computation increases rapidly with the number of facets, only relatively simple surfaces have yielded numerical solutions. Somewhat larger structures may be studied if symmetries -- such as about a rotation axis -- are identified, but these are not helpful in the case of randomly rough surfaces. The simple geometrical shapes sometimes have analytical scattering solutions. Comparison of the numerical and analytical results provides insights into the strengths and limitations of both methods.

After experimenting with some smaller numerical codes, we are now examining the Numerical Electrogmatics Code (NEC) developed at the Lawrence Livermore Laboratory. This is one of the most powerful, publicly available codes for scattering analysis in three dimensions. Though not developed for random rough surfaces, it contains elements which may be generalized and which could be valuable in the study of scattering by planetary surfaces.

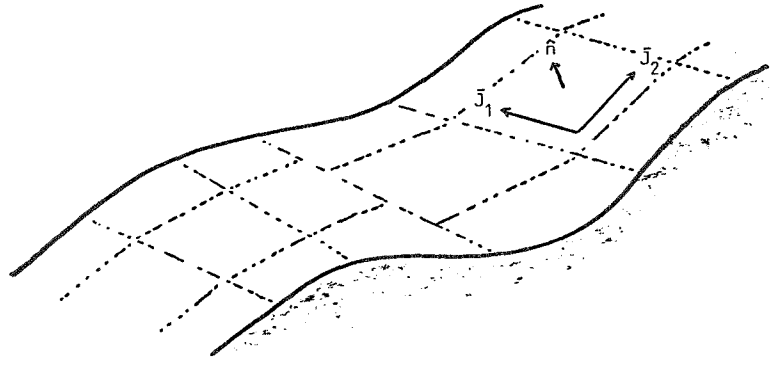

Figure - Gently undulating surface is approximated by facets defined by unit surface normals $\hat{n}$. Orthogonal current components $\bar{J}_1$ and $\bar{J}_2$ link incident and scattered fields through boundary conditions at the surface.