NEW INTEGRAL EQUATION METHODS FOR SCATTERING FROM DIFFRACTION GRATINGS

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One of the main methods to describe the scattering from rough surfaces is that of integral equations. Here we restrict the type of surfaces to diffraction gratings although the methods we discuss can be extended to arbitrary rough surfaces. The equations can be derived using Green's theorem in a periodic cell. The result is a representation of the field in the domain in terms of a boundary integral on the grating, an integral along a line (or plane) above the highest surface excursion, and side or vertical line integrals which cancel due to Floquet boundary conditions. The usual boundary integral equations in coordinate-space follow by evaluating the domain field on the grating boundary. There are several approaches of this type and we mention some of them.

The main difference in our approach here is that we set the domain field on the line (or plane) above the surface. There are several advantages to this. First, the fields on the line have an exact representation as scattered plane waves. Second, the periodic Green's function G in the grating integrals does not have a vanishing or near-vanishing argument. In coordinate-space, G is time-consuming to compute particularly for small arguments. Our values of G do not have this difficulty. Further, the Weyl representation for G simplifies (since the absolute values drop). This enables us to use spectral methods in a simple manner, and leads to integral equations in mixed spectral- and coordinate-space and fully in spectral-space. These involve topological basis modes. An additional new class of equations arises if we use conjugate topological modes in the analysis.

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