Some properties and applications of the Green’s function for Floquet-periodic domains

Jay W. Parker
Jet Propulsion laboratory
4800 Oak Grove Drive
Pasadena, CA 91109-8099

Computing retransmission and reflection of an oblique plane wave impinging on an infinite periodic region is a well-known first step in predicting the response of a frequency selective surface. We consider how to exploit a formalism that supports response prediction, as well as yielding information about an unknown array from the response, the inverse problem. One general analysis technique uses a source-type domain integral equation, leading to consideration of the Green’s function for a Floquet-periodic domain. This Green’s function corresponds to the field produced by an infinite-periodic phased array of point current elements, one such element per period, with phase changing by a constant increment from each period to the next. It also corresponds to the point-current response within a finite-width domain, with a boundary condition at the opposing surfaces that ties the field values with a phase-increment relationship. This Green’s function may be applied to a region of inhomogeneous penetrable material, providing a relationship between internal fields, local material constants, and a corresponding radiation problem due to an equivalent current distribution. A straightforward linear transformation of the equivalent current distribution produces the complex reflection and transmission for an arbitrary incoming wave.

Computation of near-field patterns from equivalent current sources appears to require \((NM)^2\) operations where \(N\) is the total discretization rank in the transverse directions, and \(M\) is the total discretization of the cell in its finite dimension. In the limit of a large number of discrete transverse-domain elements, this may be reduced to \(M^2N\log N\) by utilizing fast Fourier transforms in the transverse directions. We show how this advantage may be exploited in the analysis problem (filling the system matrix), analysis of solution sensitivity, and a cost-function Frechet derivative that constitutes an element of a versatile optimization technique. Applying such inverse problem techniques to Floquet-periodic domains may lead to insights in crystallography, characterization of patterned structures on planetary surfaces, and improved optimization for frequency selective surface designs.