EFFICIENT SOLUTION OF ACOUSTIC AND ELECTROMAGNETIC SCATTERING PROBLEMS IN THREE-DIMENSIONAL PERIODIC MEDIA

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Abstract. We present an accurate and efficient numerical method, based on integral Nyström discretizations, for the solution of three dimensional wave propagation problems in piece-wise homogeneous media that have two-dimensional (in-plane) periodicity (e.g. photonic crystal slabs). Our approach uses (**1**) A fast, high-order algorithm for evaluation of singular integral operators on surfaces in three-dimensional space that extends the methods described in [1, 2], and (**2**) A new, representation of the three-dimensional quasi-periodic Green's functions, which, based on use of infinitely-smooth windowing functions originally introduced in [5], suitable linear combinations (in the spirit of finite differences) of reflected Green's functions, and equivalent-source representations, converges super-algebraically fast throughout the frequency spectrum—even for high-contrast problems and at and around the resonant frequencies known as Wood anomalies. Our fast algorithm for computing periodic Green's functions compare favorably with the classical Ewald's summation method [3] and with other existing methods for fast summations of periodic Green's functions [4]. In addition, we show that the scattering boundary integral equations that incorporate our novel periodic Green's functions are uniquely solvable for all frequencies, including Wood anomalies.

Keywords: boundary integral equations, scattering, periodic Green's functions, fast methods.

Mathematics Subject Classifications (2000): 65.

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