Fast Huygens Sweeping Methods for High-Frequency Waves in Inhomogeneous Media

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In some applications, it is reasonable to assume that geodesics (rays) have a consistent orientation so that the Helmholtz equation may be viewed as an evolution equation in one of the spatial directions. With such applications in mind, we propose a new Eulerian computational geometrical-optics method, dubbed the fast Huygens sweeping method, for computing Green functions of Helmholtz equations in inhomogeneous media in the high-frequency regime and in the presence of caustics.The new method enjoys the following desired features: (1) it precomputes a set of local traveltime and amplitude tables; (2) it automatically takes care of caustics; (3) it constructs Green functions of the Helmholtz equation for arbitrary frequencies and for many point sources; (4) for a specified number of points per wavelength it constructs each Green function in nearly optimal complexity in terms of the total number of mesh points, where the prefactor of the complexity only depends on the specified accuracy and is independent of the frequency parameter.