Uncertainty quantification for high frequency waves

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ABSTRACT

We consider high frequency waves satisfying the scalar wave equation with highly oscillatory initial data. The speed of propagation of the medium as well as the phase and amplitude of the initial data is assumed to be uncertain, described by a finite number of independent random variables with known probability distributions. To estimate quantities of interest related to the wave solution and their statistics, we combine a high-frequency method based on Gaussian beams with sparse stochastic collocation. Although the wave solution is highly oscillatory in both physical and stochastic spaces, we show that quantities of interest based on local averages of the solution are smooth, with derivatives bounded and independent of the wavelength. This observable related regularity makes the sparse stochastic collocation approach more efficient than Monte Carlo methods. We present numerical tests that demonstrate this advantage.