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Dispersion analysis of the Chebyshev spectral element method for the wave equation in the discrete spatial frequency domain

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Dispersion analysis is an essential tool for setting up discretization parameters in the numerical simulation of wave propagation. This analysis is complex and often pessimistic for high-order finite element methods. In this work we perform a dispersion analysis of the spectral element method with (non-regular) Chebyshev collocation points for the wave equation. The numerical dispersion is assessed in the discrete spatial frequency domain, where each eigenpair of the discrete spatial operator matches an eigenpair of the exact operator, according to an article by W. A. Mulder (1999). We extend this approach by comparing the exact eigenvalues with the Rayleigh quotient of the exact eigenvectors with respect to the discrete operator. The Rayleigh quotient approach yields similar estimates of the minimum number of grid points per wavelengths in a simpler manner, which is readily extended to the two-dimensional case.