

# INFLUENCE OF MATERIAL HETEROGENEITY ON THE STABILITY OF EXPLICIT HIGH-ORDER SPECTRAL ELEMENT METHODS

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This talk and the related paper [1] describe precisely the influence of material heterogeneity on the stability of explicit time marching schemes for the high-order spectral element discretisation of wave propagation problems. The heterogeneity consists in a periodic fluctuation of the density and stiffness parameters, whose period is related to the characteristic element size of the mesh. A new stability criterion is derived analytically for quadratic and cubic one dimensional spectral elements in heterogeneous materials, which may in some situations replace the current rule of thumb. The analysis presented reveals the origin of instabilities that are often observed when the stability limit derived for homogeneous materials [2] is adapted by simply changing the velocity of the wave to account for the material heterogeneity. Several extensions of the results derived for quadratic and cubic one dimensional spectral elements are discussed, including higher order approximations, different periodicity of the material parameters and higher dimensions. Extensive numerical results demonstrate the validity of the new stability limits derived for heterogeneous materials with periodic fluctuation. Finally numerical examples of the stability for randomly fluctuating material properties are also presented, discussing the applicability of the theoretical limits derived for material properties with periodic fluctuation.

## REFERENCES

- [1] R. Sevilla and R. Cottreau, Influence of material heterogeneity on the stability of explicit high-order spectral element methods. Submitted for publication in *Comput. Phys.*, 2017.
- [2] G. Cohen, *Higher-order numerical methods for transient wave equations*, Springer, 2001.