A discontinuous Galerkin method for wave propagation in coupled elastic-acoustic media

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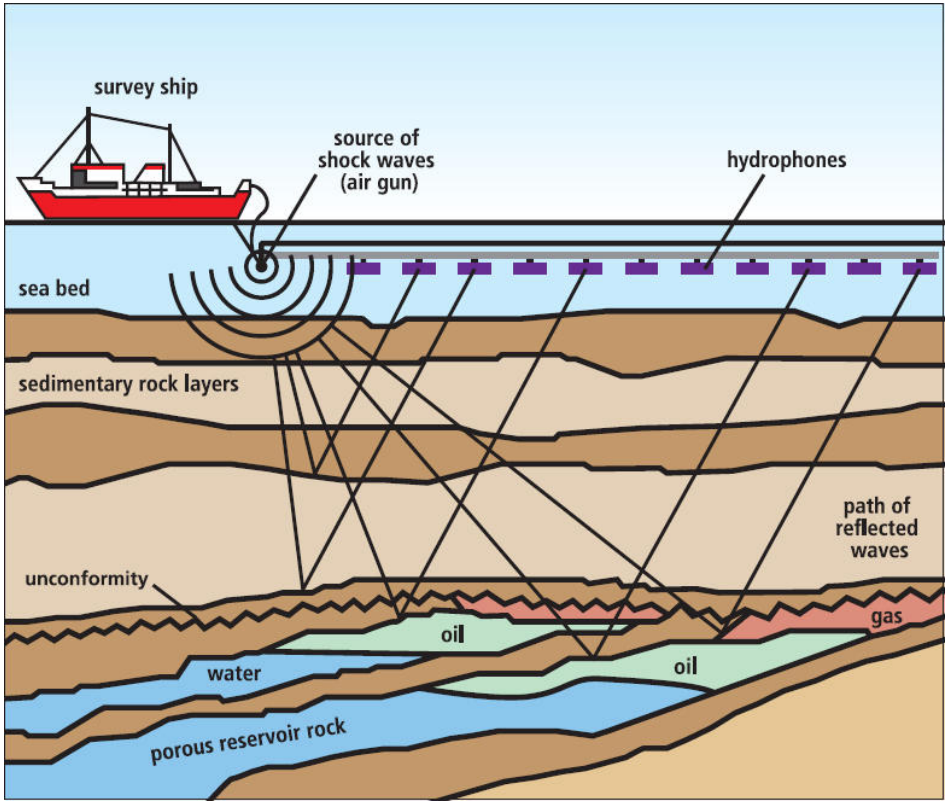
Motivation

In marine seismology, waves propagate through different subsurface layers, resulting in models with fluid-solid interfaces.

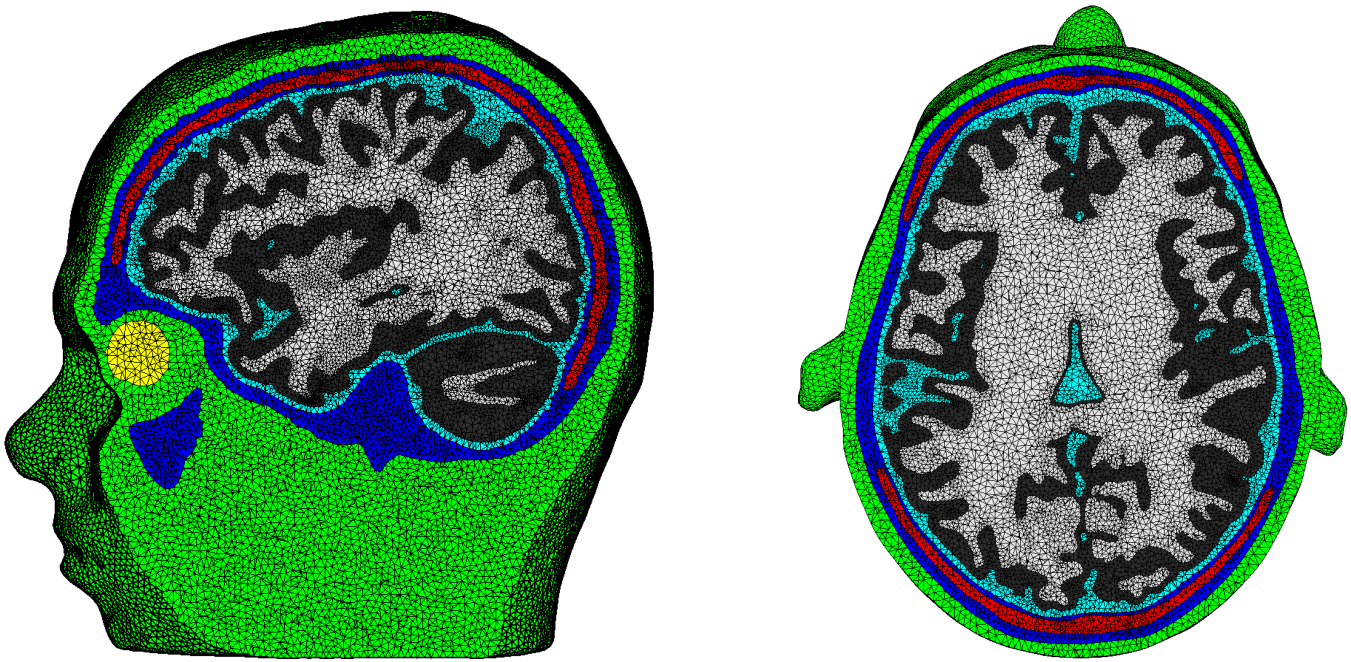


Marine seismic exploration

https://www.capeandislands.org/post/dynamite-going-your-bedroom-more-seismic-surveys-may-be-coming-atlantic-coast#stream/0

Motivation

In photoacoustic tomography (PAT), researchers want to locate brain tumors through reconstruction of initial pressure condition.



FEM mesh of an adult head

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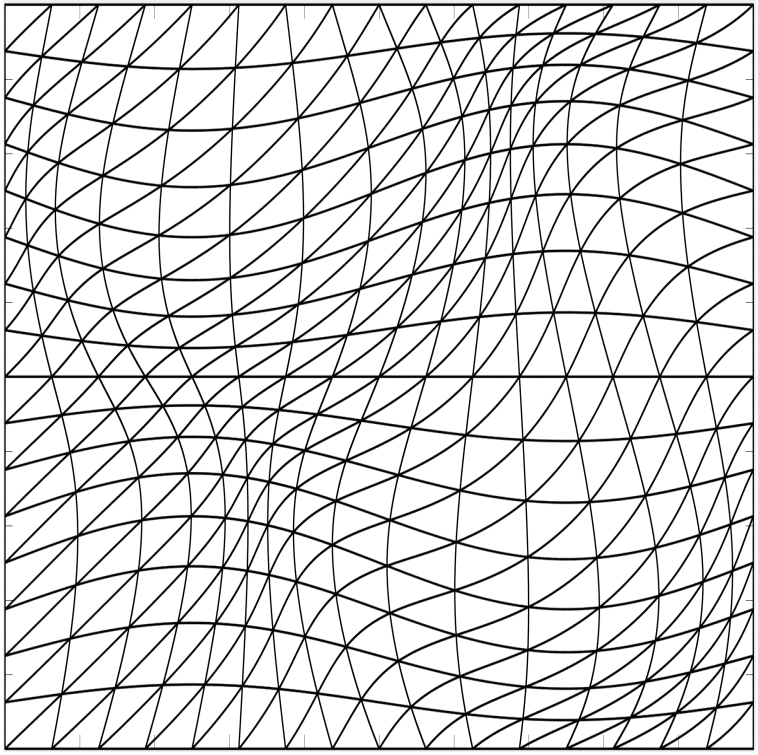
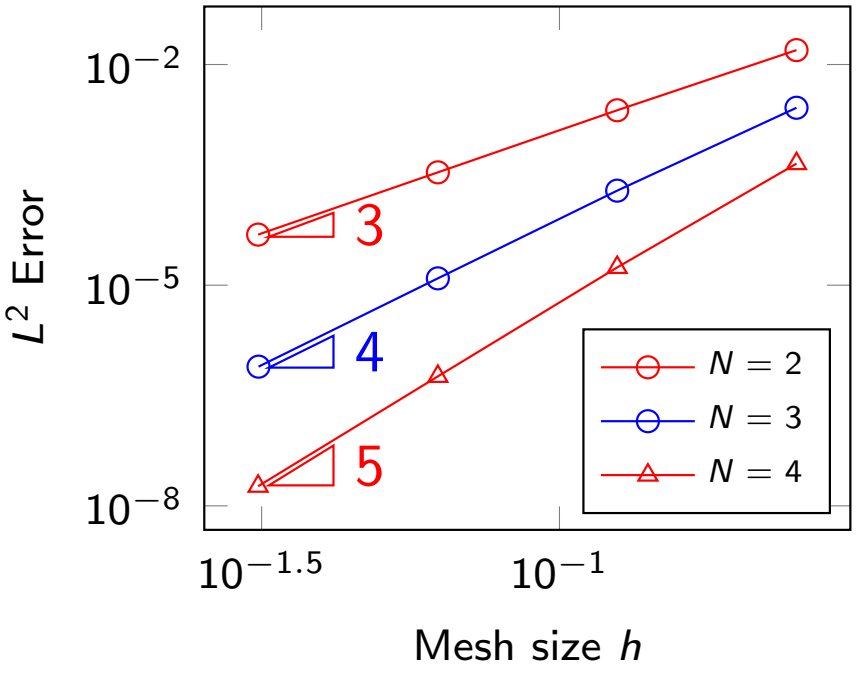
http://www.childbrain.eu/childbrain/keski-oikea/esrprojects/esr-13-development-of-new-finite-element-approaches-for-child-brain-research-and-comparison-to-standard-forward-modelling-methods-for-eeg-and-meg-source-analysis

Extension to curvilinear meshes

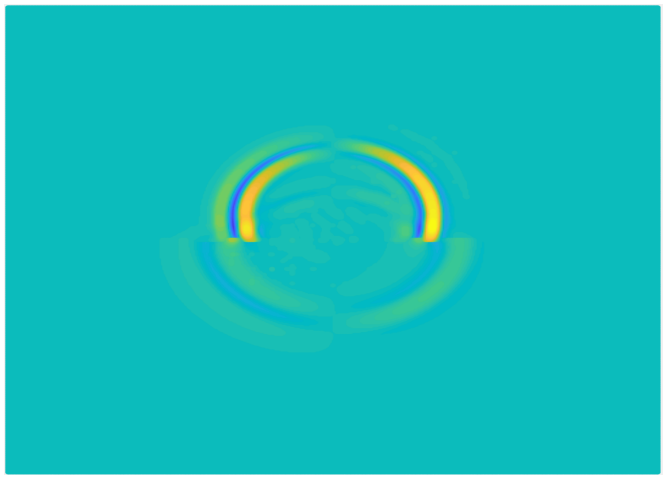


(a) Curvilinear mesh

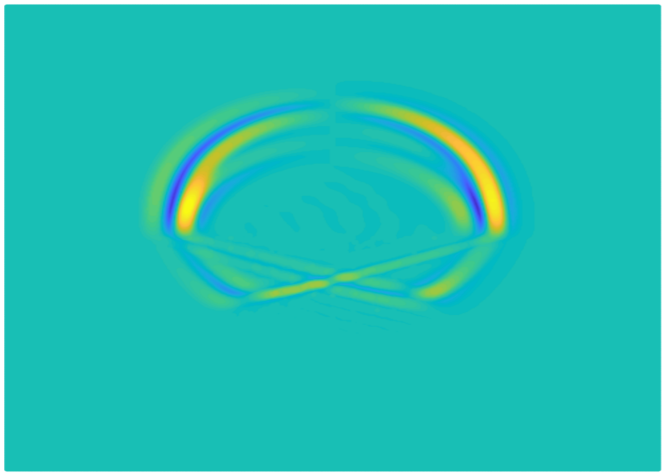


(b) Scholte wave (curvilinear)

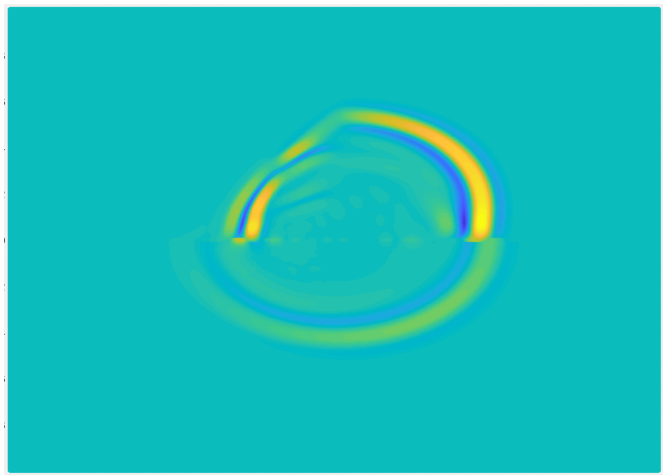
Wave propagation in different media



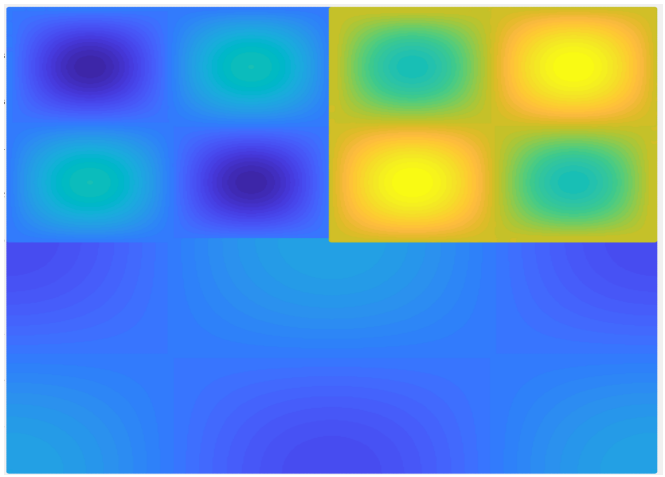
(a) isotropic+homogeneous



(b) anisotropic+homogeneous

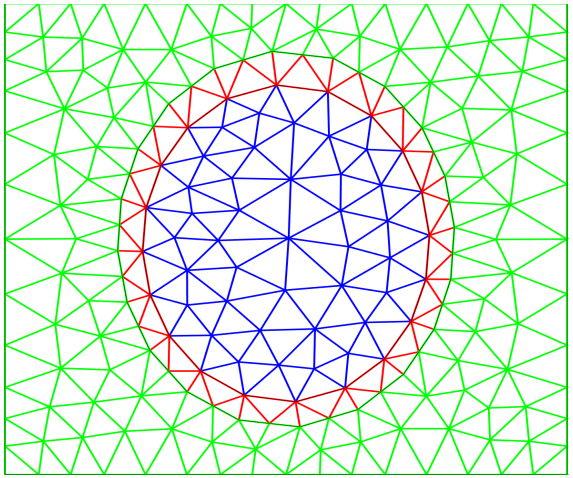


(c) isotropic+heterogeneous

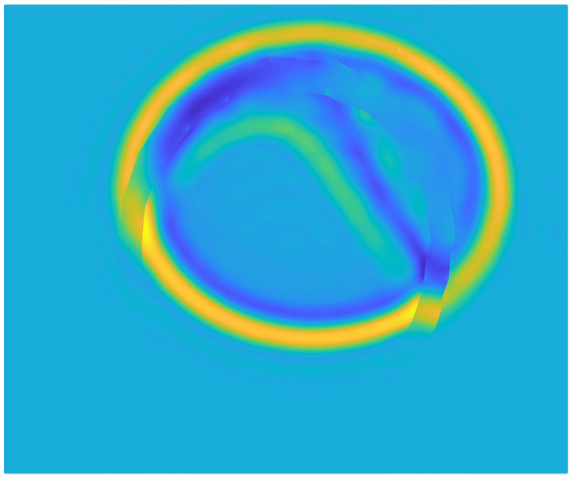


(d) $c^2(x, y) + \mu(x, y)$

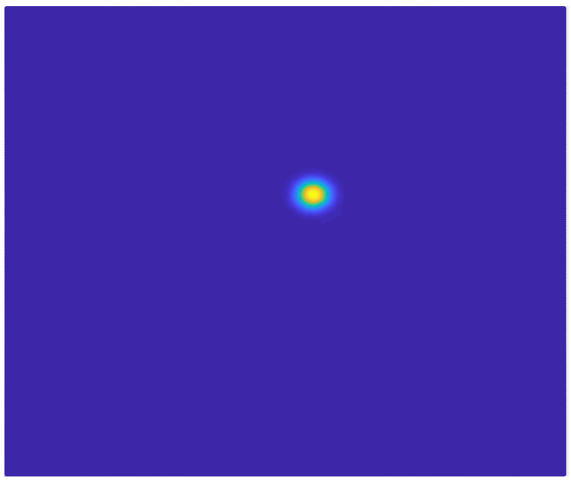
Photoacoustic tomography (PAT)



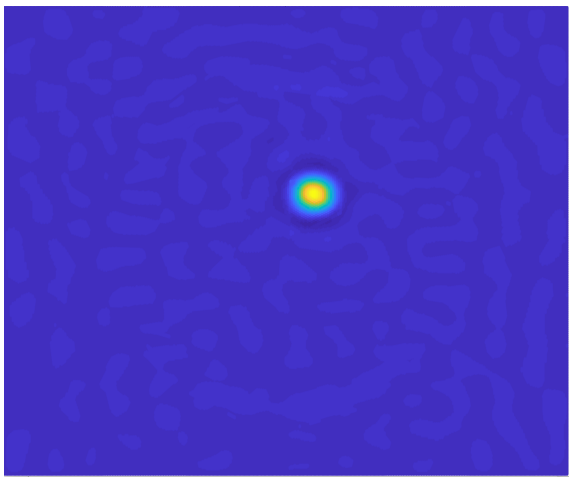
(a) Mesh



(b) Snapshot at $t = 0.6$



(c) Initial condition



(d) Reconstruction

Summary

- We derive a numerical flux across elastic-acoustic interfaces with a very simple form.
- The resulting DG method is efficient, provably energy stable, and high order accurate for arbitrary heterogeneous and anisotropic media.
- The proposed formulation can be applied on unstructured tetrahedral meshes and general curvilinear meshes.