

Technical Detail

- **Start from known material**
- **Make comparisons**
- **Go extremely slowly**
- **Repeat, repeat, repeat**

One-way wave propagation

Acoustic Wave Equation

$$\frac{1}{c^2} \partial_t^2 u - \Delta u = f$$

Identify everything on your slides.

Δ - Laplacian

One-way wave propagation

First-order system

$$\partial_z \begin{pmatrix} \mathbf{u} \\ \partial_z \mathbf{u} \end{pmatrix} = \begin{pmatrix} \mathbf{0} & \mathbf{1} \\ -\mathbf{A} & \mathbf{0} \end{pmatrix} \begin{pmatrix} \mathbf{u} \\ \partial_z \mathbf{u} \end{pmatrix} + \begin{pmatrix} \mathbf{0} \\ \mathbf{f} \end{pmatrix}$$

$$\mathbf{A} = \frac{1}{c^2} \partial_t^2 - \partial_x^2 - \partial_y^2$$

In a paper I might leave out this step.

One-way wave propagation

Diagonalize

$$\partial_z \begin{pmatrix} \mathbf{u}_+ \\ \mathbf{u}_- \end{pmatrix} = \begin{pmatrix} \mathbf{B} & \mathbf{0} \\ \mathbf{0} & -\mathbf{B} \end{pmatrix} \begin{pmatrix} \mathbf{u}_+ \\ \mathbf{u}_- \end{pmatrix} + \begin{pmatrix} \mathbf{f}_+ \\ \mathbf{f}_- \end{pmatrix}$$

+ \uparrow and - \downarrow

$\pm \mathbf{B}$ eigenvalues

One-way wave propagation

leave out the details

- B are Ψ DOs
- only OK for high-f
- relationship between $\begin{pmatrix} u_+ \\ u_- \end{pmatrix}$ and $\begin{pmatrix} u \\ \partial_z u \end{pmatrix}$
- lose horizontal propagation
- faster to code than full-wave
- implement in parallel
- implement in frequency domain
- coupling up and down
- variable c a problem
- order of approximation

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