Fluid Leakage across a Pressure Seal

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COMSOL CONFERENCE 2014 BANGALORE

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Mathematical Model ➔ Simulation

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Simulation → Mathematical Model

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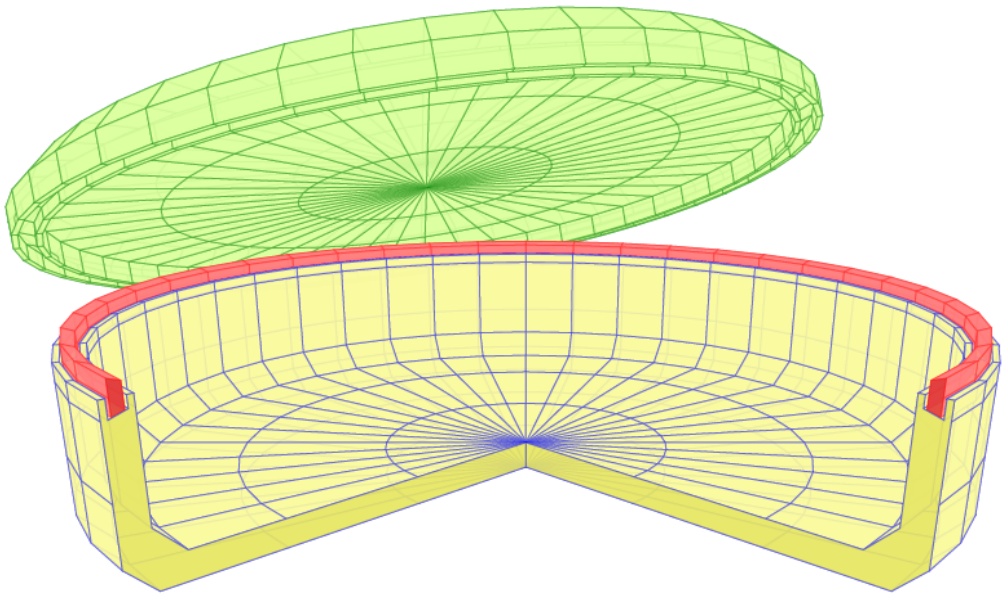
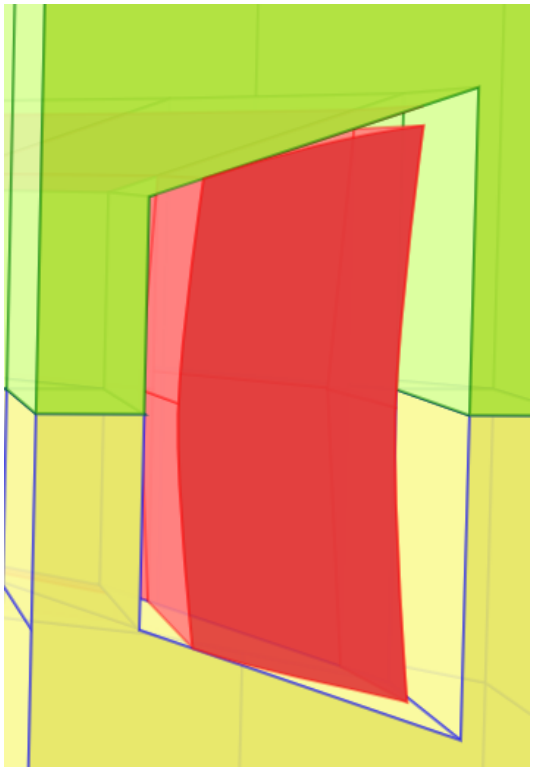
Multi-Scale Modeling (Homogenization)

- Mathematical theory of coordination between phenomena happening at different scales

Gasket Seals



Gasket Seals



Leakage rate depends on:

- Geometries
- Materials
- Surface characteristics
- Clamping forces
- Fluid pressure

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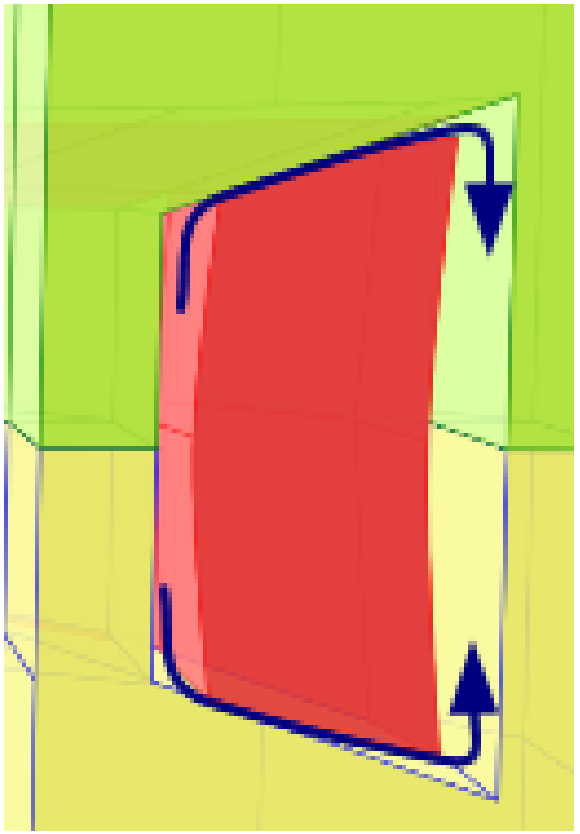
Fluid Leakage



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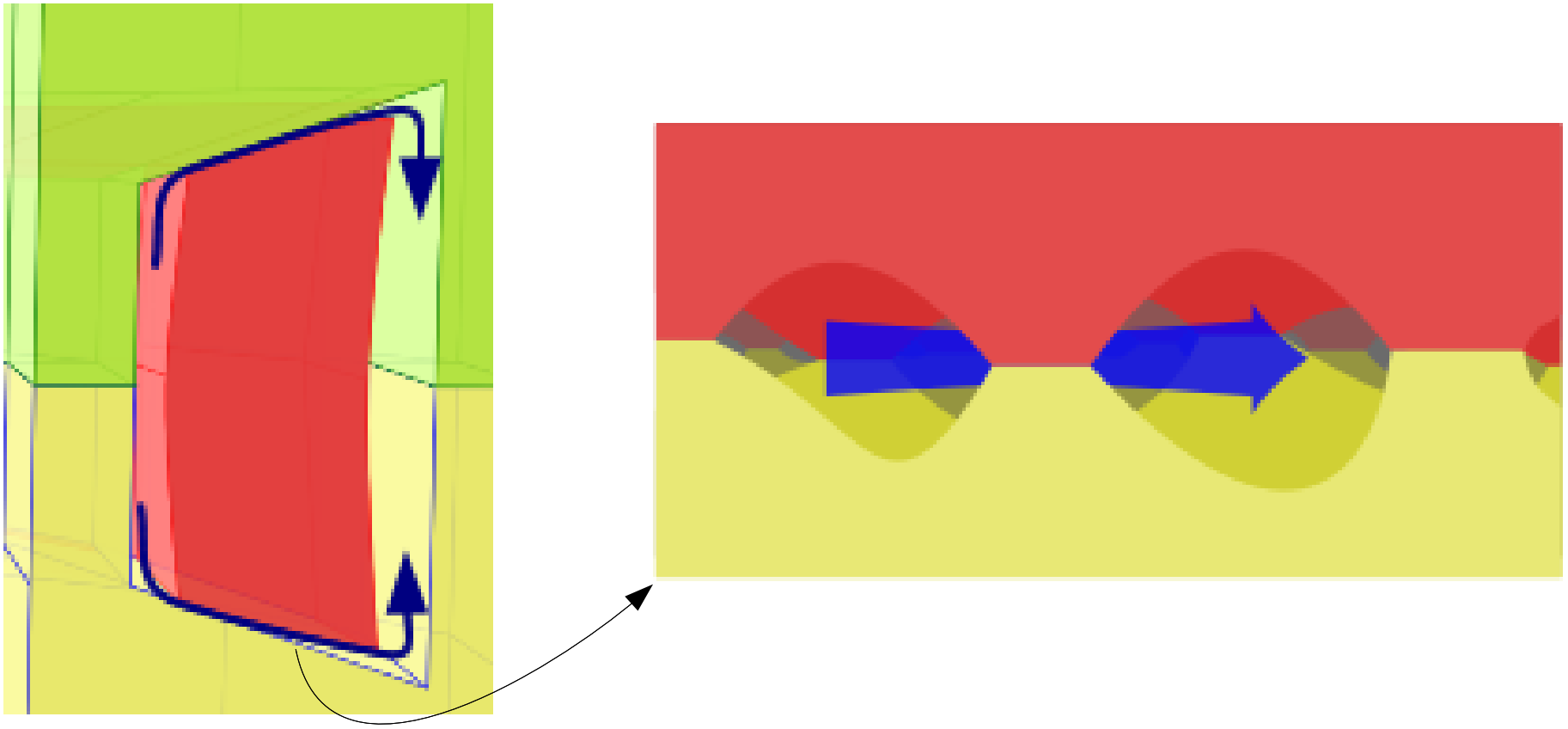
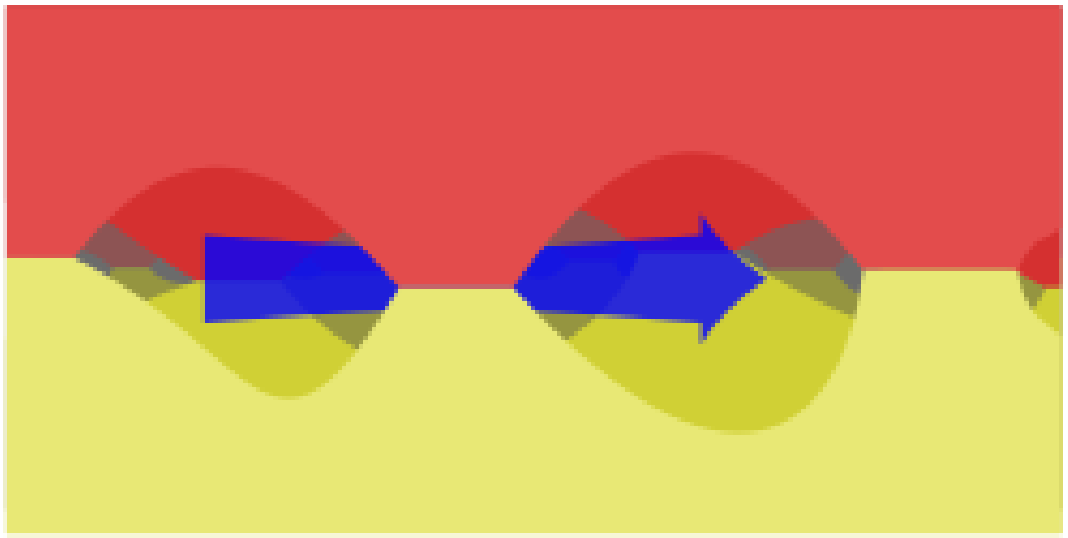
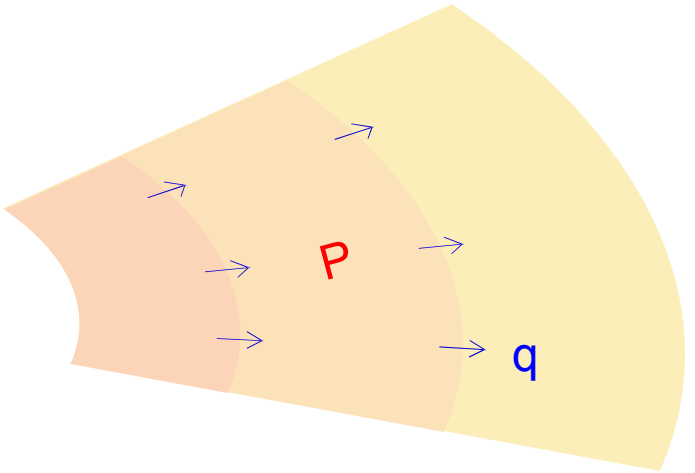
Fluid Leakage



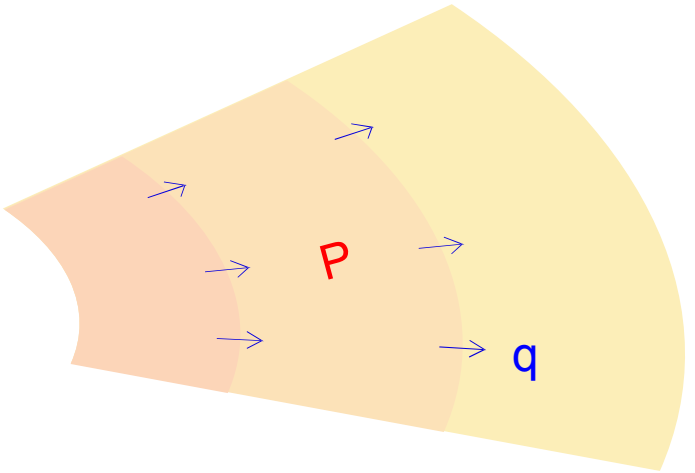
Homogenization





Homogenization

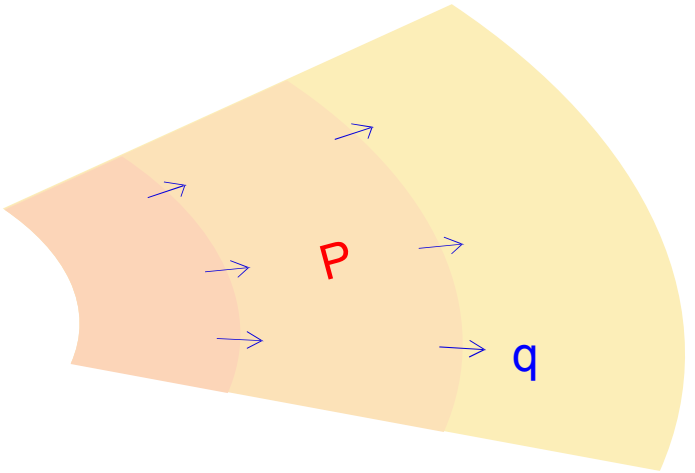
$$q = a \nabla P$$



Homogenization

$$q = a \nabla P$$

$$a = a\,(S, P, |\nabla P|)$$



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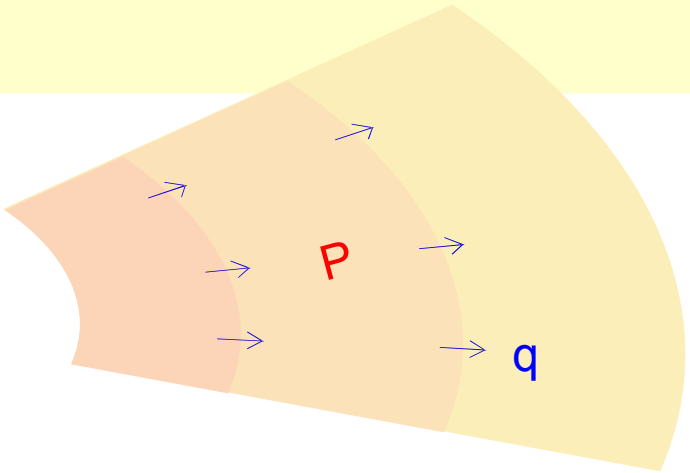

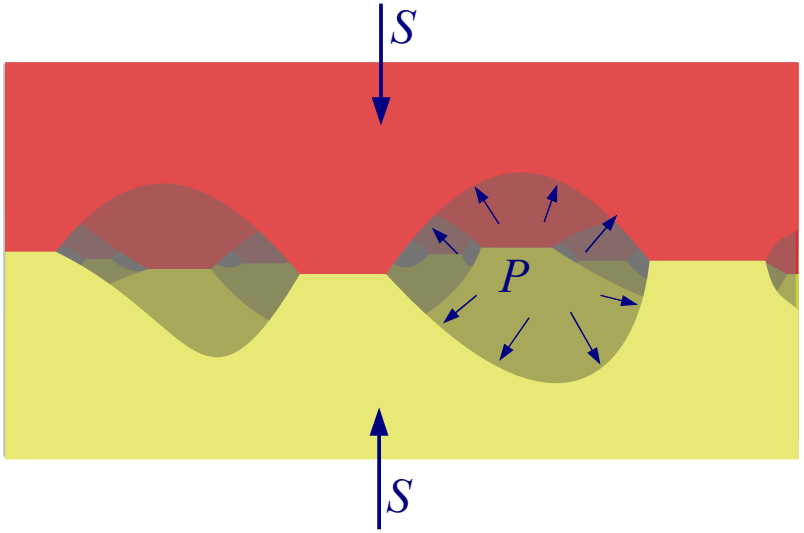

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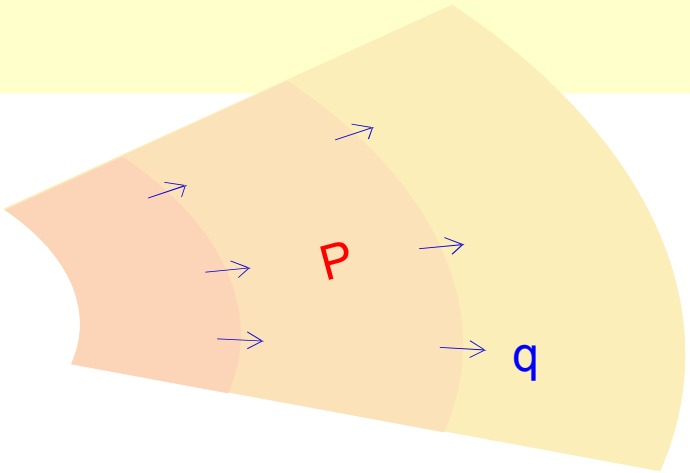
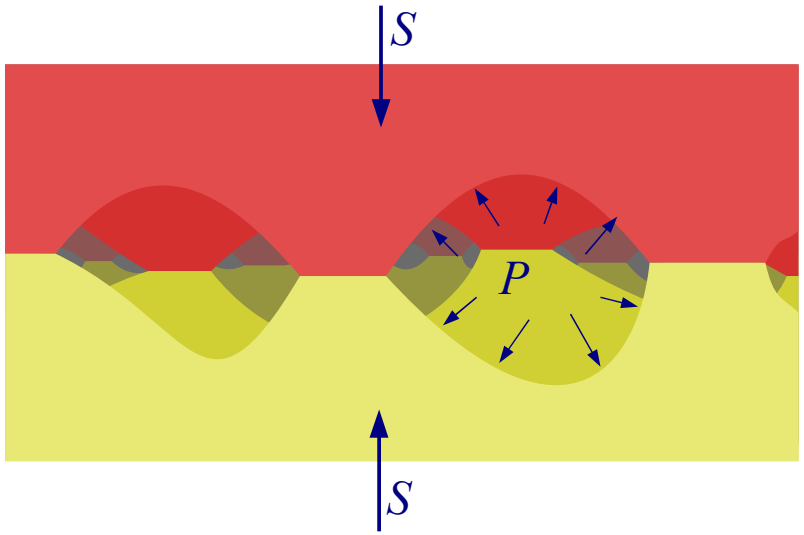
Geometric Result

$$q = a \nabla P$$

$$a = a\,(S, P, |\nabla P|)$$





Geometry of microcaverns depends only on $S - P$

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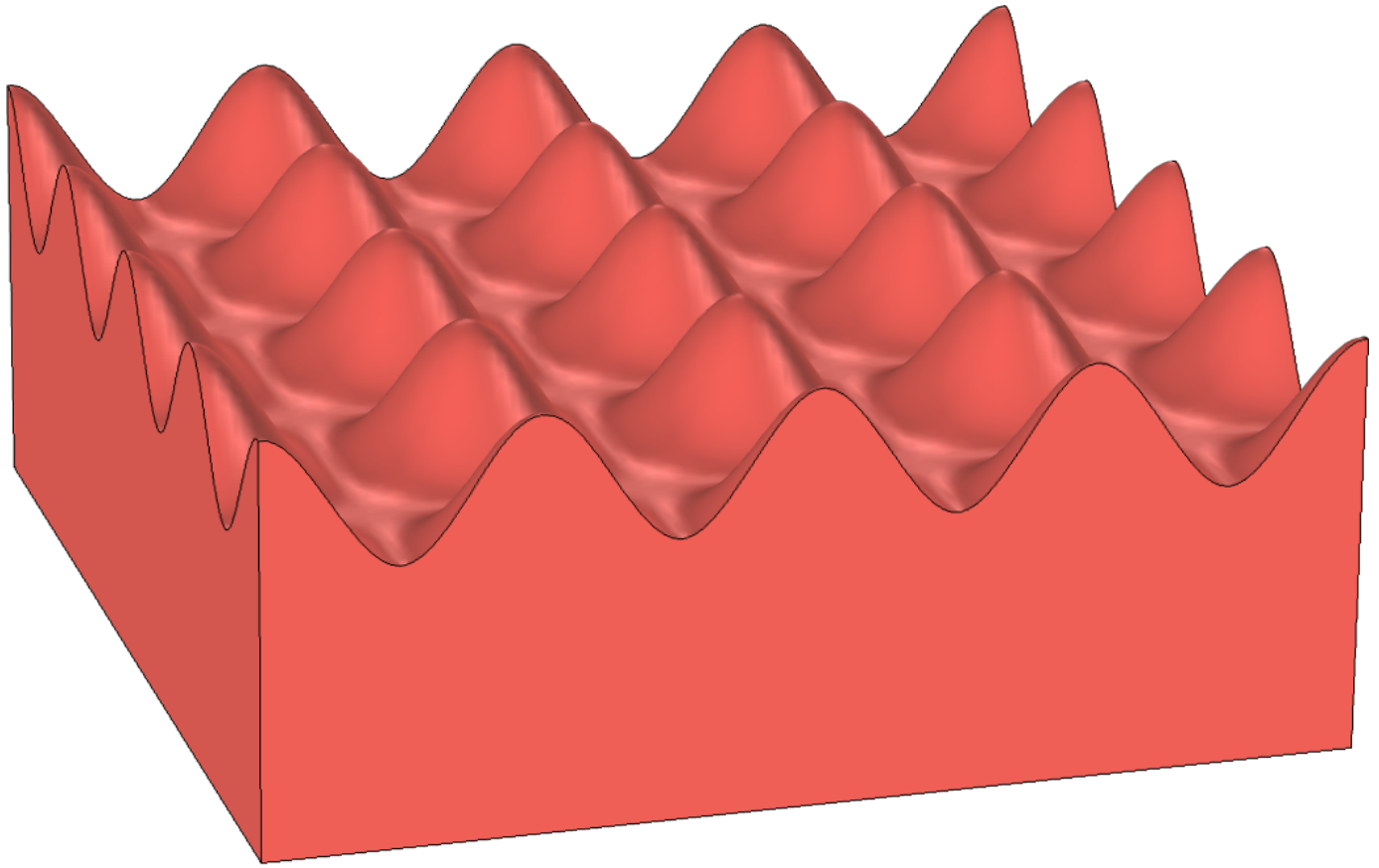
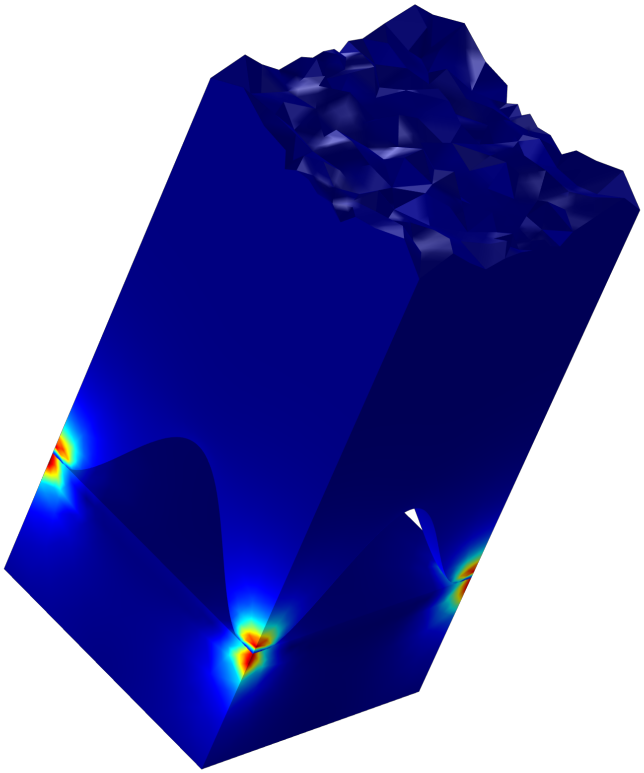
Idealization



Mechanical Simulation



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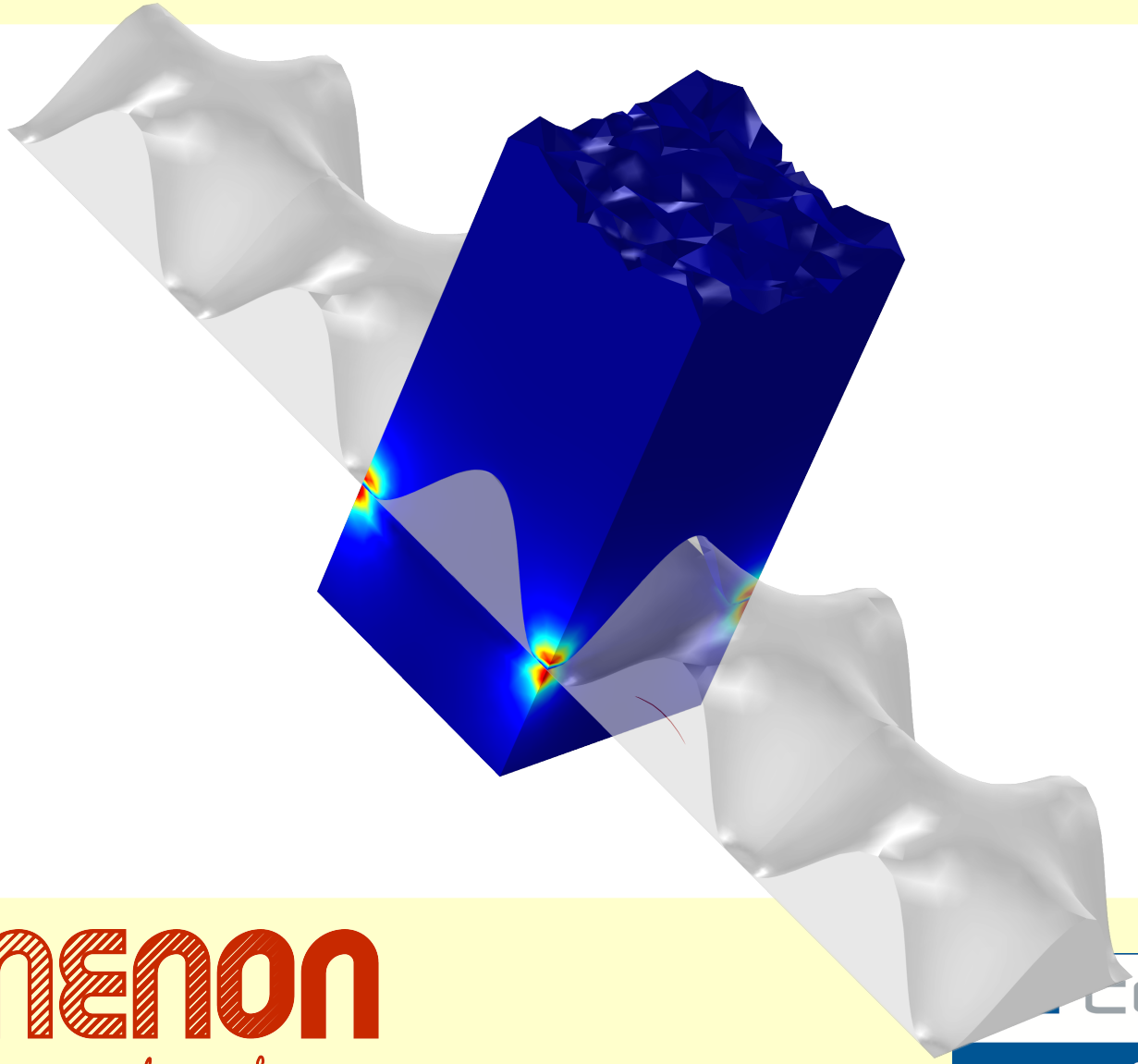
Fluid Domain



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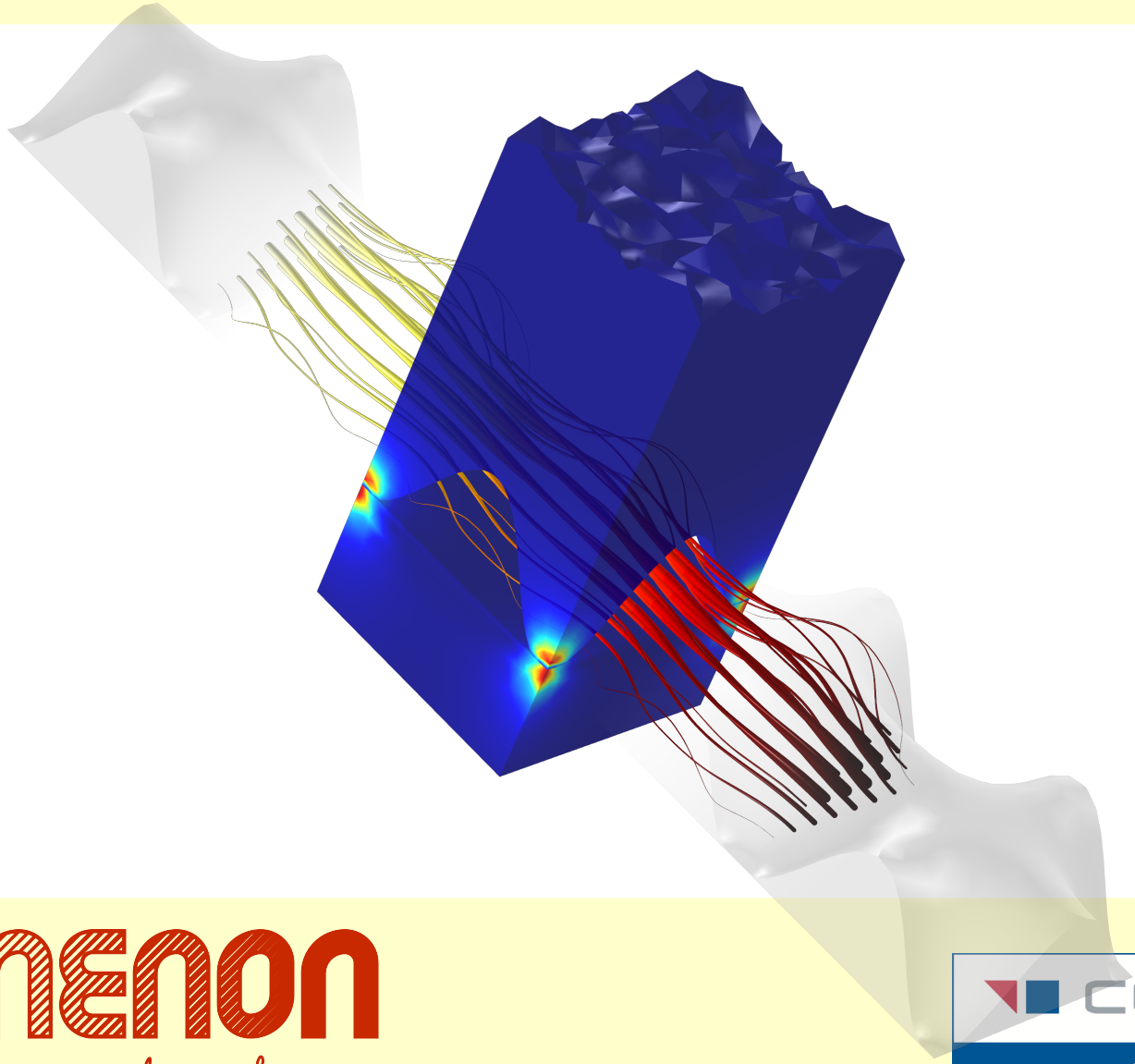
Fluid Flow



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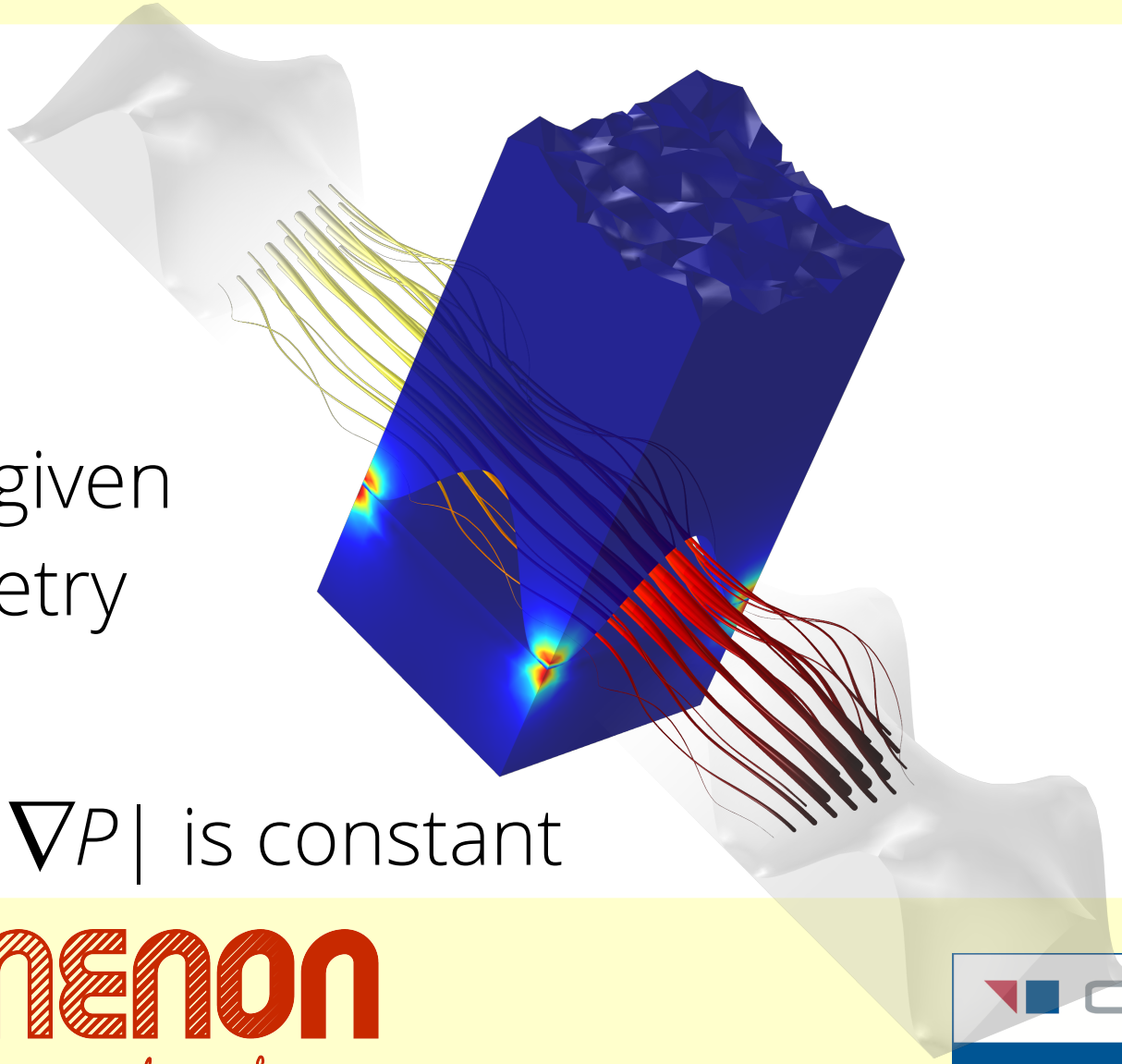
Correlation



For a given geometry

- $q \,/\, P \,|\nabla P|$ is constant

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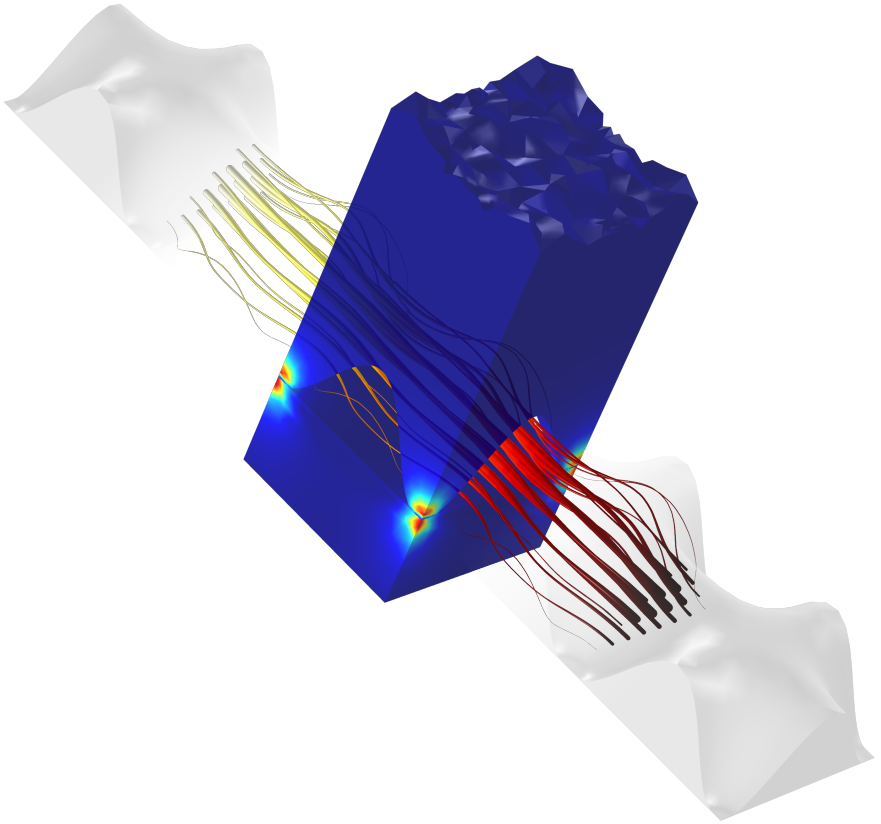
New Formula

- $q = f\,(S - P)\,P\,|\nabla P|$

For a given geometry

- $q\,/\,P\,|\nabla P|$ is constant



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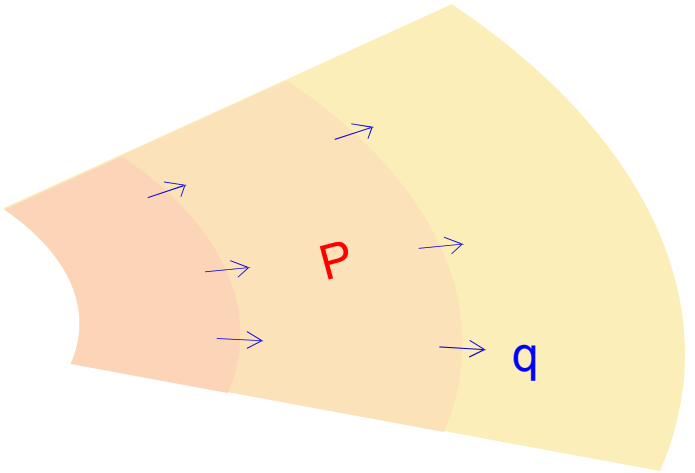
New PDE!!!

- $q = f(S - P)\, P\, |\nabla P|$



New PDE!!!

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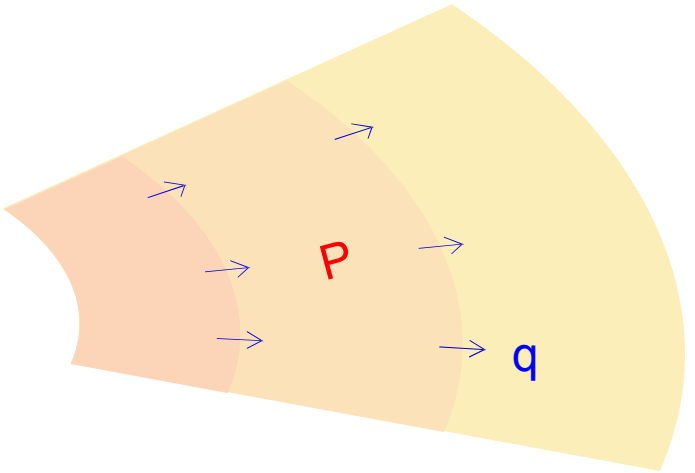
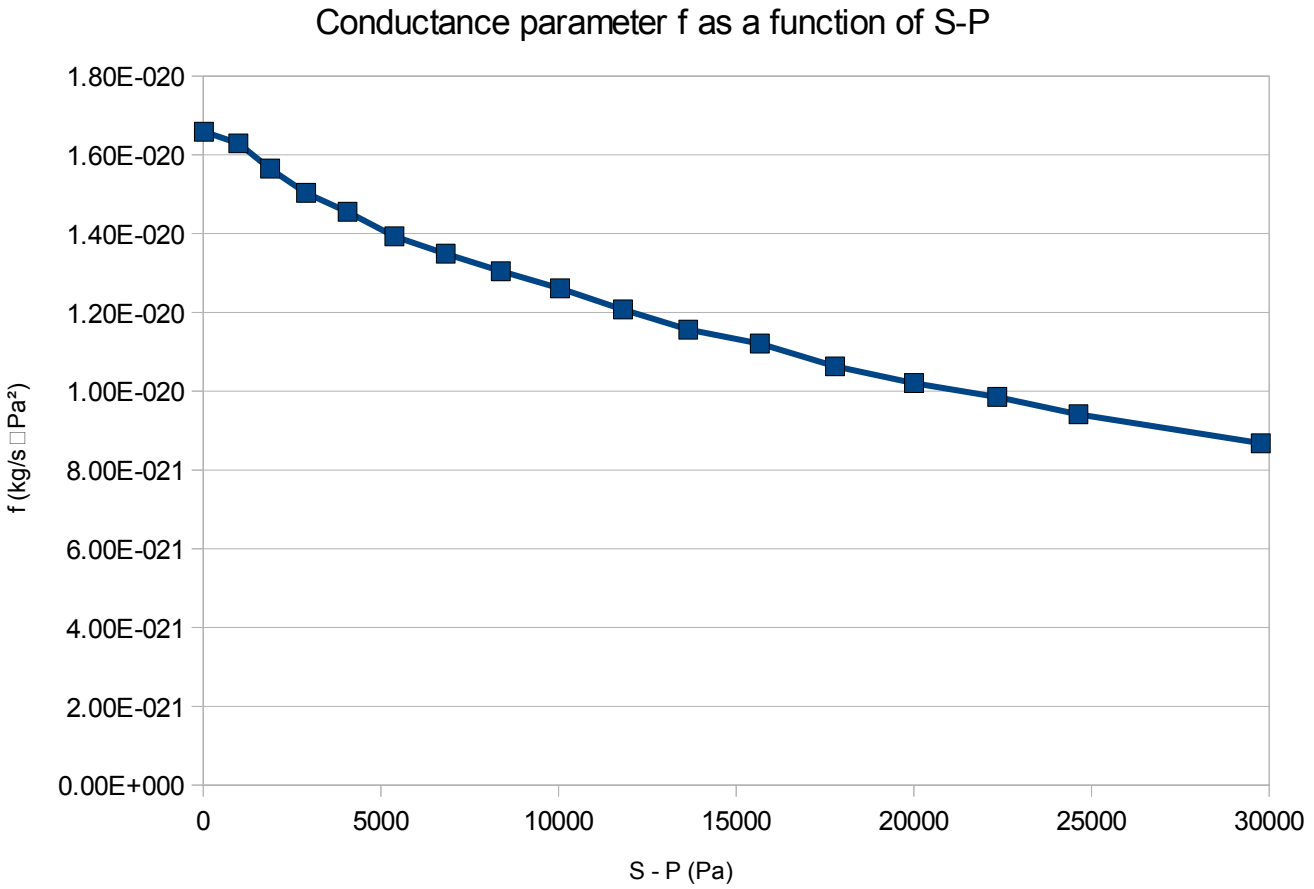


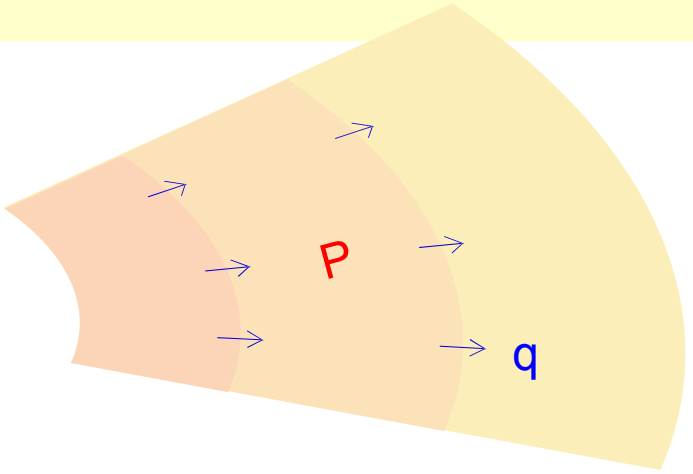
- $\nabla \cdot q = 0$

$$q = f\,(S - P)\,P\,|\nabla P|$$



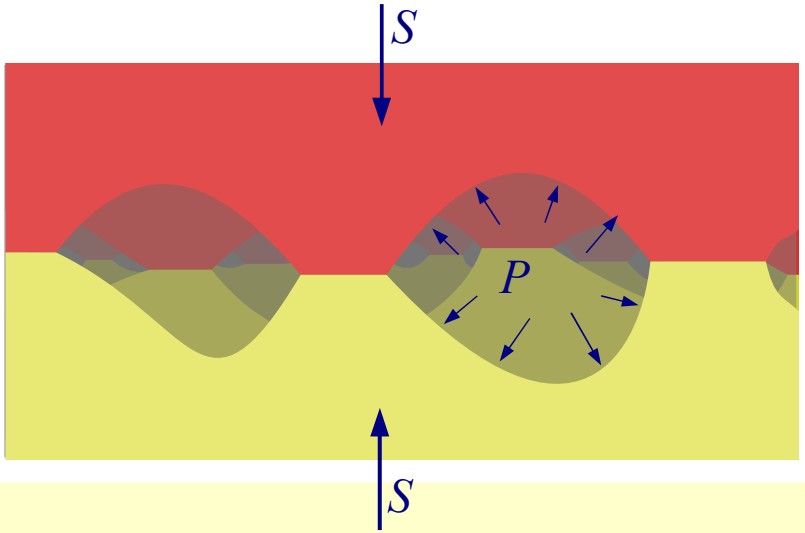
What we have achieved

$$q = a\,(S, P, |\nabla P|)\,\nabla P$$



- $q = f\,(S - P)\,P\,|\nabla P|$

$$\nabla \cdot q = 0$$



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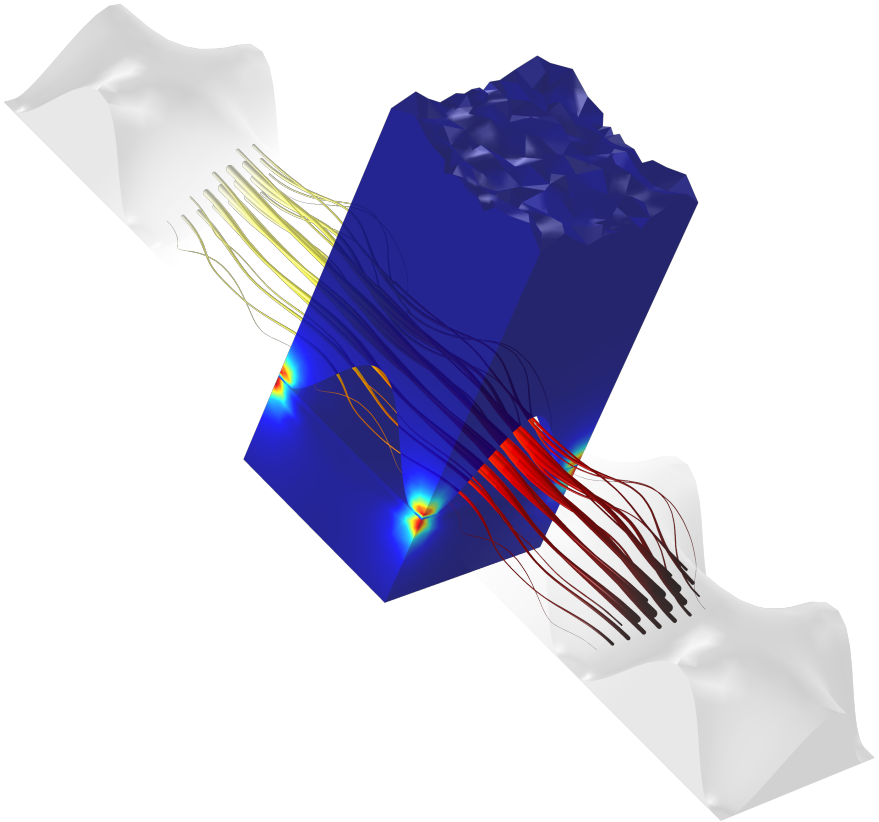
Thank you!

$$q = a\,(S, P, |\nabla P|)\,\nabla P$$

- $q = f\,(S - P)\,P\,|\nabla P|$

$$\nabla \cdot q = 0$$



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