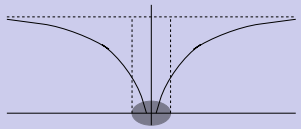
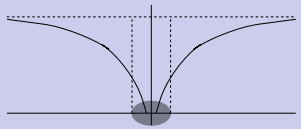


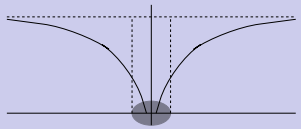
Degradation of IPU

3. Mai 2013

Inhaltsverzeichnis



Introduction

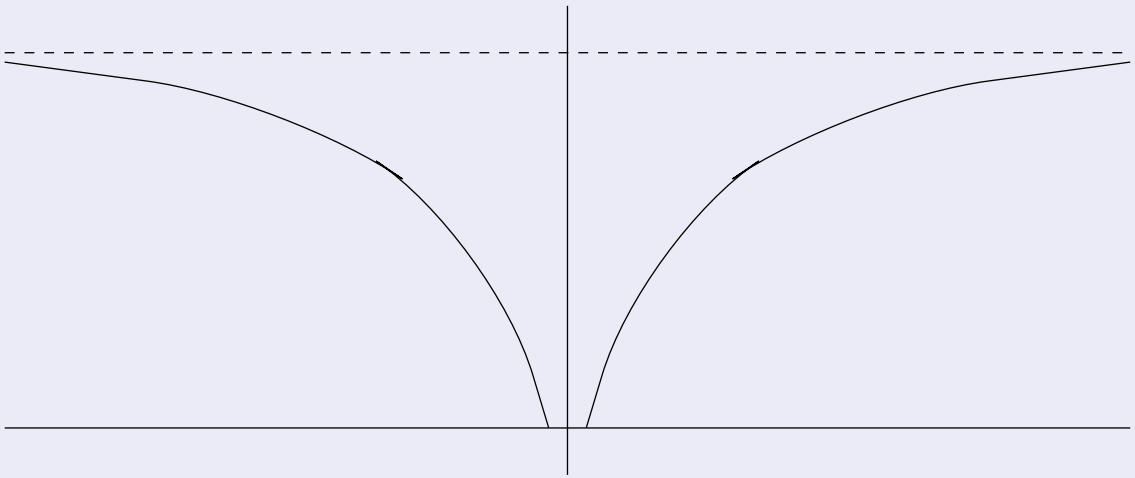


Structure of the thesis:

2.5 chapters

- The limit $t \to \infty$. (Laplace Equation)
  Proof of concept and tools
- Intoduce time. (Heat Equation)
  Fit parameters to match the experimental Data.
- Limit $t \to \infty$ + nat. degradation proportional to depth.
  Simulate field conditions.

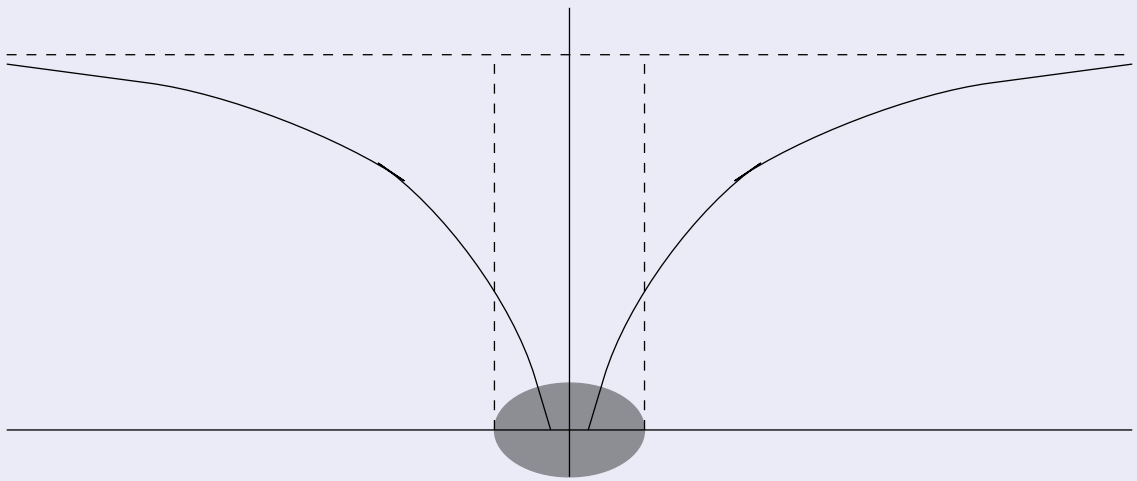
Introduction



Graphic's description - case $t \to \infty$

- Constant IPU-Level + IPU-sink (seramis)
- Fundamental solution $u(x) = \frac{-c}{x} + u_0$.

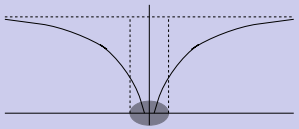
Introduction

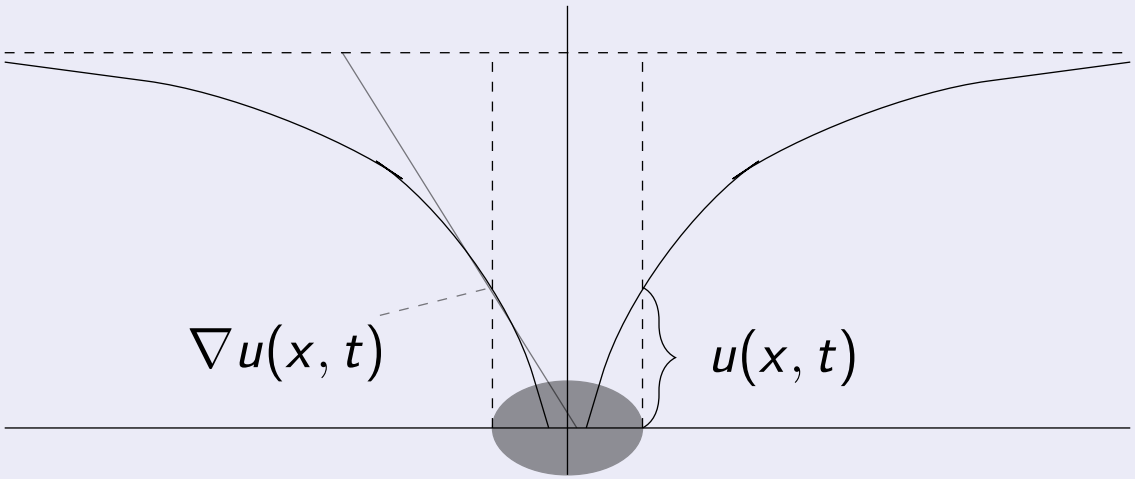


Graphic's description - the seramis

- no negative concentration outside seramis
- the system is controlled by the seramis' boundary.

Introduction

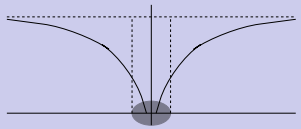




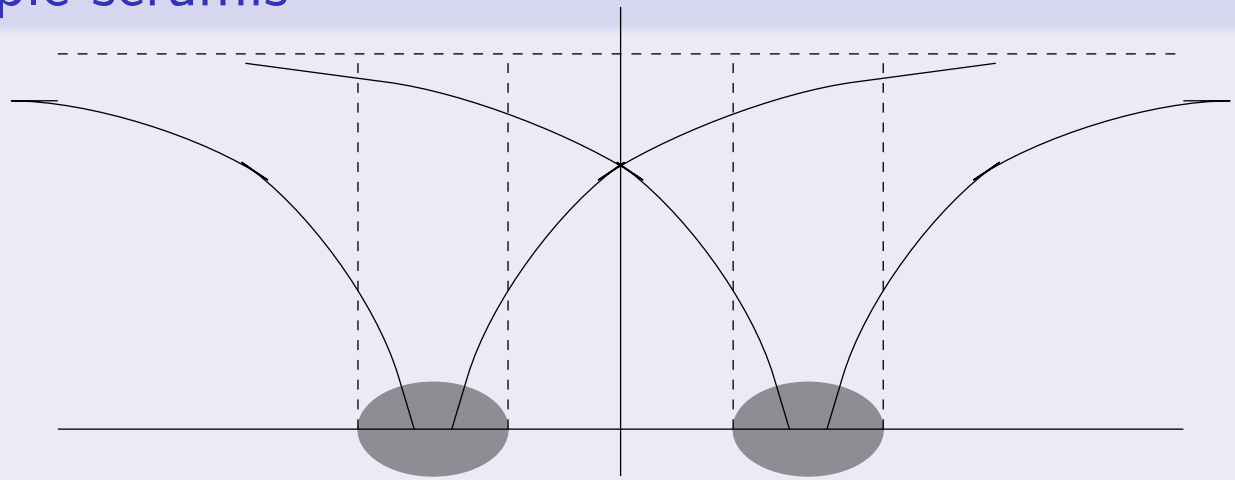
Mathematical essence

- Diffusion $0 = D\Delta u$ (Laplace Equation).
- Boundary $D\frac{du}{dr}|_{r=R} = \alpha u|_{r=R}$.

Laplace - Power series



Multiple seramis

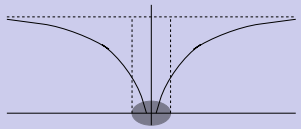


Problem

Seramis don't communicate yet.

Solution $\rightarrow$ Correction term determined by power series.

Laplace - Power series



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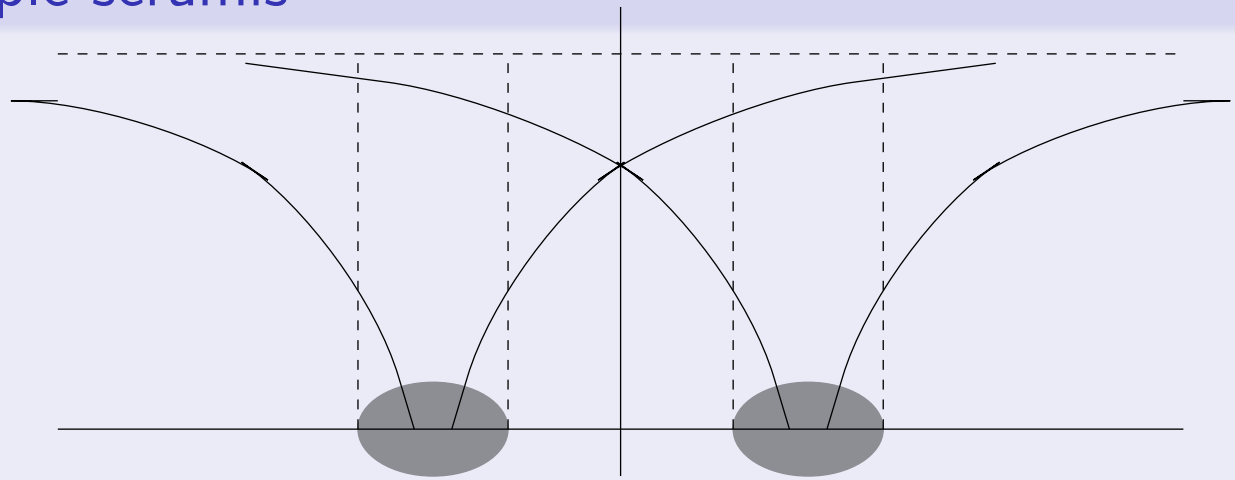

Problem

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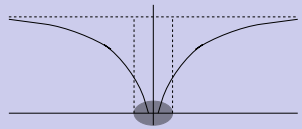
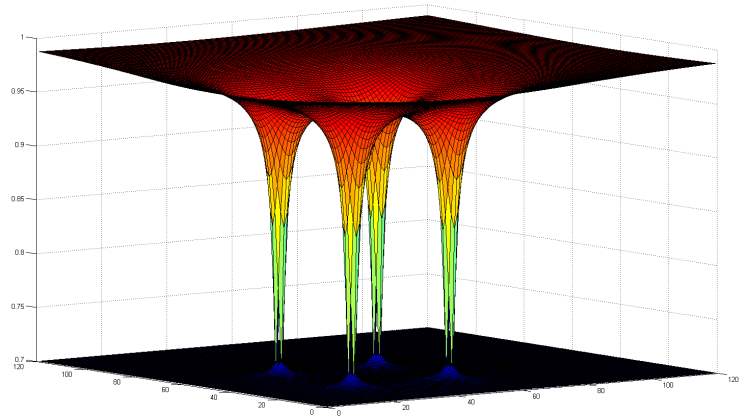
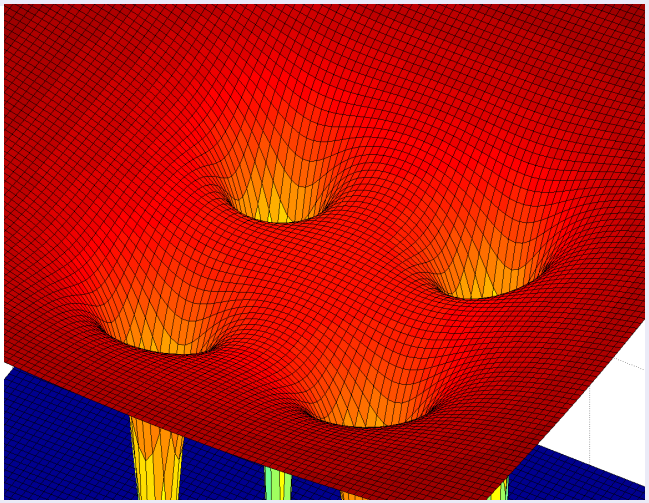
Laplace - Historical examples

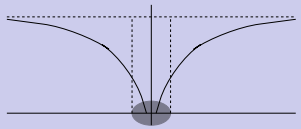


Testplots made some time ago.



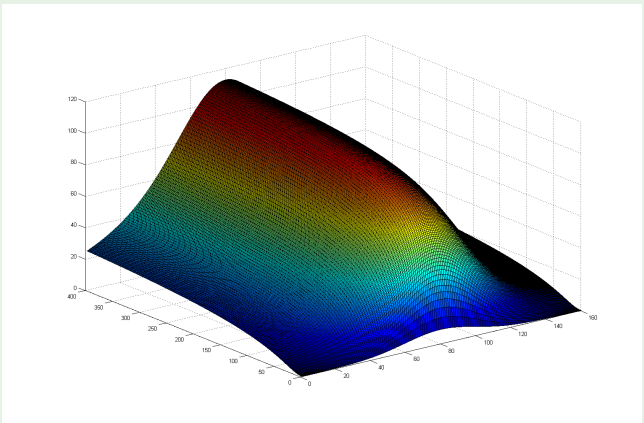


Introduce Time - The Heat Equation



The Difference

- Laplace: $0 = \Delta u$
- Heat Eq.: $u_t = \Delta u$
- $+$ natural degradation $u_t = \Delta u - \gamma u$



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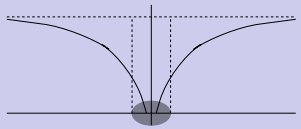

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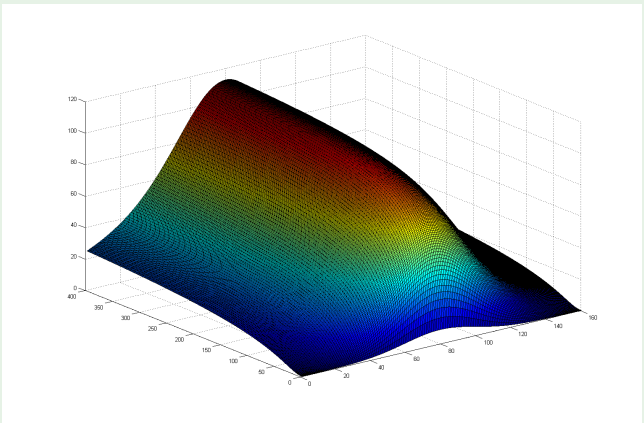
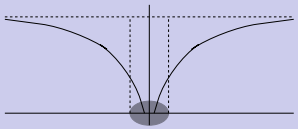
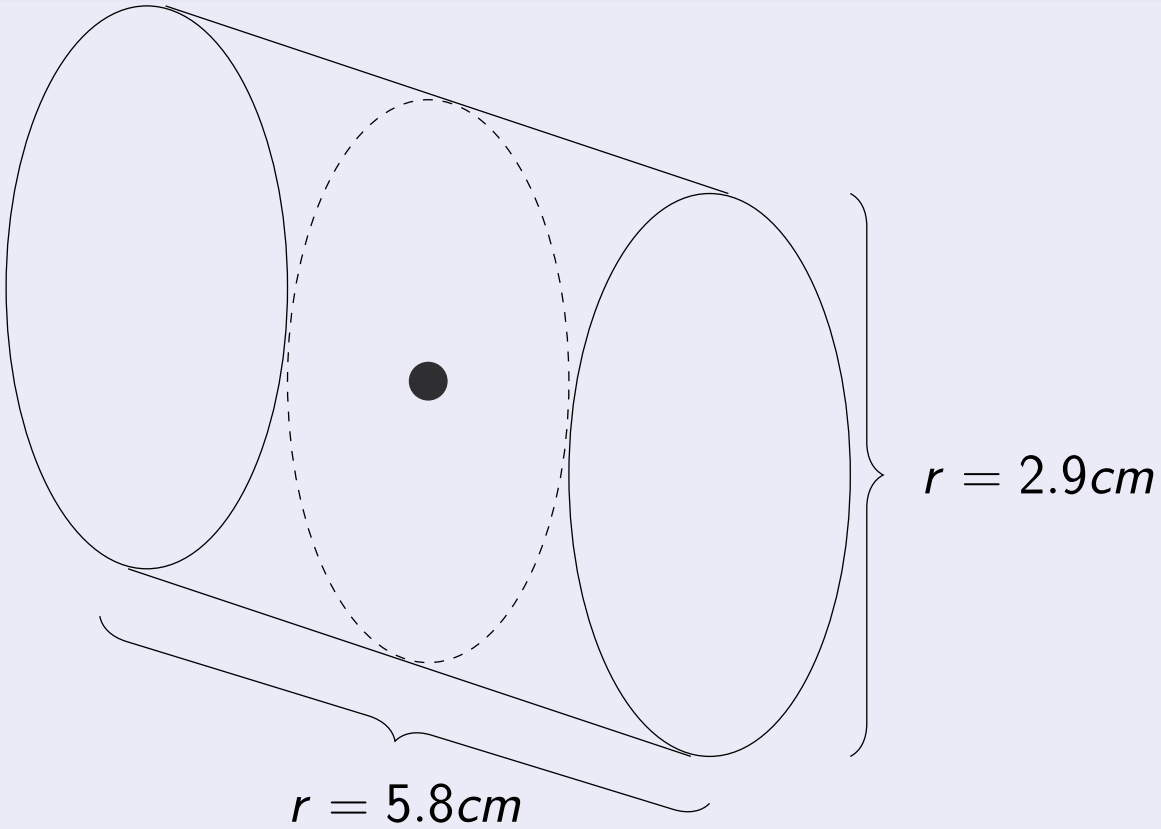


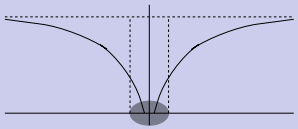
Geometry



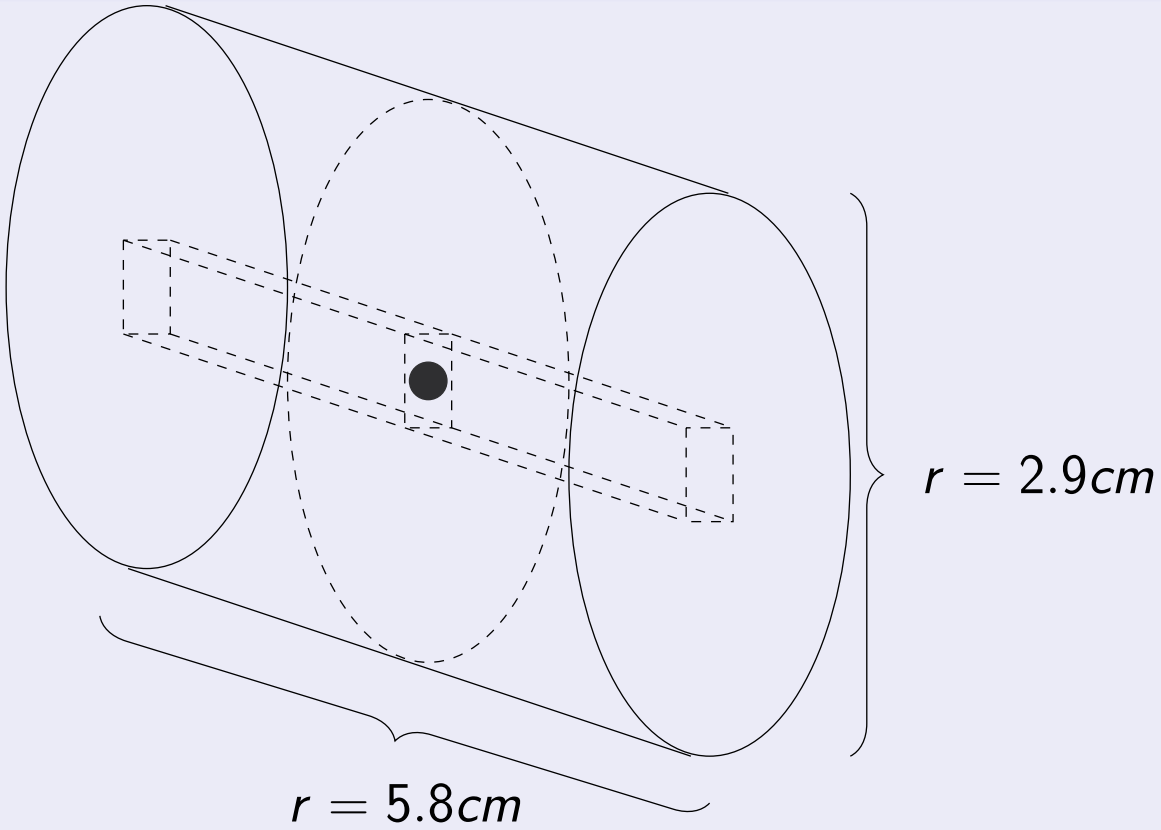
Testtube and seramis



Geometry



Only exermine the local environment



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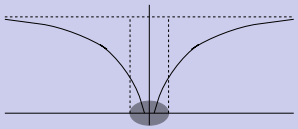
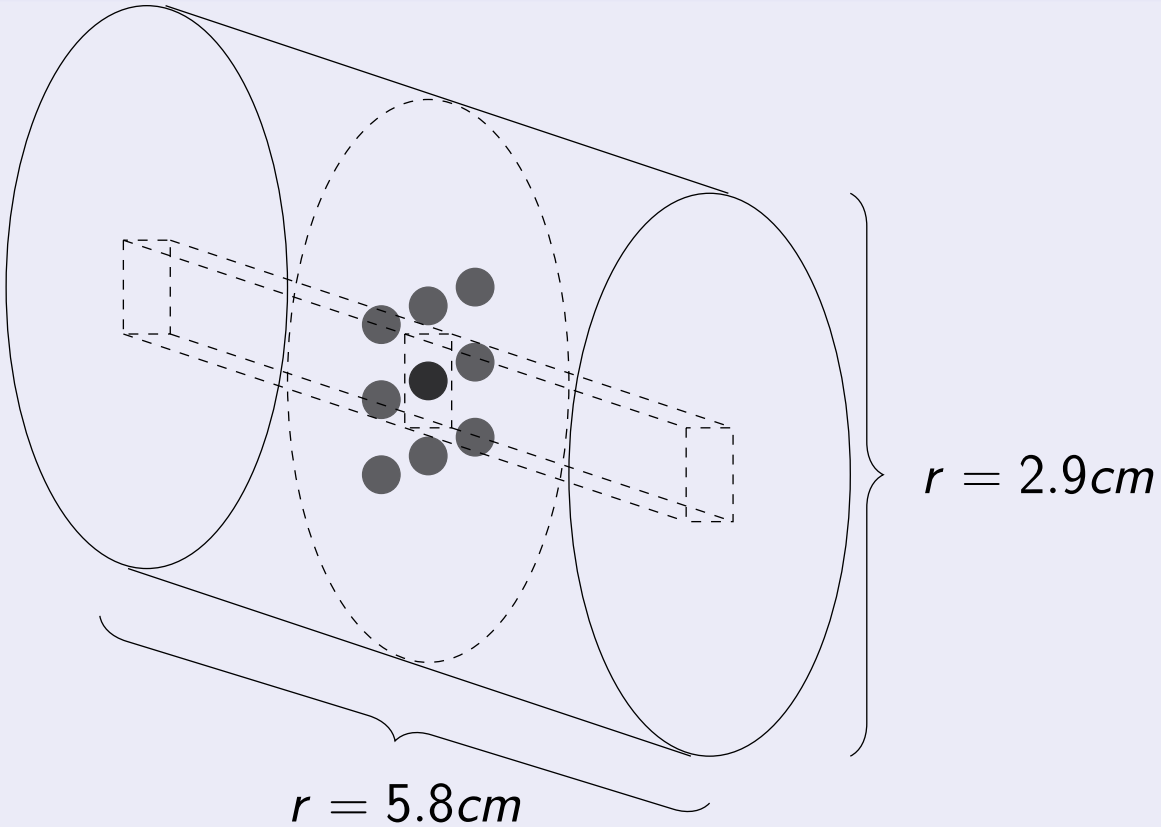
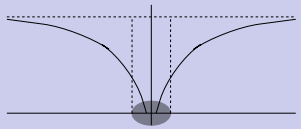


Mirrored seramis to fulfill boundary conditions



Continuous IPU Introduction



Comparsion to Laplace

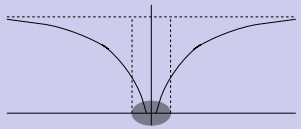
- Same $t \to \infty$
- But natural degradation

Example: With $\leftrightarrow$ without seramis

$u_0 = 1, D = 0.021, \gamma = 0.03, a_0 = 0.15, R_0 = .2.$
Shown layers $0, -1, -1.5$.
A test integration shows that in layer -3 the square $(-0.5, -0.5)(0.5, 0.5)$ contains

- With Seramis: $0.013394 \frac{mol}{m}$.
- Without Seramis: $0.027718 \frac{mol}{m}$.

Continuous IPU Introduction



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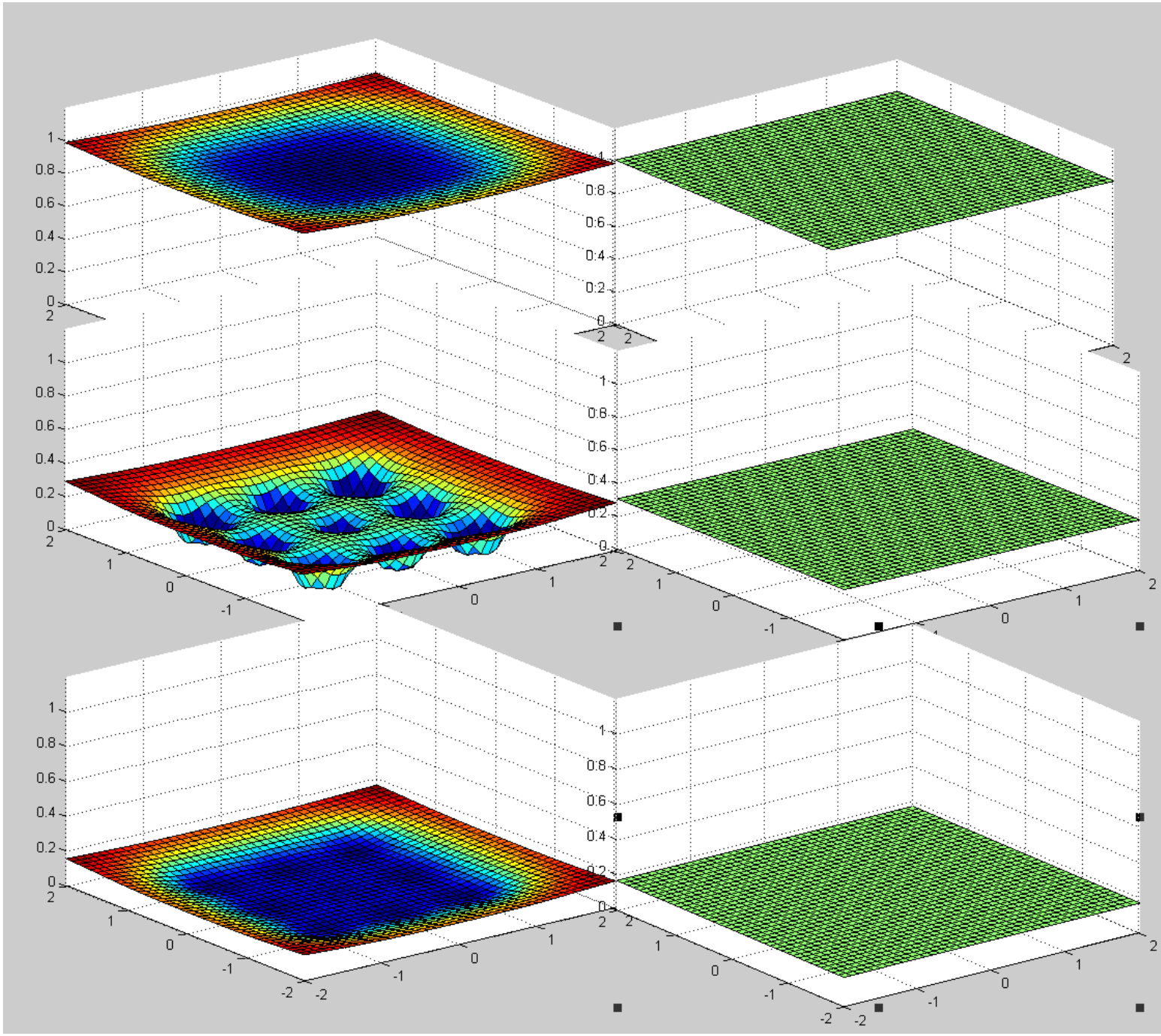

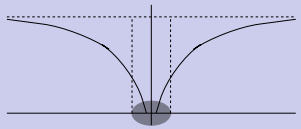

Questions?

Debug: You saw 11 frames!