

High-order Lagrange elements in FreeFem++

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Motivation

Finite element solution of **time-harmonic wave propagation problems**

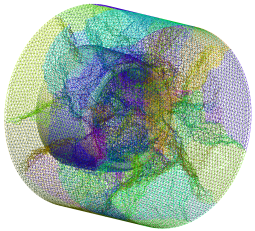
Helmholtz problem:

$$\begin{cases} -\Delta p - \kappa^2 p = s & \text{in } \Omega \\ \text{Boundary conditions} & \text{on } \partial\Omega \end{cases}$$

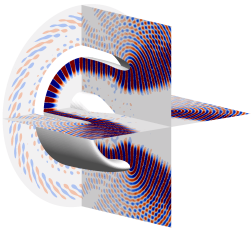
Finite element error:

$$\|p - p_h\|_{H^1} \leq C_1(\kappa h)^p + C_2 \kappa^{(p+1)} h^p$$

Finite element mesh



Numerical field

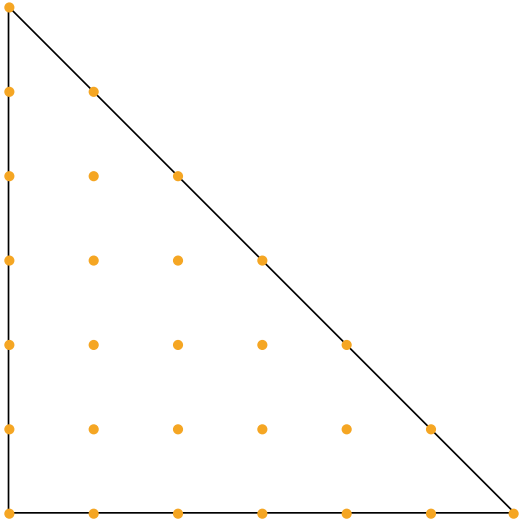


High frequency (large κ)
Phenomena close to resonance

$\rightsquigarrow$ Low approximation quality $\rightsquigarrow$

- Fine mesh (small h)
- High-order basis functions (large p)

Conclusion



Fnite element P_6