On the asymptotic analysis of the stationary Oseen equations

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We consider the stationary Oseen equations

$$\begin{aligned} -\varepsilon\Delta u + b\cdot\nabla u + cu + \nabla p &= f && \text{in } \Omega \\ \operatorname{div} u &= 0 && \text{in } \Omega \\ u &= 0 && \text{on } \Gamma \end{aligned}$$

with $0 < \varepsilon \ll 1$. We get these equations by linearization of the Navier-Stokes equations. The solutions of such singularly perturbed differential equations typically exhibit boundary layers. There exists many literature for convection-diffusion type equations. Here, we go a step further. We have a new variable p, the pressure, and there is the special condition for the incompressibility $\operatorname{div} u = 0$. That makes the analysis more complicated.

Our goal is to decompose the solution into a regular part and layer parts. If we know the structure of the boundary layer, we are able to construct a mesh for the FEM, which has better properties than an equidistant mesh. It is well known, that we can reduce oscillations of the numerical solution by layer-adapted meshes.

In this talk, we will present our findings.

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