Title: Equilibrium positions of a body immersed in a stationary Navier-Stokes flow in a planar channel

Abstract: We study the equilibrium positions for several fluid-structure interaction problems. The fluid is confined in a 2D channel that contains a body, free to move inside the channel with rigid motions (transversal translations and rotations). The motion of the fluid is generated by a laminar inflow/outflow and governed by the stationary Navier-Stokes equations.

For a model where the fluid is the air and the body represents the cross-section of a suspension bridge, therefore also subject to restoring elastic forces, we prove that for small inflows (small Reynolds number) there exists a unique equilibrium position while for large inflows we numerically show the appearance of additional equilibria. A similar uniqueness result is also obtained for a discretized 3D bridge, consisting in a finite number of cross-sections interacting with the adjacent ones.

The very same model, but without restoring forces, is used to describe the mechanism of the Leonardo da Vinci Ferry, which is able to cross a river without engines. We numerically determine the optimal orientation of the ferry allowing to cross the river in minimal time. Further models and applications are also discussed.