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Regularity issue for the system describing elastic structure interacting with Navier-Stokes equations

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We are interested in the interaction of a viscous incompressible fluid with an elastic structure, where the structure is located on a part of the fluid boundary. It reacts to the surface forces induced by the fluid and deforms the reference domain Ω to Ω_η. The fluid equations are coupled with the structure via the kinematic condition and the action-reaction principle on the interface.

We first study the 2D visco-elastic shell interacts with 3D Navier-Stokes equations. Especially in a general reference geometry (the shell deforms along the normal direction of the flexible boundary), we prove a counterpart of the classical Ladyzhenskaya-Prodi-Serrin condition yielding conditional regularity and uniqueness of a solution. This requires additionally the deformation of the shell is Lipschitz continuous.

Then we consider a 1D perfectly elastic plate, deforming vertically in flat case, interacts with 2D Navier-Stokes equations, which thereby gives a hyperbolic evolution. We show the new regularity result for this parabolic-hyperbolic coupled system. It turns out that the "parabolic effect"of the fluid suffices to regularize the solution to the coupled fluid-structure system which is previously known for the Navier-Stokes equations in fixed domains.

This is based on joint work with D. Breit (Clausthal), P. Mensah (Clausthal) and S. Schwarzacher (Uppsala).

Orateur: SU, Pei