Smoothing Properties and Lack of Compactness for a Coupled Parabolic-Hyperbolic Fluid-Structure Systems

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Abstract

In this talk we shall derive certain qualitative properties for a partial differential equation (PDE) system which comprises (parabolic) Stokes fluid flow and a (hyperbolic) elastic structure equation. The appearance of such coupled PDE models in the literature is well-established, inasmuch as they mathematically govern many physical phenomena; e.g., the immersion of an elastic structure within a fluid. The coupling between the distinct hyperbolic and parabolic dynamics occurs at the boundary interface between the media. In previous work, we have established semigroup wellposedness for such dynamics, in part through a nonstandard elimination of the associated pressure variable. However, one problem with this fluid-structure semigroup setup is that, due to the definition of the domain of the generator, there is no immediate implication of smoothing in all the fluid-structure variables; viz., the resolvent of the generator is *not* compact on the finite energy space. Consequently, one is presented with the basic question of whether smooth initial data will give rise to higher regularity of the solutions. Accordingly, one main result described here states that the mechanical, fluid, and pressure variables do in fact enjoy a greater regularity if an extra unit of Sobolev smoothness is imposed upon the initial structural component (only). A second problem of the model is the inherent lack of long time stability. In this connection, a second result described here provides for uniform stabilization of the fluid-structure dynamics, by means of the insertion of a damping term at the interface between the two media. This is joint with Irena Lasiecka and Roberto Triggiani.