Maximal regularity approach to mixture models

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One of possible approaches to model a flow of mixture of constituents is to consider fluid equations coupled with reaction-diffusion system describing the evolution of fractional masses. Here we consider this type of system, introduced in the monograph of V. Giovangigli. The key feature of the system is that the species subsystem is only degenerate parabolic. However, it exhibits a structure which, after a suitable change of unknowns, referred to as parabolic variables, turns out to exhibit parabolic regularity. After recalling the notion of maximal regularity I will present results obtained in collaboration with Yoshihiro Shibata and Ewelina Zatorska on the existence of regular solutions to considered system. Our approach is based on the Lp-Lq maximal regularity for the associated linear system. In order to consider a general multicomponent model, we established a linear maximal regularity result, which can be of independent interest. Under additional assumption on the boundedness of the domain we prove also exponential decay for the linear problem, which allows to prove the global existence for the nonlinear system under some smallness assumptions.

In the second part of my talk I would like to talk about our recent result obtained together with Piotr B. Mucha. Here a novelty is that we don't assume any regularing effect in the species subsystem. A price to pay is that we need to assume appropriate structure of the functions describing chemical reactions and, so far, we can treat only incompressible flow. We consider regular solutions in Lorentz spaces. This functional setting is not very popular in fluid mechanics, but turns out to exhibit very interesting features, promising for future investigation.