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SOME MODELS OF SPECIES INTERACTING IN FLUIDS [1]

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The emergence and evolution of spatio-temporal structures resulting from nonlinear interactions among species is observed throughout in nature and technology; typical mathematical models involve systems of advection-diffusion-reaction equations, often with a two-way coupling to fluid dynamics equations. Mathematical biology is a rich source of applications, ranging from travelling density waves in predator-prey systems to morphogenesis, the formation of organs and tissues in developing organisms [1]. Interactions of solvent molecules with polymer molecules or even macroscopical particles in suspensions lead to bulk properties deviating from Newtonian fluids; the mathematical description of the local microstructure can be interpreted as a set of nonlinearly interacting species [2]. Chemically reacting systems are perhaps the most obvious applications. Often thermal processes have to be considered additionally, in particular, in models of combustion processes [3].

Numerical and analytical techniques are often tailored to the particular problem, however, the common mathematical structure sometimes allows unified treatment of different problems. Numerical solution of problems involving multiple species often requires model reduction techniques [5]. We review some of these in this talk. Though numerical simulations provide detailed and important insights in dynamics, analytical methods have always played an important complementary role. Well-posedness of the nonlinear coupled problems for certain data and stability of certain kinds of solutions have been studied both for specific equations [6] and more arbitrary systems [4].

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