SCHEDULE

TUESDAY AFTERNOON

2:00pm Sergey Gavrilyuk (Marseille) Diffuse interface model for compressible fluid - compressible elastic-plastic solid interaction

2:45pm Gonca Aki (Berlin) An incompressible diffuse flow with phase transition

3:30pm Coffee break

4:pm Mirco Kraenkel and Dietmar Kröner (Freiburg) Numerics for phase field models

WEDNESDAY MORNING

9:30am Franck Boyer (Marseille) Numerical methods for a three-component phase field model

10:15am Maren Hantke (Magdeburg) Exact solutions to the Riemann problem for compressible isothermal Euler equations for two phase flows

11:00am Coffee break

11:30am Christoph Zeiler (Stuttgart) Curvature driven liquid-vapor flow in compressible fluids

WEDNESDAY AFTERNOON

2:00pm Gabriele Witterstein (Munich) The existence of transition profiles for compressible flows

2:45pm Nicolas Seguin (Paris) Model adaptation in hierarchies of hyperbolic systems

3:30pm Coffee break

4:pm Jonathan Jung (Strasbourg) Computing bubble oscillations on GPU

THURSDAY MORNING

9:30am Mathieu Bachmann (Aachen) Numerical simulation of shock wave bubble interactions using laser-induced cavitation bubbles

10:15am Khaled Saleh (Paris) A splitting method for the isentropic Baer-Nunziato two-phase flow model

11:00am Coffee break

11:30am Hélène Mathis (Nantes) Model adaptation for hyperbolic systems with relaxation

LIST OF PARTICIPANTS

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TITLES AND ABSTRACTS

Gonca Aki (Berlin)
An incompressible diffuse flow with phase transition

In this talk, we deal with a binary immiscible mixture whose constituents are incompressible where the incompressibility notion is related to the real densities of the constituents. We derive a system of two-phase flow which undergoes a phase separation and transition under the restriction of the second law of thermodynamics. The entropy production is given as binary products of driving forces, which vanish in equilibrium, and related fluxes. Then, we consider a scaling of the system such that the phase transition has a small thickness. We perform an asymptotic analysis in the sense of matched asymptotics. This will yield a sharp interface model as a limiting system with discontinuous velocity field and chemical potential at the interface. This is a joint work with Wolfgang Dreyer, Jan Giesselmann, and Christiane Kraus.

Mathieu Bachmann (Aachen)
Numerical simulation of shock wave bubble interactions using laser-induced cavitation bubbles

The collapse of cavitation bubbles in water is a highly dynamic process featuring, during its late stage, high velocities at the phase boundary, strong variations in the material parameters, possible liquid jet formation, and the development of shock waves in the vapor phase, as well as in the liquid. The investigation of such compressible two-phase fluid phenomena poses severe difficulties, both numerically and experimentally. In this lecture, the interaction of a collapsing bubble with an incoming shock wave is considered numerically and experimentally. This problem is important for medical applications, such as shock wave lithotripsy, as well as from a more fundamental point of view because bubbles in a cloud are exposed to the collapse shock waves of neighboring bubbles. This is a joint work with M. Alizadeh, Th. Kurz, and H. Söhnholz.

Franck Boyer (Marseille)
Numerical methods for a three-component phase field model

I will first describe a diffuse-interface model for three-phase incompressible flows. It consists in a suitable coupling between a Cahn-Hilliard system and the Navier-Stokes system. I will then discuss numerical issues related to this model and some solutions that we propose in order to deal with them. In particular the following topics will be addressed : suitable time discretization schemes, incremental projection method, conforming adaptive local refinement method, etc.

Sergey Gavrilyuk (Marseille)
Diffuse interface model for compressible fluid - compressible elastic-plastic solid interaction

A new Eulerian hyperbolic diffuse interface model for elastic-plastic solid - fluid interaction is constructed. The governing system couples the Euler equations of compressible fluids and a visco-plastic model of Maxwell-type materials (i.e. the deviatoric part of the stress tensor decreases during plastic deformations) in the same manner as models of multicomponent fluids.

A numerical treatment of the model is particularly challenging. Indeed, the model is non-conservative, so a special numerical splitting is proposed to overcome this difficulty. The numerical method was tested in the 1D case (Wilkins' flying plate problem), 2D plane case (impact of a projectile on a plate), and axisymmetrical case (Taylor test problem, impact with penetration effects, etc.). Numerical examples show the ability of the model to deal with real physical phenomena.

Maren Hantke (Magdeburg)
Exact solutions to the Riemann problem for compressible isothermal Euler equations for two phase flows with and without phase transition

We consider the isothermal Euler equations with phase transition between a liquid and a vapor phase. The mass transfer is modeled by a kinetic relation, and we prove existence and uniqueness results. Furthermore, we construct the exact solution to the Riemann problem and present numerical results for many cases. We compare our results to those to similar problems without phase transition.

Philippe Helluy and Jonathan Jung (Strasbourg)
Computing bubble oscillations on GPU

We compute the oscillations of a spherical gas bubble inside a compressible liquid. Despite its one-dimensional nature, this problem is computationally intensive. We use a recently developed Glimm projection technique in order to capture the gas-liquid interface. We also implement the algorithm on GPU in order to get fast and highly resolved numerical results.

Mirko Kraenkel and Dietmar Kröner (Freiburg)
Numerics for phase field models

This talk will present a numerical scheme for the compressible Navier-Stokes equations coupled to an Allen-Cahn type equation. These equations are deduced from the phase field model of two-phase flow introduced by Witterstein. The coupled system is solved by a discontinuous Galerkin method combined with higher-order Runge-Kutta time-steping and local grid adaptation. Numerical results in one and two space dimensions will be presented.

Hélène Mathis (Nantes)
Model adaptation for hyperbolic systems with relaxation

In the framework of hyperbolic systems with relaxation, we study an algorithm for the dynamical adaptation of models. It enables us to quantify the difference between a fine model (the model with relaxation) and a coarse model (the associated equilibrium model), from continuous and discrete points of view. The whole procedure determines automatically the space-time domains in which each model has to be used in order to take into account the local accuracy and characteristics of the flow. The adaptation procedure is applied to complex flow phenomena, for instance to the multicomponent Euler system.

Khaled Saleh (Paris)
A splitting method for the isentropic Baer-Nunziato two-phase flow model

We propose a fractional step method for computing approximate solutions of the isentropic Baer-Nunziato two-phase flow model. The scheme relies on an operator splitting method corresponding to a separate treatment of fast propagation phenomena due to the acoustic waves, on one hand, and slow propagation phenomena due to the fluid motion, on the other hand. The scheme is proven to preserve positive values of the statistical fractions and densities. We also provide two test-cases that assess the convergence of the method.

Nicolas Seguin (Paris)
Model adaptation in hierarchies of hyperbolic systems

We present a numerical strategy to detect the equilibrium parts of a given flow and to replace a complex model by a simpler one. We present this model adaptation in the case of relaxation systems. The tools are based on Chapman-Enskog expansions and relative entropy estimates. Several numerical examples are presented in the context of two-phase flows.

Gabriele Witterstein (Munich)
The existence of transition profiles for compressible flows

We consider diffusive interface models describing flows which undergo a phase change. The equations consist of the compressible Navier-Stokes system coupled with an Allen-Cahn equation (phase field equation), and are based on an energy variational formulation. We focus on a model where, in the sharp interface limit, a jump arises in the mass density on the free boundary. Here, the central point is the evaluation of the transition profiles in the interface region connecting the both bulk regions. In this talk, we will show the existence of such transition profiles for a special class of double-well potentials.

Christoph Zeiler (Stuttgart)
Curvature driven liquid-vapor flow in compressible fluids

We consider a mathematical model that describes the dynamics of compressible fluids in liquid and vapor phases. We follow the sharp interface approach and consider the dynamics at the phase boundary via micro-scale models, which describe the behavior in the bulk phase and in which the two scales are coupled with a ghost--fluid approach. We will present a micro-scale solver based on a generalization of the classical Riemann problem for two-phase fluids. The phase transition is modeled as a discontinuous wave and the effects of surface tension are included in the curvature of the phase boundary. Multidimensional numerical examples will show how surface tension affects the behavior of bubbles and droplets.