ProHyp 2024

3ᴿᴰ international Workshop on

Perspectives on Multiphase Fluid Dynamics, Continuum Mechanics and Hyperbolic Balance Laws

Conference program

22 – 26 April 2024

Hotel Villa Madruzzo, Trento, Italy

Organized by the University of Trento

The instrument that mediates between theory and practice, between thought and observation, is mathematics; it builds the connecting bridge and makes it stronger and stronger. Thus it happens that our entire present-day culture, insofar as it rests on intellectual insight into and harnessing of nature, is founded on mathematics. Already, Galileo said: Only he can understand nature who has learned the language and signs by which it speaks to us; but this language is mathematics and its signs are mathematical figures. Kant declared, "I maintain that in each particular natural science there is only as much true science as there is mathematics." In fact, we do not master a theory in natural science until we have extracted its mathematical kernel and laid it completely bare. Without mathematics today's astronomy and physics would be impossible; in their theoretical parts, these sciences unfold directly into mathematics. These, like numerous other applications, give mathematics whatever authority it enjoys with the general public.

DAVID HILBERT

Radio address given in Königsberg on 8 September 1930, on the occasion of the yearly meeting of the Society of German Natural Scientists and Physicians (english translation by James T. Smith)

1

Organizing committee:

Michael Dumbser *(University of Trento, Italy)*
Firas Dhaouadi *(University of Trento, Italy)*
Ilya Peshkov *(University of Trento, Italy)*
Laura del Río Martín *(University of Trento, Italy)*
Olindo Zanotti *(University of Trento, Italy)*

Conference secretary:

Lorena Galante (University of Trento, Italy)

This conference has been supported by:

Welcome to ProHyp 2024!

We are very pleased to welcome you to P R O H Y P 2 0 2 4, *the third International workshop on Perspectives on Multiphase Fluid Dynamics, Continuum Mechanics and Hyperbolic Balance Laws, held in Trento, Italy.*

Trento lies in the heart of the majestic Dolomiti Mountains and close to the charming Garda Lake, in a dream scenery rich of arts, history, natural beauties where excellent cuisine and good wine cannot be missed.

After the two first editions held in Magdeburg (2020) and in Marseille (2022), for this 2024 Edition there will be 40 talks given by international researchers coming from *Czech Republic, France, Germany, Italy, Russia, Spain, the United Kingdom, and the United States of America.* In this context, we hope that bringing together researchers from all over the world, theoreticians and numerical scientists, working on multiphase flows, hyperbolic equations and continuum mechanics will promote inter-community exchange and foster fruitful collaborations.

The conference will focus on the mathematical and physical aspects of:

- Modeling, analysis and numerical simulation of multiphase flows;
- Advances in hyperbolic models of continuum mechanics and physics;
- Structure-preserving numerical methods for time-dependent PDEs;
- Free boundary problems and interface motions;
- Phase transition processes;
- Modelling and numerical simulation of flows with surface tension.

In particular, the modeling, analysis and numerical treatment of multiphase fluid dynamics and classical continuum mechanics provide several difficult problems treated in the past as well as in the very recent literature. Often, very problem-specific approaches revealing different mathematical structures are used, making it difficult to provide a unified treatment of these topics.

We would like to thank our sponsors and all the participants for their enrichening contributions and we wish you a very pleasant stay in Trento and productive scientific and personal interactions during the conference!

Michael Dumbser

Chairman of the ProHyp 2024 organization committee

Firas Dhaouadi, Ilya Peshkov, Laura del Río Martín, Olindo Zanotti

ProHyp 2024 local organizing committee

ProHyp 2024, 22 – 26 April 2024, Trento, Italy

3rd International workshop on Perspectives on Multiphase Fluid Dynamics, Continuum Mechanics and Hyperbolic Balance Laws

	Monday, 22.04.2024	Tuesday, 23.04.2024	Wednesday, 24.04.2024	Thursday, 25.04.2024	Friday, 26.04.2024
08:40 – 09:00	*Opening and Welcome*				
09:00 – 09:40	E.F. Toro	E. Romenskiy	G. Warnecke	T. Ruggeri	G. Puppo
09:40 – 10:20	S. Chiocchetti	L. del Río Martín	F. Thein	G. Saccomandi	O. Hurisse
10:20 – 11:20	*Coffee Break*	*Coffee Break*	*Coffee Break*	*Coffee Break*	*Coffee Break*
11:20 – 12:00	C. Rohde	A. Thomann	H. Freistühler	D. Bigoni	W. Boscheri
12:00 – 12:40	S. Gavrilyuk	D. Ferrari	T. Crin-Barat	S. Mogilevskaya	M. Tavelli
12:40 – 14:40	*Lunch*	*Lunch*	*Lunch*	*Lunch*	*Lunch*
14:40 – 15:20	S. Müller	P. Mulet	M. Pavelka	D. Misseroni	O. Kincl
15:20 – 16:00	M. Hantke	F. Dhaouadi	V. Klika	Y. Du	A. Lucca
16:00 – 17:00	*Coffee Break*	*Coffee Break*	*Coffee Break*	*Coffee Break*	C. Brutto
17:00 – 17:40	B. Re	J. Keim	B. Nkonga	N. Kolbe	E. Zampa
17:40 – 18:20	M. Dumbser	M. Nikodemou	P. Helluy	V. Perrier	*Closure*
19:30 – …	*Welcome Reception*		*Conference Dinner*		

Daily program: Monday, 22 April 2024

08:40 – 09:00   OPENING AND WELCOME

09:00 – 09:40   **Eleuterio F. Toro**   (University of Trento, Italy)
Computational aspects of compressible multiphase flows

09:40 – 10:20   **Simone Chiocchetti**   (University of Cologne, Germany)
First order hyperbolic viscous flow using quaternion fields

10:20 – 11:20   COFFE BREAK

11:20 – 12:00   **Christian Rohde**   (University of Stuttgart, Germany)
Hyperbolic Modelling for Compressible Liquid-Vapour Dynamics

12:00 – 12:40   **Sergey Gavrilyuk**   (Aix-Marseille University, France)
The conduit equation: hyperbolic approximation and generalized Riemann problem

12:40 – 14:40   LUNCH

14:40 – 15:20   **Siegfried Müller**   (RWTH Aachen University, Germany)
Investigation of isothermal Baer-Nunziato-type models

15:20 – 16:00   **Maren Hantke**   (Martin-Luther-Universität Halle-Wittenberg, Germany)
Pressure equilibrium in Baer-Nunziato-model

16:00 – 17:00   COFFE BREAK

17:00 – 17:40   **Barbara Re**   (Politecnico di Milano, Italy)
Numerical modeling of non-equilibrium compressible two-phase flows based on a primitive formulation of the Baer-Nunziato model

17:40 – 18:20   **Michael Dumbser**   (University of Trento, Italy)
High order well-balanced finite volume and discontinuous Galerkin schemes for a first order hyperbolic reformulation of the coupled Einstein-Euler system in 3+1 general relativity

19:30 – . . .   WELCOME RECEPTION

Daily program: Tuesday, 23 April 2024

09:00   OPENING

09:00 – 09:40   **Evgeniy Romenskiy**   (Sobolev Institute of Mathematics, Russia)
Symmetric Hyperbolic Thermodynamically Compatible model of two-phase compressible fluid flow with surface tension

09:40 – 10:20   **Laura del Río Martín**   (University of Trento, Italy)
Numerical methods for compressible two-phase flows with curl involutions

10:20 – 11:20   COFFE BREAK

11:20 – 12:00   **Andrea Thomann**   (Inria Strasbourg, France)
Numerical methods for a two-fluid model derived from SHTC theory

12:00 – 12:40   **Davide Ferrari**   (University of Trento, Italy)
A unified SHTC multiphase model of continuum mechanics

12:40 – 14:40   LUNCH

14:40 – 15:20   **Pep Mulet**   (University of Valencia, Spain)
Implicit-explicit numerical methods for the isentropic compressible Cahn-Hilliard-Navier-Stokes equations

15:20 – 16:00   **Firas Dhaouadi**   (University of Trento, Italy)
Hyperbolic models for diffusion equations

16:00 – 17:00   COFFE BREAK

17:00 – 17:40   **Jens Keim**   (University of Stuttgart, Germany)
On the fidelity of the Navier-Stokes-Korteweg equations: Comparison to Molecular Dynamics Simulations

17:40 – 18:20   **Maria Nikodemou**   (University of Cambridge, United Kingdom)
A unified methodology for multi-material simulations in combustion modelling

Daily program: Wednesday, 24 April 2024

09:00   OPENING

09:00 – 09:40   **Gerald Warnecke** (Otto-von-Guericke-Universität, Germany)
On concavity of entropy and symmetrization of the full Euler system

09:40 – 10:20   **Ferdinand Thein** (Johannes Gutenberg-Universität Mainz, Germany)
On Non-Strict Hyperbolic Systems and Related Wave Phenomena

10:20 – 11:20   COFFE BREAK

11:20 – 12:00   **Heinrich Freistühler** (University of Konstanz, Germany)
Shock profiles in second-order hyperbolic systems of dissipative relativistic fluid dynamics

12:00 – 12:40   **Timothée Crin-Barat** (Friedrich-Alexander-Universität Erlangen Nürnberg, Germany)
Cattaneo's hyperbolic approximation: hypocoercivity and harmonic analysis

12:40 – 14:40   LUNCH

14:40 – 15:20   **Michal Pavelka** (Charles University, Czech Republic)
Hyperbolic heat conduction with thermal vorticity

15:20 – 16:00   **Václav Klika** (Czech Technical University in Prague, Czech Republic)
On the Compatibility of Sharp and Diffuse Interfaces Out of Equilibrium

16:00 – 17:00   COFFE BREAK

17:00 – 17:40   **Boniface Nkonga** (University Côte d'Azur, France)
Investigations of numerical approximations for the non-conservative shear shallow water model

17:40 – 18:20   **Philippe Helluy** (Inria Strasbourg, France)
A fourth-order entropic kinetic scheme

19:30 – . . .   CONFERENCE DINNER

Daily program: Thursday, 25 April 2024

09:00   OPENING

09:00 – 09:40   **Tommaso Ruggeri**   (University of Bologna, Italy)
A Nonlinear Approach to Viscoelasticity via Rational Extended Thermodynamics

09:40 – 10:20   **Giuseppe Saccomandi**   (University of Perugia, Italy)
Singular travelling waves in soft viscoelastic solids of rate type

10:20 – 11:20   COFFE BREAK

11:20 – 12:00   **Davide Bigoni**   (University of Trento, Italy)
Instabilities in structures and their link to solids

12:00 – 12:40   **Sofia Mogilevskaya**   (University of Minnesota, USA)
Surface/interface effects in elastic solids with inhomogeneities and liquid inclusions

12:40 – 14:40   LUNCH

14:40 – 15:20   **Diego Misseroni**   (University of Trento, Italy)
Geometric Mechanics of Origami Metamaterials with Tunable Poisson's Ratio

15:20 – 16:00   **Yangkun Du**   (University of Trento, Italy)
Nonlinear Indentation of Second-order Hyperelastic Materials

16:00 – 17:00   COFFE BREAK

17:00 – 17:40   **Niklas Kolbe**   (RWTH Aachen University, Germany)
A new numerical method for coupled nonconservative hyperbolic systems

17:40 – 18:20   **Vincent Perrier**   (Inria Pau, France)
How to preserve an implicit divergence or curl constraint in a hyperbolic system with the discontinuous Galerkin method

18:20 – 19:20   POSTER SESSION

George Cristian Ivan   (University of Trento, Italy)
Dead, follower and pressure loads: surface waves and compressive vs. tensile bifurcations

Daily program: Friday, 26 April 2024

09:00   OPENING

09:00 – 09:40   **Gabriella Puppo**   (University of Roma - La Sapienza, Italy)
Large time steps for multifluids flows

09:40 – 10:20   **Olivier Hurisse**   (Électricité de France, France)
A Glimm like scheme for front propagation on multi-dimensional domains

10:20 – 11:20   COFFE BREAK

11:20 – 12:00   **Walter Boscheri**   (CNRS - Université Savoie Mont Blanc, France)
A structure-preserving semi-implicit IMEX finite volume scheme for ideal magnetohydrodynamics at all Mach and Alfvén numbers

12:00 – 12:40   **Maurizio Tavelli**   (University of Bolzano, Italy)
A new class of efficient high order semi-Lagrangian IMEX-DG methods on staggered unstructured meshes

12:40 – 14:40   LUNCH

14:40 – 15:05   **Ondřej Kincl**   (University of Trento, Italy)
Lagrangian Voronoi Method for Multiphase Flows

15:05 – 15:30   **Alessia Lucca**   (University of Trento, Italy)
Numerical method for efficient blood flow simulations

15:30 – 15:55   **Enrico Zampa**   (University of Trento, Italy)
Compatible finite element discretization of the time-dependent magnetic advection-diffusion equation with application to magnetohydrodynamics

15:55 – 16:20   **Cristian Brutto**   (University of Trento, Italy)
Development of an efficient fluid-structure interaction model for floating objects

16:20 – 16:45   **Solène Schropff**   (Aix-Marseille University, France)
Reference solutions for compressible single-phase flows in heated and cooled ducts

16:45   CLOSURE

Registered participants:

Davide Bigoni

Walter Boscheri

Cristian Brutto

Simone Chiocchetti

Timothée Crin-Barat

Laura del Río Martín

Firas Dhaouadi

Michael Dumbser

Yangkun Du

Davide Ferrari

Heinrich Freistühler

Elena Gaburro

Sergey Gavrilyuk

Maren Hantke

Philippe Helluy

Olivier Hurisse

George Cristian Ivan

Jens Keim

Ondřej Kincl

Václav Klika

Niklas Kolbe

Alessia Lucca

Diego Misseroni

Sofia Mogilevskaya

Pep Mulet

Siegfried Müller

Maria Nikodemou

Boniface Nkonga

Michal Pavelka

Vincent Perrier

Ilya Peshkov

Gabriella Puppo

Barbara Re

Christian Rohde

Evgeniy Romenskiy

Tommaso Ruggeri

Giuseppe Saccomandi

Solène Schropff

Maurizio Tavelli

Ferdinand Thein

Andrea Thomann

Eleuterio F. Toro

Gerald Warnecke

Enrico Zampa

Olindo Zanotti