

NEWSLETTER

of the Work Group Mathematical Fluid Mechanics

Newsletter no. 5 (2024)

Janina Kern submitted her Master thesis

Janina Kern has submitted her Master thesis: "On a Stationarity Preserving Multi-Dimensional Finite Volume Scheme for Conservation Laws". It was co-supervised by Wasilij Barsukow. Lisa Lechner also had discussions on the topic with Janina.

Wasilij had developed a technique using Fourier transforms to study the ability of a given finite volume (FV) scheme for linear hyperbolic equations to maintain discrete stationary solutions. Janina applied this to a new FV scheme called generalized Active Flux (AF). She shows that its stationarity preserving properties are similar to so called traditional AF.

The PhD defense of Claudius Birke scheduled for May 10

Claudius Birke had submitted his PhD thesis. The referee reports are in, and our faculty of mathematics and computer science now has time to evaluate the thesis with its reports, and ask questions if needed. This procedure is almost always without problems, so one can now schedule the defense of Claudius' PhD.

Claudius' so called opponents will be Fritz Röpke (Heidelberg), Komla Domelevo and myself. After taking into account the time constraints of these four persons, the defense has been scheduled for Friday May 10, in the afternoon.

$$\begin{aligned}
& -\frac{\Delta x^2 \Delta y}{16} \partial_{xxy} q + \frac{\Delta x^2 \Delta y^2}{64} \partial_{xxyy} q + \dots \Big) + \left(q - \frac{\Delta y}{2} \partial_y q + \frac{\Delta y^2}{8} \partial_{yy} q + \dots \right) \\
& + \frac{1}{4} \left(q - \frac{\Delta y}{2} \partial_y q + \frac{\Delta y^2}{8} \partial_{yy} q + \frac{\Delta x}{2} \partial_x q - \frac{\Delta x \Delta y}{4} \partial_{xy} q - \frac{\Delta x \Delta y^2}{16} \partial_{xyy} q + \frac{\Delta x^2}{8} \partial_{xx} q \right. \\
& \left. - \frac{\Delta x^2 \Delta y}{16} \partial_{xxy} q + \frac{\Delta x^2 \Delta y^2}{64} \partial_{xxyy} q + \dots \right) + 4 \left(q + \frac{\Delta x}{2} \partial_x q + \frac{\Delta x^2}{8} \partial_{xx} q + \dots \right) \\
& + \frac{1}{4} \left(q + \frac{\Delta y}{2} \partial_y q + \frac{\Delta y^2}{8} \partial_{yy} q + \frac{\Delta x}{2} \partial_x q + \frac{\Delta x \Delta y}{4} \partial_{xy} q + \frac{\Delta x \Delta y^2}{16} \partial_{xyy} q + \frac{\Delta x^2}{8} \partial_{xx} q \right. \\
& \left. + \frac{\Delta x^2 \Delta y}{16} \partial_{xxy} q + \frac{\Delta x^2 \Delta y^2}{64} \partial_{xxyy} q + \dots \right) + \left(q + \frac{\Delta y}{2} \partial_y q + \frac{\Delta y^2}{8} \partial_{yy} q + \dots \right) \\
& + \frac{1}{4} \left(q + \frac{\Delta y}{2} \partial_y q + \frac{\Delta y^2}{8} \partial_{yy} q - \frac{\Delta x}{2} \partial_x q - \frac{\Delta x \Delta y}{4} \partial_{xy} q - \frac{\Delta x \Delta y^2}{16} \partial_{xyy} q + \frac{\Delta x^2}{8} \partial_{xx} q \right. \\
& \left. + \frac{\Delta x^2 \Delta y}{16} \partial_{xxy} q + \frac{\Delta x^2 \Delta y^2}{64} \partial_{xxyy} q + \dots \right) + 2 \left(q - \frac{\Delta x}{2} \partial_x q + \frac{\Delta x^2}{8} \partial_{xx} q + \dots \right) \\
& - 9 \left(q + \frac{\Delta y^2}{24} \partial_{yy} q + \frac{\Delta x^2}{24} \partial_{xx} q + \frac{\Delta x^2 \Delta y^2}{576} \partial_{xyxx} q + \dots \right)
\end{aligned}$$

A sample calculation from Janina's Master thesis. Extensive use of Mathematica was needed to get through the calculations.



A xkcd comic.

Sebastian Schmidt submits Master thesis

Sebastian Schmidt submitted his Master thesis "Comparing well-balanced schemes for the Euler equations with gravity". It is a literature survey of various well-balanced schemes, including relaxation schemes.

Simon Markfelder has accepted his 'junior professorship' in Konstanz

Simon Markfelder had an offer for a six year temporary post-doc position at the University of Konstanz. Such a position is considered prestigious, which is why it is called 'junior professorship'.

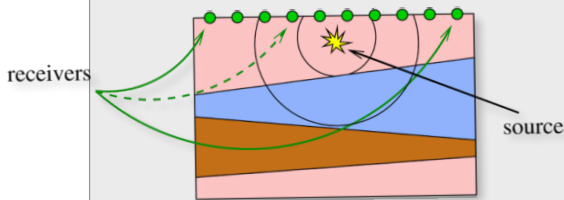
Simon has now decided to go there and accepted the position. He will move to Konstanz and begin his position in September of this year.

Good luck, Simon!

Melissa Lange begins with her Master thesis

Melissa Lange began to work on her Master thesis. She will study a theoretical technique, called 'optimal transport', that was used by [Yunan Yang](#) to improve the solution of seismic inverse problems.

Seismic inverse problems try to infer the geological structure below the surface of the earth from waves, that are sent from one point near the earth's surface, and its below ground reflections measured at other points on the earth's surface. The geological structure is found using an optimization problem that uses a norm coming from optimal transport.



Seismic inversion

Miriam Schönleben begins her Master thesis

Miriam Schönleben has begun with her Master thesis. She considers an existing numerical wave equations solver that is enhanced by machine learning (Luis Kaiser's extension of *Nguyen, Tsai: Numerical Wave Propagation Aided by Deep Learning. Journal of Computational Physics 475, (2023)*), and plans to apply this technique to another PDE model. Richard Tsai (University of Texas in Austin, USA) agreed to co-supervise this project.

Submissions to HONOM

In September there will be a conference on high order numerical methods for hyperbolic equations in Crete, [HOMOM 2024](#) organized by Elena Gaburro. - Wasilij Barsukow, Junming Duan, Lisa Lechner, and myself all submitted contributed talks there on various aspects of the Active Flux method: Stability, limiting, arbitrary order and structure preserving properties. Lets hope the topic is of sufficient interest to warrant so many contributions.

Upcoming scientific conferences

Click on the links and check where you might want to participate.

- April 22 - 26, 2024: ProHyp2024, [Workshop on Multiphase Fluid Dynamics, Continuum Mechanics and Hyperbolic Balance Laws](#), in Trento, Italy, organized by Michael Dumbser
- June 5 - 7, 2024: [Analysis of dissipation in compressible and inviscid fluids](#), in Konstanz, Germany, organized among others by Emil Wiedemann
- July 1 - 5, 2024: [XIX International Conference on Hyperbolic Problems: Theory, Numerics and Applications \(HYP 2024\)](#) in Shanghai, China, at Shanghai Jiao Tong University, organized by Yachun Li & Ya-Guang Wang
- July 8 - 11, 2024: [Modern Perspectives in Applied Mathematics: Theory and Numerics of PDEs](#) in Zürich, organized by Sid Mishra
- Aug. 26 - 30, 2024: [11th International Conference on Multi-Material Fluid Flow \(MultiMat 2024\)](#) in Colorado, USA, organized by the Lawrence Livermore National Laboratory, USA
- Sept. 9 - 13, 2024: [Conference on high-order nonlinear numerical methods for evolutionary PDEs \(HONOM2024\)](#) on the Crete Island, Greece, organized by Elena Gaburro
- March 3 - 7, **2025**: [SIAM Conference on Computational Science and Engineering \(CSE25\)](#), in Fort Worth, Texas, USA
- June 9 - 13, 2025: NumHyp 2025, in Darmstadt
- Sept. 14 - 20, 2025: Hirscheegg Workshop, in the Kleinwalsertal, Austria, organized by Gerald Warnecke and others
- sometime in **2026**: Finite Volume and Complex Applications 11, in Münster, Germany

Kathrin's, Lena's and my talk accepted at HYP 2024

July 1 - 5 the 19th Int. Conf. on Hyperbolic Problems ([HYP 2024](#)) will take place in Shanghai, China. Lena Baumann, Kathrin Hellmuth and myself plan to attend. The three of us had submitted contributed talks there. All three of them have been accepted for presentation.

Some German and Chinese mathematicians working on hyperbolic problems have a joint Sino-German project, funded among others by the German DFG. This project will cover our flights to Shanghai.



A partial view of the Shanghai Jiao Tong Minhang Campus. HYP2024 will take place on this campus.