

NEWSLETTER

of the Work Group Mathematical Fluid Mechanics

Newsletter no. 6 (2022)

Sandra Warnecke's paper accepted

The paper Hahn, B, Kienle-Garrido, Klingenberg, C., Warnecke, S: "Using the Navier-Stokes equation for motion estimation in dynamic imaging", Inverse Problems and Imaging (2022) has been accepted for publication.

PhD defense of Farah Kanbar on April 5



Farah had submitted her PhD thesis in Dec. 2021. Afterwards it was refereed. Then the faculty of mathematics and computer science were given the time to check everything. All this is now finished, so the only thing left for Farah is to pass her PhD defense on April 5 at 2:30 pm.

Her opponents will be Anja Schlömerkemper, Rony Touma (via Zoom) and myself. - Good luck, Farah!

Lena Baumann was awarded a PhD stipend



Lena Baumann had applied for a stipend for her PhD from the Stiftung der deutschen Wirtschaft. Her application consisted among other things of a research plan for her PhD thesis and of proof of her social engagements.

She then made it to the second round with a thorough interview. Now she heard that she received the stipend. It will last until the end of March 2025. Congratulations, Lena!

This is a poster I made for a workshop. It summarizes the paper by Sandra et al. This work came out of Sandra's Master thesis. It needed quite a bit of patience until the paper was finally published.

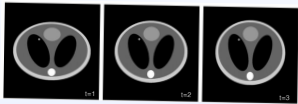
Computer tomography for body tissue in motion

Christian Klingenberg
Würzburg University, Germany

Dept. of Mathematics
Würzburg University
Emil-Fischer-Straße 40
97074 Würzburg
GERMANY

jointly with Bernadette Hahn (Stuttgart, Germany) and Sandra Warnecke (Würzburg)

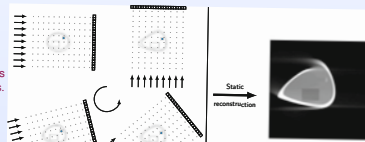
Suppose you want to do use computer tomography on moving tissue. We have in mind the breathing cycle of a person:



The evolution of a 2-d cut through a body reminiscent of a half cycle of breathing. One slices the two parts of the lung (black), the spine (white) and a small white dot in the right lung representing cancer.

But computer tomography (CT) is designed for static bodies.

When applying CT to bodies whose shape varies in time, one obtains artifacts.



the body changes its shape while being scanned by a CT in a static reconstruction the cancer is barely visible

This leads us to model the motion by a partial differential equations (PDE) in Lagrange coordinates.

As long as the deformation of the body is small, the solution of the PDE allows us to transform the deformation back to its initial position and thus solve the inverse problem of a "stationary" problem.

We model the moving tissue shown above by 2-space dimensional linear elasticity

$$\rho \frac{\partial^2 u_k}{\partial t^2} = \hat{v}_k + \mu \left(\frac{\partial^2 u_k}{\partial x_1^2} + \frac{\partial^2 u_k}{\partial x_2^2} \right) + (\lambda + \mu) \frac{\partial}{\partial x_k} \left(\frac{\partial u_1}{\partial x_1} + \frac{\partial u_2}{\partial x_2} \right) \quad \text{for } k = 1, 2.$$

Navier-Cauchy equations

The movement is achieved by a time-dependent deformation of the boundary.

This is solved numerically and then used as a motion compensation for image reconstruction.



static reconstruction at time t = 2



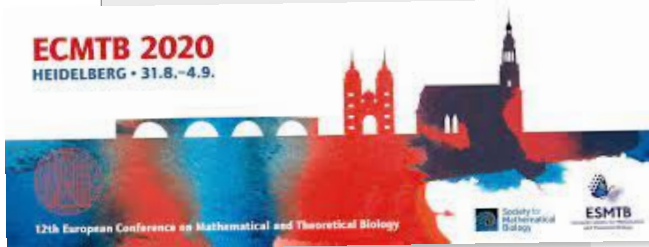
dynamic reconstruction with motion information from solving the PDE at time t = 2 the cancer becomes visible

for more information, see the preprint: arXiv:2009.04212

Conference on mathematical biology

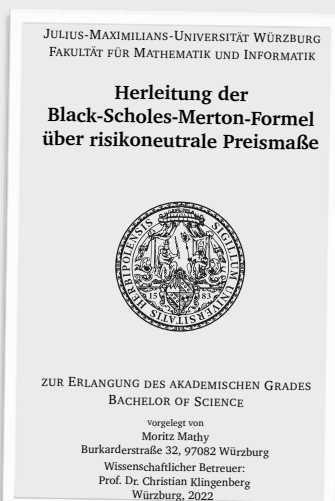
The [12th European Conference on Mathematical and Theoretical Biology](#) will take place Sept. 19 - 23, 2022 in Heidelberg.

It is being organized by Anna Marciniak. She obtained her PhD from Willi Jäger. I had been a postdoc with Jäger.



Moritz Mathy submitted his Bachelor thesis

Moritz Mathy submitted his Bachelor thesis titled "*Herleitung der Black-Scholes-Merton-Formel über risikoneutrale Preismaße*". This subject is a great way to become acquainted with stochastic integration.



Upcoming scientific conferences

Go ahead and click the links to check where you might want to participate.

- Jan. 10 - June 24, 2022: [Frontiers in kinetic theory: connecting microscopic to macroscopic scales - KineCon 2022](#), a one semester program organized at the Newton Institute at Cambridge University with 5 one week workshops in this time
- April 4 - 8, 2022: [High order nonlinear numerical methods for evolutionary PDEs: theory and applications \(HONOM\)](#) in Braga, Portugal, organized by Raphael Loubère und Stephane Clain
- April 10 - 15, 2022: [Structure preserving discretizations](#), in Oberwolfach, organized by Bruno Després, Michael Dumbser, myself
- May 11 - 13, 2022: [High-order Time Discretization Methods for PDEs](#), on the island of Capri, Italy, organized by Lorenzo Pareschi, Giovanni Russo and others
- May 16 - 20, 2022: [The Boltzmann Equations: in the trail of Torsten Carlemann](#), near Stockholm, Sweden
- May 23 - 29, 2022: [Sharing Higher-order Advanced Research Know-how on Finite Volume \(SHARK-FV\)](#) in Portugal, organized by Raphael Loubère und Stephane Clain
- June 12 - 18, 2022: [Summer School on "Methods and models of kinetic theory"](#) organized by Marzia Bisi (Parma) among others
- June 20 - 25: HYP2022: [18th International Conference on Hyperbolic Problems, Theory, Numerics, Applications](#) - Part 2 (formerly HYP 2020), in Malaga, Spain, organized by Carlos Pares
- June 19 - 24, 2022 ["Numerical methods for kinetic equations"](#) a *summer school* by Eric Sonnendrücker and Lukas Einkemmer in the alps in Italy
- June 27 - July 1, 2022: [Hyperbolic balance laws & beyond](#), in Magdeburg, organized by Helzel and Lukacova
- July 18 - 22, 2022: [When Kinetic Theory meets Fluid Mechanics](#), in Zürich, organized among others by Alexis Vasseur
- Aug. 22 - 26, 2022: [10th International Conference on Numerical Methods for Multi-Material Fluid Flow \(MULTIMAT 2021\)](#) in Zürich, organized by Remi Abgrall and others
- Sept. 12 - 14, 2022: [Nils Henrik Risebro birthday conference](#) in Oslo, organized among others by Fjordholm, Holden, Mishra
- Sept. 26 - 30, 2022: [Horizons in non-linear PDEs](#), a *summer school* in Ulm, organized by Emil Wiedemann and others
- Oct. 9 - 14, 2022: [Computation of hyperbolic and related PDEs: A conference in honor of Remi Abgrall](#), organized by Sid Mishra at ETH Zurich on Monte Verità (Ascona, Switzerland)
- Sept.. 19 - 23, 2022: [12th European Conference on Mathematical and Theoretical Biology](#) in Heidelberg, organized by Anna Marciniak (Heidelberg) and others
- Nov. 14 - 18, 2022: [Kinetic Theory](#), in Luminy (near Marseille, France), organized by José Carillo, Markus Schmittchen and others