University Center for Mathematical Modeling, Applied Analysis and Computational Mathematics

Semester Seminar, May 6, 2019, 8:10–12:10, Room K2

Schedule

Time	Speaker	Title
8:10		Opening
8:15	Marek Cúth	Lipschitz free p-spaces
8:35	Stefano Pozza	Lanczos algorithm as a network reduction method
8:55	Karel Tůma	Three-dimensional multiphase transformations in shape memory alloys
9:15	Sebastian Schwarzacher	Solenoidal Extensions and fluid structure interactions
9:35		Coffee break
9:45	Malte Kampschulte	Information loss in oscillation and concentration phenomena
10:05	Matthias Sroczinski	Asymptotic stability in a second-order symmetric hyperbolic system modeling the relativistic dynamics of viscous heat-conductive fluids with diffusion
10:25	Michal Pavelka	Why Hamiltonian mechanics?
10:45		Coffee Break
11:00	Klára Kalousová	Titan's climate may explain the presence of its deep ocean
11:20	Josef Hanuš	High-resolution observations of asteroid (2) Pallas
11:40	Jaroslav Haas	Stellar dynamics at the centre of the Milky Way
12:00		Conclusion

Abstracts

Marek Cúth: Lipschitz free p-spaces. Given a metric space M, it is possible to construct a Banach space $\mathcal{F}(M)$ in such a way that the Lipschitz structure of M corresponds to the linear structure of $\mathcal{F}(M)$. This space $\mathcal{F}(M)$ is sometimes called "Lipschitz-free space". In a joint paper with F. Albiac, J. L. Ansorena and M. Doucha we studied a generalization of this notion to quasi-metric spaces. I will try to present the motivation for this study and briefly mention some of our results and an interesting problem we arrived at.

Jaroslav Haas: Stellar dynamics at the centre of the Milky Way. In my talk, I will introduce the complex environment of the centre of our Galaxy and focus on some of the currently investigated aspects of the dynamical evolution of its stellar component.

Josef Hanuš: High-resolution observations of asteroid (2) Pallas. By visiting the two largest bodies in the asteroid belt, the dwarf planet (1) Ceres and protoplanet (4) Vesta, the Dawn mission unveiled two strikingly different worlds, illustrating the complex compositional and geological diversity of the asteroid belt. Here, I will discuss and interpret the high angular resolution observations of the third largest main belt asteroid, (2) Pallas, performed with the extreme Adaptive-Optics (AO)-fed SPHERE imager on the Very Large Telescope (VLT).

Klára Kalousová: Titan's climate may explain the presence of its deep ocean. Titan, Saturn's largest moon, has a deep ocean below an icy crust of 50-100km. Although several hypotheses have been proposed, the question of how the liquid ocean can be maintained over geological timescales has not yet been resolved. Titan is also the only moon in the solar system with a dense atmosphere which is composed mainly of nitrogen with some amount of methane and other compounds. The presence of hydrocarbon lakes on Titan's Northern Pole indicates that at least some of the methane precipitates on the surface. Besides being trapped in the lakes, liquid methane can also percolate into the subsurface and react with water ice to form methane clathrates that have more than an order of magnitude smaller thermal conductivity than water ice at Titan's surface temperature. A few kilometers thick layer of methane clathrates that can form within tens of kiloyears thus acts as an efficient insulator and can significantly limit the amount of heat that is extracted from Titan's deep interior. This process may help explain the presence of Titan's deep subsurface ocean.

Malte Kampschulte: Information loss in oscillation and concentration phenomena. When taking limits in multiscale problems, important features of solutions are often shrunk to infinitesimal size and thus lost to the classical point of view. To properly capture all aspects of the solution one then has to relax the notion of a function using one of many related concepts. Here a balance needs to be found between needlessly over-generalizing the problem and accidentally loosing important information. The aim of this short talk is to illustrate the usefulness of tailoring the right relaxation to a given problem using various examples.

Michal Pavelka: Why Hamiltonian mechanics? When is it useful to use Hamiltonian mechanics, especially in continuum physics? What is Hamiltonian continuum mechanics in the Eulerian frame? What are the befenits and unexpected consequences?

Stefano Pozza: Lanczos algorithm as a network reduction method. The talk will illustrate some preliminary work on the connections between properties of a network (as the ones related to the network walks), Krylov subspace methods, and continued fractions. Such connections are spread in the literature. Summarizing them is the first step towards a new work on Krylov subspace methods for complex network analysis and matrix function approximation.

Sebastian Schwarzacher: Solenoidal Extensions and fluid structure interactions. We study the unsteady Navier Stokes equations in two and three dimensions interacting with a non-linear flexible shell of Koiter Type. The latter one constitutes a moving part of the boundary of the physical domain of the fluid. This leads to a coupled system of PDEs. The fluid-structure interactions is captured in form of a weak momentum equation, where the space of testfunctions is part of the concept of solutions. We introduce new methods that allow to prove higher regularity estimates for the shell. Due to the improved regularity estimates it is then possible to extend the known existence theory to weak solutions for non-linear Koiter shell models. This is a work that was achieved in collaboration with B. Muha (Univ. of Zagreb).

Matthias Sroczinski: Asymptotic stability in a second-order symmetric hyperbolic system modeling the relativistic dynamics of viscous heat-conductive fluids with diffusion. The talk reports results on a system of partial differential equations that models the relativistic dynamics of viscous, heat-conductive fluids with diffusion. We introduce the equations and outline the proof for global-in-time existence and asymptotic decay of small solutions. First decay and energy estimates for solutions to the linearized equations are shown. Then a priori decay and energy estimates for small solutions are proven by treating the nonlinear equations as perturbations to the linearized ones. These estimates then allow to extend local solutions for all times.

Karel Tůma: Three-dimensional multiphase transformations in shape memory alloys. Recently developed phase-field model for martensitic transformations is modified in order to take into account the transformation between cubic austenite and three variants of tetragonal martensites in NiAl. This requires to adopt three order parameters to distinguish between individual phases. In our model we adopt the double obstacle potential which enables to obtain a sharper interface than in case of double well, the physical restrictions on the order parameters are treated using a classical penalty method.

This new model is used to compute a compression of a piece of NiAl with a ball indenter (by contact). The material is at $t = 0$ in the austenite phase and during the compression it transforms into three different variants of martensite. Since we deal with a full 3D problem, the problem is huge (more than 10 mil. DOFs) and our finite element implementation has to scale reasonably with the number of threads.