BRIDGING THE GAP OBERSEMINAR ANALYSIS

WEDNESDAYS 11:00 AM VIA ZOOM

Schedule

04.11.20 **Gustav Holzegel**

Wave Equations on Black Hole Spacetimes – An Introduction

Abstract: This will be an introductory talk on the study of wave equation on black hole spacetimes. I will describe some of the fundamental geometric properties of black holes and how they are reflected in the PDE estimates. I will discuss the geometric origin of vectorfield estimates for the linear wave equation on Schwarzschild (and time permitting also the Kerr spacetimes) and explain in what ways they are robust to perturbations. The connection to the stability of black holes and the analysis of the Teukolsky equation will also be made.

18.11.20 **André Schlichting**

Oscillatory behavior of bubbleator dynamics

Absract: It is well known that kinetic models satisfying the so-called detailed balance condition have an entropy functional which can be used to derive convergence to equilibrium results. On the other hand, there are many physical situations (typically open systems) where it is natural to use kinetic equations for which a detailed balance condition does not hold. In these cases, more complicated dynamical behavior can arise, for instance, oscillatory behaviors. A class of kinetic equations where it is not a priori evident if temporal oscillations can occur are the coagulation-fragmentation equations.

In the talk, we concentrate on Becker-Döring type dynamics, in which only a single monomer can attach or detach from a cluster. These equations have been extensively used to model chemical-physical systems and especially bubbleator dynamics. In this talk, I will describe such models for which the onset of periodic oscillations can be proven by formal asymptotics. One of the models represents the formation of large clusters in a Becker-Döring equation having a source of monomers and removal of large clusters.

Joint work with Barbara Niethammer, Bob Pego, and Juan Velazquez.

25.11.20 **Angela Stevens**

Cross-Diffusion, "Aggregation"-Equations, and Singularities - an Introduction

Absract:Cross-diffusion models in biomathematics are of strong interest, e.g. in ecology. A well known example in microbiology is the by now classical Keller-Segel model for chemotaxis. The original system of four PDEs can be reduced to two PDEs: a diffusion equation with strong nonlinear drift for chemotactically moving cells and a reaction-diffusion equation for the attractive chemical agent. In a further

reduction this model relates to classical models for self-gravitational collapse. A change of sign for the nonlinear drift relates to semi-conductor equations.

Interestingly, the occuring blowup of solutions relates to the biological phenomena of self-organisation. In two spatial dimensions a crucial dichotomy was proved in the 90's, namely blowup of solutions vs. existence of global solutions in dependence of a critical parameter, which relates to the strength of the nonlinear drift or to a critical mass. Proofs depend, e.g. on the Moser-Trudinger inequality and non-trivial stationary states relate to a certain extent to the Gauss-Bonnet formula.

Solving the stationary reaction-diffusion equation for the chemical agent, and plugging it into the diffusion-drift equation, a non-local equation with Newtonian or Bessel potential results. Generalizing these potentials relates to the analysis of by now so-called aggregation equations.

In this talk we present qualitative results on pattern formation within this class of nonlinear equations, including the development of singularities.

02.12.20 **Joachim Lohkamp**

The Secret Hyperbolic Life of Positive Scalar Curvature

Abstract: This is a non-technical introduction to some ideas to derive results in scalar curvature geometry and general relativity using also singular solutions of variational problems. A typical class of such solutions are area minimizing hypersurfaces. They are known to admit complicated singular sets. We will see how, even without knowing the structure of these singular loci, Gromov hyperbolic geometry gives us a fine control over the asymptotic analysis of elliptic operators on such hypersurfaces towards their singularities.

09.12.20 **Sebastian Throm**

Long-time behaviour for coagulation models

Abstract: Coagulation of clusters is a widespread phenomenon in natural and industrial processes which particularly occurs on a huge range of length scales. Examples include the formation of raindrops in clouds and polymers but also macroscopic processes such as the formation of planets. In this talk, we will consider kinetic models describing these systems and we will particularly focus on their long-time behaviour.

16.12.20 **Christopher Kauffman**

Global Stability for the Einstein-Maxwell-Klein-Gordon System

Abstract: This will cover global stability results for the massless Einstein-Maxwell-Klein-Gordon system for small initial data. In particular, the two main concepts we take advantage of are the weak null condition, which shows up in a substantial way in both the Einstein and the MKG portions of the analysis, as well as a frame of modified wave coordinates, which capture more precisely the decay rates of certain components of each system without losing the relative simplicity of standard wave coordinates.

20.01.21 **Konstantinos Zemas**

Rigidity estimates for isometric and conformal maps on the sphere

Abstract: In this talk I would like to discuss both linear and nonlinear stability aspects of the class of rigid motions (resp. Möbius transformations) of the standard round sphere among maps from the sphere into the ambient Euclidean space. Unlike similar in flavour results for maps defined on domains, not only an isometric (resp. conformal) deficit is necessary in this more flexible setting, but also a deficit measuring the distortion of the sphere under the maps in consideration. The latter is defined as an associated isoperimetric type of deficit.

We will mostly focus on the case when the ambient dimension is 3 and also explain why, in both cases, the estimates are optimal in their corresponding settings. The adaptations needed in higher dimensions will also be addressed. We also obtain linear stability estimates for both cases in all dimensions. These can be regarded as Korn-type inequalities for the combination of the quadratic form associated with the isometric (resp. conformal) deficit on the sphere and the isoperimetric one.

This is joint work with S. Luckhaus.

27.01.21 **Oliver Graf**

The spacelike-characteristic Cauchy problem with bounded L2 curvature in general relativity

Abstract: In this talk I will review the classical Cauchy problem for Einstein equations. I will explain some of its geometric features and recast the equations as a system of coupled quasilinear transport-elliptic-Maxwell equations. I will present the global-in-time existence conjecture (aka the conjecture of weak cosmic censorship) and how low regularity local existence results (as the celebrated bounded L2 curvature theorem) can be used to get insight on the formation of singularities. I will then review the classical bounded L2 curvature theorem of Klainerman-Rodnianski-Szeftel and present a version generalised to initial data posed on an initial spacelike and an initial characteristic hypersurface that I obtained jointly with Stefan Czimek.

03.02.21 **Julius Lohmann**

On the Wasserstein distance with respect to a generalization of the urban metric

Abstract: In this talk I use the idea of branched transport to motivate the study of certain network-like sets with Hausdorff dimension less or equal to one. In the branched transport problem we consider a concave (and thus subadditive) transportation cost which describes the cost of moving mass per unit distance. The branched transport problem seeks for an optimal mass flux between two given probability measures (i.e. source and sink distributions). We proved that it can be written as a shape optimization problem on networks equipped with a network transport cost. In this generalization of the urban planning problem, i.a., the Wasserstein distance between the given probability measures has to be determined. In our case, it corresponds to the problem of finding an optimal transport plan concerning a pseudometric which encodes the cost for traveling from one point to another. This is a joint work with Benedikt Wirth and Bernhard Schmitzer.