

2021 Iowa PDE Schedule

9:30-10:00 *Coffee & Pastries*

MORNING SESSION Chair: Hailiang Liu

10:00--10:05 Welcome

10:10--10:50 **Pelin Guven Geredeli** (ISU)

Uniform decay of the solutions to a compressible Oseen-structure interaction PDE system

10:50 -- 11:20 Coffee break

11:20--12:00 **Xiaoyi Zhang** (UI)

Dynamics of threshold solutions for focusing nonlinear Schrodinger equation with inverse square potential

12:00--1:40 *Lunch (on your own)*

AFTERNOON SESSION Chair: Paul Sacks /Tong Li

1:40 -- 2:20 **Pablo Raúl Stinga** (ISU)

Harnack inequality for fractional nondivergence form elliptic equations

2:25 --3:05 **Lihe Wang** (UI)

Geometric theorems from capacity of domains

3:10 --3:35 Coffee break

3:35 -- 4:15 **Jue Yan** (ISU)

A new direct discontinuous Galerkin method with interface correction for two-dimensional compressible Navier-Stokes equations.

4:20--5:00 **Hailiang Liu** (ISU)

Critical thresholds in Euler-Poisson-Alignment system with repulsive forcing

6:00--8:00 **Dinner**

Abstracts:

Uniform Decay of the Solutions to a Compressible Oseen-Structure Interaction PDE System

Pelin Guven Geredeli

Iowa State University

Abstract: In this study, we consider a linearized compressible flow structure interaction PDE model for which the interaction interface is under the effect of material derivative term. While the linearization takes place around a constant pressure and density components in structure equation, the flow linearization is taken with respect to a non-zero, fixed, variable ambient vector field. This process produces extra “convective derivative” and “material derivative” terms which causes the coupled system to be nondissipative. We analyze the long time dynamics in the sense of uniform stability in an invariant subspace (one dimensional less) of the entire state space where the continuous semigroup is “uniformly bounded”.

Critical thresholds in Euler-Poisson-Alignment system with repulsive forcing

HAILIANG LIU

Iowa State University

Abstract. In this talk I will discuss our recent work on critical thresholds for the global well-posedness of the Euler-Poisson-alignment (EPA) system. We derive bounds on subcritical and supercritical regions for the system with bounded kernel and repulsive forcing, thereby proving the existence of a critical threshold in the space of initial configurations. To obtain these bounds, we construct invariant regions, the boundaries of which are composed of several pieces. Each piece is in fact a solution trajectory to an auxiliary system. We use these trajectories of the auxiliary systems to establish a comparison with the

concerned system in the phase plane. For EPA systems with weakly singular kernel, we construct a subcritical region with sharper bounds on the nonlocal term. This is a joint work with Manas Bhatnagar (ISU) and Changhui Tan (USC).

Title: **Harnack inequality for fractional nondivergence form elliptic equations**

Pablo Raúl Stinga

Iowa State University

Abstract: We prove the interior Harnack inequality for nonnegative solutions to fractional elliptic equations driven by fractional powers of nondivergence form elliptic operators. Such equations appear in several applications, including the analysis of fractional Monge--Ampère equations. This is joint work with Mary Vaughan (UT Austin).

Geometric theorems from capacity of domains

Lihe Wang

University of Iowa

Abstract: We will introduce a concept of capacity near the boundary of a domain using solutions of elliptic equations and show the rigidity and regularity of the domains from these properties.

Title: **A new direct discontinuous Galerkin method with interface correction for two-dimensional compressible Navier-Stokes equations**

Author: **Jue Yan & Mustafa Danis**

Iowa State University

Abstract: We propose a new formula for the nonlinear viscous numerical flux and extend the direct discontinuous Galerkin method with interface correction (DDGIC) to compressible Navier-Stokes equations. The new DDGIC framework is based on the observation that the nonlinear diffusion can be represented as a sum of multiple individual diffusion processes corresponding to each conserved variable. A set of direction vectors corresponding to each individual diffusion

process is defined and approximated by the average value of the numerical solution at the cell interfaces. The new framework only requires the computation of conserved variables' gradient, which is linear and approximated by the original direct DG numerical flux formula. The proposed method greatly simplifies the implementation, and thus, can be easily extended to general equations and turbulence models. Numerical experiments with P_1 , P_2 , P_3 and P_4 polynomial approximations are performed to verify the optimal $(k+1)^{\text{th}}$ high-order accuracy of the method. The new DDGIC method is shown to be able to accurately calculate physical quantities such as lift, drag, and friction coefficients as well as separation angle and Strouhal number.

Title: Dynamics of threshold solutions for focusing nonlinear Schrodinger equation with inverse square potential

Xiaoyi Zhang,
University of Iowa

Abstract: In this talk, I will discuss our recent work on focusing Schrodinger equation with inverse square potential with the emphasis on the energy critical problem. We prove the existence and uniqueness of the stable/unstable manifold of the ground state and classify the solutions on the energy surface of the ground state. This is a joint work with Y. Kai and C. Zeng.