Applied Complex and Computational Analysis Meeting @ IIT Hyderabad, February 2024

Speaker: Tomoo Yokoyama (Saitama University)

Title: On blowups of stagnation points of 2D potential flows

Abstract: We discuss what kinds of limit sets of 2D potential flows occur. In fact, it is not known whether the resulting flows by blowup isolated stagnation points of 2D potential flows on the Riemannian surfaces can be realized as 2D potential flows.

Speaker: Michiaki Onodera (Tokyo Institute of Technology)

Title: Backus problem in geophysics

Abstract: The Backus problem consists in reconstructing a harmonic function from the modulus of its gradient on the boundary. If the given boundary data is close to that of the monopole, one can resolve the problem uniquely; while the corresponding perturbation problem for the dipole had not been studied until recently. This is due to the fact that the linearized problem at the dipole is an irregular oblique derivative problem, for which a loss of derivatives generally occurs. We establish a weighted Schauder estimate for such a problem and apply it to resolve the Backus problem near the dipole. This talk is based on joint work with Toru Kan (Osaka Metropolitan University) and Rolando Magnanini (University of Florence).

Speaker: Manish Kumar (BITS Pilani, Hyderabad Campus)

Title: Fractional Fourier transform and its application

Abstract: This work provides a concise overview of the fractional Fourier transform (FrFT) and its essential properties, emphasizing its relevance to tempered distributions. The study further delves into the examination of generalized pseudo-differential operators, incorporating two classes of symbols, and their intricate connection with fractional Fourier transforms. The primary goal is to elucidate the correlation between these operators and FrFT. Additionally, the work underscores a practical application wherein the fractional Fourier transform is employed to solve a generalized heat equation. This serves to highlight the versatile and practical nature of FrFT in tackling mathematical challenges, particularly within the domain of partial differential equations.

Speaker: Takashi Sakajo (Kyoto University)

Title: Analytic models of nematic cell alignment

Abstract: We consider the orientational order that arises from the alignment of anisotropic biological cells confined in bounded domains. It is known that topological defects, where the orientation angles are not well-defined, play an important role in the global pattern formation of cell alignment. The orientational order of cells is theoretically modeled as

a harmonic function achieving the minimum elastic energy state of the nematic liquid crystal. In this talk, we introduce an analytic formula of cell angle in the single and doubly connected domains, where topological defects and boundary shapes are represented as the positions of logarithmic singularities and as conformal maps from a given region to a standard annular region respectively.

Speaker: Yuuki Shimizu (The University of Tokyo)

Title: Numerical computation for multiple solutions for the Plateau problem

Abstract: The soap film can take on various shapes, even when the wire remains unaltered in shape. Can we estimate the number of all shapes in soap films from the wire's shape? To rephrase mathematically, this can be described as determining the number of all solutions to the Plateau problem based on geometric quantities representing the boundary shape. Although there are numerous related studies in geometric analysis, it remains a challenging problem to determine the exact number of solutions, even in simple settings. In this research, by leveraging complex analysis of minimal surfaces, a numerical scheme for calculating multiple solutions to the Plateau problem has been developed, which is grounded in the method of fundamental solutions. The talk will highlight the application of complex analysis in the context of minimal surfaces. After quickly overviewing the entire research, we will focus on the insights into the relationship between the number of solutions and the boundary shapes obtained through numerical experimentation. This is joint work with Dr. Koya Sakakibara (Kanazawa University).

Speaker: Sreethin Sreedharan Kallyadan (IIT Madras)

Title: On the quadrilateral geometries of four vortex relative equilibria

Abstract: In this talk, we shall discuss about the equilibrium patterns possible in an interacting collection of four vortices within the framework of the point-vortex model. These persistent patterns, referred to as relative equilibrium configurations, have been observed in a variety of two-dimensional fluid flow situations. One can systematically classify the quadrilateral geometries associated with four-vortex relative equilibria based on the type of triangle formed while joining the locations of the first three vortices. We show that relative equilibrium configurations generally exist as one-dimensional continua consisting of a disconnected pair of bounded and unbounded components. Finally, we look at the bifurcation behaviors associated with continua and explore a few interesting symmetric classes of relative equilibrium configurations in detail.