Online Symposium on Conservation Laws and Related Topics

(In honour of Prof. G. D. Veerappa Gowda on the occasion of his retirement)

July 31, 2020 9:00 AM - 4:20 PM

Abstracts of Talks

Hyperbolic equations - a short overview

K. T. Joseph (TIFR CAM)

9:00 AM - 9:25 AM

Abstract: In this non technical talk we discuss some basic questions in the theory of hyperbolic equations and progress made. We touch up on some aspects of linear and nonlinear equations.

A class of triangular systems in fractional BV spaces

Anupam Pal Choudhary (NISER)

9:30 AM - 9:55 AM

Abstract:In this talk, we shall discuss about entropy solutions for a class of triangular systems involving a transport equation in the framework of BV^s (fractional BV spaces). This is based on a joint work with C. Bourdarias, B. Guelmame and S. Junca.

Operator splitting for the fractional Korteweg-deVries equation

Rajib Dutta (IISER Kolkata)

10:00 AM - 10:25 AM

Abstract: We aim to analyze operator splitting for the fractional Korteweg-de Vries equation, $u_t = uu_x + (-\Delta)^{\alpha/2}u_x$, $\alpha \in [1, 2]$. Under the appropriate regularity of the initial data, we demonstrate the convergence of approximate solutions obtained by the Godunov and Strang splitting. We show that for the Godunov splitting, first order convergence in L^2 is obtained for the initial data in $H^{1+\alpha}$ and in case of the Strang splitting, second order convergence in L^2 is obtained for initial data in $H^{1+2\alpha}$. The obtained rates are expected in comparison with the KdV ($\alpha = 2$) case. This is a joint work with Tanmay Sarkar.

Approximations of hyperbolic systems using conservation laws with discontinuous flux

Aekta Aggarwal (IIM Indore)

11:00 AM - 11:25 AM

Abstract: The talk will discuss about some interesting problems arising in physics, which are modelled by systems of hyperbolic PDEs. The talk will describe the numerical approximations, proposed in various studies [1, 2, 3, 4], which are based on theory of conservation laws with discontinuous flux, detailed in [5] and references therein. Numerical simulations, connection with physical properties and some recently obtained results will be shown.

References

[1] Adimurthi, Aekta Aggarwal, and G. D. Veerappa Gowda. Godunov-type numerical methods for a model of granular flow. *Journal of Computational Physics*, 305:1083-1118, 2016.

[2] Aekta Aggarwal, Ganesh Vaidya, and G. D. Veerappa Gowda. Godunov type solvers for hyperbolic systems admitting δ-shocks. *arXiv preprint arXiv:2006.14971*, 2020.

[3] Aekta Aggarwal, Manas Ranjan Sahoo, Abhrojyoti Sen, and Ganesh Vaidya. Solutions with concentration for conservation laws with discontinuous flux and its applications to numerical schemes for hyperbolic systems. *Studies in Applied Mathematics.*

[4] Adimurthi, Aekta Aggarwal, and G. D. Veerappa Gowda. Godunov-type numerical methods for a model of granular flow on open tables with walls. *Communications in Computational Physics*, 20(4):1071-1105, 2016.

[5] Adimurthi, Siddhartha Mishra, and G. D. Veerappa Gowda. Optimal entropy solutions for conservation laws with discontinuous flux-functions. *Journal of Hyperbolic Differential Equations*, 2(04):783-837, 2005.

Entropy stable discontinuous Galerkin schemes for the relativistic hydrodynamic Equations

Harish Kumar (IIT Delhi)

11:30 AM - 11:55 AM

Abstract: In this article, we present entropy stable discontinuous Galerkin numerical schemes for equations of special relativistic hydrodynamics with the ideal equation of state. The numerical schemes use the summation by parts (SBP) property of Gauss-Lobatto quadrature rules. To achieve entropy stability for the scheme, we use two-point entropy conservative numerical flux inside the cells and a suitable entropy stable numerical flux at the cell interfaces. The resulting semi-discrete scheme is then shown to entropy stable. Time discretization is performed using SSP Runge-Kutta methods. Several numerical test cases are presented to validate the accuracy and stability of the proposed schemes. This is a joint work with Dr. Biswarup Biswas.

An alternate time discretization of discontinuous Galerkin method applied to a system of conservation laws

Sudarshan Kumar (IISER TVM)

12:00 Noon - 12:25 PM

Abstract: In this talk, we discuss a high-order scheme for the discretization of the hyperbolic system of conservation laws. The Lax–Wendroff time discretization is an alternative method to the popular total variation diminishing Runge–Kutta time discretization of discontinuous Galerkin schemes of high-order. The resulting fully discrete schemes are known as LWDG and RKDG methods, respectively. Although LWDG methods are in general more compact and efficient than RKDG methods of comparable order of accuracy, the formulation of LWDG methods involves the successive computation of exact flux derivatives. The proposed method avoids the computation of exact flux derivatives and is easier to implement than their original LWDG versions. In particular, the formulation of the time discretization of the proposed method does not depend on the flux being used. Numerical results for the scalar and system cases in one and two space dimensions indicate it is more efficient in terms of error reduction per CPU time than LWDG methods of the same order of accuracy. Moreover, increasing the order of accuracy leads to substantial reductions of numerical error and gains in efficiency for solutions that vary smoothly.

Numerical methods for shear shallow water model

Praveen Chandrashekar (TIFR CAM)

1:45 PM - 2:10 PM

Abstract: The shear shallow water model provides an approximation for shallow water flows by including the effect of vertical shear in the model. This model can be derived from the depth averaging process

by including the second order velocity fluctuations which are neglected in the classical shallow water approximation. The resulting model has a non-conservative structure which resembles the 10-moment equations from gas dynamics. This structure facilitates the development of path conservative schemes and we construct HLL, 3-wave and 5-wave HLLC-type solvers. An explicit and semi-implicit MUSCL-Hancock type second order scheme is proposed for the time integration. Several test cases including roll waves show the performance of the proposed modeling and numerical strategy.

On fractional conservation laws with noise

Ujjwal Koley (TIFR CAM)

2:15 PM - 2:40 PM

Abstract: In this talk, we discuss some of the main mathematical problems connected to multidimensional degenerate fractional conservation laws with noise. In particular we show existence and uniqueness of entropy solutions, and derive continuous dependence estimate on the nonlinearities of the entropy solutions.

Weakly nonlinear high-frequency waves

S. Baskar (IIT Bombay)

3:00 PM - 3:25 PM

Abstract: High-frequency waves occur in many applications, including acoustics, optics, and seismology. Since the wavelength is shorter compared to the distance of propagation (multi-scale problem), the problem is mathematically challenging, and numerical computation becomes more expensive if we use the full governing system. An appropriate approximation to the standard governing system becomes indispensable. In this talk, we discuss the weakly nonlinear and high- frequency approximations to quasi-linear hyperbolic systems in multi-dimensions with an application to the Euler system.

On physics informed neural networks (PINNs) for approximating PDEs

Siddhartha Mishra (ETH Zürich)

3:30 PM - 3:55 PM

Abstract: Physics informed neural networks (PINNs) have very recently emerged as a powerful tool for numerical approximations of PDEs. In this talk, we will present some of thefirst rigorous error estimates on PINNs in the context of the forward problem for PDEs. Utilizing the stability of the underlying PDE, the generalization (approximation) error of the PINN will be bounded in terms of the training error and the number of training points. The abstract framework will be illustrated with examples of linear and nonlinear PDEs.

The academic achievements of G. D. Veerappa Gowda

Shyam Sundar Ghoshal (TIFR CAM)

4:00 PM - 4:20 PM

Abstract: Prof. Gowda, during his long and distinguished academic career at TIFR, has made enormous contributions to research in the field of hyperbolic conservation laws. In this talk we describe some of his most important works.