Pratyuksh Bansal

Curriculum Vitae

Doctoral thesis

Topic
: *Numerical Approximation of the Acoustic Wave Equation and of Statistical Solutions of the incompressible Navier-Stokes Equations*

Supervisors
: Prof. Christoph Schwab and Prof. Siddhartha Mishra
Seminar for Applied Mathematics, ETH Zurich

Description
: The thesis is broadly split into two parts. In the first part, we propose a space-time discontinuous Galerkin (DG) scheme for numerically solving the acoustic wave equation in polygons. We prove convergence and error estimates for solutions with geometric singularities arising due to corners and multi-material interfaces using meshes with local refinement at the corners. Numerical experiments confirm the theory. We also propose a sparse space-time DG method and numerically investigate its performance.

In the second part, we compute statistical solutions of incompressible Navier-Stokes equations for high Reynolds numbers and study the effect of boundary conditions on their convergence. We discretise the governing equations in spatial dimensions using the Finite element method with divergence-free function spaces on unstructured meshes and integrate in time with implicit and semi-implicit methods. We sample the probability space with Monte-Carlo sampling. As post-processing steps, we compute mean and variance of the solutions, and we also approximate the Wasserstein metrics and structure functions of the solution. The code is developed in C++ with MPI parallelization and its performance has been tested on upto 1000 cores on the Euler cluster at ETH Zurich.

Masters Thesis

Title
: *Fast Solver for Extended Gas Dynamics in 2D based on Maximum Entropy Closure*

Supervisors
: Dr Roman Pascal Schärer and Prof. Manuel Torrilhon
MathCCES, RWTH Aachen

Description
: We developed a highly optimized and efficient 2D solver on hybrid CPU-GPU architectures, using the 35-moment system equipped with maximum entropy closure for studying non-equilibrium processes in rarefied gas flows.

Research Experience

2017-2021
: **PhD**, *Prof. Christoph Schwab*, SAM, ETH Zurich.
Development of numerical solvers that approximate the acoustic wave equation and statistical solutions of the incompressible Navier-Stokes equations.

2016
: **Research Assistant**, *Prof. Siegfried Müller*, IGPM, RWTH Aachen.
Development of a discontinuous Galerkin based numerical solver for testing a novel multiphase flow model.

2015
: **Research Assistant**, *Dr Roman Pascal Schärer*, MathCCES, RWTH Aachen.
Development of a fast solver on GPUs with CUDA to numerically approximate the solution of the Boltzmann equation, for 1D physical space and 2D axisymmetric velocity space, using moment methods equipped with the non-linear maximum entropy closure.

Teaching Experience

Spring 2020
: **Teaching Assistant**, *Prof. O. Schenk*, High performance computing lab, ETHZ.

Autumn 2019
: **Teaching Assistant**, *Prof. S. Mishra*, Advanced Numerical Methods for CSE, ETHZ.

Spring 2019
: **Teaching Assistant**, *Dr R. Käppeli*, Numerical methods, ETH Zurich.

Autumn 2018	**Teaching Assistant**, *Prof. C. Hanckes*, Advanced Numerical methods for CSE, ETH Zurich.
Spring 2018	**Teaching Assistant**, *Dr R. Käppeli*, Numerical methods, ETH Zurich.
Autumn 2017	**Teaching Assistant**, *Prof. R. Alaifari*, Numerical methods for CSE, ETH Zurich.

Conferences, Summer Schools and Block courses

2020	**CSCS-USI: Effective HPC and Data Analytics**. Summer School.
2019	**WAVES**, Vienna, contributed talk.
2019	36th Short course on Modelling and computation of multiphase flows, Zurich.
2018	**PASC**, Basel, attendee.

Publications

2021	**Numerical approximation of statistical solutions of 2D incompressible Navier-Stokes Equations**, *Journal of Computational Physics*, under review.
2020	**Space-time discontinuous Galerkin approximation of acoustic waves with point singularities**, *IMA Journal of Numerical Analysis*, P. Bansal, A. Moiola, I. Perugia, Ch. Schwab.
2017	**Efficient Algorithms and Implementations of Entropy-based closures for Rarefied Gas Dynamics**, *Journal of Computational Physics*, R. P. Schäerer, P. Bansal, M. Torrilhon.
2015	**Entropy-based Moment Closures for Gas Dynamics**, *NEGF15-63*, R. P. Schäerer, P. Bansal, M. Torrilhon, conference proceeding.

Education

2017–2021	**PhD in Applied Mathematics**, *ETH Zurich*, Switzerland.
2014–2016	**MSc in Simulation Sciences**, *RWTH Aachen*, Germany.
2010–2014	**BTech in Mechanical Engineering**, *IIT Guwahati*, India.

Technical Skills

Basic	Paraview, Matlab, Mathematica, Fortran
Expert	Linux, OpenMP, Python, SQL
Advanced	C++, MPI, CUDA