Neeraj Sarna

Max Planck Institute for Dynamics of Complex Technical Systems,
Computational Methods in Systems and Control Theory (CSC),
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Education

Jan. 2016-Feb. 2019 — Doctor of Philosophy
Institute: Mathematics Division of the Center for Computational Engineering Sciences (MathCCES), RWTH, Aachen, Germany
Thesis: Entropy Stable Hermite Approximations of The Boltzmann Equation
Advisor: Prof. Dr. Manuel Torrilhon

Oct. 2013-Oct. 2015 — Master of Science (*with distinction*) | details of the master's courses
Institute: Simulation Sciences, RWTH, Aachen, Germany
Cumulative GPA: 1.1/4.0 (Max. 1.0)
Thesis: Hermite Approximations for Chemically Reacting Gaseous Mixture
Advisor: Prof. Dr. Manuel Torrilhon

Aug. 2009-April 2013 — Bachelor of Technology
Faculty: Mechanical Engineering, Indian Institute of Technology, Delhi, India
Cumulative GPA: 8.1/10.0 (Max. 10)
Thesis: Computational and Experimental Study of a Water Turbine Interaction with Granular Media
Advisor: Prof. Dr. P.M.V Subbarao

Work Experience

March. 2019-present — Postdoctoral Researcher
Institute: Computational Methods in Systems and Control Theory (CSC), Max Planck Institute, Magdeburg, Germany
Advisors: Prof. Dr. Peter Benner and Dr. Sara Grundel

Oct. 2014-Oct.2015 — Research Assistant (Hiwi)
Employer: Prof. Dr. Siegfried Müller, Institute of Geometry and Practical Mathematics, RWTH, Aachen, Germany

Nov. 2013-Nov. 2015 — Research Assistant (Hiwi)
Employer: Prof. Dr. Manuel Torrilhon, MathCCES, RWTH, Aachen, Germany

Research Interests

1. Non-linear and data-driven model reduction of hyperbolic equations.
2. Entropy stable and adaptive numerical schemes for kinetic equations.

3. Error analysis for modeling and discretization errors.
4. Software development for scientific computing.

Preprints

1. Neeraj Sarna and Sara Grundel. Model reduction of time-dependent hyperbolic equations using collocated residual minimisation and shifted snapshots. *arXiv:2003.06362*, 2020.
2. Jonas Bünger, Neeraj Sarna, and Manuel Torrilhon. Stable boundary conditions and discretization for PN equations. *arXiv:2004.02497*, 2020

Publications

1. Neeraj Sarna, Harshit Kapadia, and Manuel Torrilhon. Simultaneous-approximation-term based boundary discretization for moment equations of rarefied gas dynamics. *Journal of Computational Physics*, 407:109243, 2020a.
2. Neeraj Sarna, Jan Giesselmann, and Manuel Torrilhon. Convergence analysis of Grad's hermite expansion for linear kinetic equations. *SIAM Journal on Numerical Analysis*, 58 (2):1164–1194, 2020b.
3. Neeraj Sarna and Manuel Torrilhon. Entropy stable Hermite approximation of the linearised Boltzmann equation for inflow and outflow boundaries. *Journal of Computational Physics*, 369:16 – 44, 2018a.
4. Neeraj Sarna and Manuel Torrilhon. On stable wall boundary conditions for the Hermite discretization of the linearised Boltzmann equation. *Journal of Statistical Physics*, 170(1):101–126, 2018b.
5. Manuel Torrilhon and Neeraj Sarna. Hierarchical Boltzmann simulations and model error estimation. *Journal of Computational Physics*, 342:66 – 84, 2017.

Conference Proceedings

1. Neeraj Sarna and Manuel Torrilhon. On the moments of the Boltzmann's collision operator arising from chemical reactions. *AIP Conference Proceedings*, 1786(1):140005, 2016.
2. Vinay Kumar Gupta, Neeraj Sarna, and Manuel Torrilhon. Grad's moment equations for binary hard sphere gas-mixtures. *4th Micro and Nano Flows Conference, University College London, UK*, pages 26–59, 2014.

Contributed Talks in Conferences and Workshops

1. ICIAM19, International Conference on Industrial and Applied Mathematics, Valencia, Spain, 2019.
   Talk: *Grid and Model Adaptivity for Kinetic Equations*.
2. MPI Group Retreat & Workshop19, Identification, Simulation and Control of Complex Dynamical Systems from Data.
   Talk: *Adaptive Dictionaries: Model Order Reduction of Hyperbolic Equations*.
3. NEGF18, 3rd European Conference on Non-Equilibrium Gas Flows, Strasbourg, France, 2018.
   Talk: *Model Adaptivity for the Boltzmann Equation on Bounded Position Domains*.
4. FEF17, 19th International Conference on Finite Elements in Flow Problems, Rome, Italy, 2017.
   Talk: *Numerical Study of Higher Order Discontinuous Galerkin Schemes for Hermite approximation of the Boltzmann equation*.

5. RGD30, 30th International Symposium on Rarefied Gas Dynamics, Victoria, Canada, 2016.
   Talk: *Hermite Spectral approximation of Boltzmann Equation with Chemical Reactions.*

Invited Talks and Seminars

1. Institute: Technical University of Darmstadt, Host: Prof. Dr. Jan Giesselmann.
   Talk: *Linear Kinetic Equations and its Stable Discretization.*
2. Institute: University of Cologne, Host: Prof. Dr. Gregore Gassner.
   Talk: *Entropy Stable Numerical Methods for Kinetic Equations.*
3. Institute: RWTH, Weekly Seminar, Graduate School: Energy, Entropy, and Dissipative Dynamics.
   Talk: L^2*-Stable Numerical Schemes for Linear Kinetic Equations.*

Awards, Honors and Achievements

Feb. 2020	ICERM/NSF funding to attend semester workshop (Feb-May) titled *Model and Dimension Reduction in Uncertain and Dynamical Systems*, ICERM, Brown University, USA.
May 2011	Georgius Agricola Scholarship for summer research stay at University Of Ostrava, Czech Republic.
July 2009	All India Rank-587 in Joint Entrance Examination (JEE).

Research stays

Feb.-March 2020	ICERM, Brown University, USA.
June 2019	Mathematics Department, TU Darmstadt, Germany Host: Prof. Dr. Jan Giesselmann.
May-June 2011	Mechanical Engineering Department, University Of Ostrava, Czech Republic.

Teaching Assistance

2018:	Mathematical Foundations-4 *Lecturer:* Prof. Dr. Sebastian Noelle and Prof. Dr. Manuel Torrilhon	| details of the course
2017:	Mathematical Foundations-5 *Lecturer:* Prof. Dr. Jan Gisselmann	| details of the course
2016 & 2017:	Mathematical Models in Science and Engineering *Lecturer:* Prof. Dr. Manuel Torrilhon, Dr. Hossein Gorji	| details of the course
2016:	Mathematical Foundations-2 *Lecturer:* Prof. Dr. Martin Frank	| details of the course

Programming Skills

1. *Advanced Programming Knowledge:* C, C++, OpenMP, MPI, Matlab
2. *Intermediate Programming Knowledge:* Python, Fortran 90, Fortran 77

References

Prof. Dr. Manuel Torrilhon — *Chair of the Mathematics Division of the Center for Computational Engineering Science*, RWTH, Aachen, Germany
email: mt@mathcces.rwth-aachen.de

Prof. Dr. Jan Giesselmann — *Department of Mathematics*, TU Darmstadt, Darmstadt, Germany
email: giesselmann@mathematik.tu-darmstadt.de

Group Head: Prof. Dr. Peter Benner
Team Leader: Dr. Sara Grundel — *Max Planck Institute*, Magdeburg, Germany
email: benner@mpi-magdeburg.mpg.de, grundel@mpi-magdeburg.mpg.de

Details of Master's Courses

Semester-1:	Applied Quantum Mechanics, Data Analysis and Visualisation, From Molecular To Continuum Physics-1, Numerical Methods for PDEs, Parallel Programming-1
Semester-2:	Fast Iterative Solvers, Finite Volumes and Finite Element Techniques, From Molecular To Continuum Physics-2, Model Based Estimation Methods, Parallel Computing for Computational Mechanics
Semester-3:	Numerical Methods for the Geo-Sciences, Computational Contact Mechanics, Lattice-Boltzmann Method, Simulation Sciences Laboratory

Details of Courses Taught

Mathematical Foundations-2:	differential calculus, ODE's, interpolation techniques, numerical integration and quadrature, direct solvers for linear systems, Newton-Raphson method
Mathematical Foundations-4:	finite differences, a-priori convergence analysis, Von-Neumann stability analysis, fast fourier transforms, iterative solvers, fundamental solutions, distributions, Hilbert spaces.
Mathematical Foundations-5:	weak derivatives, L^p spaces, Sobolev spaces, finite element methods, Lax-Milgram theorem, mixed finite element methods, inf-sup stability conditions, hyperbolic conservation laws, entropy solutions, finite volume schemes, Riemann solvers, discrete entropy inequality.
Mathematical Models in Science and Engineering:	tensor analysis, kinematics, Reynold's transport theorem, conservation laws, Piola-Kirchoff-Tensors, Mooney-Rivlin material Hooke's law, kinetic gas theory, electrodynamics, magnetohydrodynamics