# Neeraj Sarna

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*Computational Methods in Systems and Control Theory (CSC),*
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## Personal Data

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| Place and Date of Birth: | Bhopal, India \| 01 May 1991 |
| Current Address: | Am Weinhof-4, Magdeburg, Germany |

## Education

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| Jan. 2016-Feb. 2019 | Doctor of Philosophy<br>*Institute*: Mathematics Division of the Center for Computational Engineering Sciences (MathCCES), RWTH, Aachen, Germany<br>*Thesis*: Entropy Stable Hermite Approximations of The Boltzmann Equation<br>Advisor: Prof. Dr. Manuel Torrilhon |
| Oct. 2013-Oct. 2015 | Master of Science (*with distinction*) \| details of the master's courses<br>*Institute*: Simulation Sciences, RWTH, Aachen, Germany<br>*Cumulative GPA*: 1.1/4.0 (Max. 1.0)<br>*Thesis*: Hermite Approximations for Chemically Reacting Gaseous Mixture<br>*Advisor*: Prof. Dr. Manuel Torrilhon |
| Aug. 2009-April 2013 | Bachelor of Technology<br>*Faculty*: Mechanical Engineering, Indian Institute of Technology, Delhi, India<br>*Cumulative GPA:* 8.1/10.0 (Max. 10)<br>*Thesis*: Computational and Experimental Study of a Water Turbine Interaction with Granular Media<br>Advisor: Prof. Dr. P.M.V Subbarao |

## Work Experience

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| March. 2019-present | Postdoctoral Researcher<br>*Institute*: Computational Methods in Systems and Control Theory (CSC), Max Planck Institute, Magdeburg, Germany<br>Advisors: Prof. Dr. Peter Benner and Dr. Sara Grundel |
| Oct. 2014-Oct.2015 | Research Assistant (Hiwi)<br>*Employer*: Prof. Dr. Siegfried Müller, Institute of Geometry and Practical Mathematics, RWTH, Aachen, Germany |
| Nov. 2013-Nov. 2015 | Research Assistant (Hiwi)<br>*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

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| 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

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

## Teaching Assistance

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

## Details of Master's Courses

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

## Details of Courses Taught

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