Sugan Durai Murugan

Curriculum Vitae

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Education

2020–Present	**PhD, Physics**, International Centre for Theoretical Sciences, Tata Institute of Fundamental Research (ICTS-TIFR), Bangalore, India.

Thesis

Title - ***Implications of inviscid hydrodynamics and its variants for turbulence and statistical physics.***

Advisor - *Prof. Samriddhi Sankar Ray.*

2017–2020	**MS, Physics**, International Centre for Theoretical Sciences, Tata Institute of Fundamental Research (ICTS-TIFR), Bangalore, India.
2009–2013	**BTech, Mechanical Engineering**, Indian Institute of Technology Madras (IIT Madras), Chennai, India.

Research Interests

My interests lie in the theoretical understanding of turbulence at the intersection of statistical physics, mathematical analysis, and state-of-the-art numerical simulations. Thus, on one hand, I have examined the dynamics of the Galerkin-projected inviscid equations of hydrodynamics and its implications for the finite-time blow-up problem of the Euler equation, while on the other, I have used such Gibbs solutions to derive the thermal bound of many-body chaos in classical systems. I have also looked at different variants of the Navier-Stokes equation — involving either micro surgeries on the nonlinear triadic interactions or modifications of the linear viscous operator — and the generality of multifractal statistics. Finally, I have been working on using closure models of turbulence, which arise from statistical field theories, to reexamine the dynamo problem in arbitrarily large spatial dimensions.

Keywords

Turbulence, fluid dynamics, DNS, non-equilibrium statistical physics, non-linear dynamics, many-body chaos, multi-fractal spectrum, thermalization, weak solution, singularity, shell models, closure models, EDQNM, dynamo.

Publications

Published

2022   *On the thermalization of the three-dimensional, incompressible, Galerkin-truncated Euler equation,*
Sugan Durai Murugan and S. S. Ray.
arXiv:2209.05046. (under review in Phys. Rev. Fluids)

2021   *Many-body Chaos in Thermalised Fluids,*
Sugan Durai Murugan, D. Kumar, S. Bhattacharjee, and S. S. Ray.
Phys. Rev. Lett. 127, 124501(2021).

2020   *Suppressing thermalization and constructing weak solutions in truncated inviscid equations of hydrodynamics: Lessons from the Burgers equation,*
Sugan Durai Murugan, U. Frisch, S. Nazarenko, N. Besse, and S. S. Ray.
Phys. Rev. Research 2, 033202(2020).

In preparation

2023   *The dynamo problem in d dimensions: A closure model study,*
Sugan Durai Murugan, S. S. Ray, and D. Vincenzi.

2023   *Distribution of singular structures in turbulence: A local multi-fractal measure approach,*
S. Mukherjee, **Sugan Durai Murugan**, and S. S. Ray.

2023   *Tracking the origins of uncertainty in fully-developed turbulence,*
Sugan Durai Murugan and S. S. Ray.

Talks, Conferences and Workshops

March 2023   Talk - **Implications of inviscid hydrodynamics and its variants for turbulence and statistical physics** ,
Seminar, Simons Turbulence Collaboration, *Online*.

January 2023   Talk - **Effects of spatial dimension in the dynamo effect using EDQNM-MHD model**,
Conference - *Turbulence: Problems at the interface of mathematics and physics*, ICTS-TIFR, India.

December 2022   Talk - **Galerkin-truncated solutions to the 3D incompressible Euler equation**,
Seminar, Team Calisto, Nice, France.

November 2022   Talk - **On the thermalization of the 3D incompressible, Galerkin-truncated Euler equation**,
GDR Navier-Stokes 2.00, Université de Lille, Lille, France.

October 2022   Talk - **Thermalized fluids − Solutions to truncated ideal hydrodynamical equations**,
Statistical physics journal club meeting, ICTS-TIFR, India.

March 2022	Talk -**Many body chaos in thermalized fluid**, Workshop - *Stochastic approaches to turbulence in hydrodynamical equations - New challenges at the mathematics-physics interface (Hybrid)*, Banff International Research Station, Banff, Canada.
May 2021	Talk - **Constructing weak solutions - Lessons from the inviscid Burgers equation**, Euromech Colloquium - *Extreme dissipation and Intermittency in turbulence (Online)*, Delft, Netherlands.
Feb 2019	Talk - **Predicting evolution of Mixed layer in ocean**, Workshop - *Air-sea interactions in the Bay of Bengal from monsoons to mixing*, ICTS-TIFR, India.
Feb 2020	Poster - **Constructing weak solutions to 1D Burgers equation**, Inhouse Colloquium, ICTS-TIFR, India.

Projects (Other than Doctoral Thesis)

2019	**A study on eddy damped quasi-normal Markovian (EDQNM) closure model of turbulence**, Guide - *Prof. Samriddhi Sankar Ray*, ICTS-TIFR, India.
2019	**Physics of vertically falling soap film**, Guide - *Prof. Rama Govindarajan*, ICTS-TIFR, India.
2019	**Finite time Lyapunov exponents for inertial particles near vortical region for varying Stokes number**, Guide - *Prof. Rama Govindarajan*, ICTS-TIFR, India.
2018	**A study on GOY shell model of turbulence**, Guide - *Prof. Samriddhi Sankar Ray*, ICTS-TIFR, India.
2013	**Modelling and simulation of turning process and tool edge radius effect on micro turning process using finite element method.**, Guide - *Prof. G.L. Samuel*, IIT Madras, India.

Teaching Assistant

Jan-Apr 2022	**Classical mechanics**, *Core* course, ICTS-TIFR, India.
Jan-Apr 2021	**Modern theory of turbulence**, *Elective* course, ICTS-TIFR, India.

Scholastic Achievements

All India rank

2017	**5** - JEST, **32** - JAM Physics
2016	**26** - JEST, **12** - GATE Physics
2013	**652** - GATE Mechanical Engineering
2009	**183** - AIEEE, **646** - IITJEE

Others

2009	**Third rank** in state-level mock IITJEE entrance exam.
2007	**School topper** in ICSE board exam.

Work Experience

2015–2017   **School teacher**, Edusol Private Learning Ltd, Chennai, India.
Teaching physics and mathematics for high school students for cracking competitive college entrance exams.

2013–2015   **Assistant Manager**, Energo Engineering Projects Ltd, New Delhi, India.
On-site engineering, commissioning of ash handling system for 2X500 MW thermal power plant at Tuticorin, India

May-July 2012   **Intern**, Rane TRW Steering System Ltd, Chennai, India.
Investigating properties of advanced vane pump materials and prototype simulation using finite element method.

May-July 2011   **Intern**, Hyundai Motors India Ltd, Chennai, India.
Identifying ways to improve efficiency for compressed air network and reduce power consumption.

Computer Skills

- **Programming languages -** C, FORTRAN, Python, MATLAB, Latex, Paraview and Mathematica.
- **CAD softwares -** AutoCAD, Pro-E, DEFORM and Inventor.
- **Graphic designing softwares -** Photoshop, Illustrator, After Effects, 3Ds Max and Maya

Proficiency of languages

- **English** - *Professional*
- **Tamil** - *Native speaker*
- **Telugu, Hindi, Kannada** - *Working*
- **French** - *Elementary*

Academic Referees

- **Professor Samriddhi Sankar Ray**
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  Tata Institute of Fundamental Research,
  Bengaluru India.
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- **Professor Rama Govindarajan**
  International Centre for Theoretical Sciences,
  Tata Institute of Fundamental Research,
  Bengaluru India.
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- **Professor Subhro Bhattacharjee**
  International Centre for Theoretical Sciences,
  Tata Institute of Fundamental Research,
  Bengaluru India.
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- **Professor Dario Vincenzi**
  CNRS UMR 7351 - Laboratoire Jean Alexandre Dieudonné,
  Université Côte d'Azur,
  Nice France.
  `dario.vincenzi@univ-cotedazur.fr`