

# Sugan Durai Murugan Velazhagan

## 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. On the one hand, I examined the dynamics of the Galerkin-truncated inviscid hydrodynamical equations, understanding their thermalization to successfully find a weak solution by suppressing their dynamics. On the other hand, I have used such Gibbs solutions to derive the thermal bound of many-body chaos in classical systems. I have also worked with different variants of the Navier-Stokes equation—involving either microsurgeries on the nonlinear triadic interactions or fractional Laplacian modifications to the linear viscous operator—and the local nature of multifractal statistics for fully-developed turbulence. Currently, I am working on the effect of spatial dimension on the dynamo effect by adapting closure models of turbulence derived from statistical field theories to magneto-hydrodynamical turbulence. Characterizing the spatial origins of uncertainty in fully-developed turbulent flows is another area I am presently into.

### 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.

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## Publications

### Published

- 2023 *Turbulent flows are not uniformly multifractal*  
S. Mukherjee, **Sugan Durai Murugan**, R. Mukherjee, and S. S. Ray.  
**arXiv:2307.06074**
- 2023 *Genesis of thermalization in the three-dimensional, incompressible, Galerkin-truncated Euler equation*,  
**Sugan Durai Murugan** and S. S. Ray.  
**Phys. Rev. Fluids 8, 084605(2023)**
- 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—no-dynamo transition: Insights from a d-dimensional closure model for magnetohydrodynamic turbulence*,  
**Sugan Durai Murugan**, G. Krstulovic, S. S. Ray, and D. Vincenzi.
- 2023 *Tracking the origins of uncertainty in fully-developed turbulence*,  
**Sugan Durai Murugan** and S. S. Ray.

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## Talks, Conferences and Workshops

- Apr 2023 Talk - ***Effect of spatial dimension on the Dynamo effect: An EDQNM approach***,  
In-House Symposium, ICTS-TIFR, India.
- Mar 2023 Talk - ***Implications of inviscid hydrodynamics and its variants for turbulence and statistical physics***,  
Seminar, Simons Turbulence Collaboration, Online.
- Jan 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.
- Dec 2022 Talk - ***Galerkin-truncated solutions to the 3D incompressible Euler equation***,  
Seminar, Team Calisto, Nice, France.
- Nov 2022 Talk - ***On the thermalization of the 3D incompressible, Galerkin-truncated Euler equation***,  
GDR Navier-Stokes 2.00, Université de Lille, Lille, France.
- Oct 2022 Talk - ***Thermalized fluids – Solutions to truncated ideal hydrodynamical equations***,  
Statistical physics journal club meeting, ICTS-TIFR, India.

- Mar 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.

### Computer Skills

- **Programming languages** - C, FORTRAN, Python, MATLAB, and Mathematica.
- **Visualization tools** - Paraview.
- **Technical writing** - Latex.
- **Computer aided drawing** - AutoCAD, DEFORM, and Inventor.
- **Graphic designing** - Photoshop, Illustrator, and After Effects

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## Academic Referees

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| ○ <b>Professor Samriddhi Sankar Ray</b><br>International Centre for Theoretical Sciences,<br>Tata Institute of Fundamental Research,<br>Bengaluru India.<br>ssray@icts.res.in  | ○ <b>Professor Rama Govindarajan</b><br>International Centre for Theoretical Sciences,<br>Tata Institute of Fundamental Research,<br>Bengaluru India.<br>rama@icts.res.in |
| ○ <b>Professor Subhro Bhattacharjee</b><br>International Centre for Theoretical Sciences,<br>Tata Institute of Fundamental Research,<br>Bengaluru India.<br>subhro@icts.res.in | ○ <b>Professor Dario Vincenzi</b><br>CNRS UMR 7351 - Laboratoire Jean Alexandre Dieudonné,<br>Université Côte d'Azur,<br>Nice France.<br>dario.vincenzi@univ-cotedazur.fr |

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## Scholastic Achievements

All India rank in National level entrance examinations

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

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## Work Experience

- 2015–2017 **School teacher**, Edusol Private Learning Ltd, Chennai, India.  
*Teaching physics and mathematics for high school students for national level entrance exams.*
- 2013–2015 **Assistant Manager**, Energo Engineering Projects Ltd, New Delhi, India.  
*Engineering and on-site commissioning of ash handling system for 2X500 MW thermal power plant at Tuticorin, India*
- May-Jul **Intern**, Rane TRW Steering System Ltd, Chennai, India.  
2012 *Properties of advanced vane pump materials and prototype simulation using finite element method.*
- May-Jul **Intern**, Hyundai Motors India Ltd, Chennai, India.  
2011 *Identifying ways to improve efficiency and reduce power consumption for compressed air network in the manufacturing plant.*

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## Proficiency of languages

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

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## Interests

- **Sports and Fitness** - Football, squash, cricket, Kung-fu, marathon, cycling, trekking and calisthenics.
- **Hobbies** - Chess, harmonica, cooking and graphic designing.