

# Sanjeev Kumar Ghai

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## Research Associate

Department of Engineering  
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## Summary

I am computational engineer with a PhD in Computational Fluid Dynamics and several years' post-doctoral experience in the UK. My research focuses on stochastic methods for turbulent reacting flows, flame-wall interaction and data-driven modelling of combustion systems, with multiple peer-reviewed publications and industry collaborations. I combine practical hands-on experience with CFD platforms (OpenFOAM, ANSYS Fluent), numerical coding (C++, Fortran, Python, MATLAB) and data-analysis/visualisation tools.

## Education

**MTech + Ph.D., Indian Institute of Technology Kanpur** 07/2014 - 10/2020  
(QS Ranking in 2024 is 93 in Engg. and Tech.)

### PhD in Computational Fluid Dynamics

Adviser: Dr. Santanu De

Thesis Title: *Development and applications of Stochastic Multiple Mapping Conditioning Approach for multi regime turbulent reacting flows.*

**BTech., Shaheed Udham Singh College of Engg. & Tech., Mohali** 08/2009 - 05/2013  
**Mechanical Engineering: First Class with Honours (Gold Medalist)**

## Skills

- **Technical Skills:** Data Analysis, Statistics, Stochastic Methods, Combustion, Chemical Kinetics, Multiphase Flows, Fluid Mechanics, Machine learning, Computational Fluid Dynamics (CFD), Turbulence Modelling, CAD Modelling, Heat Transfer Analysis
- **Data Analysis and CFD Softwares:** ANSYS Fluent, OpenFOAM, MATLAB, Solidworks, AUTO-CAD, and Visual Basic
- **Programming Languages:** C++, Python, Fortran
- **Languages:** English (Fluent), Hindi and Punjabi (Native)

## Research Interests

- Chemically reacting flows
- Chemical Kinetics
- Computational Fluid Dynamics
- Heat Transfer
- Turbulence
- Fluid Mechanics
- Spray Combustion
- Flame Wall Interaction
- Advanced Turbulent Combustion Modelling
- Flame Dynamics
- MILD and Premixed Combustion

## Work Experience

**Research Associate, University of Cambridge, UK** 04/2024-Present

- Analyzing large-scale CFD datasets to extract insights on turbulent combustion phenomena for Rolls-Royce.
- Developing data-driven models to optimize flame dynamics in lean-burn, low-emission combustion systems.
- Leading data analysis initiatives, integrating experimental and simulation data to improve predictive capabilities.
- Collaborating with industry partners to translate research findings into practical engineering solutions.
- Presenting insights through visualizations, reports, and technical papers, facilitating knowledge transfer to stakeholders.

**Research Associate, Newcastle University, UK** 05/2021-04/2024

- Investigated heat transfer and fluid dynamics in turbulent boundary layers using Direct numerical simulations (DNS).
- Developed novel models for more accurate predictions of scalar statistics in wall bounded flows.
- Contributed to grant proposal writing and securing funding for research initiatives.
- Mentored graduate students and collaborated with industry partners on joint research projects.
- Published several papers in peer-reviewed journals and presented findings at conferences worldwide.

**Research Associate, Indian Institute of Technology Bombay** 11/2020-05/2021

- Conducted research on combustion instability and pollutant emissions in gas turbine engines.
- Implemented stochastic modeling techniques to analyze turbulent reacting flows in real-world conditions.
- Contributed to grant proposal writing and securing funding for research initiatives.

**Research Assistant, Indian Institute of Technology Kanpur** 07/2014-10/2020

- Developed computational models for turbulent reacting flows for multi regime turbulent reacting flows.
- Analyzed data using statistical methods and validated numerical simulations with experimental results.
- Published several papers in peer-reviewed journals and presented findings at conferences worldwide.

**Project Engineer, Engine Testing Laboratory SML-ISUZU Ropar** 06/2013-06/2014

- Managed engine testing projects for performance evaluation and emissions testing.
- Conducted feasibility studies and provided technical support to design and development teams.
- Implemented quality assurance procedures to ensure compliance with industry standards.

**Research Trainee, Engine Testing Laboratory SML-ISUZU Ropar** 07/2012-12/2012

- Assisted senior engineers in conducting experimental tests on diesel engines.
- Compiled test data and assisted in analyzing results to improve engine performance.
- Gained hands-on experience with engine instrumentation and testing methodologies.

## Teaching Experience

- **Academic Supervisions, University of Cambridge, UK** 2025
  - IAP4 Mathematics supervisions at Lucy Cavendish
  - Mathematics and Programming II
- **Tutor, Newcastle University, UK** 2021 - 2023
  - ENG1005 : Thermofluid Mechanics Lab (Winter 2021)
  - MEC8062: Turbulent Fluid Flow and Modelling (Autumn 2022)
  - MEC3032: Advanced Thermofluid Dynamics (Winter 2023)
  - MEC3028: Computational Heat & Fluid Flow (Autumn 2023)
- **Teaching Assistant, Indian Institute of Technology Kanpur** 07/2014 - 08/2019
  - ME681A: Mathematical Methods in Engineering (Winter 2019)
  - ME401A: Energy Systems II (Fall 2015)
  - ME643A: Combustion and Environment (Winter 2016, 2017)
  - ME647A: An Introduction to turbulence (Fall 2016)
  - ME301A: Energy Systems I (Fall 2017, 2018)
  - ME745A: Modeling of Turbulent combustion (Winter 2018)

## Master's Dissertation Supervision

- **Sudhakar Singh (MTech)**  
Sparse-Lagrangian MMC simulations of pilot-stabilized jet diffusion flames
- **Rajat Gupta (Ms. by research)**  
Numerical Simulations of Turbulent Lifted Jet Diffusion Flames using Stochastic Multiple Mapping Conditioning Approach
- **Paranaya Keshari Nahak (MTech)**  
Large Eddy Simulation of Turbulent Lifted Dimethyl Ether Flame using Sparse-Lagrangian Multiple Mapping Conditioning Approach

## Awards

- 2nd Prize winner based on audio-visual category in UKCTRF (2022)
- Global Talent Endorsement, UKRI (2021)
- Travel Fellowship Award Combustion Institute, Pittsburg, USA (2018)
- Ministry of Human Resource and Development Fellowship, New Delhi (2014-2019)
- Gold Medal in Bachelors, Shaheed Udham Singh College of Engg. & Tech., Mohali (2013)
- Graduate Aptitude Test for Engineers (GATE) Three times (2013, 2014, 2015)

## Reviewer for Journals

- Proceedings of the Combustion Institute
- Physics of Fluids

## Professional Affiliations

- Member, The Combustion Institute

## Journal Publications

1. Sanjeev Kumar Ghai, Santanu De & Andreas Kronenburg, Numerical simulations of turbulent lifted jet diffusion flames in a vitiated coflow using stochastic multiple mapping conditioning approach, *Proceedings of the Combustion Institute*, 37 (2), 2019, 2199-2206.
2. Sanjeev Kumar Ghai & Santanu De, Numerical modelling of turbulent premixed combustion using RANS based stochastic multiple mapping conditioning approach, *Proceedings of the Combustion Institute*, 37(2), 2019, 2519-2526.
3. Sanjeev Kumar Ghai & Santanu De, Numerical investigation of auto-igniting turbulent lifted CH<sub>4</sub>/Air jet diffusion flames in a vitiated co-flow using a RANS based stochastic multiple mapping conditioning approach, *Combustion and Flame*, 203, 2019, 362-374.
4. Sanjeev Kumar Ghai, Santanu De, Numerical investigation of flow and scalar fields of piloted, partially-premixed dimethyl ether/air jet flames using stochastic multiple mapping conditioning approach, *Combustion and Flame*, 208, 2019, 480-491.
5. Sanjeev Kr. Ghai, Umair Ahmed, Nilanjan Chakraborty & Markus Klein, Entropy Generation during Head-On Interaction of Premixed Flames with Inert Walls within Turbulent Boundary Layers, *Entropy*, 24 (4), 2022, 463.
6. Sanjeev Kr. Ghai, Umair Ahmed, Nilanjan Chakraborty & Markus Klein, Energy integral equation for premixed flame-wall interaction in turbulent boundary layers and its application to turbulent burning velocity and wall flux evaluations. *International Journal of Heat and Mass Transfer*, 196, 2022, 123230.
7. Sanjeev Kr. Ghai, Umair Ahmed, Nilanjan Chakraborty & Markus Klein, Enstrophy evolution during head-on wall interaction of premixed flames within turbulent boundary layers, *Physics of Fluids*, 34, 2022, 075124.
8. Sanjeev Kr. Ghai, Umair Ahmed, Nilanjan Chakraborty & Markus Klein, Turbulent kinetic energy evolution in turbulent boundary layers during head-on interaction of premixed flames with inert walls for different thermal boundary conditions. *Proceedings of the Combustion Institute*, 39(2), 2023, 2169-2178.
9. Sanjeev Kr. Ghai, Umair Ahmed, Nilanjan Chakraborty, Effects of fuel Lewis number on wall heat transfer during oblique flame-wall interaction of premixed flames within turbulent boundary layers. *Flow Turbulence and Combustion*, 111, 2023, 867-895.
10. Sanjeev Kr. Ghai, Umair Ahmed, Nilanjan Chakraborty, Statistical behaviour and modelling of variances of reaction progress variable and temperature during flame-wall interaction of premixed flames within turbulent boundary layers, *Flow Turbulence and Combustion*, 112, 2024, 845-878.
11. Sanjeev Kr. Ghai, Umair Ahmed, Nilanjan Chakraborty, Modelling of Flame Surface Density during flame-wall interaction of premixed flames within turbulent boundary layers, *Combustion Science and Technology*, 2024 (Article in press), <https://doi.org/10.1080/00102202.2024.2326649>.
12. Sanjeev Kumar Ghai, Rajat Gupta, Santanu De, Effects of Partial Premixing and coflow temperature on flame stabilization of lifted jet flames of dimethyl ether in a vitiated coflow based on stochastic MMC approach, *Fluids*, 9(6), 125 (2024).
13. Umair Ahmed, Sanjeev Kr. Ghai, Nilanjan Chakraborty, Assessment of laws of the wall during flame-wall interaction of premixed flames within turbulent boundary layers, *Flow Turbulence and Combustion*, 112, 1161-1190, (2024).
14. Umair Ahmed, Sanjeev Kr. Ghai, Nilanjan Chakraborty, Relations between Reynolds stresses and their dissipation rates during premixed flame-wall interaction within turbulent boundary layers, *Physics of Fluids*, 36, 045120 (2024).
15. Umair Ahmed, Sanjeev Kr. Ghai, Nilanjan Chakraborty, Direct Numerical Simulation Analysis of the Closure of Turbulent Scalar Flux during Flame-Wall Interaction of Premixed Flames within Turbulent Boundary Layers, *Energies*, 17(8), 1930 (2024).

16. Sanjeev Kumar Ghai, Umair Ahmed, Nilanjan Chakraborty, Markus Klein, Multiscale analysis of Reynolds stresses and dissipation during premixed flame wall interaction, *Physics of Fluids*, 2024 (in Press).
17. Nilanjan Chakraborty, Sanjeev Kr. Ghai, Hong Im, Anisotropy of Reynolds stresses and their dissipation rates in lean H<sub>2</sub>-air flames in different regimes of turbulent premixed combustion, *Energies*. 2024; 17(21):5325.
18. Sanjeev Kumar Ghai, Umair Ahmed, Nilanjan Chakraborty, Effects of thermal boundary conditions on scalar and turbulence statistics during premixed flame-wall interaction within turbulent boundary layers, *Flow Turbulence and Combustion*, 2024 (Article in Press).

### **Under submission or preparation**

19. Pranaya Nahak, Sanjeev Kumar Ghai, Eshan Sharma, Santanu De & Matthew J. Cleary, Stabilization of lifted dimethyl ether jet diffusion flames in vitiated coflow using MMC-LES. Fuel (to be Submitted).
20. Nilanjan Chakraborty, Sanjeev Kr. Ghai, Umair Ahmed, Effects of fuel Lewis number on turbulent flow statistics in oblique-wall quenching of premixed V-shaped flames within turbulent channel flows, (to be submitted).

### **Conference Presentations**

1. Sanjeev Kumar Ghai, Santanu De, Simulations of Lifted Jet Diffusion Flames using RANS-based Stochastic Multiple Mapping Conditioning Approach, 6th International and 43rd National Conference on Fluid Mechanics and Fluid Power, Allahabad, India, 2016.
2. Sudhakar Singh, Sanjeev Kumar Ghai & Santanu De. LES of Lifted Jet Flames using Sparse Lagrangian Multiple Mapping Conditioning Approach, 1st International Conference on Sustainable Energy and Environmental Challenges (SEEC-2017), February 26-28, 2017, CIAB Mohali, Punjab.
3. Sanjeev Kumar Ghai, Santanu De. Investigation of lift-off height variation in turbulent CH<sub>4</sub> /Air jet diffusion flames using stochastic multiple mapping conditioning approach, 1st International Conference on Sustainable Energy and Environmental Challenges (SEEC-2017), February 26-28, 2017, CIAB Mohali, Punjab.
4. Sanjeev Kumar Ghai, Santanu De, Ashoke De. RANS/MMC modeling of piloted turbulent dimethyl ether/air jet diffusion flame, Asia-Pacific Conference on Combustion (ASPACC), 10-14 December 2017, Sydney.
5. Sanjeev Kumar Ghai, Santanu De. Numerical Investigation of turbulent lifted jet diffusion flames using Stochastic Multiple Mapping Conditioning Approach, 24th National and 2nd International ISHMT-ASTFE Heat and Mass Transfer (IHMTC-2017), December 27-30, 2017, BITS Pilani, Hyderabad, Telangana.
6. Sanjeev Kumar Ghai, Santanu De. Stochastic MMC modelling of turbulent piloted jet diffusion flame, 2nd International Conference on Sustainable Energy and Environmental Challenges (SEEC-2018), December 31-January 3, 2018, IISc, Bangalore.
7. Sanjeev Kumar Ghai, Santanu De & Andreas Kronenburg, Numerical simulations of turbulent lifted jet diffusion flames in a vitiated coflow using stochastic multiple mapping conditioning approach, 37th International symposium on combustion, Dublin Ireland, 2018.
8. Sanjeev Kumar Ghai & Santanu De, Numerical modelling of turbulent premixed combustion using RANS based stochastic multiple mapping conditioning approach 37th International symposium on combustion, Dublin Ireland, 2018.
9. Sanjeev Kumar Ghai, Rajat Gupta & Santanu De, Partially premixed jet flames of dimethyl ether/air in a hot vitiated coflow, Mediterranean combustion symposium, Tenerife Spain, 16 -20 June 2019.

10. Sanjeev Kr. Ghai, Umair Ahmed, & Nilanjan Chakraborty, Evaluations of turbulent burning velocity and wall heat flux using integral energy equation for premixed flame-wall interaction in turbulent boundary layers, UKCTRF Annual Conference 2021, Brunel University, in London from Wednesday Dec, 1-2, 2021.
11. Umair Ahmed, Sanjeev Kr. Ghai, Nilanjan Chakraborty & Markus Klein, Scalar statistics in premixed flame-wall interaction within turbulent boundary layers under different flow configurations, 17th UK Heat Transfer Conference, 4-6 April 2022, Manchester, UK.
12. Sanjeev Kr. Ghai, Umair Ahmed, Nilanjan Chakraborty & Markus Klein, Performance of wall functions in premixed flame wall interaction within turbulent boundary layers, 33rd International Conference on Parallel Computational Fluid Dynamics, May 25-27, 2022, Alba Italy.
13. N Chakraborty, U Ahmed, Sanjeev Kr. Ghai, Premixed flame-wall interaction and heat transfer characteristics in turbulent boundary layers: Insights based on Direct Numerical Simulations Pages 23-35, Proceedings of CONV-22: Int. Symp. on Convective Heat and Mass Transfer, June 5 – 10, 2022, Turkey.
14. Sanjeev Kr. Ghai, Umair Ahmed, Nilanjan Chakraborty, Statistical behaviour and modelling of variances of reaction progress variable and temperature during flame-wall interaction of premixed flames within turbulent boundary layers, Mediterranean combustion symposium, Luxor Egypt, 2023.
15. Umair Ahmed, Sanjeev Kr. Ghai, Liyaun Liu, Nilanjan Chakraborty, Statistical behaviour and closure of turbulent scalar flux during turbulent premixed flame-wall interaction within turbulent boundary layers, Proceedings of the European Combustion Meeting, Rouen, France, Apr 26-28, 2023.
16. Nilanjan Chakraborty, Sanjeev Kr. Ghai, Umair Ahmed, Effects of fuel Lewis number on turbulent flow statistics in oblique-wall quenching of premixed V-shaped flames within turbulent channel flows, ETMM-14, Barcelona Spain, September 6-8, 2023.

## Book Chapters

1. Sanjeev Kumar Ghai, Santanu De. A Review on Autoignition in Laminar and Turbulent Nonpremixed Flames, published in *Combustion for Power Generation and Transportation*, 11-37, Springer (2017).
2. Sanjeev Kumar Ghai, Santanu De, Konstantina Vogiatzaki, Matthew J. Cleary. Theory and Application of Multiple Mapping Conditioning for Turbulent Reactive Flows, published in *Modeling and Simulation of Turbulent Combustion*, 447-474, Springer (2018).

## Short Courses and Workshops Attended

- **International Combustion Institute Winter School (ICIWS INDIA 2015)** 12-23 Dec 2015  
Guest Faculty: Prof. Forman Williams, Prof. Eliseo Ranzi, Prof. Kal Seshadri, Prof. Andreas Driezler, Prof. Tim Liewen, Prof. Suresh Menon
- **Gian Courses: At Indian Institute of Technology Kanpur**
  - Combustion: Science, Technology and Processes 9-18 May 2016  
Guest Faculty: Prof. Thierry Poinsot
  - Numerical Modelling of Multiphase Flows 30 Oct - 18 Nov, 2017  
Guest Faculty: Prof. Olivier Desjardins

## References

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- **Prof. Nilanjan Chakraborty**

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