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Rajaram Lakkaraju

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Fields of specialization

Turbulence, Multi-phase flows, Fluid-Structure interactions, Direct numerical simulations

Work experience

- **Indian Institute of Technology Kharagpur** **West bengal, India**
Assistant Professor on Tenure Track *December 2014–Present*
- **Birla Institute of Technology-Pilani** **Goa, India**
Assistant Professor on Tenure Track *July 2013–December 2014*
- **Koneru Lakshmaiah University** **Andhra Pradesh, India**
Visiting Faculty Fellow *March 2013–June 2013*

Education

Academic qualifications.....

- **Doctor of Philosophy** **2009–2013**
University of Twente, Enschede *The Netherlands*
- **M. S. (Engg.)** **2005–2007**
Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore *India*
- **B. Tech (Mechanical Engineering)** **2000–2004**
Acharya Nagarjuna University, Andhra Pradesh *India*
- **10+2** **1998–2000**
Board of Intermediate Examination, Andhra Pradesh *India*

Theses on research work

- **PhD thesis:** *'Boiling turbulent Rayleigh-Bènard convection'*
Enhancement in heat transport is an utmost important issue in power generation and steel making industries for an overall gain in production and performance of the plant. In the industries, large amounts of heat is exchanged between the components where a liquid undergoes a phase change and an important question in these situations is 'why does an increase in heat transport when phase change occurs?' In-order to understand this, I performed direct numerical simulations on water near the boiling point in a cylindrical cell with point-like, two-way coupled vapor bubbles using Eulerian-Lagrangian framework. In general, vapor bubbles promote the detachment of hot plumes by increasing the fluctuations (both velocity and temperature) inside the boundary layers, thus enhancing the advection of heat. In addition, bubbles act as

direct carriers of heat (latent heat) while rising in the flow by transporting heat from the hot to the colder regions. These complex interplay mechanisms lead to the enhancement of the heat transport in a boiling process.

Advisors: *Detlef Loshe (University of Twente) & Andrea Prosperetti (Johns Hopkins University)*

- **M. S. (Engg.) thesis:** *'Studies on buoyancy induced open shear flows: Plane thermal plumes'*

A thermal plume is a layer of warm fluid rising due to buoyancy in a relatively calm and cold environment. In nature, thermal plumes are widely visible as exhaust from hot chimneys, volcanic eruptions, cloud formations and many more. Usually, thermal plumes are created on hot spots where a local temperature exceeds the ambient fluid temperature. As the plume moves away from its source, it gets widened and entrains the local surrounding cold fluid. One important question in this regard is 'how does local velocity and temperature varies away from the hot source?' The time-averaged mean velocity and temperatures are solved under higher-order boundary layer approximations. It is found that the mean flow is unstable in general and usually undergoes a series of transitions to turbulence. In-order to understand this, small amplitude disturbances and their amplification rates are computed using non-parallel approximations. The local disturbances are amplified due to the interplay mechanism between the buoyancy and viscous forces, thus triggering the flow to undergo transition. This work has uncovered a new instability mode and suggests a hydrodynamic and thermal interaction between the unstable energy modes.

Advisor: *Meheboob Alam (Jawaharlal Nehru Centre for Advanced Scientific Research)*

Technical skills

- **Programming Languages:** Proficient in: C, C++, Python, Matlab, TeX
Also basic ability with: MPI, OpenMP, CUDA.
- **Industry Software Skills:** SolidWorks, AutoCAD, Ansys, MS Office products.

Awards and Honors

- **INSPIRE Faculty Award** given by Indian National Science Academy and Department of Science and Technology, India (2015-2020)
- **FOM Fellowship** to pursue Ph.D program by Foundation for Fundamental Research on Matter (FOM), The Netherlands (2009-2004)
- **DST Fellowship** Graduate scholarship for Masters program by Department of Science and Technology, India (2005)
- **GATE 2004-** Secured 98.98% and 246 rank (out of nearly 50000 students) in the Mechanical engineering stream

Teaching experience

- **Undergraduate:** Gas dynamics, Applied Thermodynamics, Mechanical vibrations
- **Postgraduate:** Computational methods in thermal engineering, Finite element methods, Theory of elasticity and plasticity, Twophase flows
- **Laboratory:** Gas dynamics, Refrigeration and airconditioning, Engineering drawing

Academic-Industrial collaborations

During 2009-2013, I was actively engaged with **SHELL Global**, **DSM**, **AkzoNobel**, and **Tata Steel** industries located in The Netherlands through industry partnership program and sent confidential reports to improve the plant thermal efficiency

Publications

- R. Lakkaraju, F. Toschi, and D. Lohse, Bubbling reduces intermittency in thermal convection, **Journal of Fluid Mechanics**, 745, 1-24 (2014), Appreciated as cover page article also
- R. Lakkaraju, R. J. A. M. Stevens, P. Oresta, R. Verzicco, D. Lohse, and A. Prosperetti, Heat transport in bubbling turbulent convection, **Proceedings of the National Academy of Sciences of the United States of America (PNAS)**, 110 (23) 9237-9242 (2013)
- R. Lakkaraju, R. J. A. M. Stevens, R. Verzicco, S. Grossman, A. Prosperetti, C. Sun, and D. Lohse, Spatial dependence of fluctuations and flux in turbulent Rayleigh-Bénard convection, **Physical Review E**, 86, 056315 (2012)
- R. Lakkaraju, L. E. Schmidt, P. Oresta, F. Toschi, R. Verzicco, D. Lohse, and A. Prosperetti, Effect of vapor bubbles on velocity fluctuations and dissipation rates in bubbly Rayleigh-Bénard convection, **Physical Review E**, 84, 036312 (2011)
- R. Lakkaraju and M. Alam, Effects of Prandtl number and a new instability mode in a plane thermal plume, **Journal of Fluid Mechanics**, 592, 221-232 (2007)

Referee for Journals

- Journal of Fluid Mechanics
- Journal of The Institution of Engineers (India): Series C

Research grants

- **DST-Fast Track Young Scientist** Novel computational methods to understand voice generation mechanism of human vocal-folds (2015-2018)-**2.92 million INR**
- **INSPIRE Faculty grant** Novel computational strategy to understand two-phase flows (2015-2020)-**3.50 million INR**
- **ISIRD grant** Novel computational strategy to understand aggregation and swimming of gyrotactic microorganism in oceans (2014-2016)-**2.29 million INR**

Interests and extra-curricular activity

- I am a "Faculty Advisor" for freshers joined in year 2015 in the department of mechanical engineering, IIT Kharagpur. This required me to guide, look after, and ensure that freshers will have an excellent time in their first year.
- Key member in developing an electronic repository system for the department of mechanical engineering, IIT Kharagpur