Vatsal Sanjay

Thermal Engineering, Senior Year

Department of Mechanical and Industrial Engineering,
Indian Institute of Technology Roorkee
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On a quest in the world of multi-phase flows

Research Interests

Two-phase flow
- Liquid jets & their interactions
- Computational multi-fluid dynamics
- Droplets & bubbles dynamics
- Liquid Sheets (curtains) formation & stability
- Interface reconstruction
- Boiling heat transfer

Fire
- Compartmental fire
- Fire propagation and soot flow

Education

2013 – 2018 **Integrated Dual Degree**

B.Tech (Mechanical Engineering) & M.Tech (Thermal Engineering) Indian Institute of Technology Roorkee, Uttarakhand, India
Completed the requirements of the degree with CGPA: **9.14**/10

2013 **High School**, *Central Board of Secondary Education*, India

2013 **AISSCE**, Graduated with **96.4%** marks

2011 **AISSE**, Graduated with CGPA of **10**/10

Research Experience

2016 **Research Intern**

May - July Fluid Mechanics & Acoustics Laboratory - UMR 5509, *Université Claude Bernard Lyon1*, France

Supervisors: **Prof. Jean-Philippe Matas**, **Prof. J. John Soundar**, **Prof. Mickaël Bourgoin**

Project: **Numerical investigation of the Landau film entrainment and rotary entrainment**
- Understanding of the classical Landau-Levich film entrainment problem.
- Studied the film characteristics using the perturbation theory.
- Conducted numerical simulations to understand the assumptions taken in the analytical analysis.
- Established the groundwork for numerical simulation of rotary entrainment using Gerris.

2014 – 2018 **Research Scholar**

Two-phase and microfluidics group, *Indian Institute of Technology Roorkee*, Uttarakhand, India

Supervisor: **Prof. Arup Kumar Das**, Department of Mechanical and Industrial Engineering, IIT Roorkee

Thesis: Understanding of mutual interactions between liquid jets: Entrainment and sheet formation.

Two-phase flow

2015 **Bubble entrainment by plunging liquid jets on pool**
- Conducted a series of experiments and full scaled Direct Numerical Simulations (DNS) using Gerris to show a one-to-one correspondence between the two.
- Captured the instance of pinch-off of first annular bubble to mark the entrainment inception using high-speed camera operated at 2800 frames per second.
- Studied the asymmetry arising in the inception stage and bubble cluster due to inclined jet impingement.
- Studied the interaction between bubble clusters formed by impact of two liquid jets onto pool surface.

2016 **Collision of liquid jets**
- Conducted full-scaled numerical simulations using Gerris, to explore the physics of liquid jet collision.
- Characterized the resultant liquid sheet using the dimensionless parameters.
- Developed an understanding of the kinematics of the fluid parcels inside the liquid sheet.
- Established an analogy between impact of liquid jets with colliding train of fluid quanta.
- Conducted experimental investigation to characterize different regimes of liquid jets impingement.

- Investigated the formation of finger-like projections as a result of Plateau-Rayleigh instability.
- Studied effects of inertia induced asymmetries in the collision of liquid jets through detailed experiments and analogy of inelastic collision of fluid quanta.
- Developed an in-house post-processing code using the *gfs2oogl* library and MATLAB.

2016 **Multi-scale simulations**

- Working on coupling of the Volume of Fluid (VOF) - Lagrangian Point Particle (LPP) methodology.
- Used a hybrid method to study multi-scale phenomena, like jet atomization & bubble bursting.
- Characterized atomization by collision of liquid jets: a result of Kelvin-Helmholtz instability.
- Future endeavor: incorporation of a novel conversion criterion, whereby a finite sized droplet or smaller fluid parcel is converted into multiple particles instead of one as in traditional LPP.

2016 **Numerical simulation of the drainage of kitchen sink**

- Carried out full-scaled simulations to model the gravity assisted drainage of reservoir.
- Studied the mutual interplay of body forces and surface forces on the drainage of reservoir.
- Future endeavor: Simulation of emptying of partially filled bottles using Gerris.

2017 **Phase change heat transfer**

- Understanding of the phase-change model incorporated in LAMMPS-SPH multiphase solver.
- Investigating preferential bubble pinch-off from staggered cylindrical arrangement.
- Future endeavor: simulation of nucleate boiling with dynamic contact angle.

Fire Dynamics

2014 **Study of flame propagation**

- Conducted three-dimensional Large Eddy Simulations (LES) using Fire Dynamics Simulator.
- Investigated compartmental fire in presence of furniture in single and multi-storeyed buildings.
- Calculated Available Safe Evacuation Time (ASET) in case of fire hazard.
- Simulated fire inside real-life modeled railway compartments to establish critical spots.
- Studied fire propagation behavior in presence of patterned flammable obstructions.
- Investigated the effects of wind flow over fire spread in typical arrangement of bushes.

Technical Skills

CFD: Gerris, Basilisk C, LAMMPS-SPH & MD, PARIS Simulator, Fire Dynamics Simulator, OpenFOAM, ANSYS-Fluent

Languages: C, C++, MATLAB, Python, LaTeX

Lab based: LabView: Voltage & current module, Conductivity & optical probes, High speed camera imaging & image processing

Others: Octave, SolidWorks, AutoCAD

Research Publications

To access the full-texts, please visit **my web page**.

2018 Jain, A., **Sanjay, V**, and Das, A. K. (2018). "Consequences of inclined and dual jet impingement in stagnant liquid and stratified layers". In: *Chemical Engineering Science (Under Review)*.

2018 Soni, A., **Sanjay, V**, and Das, A. K. (2018). "Formation of fluid structures due to jet-jet and jet-sheet interactions". In: *AIChE J. (Under Review)*.

2018 Rathia, S. K., **Sanjay, V**, and Das, A. K. (2018). "Investigation of the fire propagation across the patterned obstructions with single and two point ignitions". In: *(Under Review)*.

2017 **Sanjay, V** and Das, A. K. (2017c). "On air entrainment in a water pool by impingement of a jet". In: *AIChE J.* 63.11, pp. 5169–5181. ISSN: 1547-5905. DOI: 10.1002/aic.15828.

2017 **Sanjay, V** and Das, A. K. (2017a). "Formation of Liquid Chain by Collision of Two Laminar Jets". In: *Physics of Fluids* 29.11, p. 112101. DOI: 10.1063/1.4998288.

2017 **Sanjay, V** and Das, A. K. (2017b). "Numerical Assessment of Hazard in Compartmental Fire Having Steady Heat Release Rate from the Source". In: *Building Simulation*. DOI: 10.1007/s12273-017-0411-y.

Scholastic Awards and Achievements

2017 **All India Rank 2988**, *Graduate Aptitute Test in Engineering*, among 190648 candidates.

2015 **Summer Undergraduate Research Award**, *Indian Institute of Technology Roorkee.*
Awarded summer fellowship for two months long research project.

2013 **All India Rank 1512**, *JEE Advanced, India*, in top 1% of the total appearing students.

2013 **All India Rank 765**, *JEE Mains, India*, Percentile score of 99.8%.

Relevant Course Work

MIN-527	Computational Fluid Dynamics	MIN-511A	Modelling & Simulations
MIN-521	Advanced Fluid Mechanics	MIN-522	Advanced Heat Transfer
MIN-536	Convective Heat and Mass Transfer	NPTEL	Two-phase flow & Heat Transfer
IMA-301	Advanced Engineering Mathematics	MA-004	Numerical Methods
MA-001	Mathematics - I	PH-001	Mechanics

Extra-Curricular

Teaching Assistant (TA)

2017 **Engineering Drawing (MIN-108)**
- Conducting practical classes in the Autumn semester of 2017-18.

Mentor

2015–2016 **Mechanical and Industrial Engineering Students' Society**, *IIT Roorkee*
- Demonstrated advanced image processing techniques using MATLAB.

2015–2017 **Academic Reinforcement Program**, *IIT Roorkee*
- Taught Mechanics (PHN-001) and Mathematics (MAN-001) to the freshmen batch in the weekend classes.

2016–2017 **Student Mentorship Program**, *IIT Roorkee*
- Guided freshmen year students through the first year of college life.

Mechanical & Industrial Engineering Students' Society, *IIT Roorkee*

2014 **President**
- Joined as **Executive Member** in 2014-15 and served as **Joint Secretary** in the year 2015-16.
- Organized departmental social events and vocational workshops.

National Service Scheme, *IIT Roorkee*

2013–2014 **Volunteer**
- Participation in street plays on campus and villages nearby for awareness on socio-political issues.

Peer-Reviewed Conference Proceedings

To access the full-texts, please visit **my web page**.

2017 **Sanjay, V**, Darshan, M. B., Kumar, P., and Das, A. K. (2017). "Spatial preference of film growth in boiling and localized suppression of bubble release". In: *Paper ID: IHMTC-2017-09-1283, 24th National and 2nd International ISHMT-ASTFE Heat and Mass Transfer Conference*.

2017 Soni, A., **Sanjay, V**, and Das, A. K. (2017). "Consequences of interaction between asymmetric liquid jets". In: *Paper ID: 64, 44th National Conference on Fluid Mechanics and Fluid Power*.

2017 Jain, A., **Sanjay, V**, and Das, A. K. (2017a). "Asymmetry in air entrainment inside liquid pool due to impingement of an inclined jet". In: *Paper ID: IHMTC2017-13-0828; 24th National and 2nd International ISHMT-ASTFE Heat and Mass Transfer Conference*.

2017 Jain, A., **Sanjay, V**, and Das, A. K. (2017b). "Interaction of bubble clusters formed due to adjacent impingement of liquid jets in a pool". In: *Paper ID: 68, 44th National Conference on Fluid Mechanics and Fluid Power*.

2017 Rathia, S. K., **Sanjay, V**, and Das, A. K. (2017b). "Study of fire propagation in the presence of patterned flammable obstructions". In: *Paper ID: IHMTC2017-04-0814, 24th National and 2nd International ISHMT-ASTFE Heat and Mass Transfer Conference*.

2017 Rathia, S. K., **Sanjay, V**, and Das, A. K. (2017a). "Extent of fire spread during interaction of two ignition points". In: *Paper ID: 65; 44th National Conference on Fluid Mechanics and Fluid Power*.

2016 **Sanjay, V** and Das, A. K. (2016a). "On the gas-liquid entrainment by impingement of liquid jet onto a pool". In: *Reference #50, 9th International Conference on Multiphase Flow*.

2016 Agarwal, A., Sarda, M., Kaushik, J., **Sanjay, V**, and Das, A. K. (2016). "Investigation of flame and soot Propagation in non-air conditioned railway locomotives". In: *International Journal of Computer, Electrical, Automation, Control and Information Engineering* 10.9, pp. 1433–1441.

2016 Kaushik, J., Agarwal, A., Sarda, M., **Sanjay, V**, and Das, A. K. (2016). "Study of fire propagation and soot flow in a pantry car of railway locomotive". In: *International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering* 10.9, pp. 1617–1622.

2016 Sarda, M., Agarwal, A., Kaushik, J., **Sanjay, V**, and Das, A. K. (2016). "Numerical simulations of fire in typical air conditioned railway coach". In: *International Journal of Computer, Electrical, Automation, Control and Information Engineering* 10.9, pp. 1520–1527.

2016 **Sanjay, V** and Das, A. K. (2016b). "On the numerical simulations of kitchen sink vortex". In: *Paper ID: 217, 6th International and 43rd National Conference on Fluid Mechanics and Fluid Power*.

2016 Datta, S., **Sanjay, V**, Kumar, P., and Das, A. K. (2016). "Investigation of jet atomization - a multi-scale approach". In: *Paper ID: 218, 6th International and 43rd National Conference on Fluid Mechanics and Fluid Power*.

2016 Aggarwal, A., **Sanjay, V**, Kumar, P., and Das, A. K. (2016). "Generation of a liquid sheet by an oblique impingement of interacting jets: a numerical investigation". In: *Paper ID: 267, Proceedings of CHEMCON*.

2015 **Sanjay, V** and Das, A. K. (2015a). "Bubble life cycle during entrainment by Jet impingment in liquid pool". In: *ID FM-052, Proceedings of CHEMCON*.

2015 **Sanjay, V** and Das, A. K. (2015b). "Building fire safety: numerical simulation and evacuation planning". In: *Proceedings of 14th International Conference of the International Building Performance Simulation Association*, pp. 897–904.

References

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