

# VERTICAL: SOFT AND ACTIVE MATTER & MECHANICS OF MATERIALS

## IDPHD2026001 Study of Droplet Dynamics Using Experimental, Computational, and Machine Learning Methods

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### Abstract

The project aims to study droplet dynamics using an integrated approach combining experiments, computational fluid dynamics (CFD), and machine learning methods. Controlled experiments will be carried out to examine droplet motion, deformation, breakup, and interactions under varying flow and environmental conditions, using high-speed imaging techniques already established within the group. CFD simulations will complement the experiments and provide detailed insight into the underlying fluid dynamic mechanisms. Machine learning techniques will then be employed to analyse the generated data obtained from the experiments and numerical simulations. This combined approach will lead to a clearer understanding of droplet dynamics and offer a robust framework for modeling complex droplet-driven processes relevant to both natural phenomena and engineering applications, including microfluidic devices.

### Keywords

*Fluid Dynamics, Droplet, Experiments, CFD, ML*

### Funding

**MoE Regular Student**

### Background & Motivation

Droplet dynamics plays a crucial role in many natural phenomena and engineering applications, including rainfall, sprays, and microfluidic systems. Understanding droplet motion, deformation, breakup, and interactions under complex flow conditions remains challenging. Consequently, advanced experimental techniques, CFD, and machine learning approaches are increasingly important for addressing these challenges in modern scientific and industrial applications.

### Essential Qualifications

BE/B-Tech, ME/MTech in Mechanical, Chemical, and Aerospace Engineering; MSc in Physics with fluids background

### Desirable Qualifications

Knowledge of Fluid Mechanics and Heat Transfer

### Key Publications (Last 3 Years)

1. N. V. Anirudh, S. Behera and K. C. Sahu, Unveiling crown-finger instability of a non-spherical drop impacting a liquid surface, *Journal of Fluid Mechanics*, 2026, 1030, A9.
2. N. V. Anirudh, S. Behera and K. C. Sahu, Coalescence of non-spherical drops with a liquid surface, *International Journal of Multiphase Flow*, 2024, 175, 104800.
3. S. S. Ade, L. D. Chandrala and K. C. Sahu, Size distribution of a drop undergoing breakup at moderate Weber numbers, *Journal of Fluid Mechanics*, 2023, 959, A38.
4. S. S. Ade, P. K. Kirar, L. D. Chandrala and K. C. Sahu, Droplet size distribution in a swirl airstream using in-line holography technique, *Journal of Fluid Mechanics*, 2023, 954, A39.
1. S. S. Ade, D. Gupta, L. D. Chandrala and K. C. Sahu, Application of deep learning and inline holography to estimate the droplet size distribution, *International Journal of Multiphase Flow*, 2024, 177, 104853.

### Broad Proposal Objectives

[View Broad Proposal Objectives \(PDF\)](#)