23rd JUNE 2022

Thursday, 11:00 IST (5:30 UTC)

#AzadiKaAmritMahotsav

MINISTRY OF EARTH SCIENCES

Lecture Series on Cloud and Precipitation Physics and Dynamics

Microphysics of droplets in an airstream

About the speaker:

Kirti Sahu is a professor at the Department of Chemical Engineering, IIT Hyderabad. He obtained his PhD degree from JNCASR, Bangalore, in 2007 and was a Postdoctoral Fellow at the Imperial College London from 2006 to 2009 and then joined IIT Hyderabad as a faculty. His research interest includes the study of clouds and raindrops, interfacial flows and hydrodynamic instabilities. Kirti has received many recognitions. Notable among them are young scientist awards from the Indian National Science Academy, National Academy of Sciences India, Young Associate of Indian Academy of Sciences and VASVIK Award. He is an elected fellow of the Institute of Physics, UK. He served as an associate editor of the Journal of Engineering Mathematics and Fluid Dynamics and Materials Processing.

Abstract:

Raindrops reach earth in a wide variety of shapes and sizes due to the complex interaction between droplets and the atmosphere and the accompanying microphysical processes such as fragmentation, coalescence, and phase change. These microphysical processes are further influenced by various factors, including meteorological conditions, the airstream and cloud type from which raindrops originate, and the earth's topology. The distribution of shape and size of raindrops is one of the important factors in rainfall modelling. In this talk, we will discuss the interaction of a droplet with an airstream. In swirl flow, the droplet experiences oppose-flow, cross-flow and co-flow conditions depending on its ejection location, the velocity of the airstream and the swirl strength, which results in distinct droplet morphologies as compared with the straight airflow situation. We observe a new breakup phenomenon, termed as 'retracting bag breakup', as the droplet encounters a differential flow field created by the wake of the swirler's vanes and the central recirculation zone in swirl airflow. A regime map demarcating the various modes, such as no breakup, vibrational breakup, retracting bag breakup and bag breakup modes, is presented for different sets of dimensionless parameters influencing the droplet morphology and its trajectory. In contrast to the straight flow, the swirl flow promotes the development of the Rayleigh–Taylor instability, enhancing the stretching factor in the droplet deformation process, resulting in a larger number of fingers on the droplet's surface. In order to gain physical insight, a theoretical analysis based on the Rayleigh–Taylor instability is proposed for the swirl flow. We will also discuss our recent findings obtained using an inline holography technique that provides the size distributions of satellite droplets caused by the fragmentation of a larger droplet.

Prof. Kirti Chandra Sahu

Department of Chemical Engineering
Indian Institute of Technology Hyderabad
Sangareddy, Telangana 502 284, India

https://youtu.be/5ldhLlWNvBY