Summer Research Program on Dynamics of Complex Systems
Discussion meeting (21-23 July 2016)

Schedule:

Thu, 21 July	Speaker	Affiliation	Talk Title
10:30-11:00 AM	Registration		
11:00-11:30 AM	tea/coffee		
11:30-12:00 Noon	M. Lakshmanan	Bharathidasan University, Tiruchirappalli	Soliton and Some of its Geophysical/Oceanographic Applications
12:00-12:30 PM	A S Vasudeva Murthy	TIFR Centre for Applicable Mathematics, Bangalore	Revisiting the slow manifold of the Lorenz-Krishnamurthy quintet
12:30-03:00 PM	lunch/discussions		
03:00-03:30 PM	Argha Banerjee	Indian Institutes of Science Education and Research, Pune	Understanding glacier fluctuations in the Himalaya through simple models
03:30-04:00 PM	tea/coffee		
04:00-04:30 PM	Samriddhi Sankar Ray	International Centre for Theoretical Sciences - TIFR, Bangalore	Lessons from Droplets in Turbulent Flows for Cloud Microphysics
16:30-05:00 PM	Partha Guha,	SN Bose National Centre for Basic Sciences, Kolkata	Geometric Approach to the study of Non-conservative Systems.

Fri, 22 July	Speaker	Affiliation	Talk Title
10:00-10:30 AM	Attreyee Ghosh	Indian Institute of Science, Bangalore	Modeling the Deep Earth
10:30-11:00 AM	Vishal Vasan	International Centre for Theoretical Sciences - TIFR, Bangalore	
11:00-11:30 AM	tea/coffee		
11:30-11:45 AM	Deepu P.	TIFR Centre for Interdisciplinary Sciences, Hyderabad	
11.45-12:00 Noon	Rupali Sonone	Savitribai Phule Pune University, Pune	
12:00-12:15 PM	Mukesh Raghav	International Centre for Theoretical Sciences - TIFR, Bangalore	
12:15-12:30 PM	Sandeep Mohapatra	Indian Institute of Tropical Meteorology, Pune	
12:30-03:00 PM	lunch/discussions		
03:00-03:30 PM	Kusala Rajendran	Indian Institute of Science, Bangalore	Geophysical environment of the Indian subcontinent: the hazard challenges and mitigation
03:30-04:00 PM	tea/coffee		
04:00-04:30 PM	Anirban Guha	Indian Institute of Technology, Kanpur	On the connection between wave resonance, shear instability and oscillator synchronization
16:30-05:00 PM	Sylvain Mangiarotti	Centre d’Etudes Spatiales de la Biosphère, Toulouse, France	Global modeling – A deterministic technique for modeling chaotic behaviors from observational data

Sat, 23 July	Speaker	Affiliation	Talk Title
10:00-10:15 AM	Resmi	National Institute of Technology, Calicut	Quasi geostrophic dynamics near the equator
10:15-10:30 AM	Shailendra Rathor	Indian Institutes of Technology, Kanpur	Two-dimensionalisation of Rotating 3D Turbulence Revisited
10:30-10:45 AM	Rupak Mukherjee	Institute for Plasma Research, Gandhinagar, Gujarat	Study of Momentum Equation in One and Two Dimensions
11:00-11:30 AM	tea/coffee		
12:00-12:30 PM	Sanjay Puri	Jawaharlal Nehru University, New Delhi	Cooling in Granular Gases
12:30-03:00 PM	lunch/discussions		

Lecturer	Abstract
M. Lakshmanan	Soliton and Some of its Geophysical/Oceanographic Applications-a brief overview of the general theory of soliton and derivation of Korteweg-de Vries equation and its generalizations in the hydrodynamical context. Then I intend to discuss its potential applications in the description of tsunamis, internal waves, Rossby waves and bores. In this context a description of rogue waves is also important. I will also try to speculate on some possible extensions in higher dimensions.
A S Vasudeva Murthy	Revisiting the slow manifold of the Lorenz-Krishnamurthy quintet -A system of five nonlinear ODE’s has been proposed by Ed. Lorenz and V. Krishnamurthy in the mid 80’s as a model for the interaction of slow and fast time scale waves in the atmosphere. Slow manifolds are solutions that are devoid of of fast waves. The precise way of constructing these manifolds has been controversial. We present a slow manifold based on minimising evolution rate: a technique proposed by Sharath Girimaji in 1999.
Argha Banerjee	Understanding glacier fluctuations in the Himalaya through simple models-Mountain glaciers form due to a net accumulation of snow at the higher reaches, which subsequently flows downslope and melts in the lower part of the glacier. They are important in the context of climate, hydrology and landscape evolution in the mountains. Our Himalayan glaciers are not so well-studied as compared to glaciers in other parts of the world. A shortage of data on climate and glaciers, the presence of extensive supra-glacial debris cover, a strong avalanche contribution to mass balance are some of the problems that need to be addressed to understand Himalayan glaciers better. This would allow for reliable assessment of the future of Himalayan glaciers and the possible impacts on the river run-off and climate. We describe some available data on glaciers from this region and discuss how several puzzles there can be solved using very simple zero and one-dimensional descriptions of glacier dynamics.
Anirban Guha	Homboe (Geophys. Publ., vol. 24, 1962, pp. 67–112) postulated that resonant interaction between two or more progressive, linear interfacial waves produces exponentially growing instabilities in idealized (broken-line profiles), homogeneous or density-stratified, inviscid shear layers. We have generalized Holmboe’s mechanistic picture of linear shear instabilities by (i) not initially specifying the wave type, and (ii) providing the option for non-normal growth. We have demonstrated the mechanism behind linear shear instabilities by proposing a purely kinematic model consisting of two linear, Doppler-shifted, progressive interfacial waves moving in opposite directions. Moreover, we have found a necessary and sufficient condition for the existence of exponentially growing instabilities in idealized shear flows. The two interfacial waves, starting from arbitrary initial conditions, eventually phase-lock and resonate (grow exponentially), provided the necessary and sufficient condition is satisfied. The theoretical underpinning of our wave interaction model is analogous to that of synchronization between two coupled harmonic oscillators. We have re-framed our model into a nonlinear autonomous dynamical system, the steady-state configuration of which corresponds to the resonant configuration of the wave interaction model. When interpreted in terms of the canonical normal-mode theory, the steady-state/resonant configuration corresponds to the growing normal mode of the

	discrete spectrum. The instability mechanism occurring prior to reaching steady state is non-modal, favoring rapid transient growth. Depending on the wavenumber and initial phase-shift, non-modal gain can exceed the corresponding modal gain by many orders of magnitude. Instability is also observed in the parameter space, which is deemed stable by the normal-mode theory. Using our model we have derived the discrete spectrum non-modal stability equations for three classical examples of shear instabilities: Rayleigh/Kelvin–Helmholtz, Holmboe and Taylor–Caulfield. We have shown that the necessary and sufficient condition provides a range of unstable wavenumbers for each instability type, and this range matches the predictions of the normal-mode theory.
Partha Guha	TBA
Attreyee Ghosh	Geophysical modeling is one of the most important tools to understand processes of the deep Earth. With the help of geophysical modeling we can address some of the outstanding questions regarding the processes operating within the Earth's interior and their control on shaping the surface of the planet. Much of Earth's surface observations such as gravity anomalies, plate motions, dynamic topography and lithosphere stress field, owe their origin to convection within the Earth's mantle. While we understand the basic nature of such flow in the mantle, a lot remains unexplained, including the complex rheology of the deep mantle and how this density driven convective flow couples with the shallow surface. In this talk I will show how I am using numerical modeling to understand the influence of the deep mantle on surface processes.
Vishal Vasan	TBA
Kusala Rajendran	Geophysical environment of the Indian subcontinent: the hazard challenges and mitigation-The Earth is the most dynamic planet that supports vigorous and continuous internal and external exchanges of matter and energy since its origin ~ 4.5 billion years ago. It has evolved through a series of physical and chemical processes, its boundary conditions quite unmatched with its siblings in the solar system. These processes have given rise to its life supporting systems- a magnetic field that shields it from the cosmic rays, and plate tectonic framework that has helped develop its topographic features, regulated climates, and sustainable ecosystems. Powerful earthquakes and volcanoes, some of which trigger tsunamis and landslides are the hazardous manifestations of this planet's dynamic activity. Thus, earth's documented history is punctuated by natural disasters that have even wiped out civilizations. As these events are the outcome of what happens beyond our realm of observation, we use methods in geophysics to probe the earth. Geophysics is about understanding the earth, its interior structure and processes, repositories of its natural resources and processes that lead to violent events such as earthquakes and volcanoes. It is a blend of geology, physics, chemistry and mathematics to create images that represent the processes that go on deep within the earth and help forecast the outcome. The Indian subcontinent is bounded by the plate margins formed by the collision of India and Eurasia plates- the Himalaya in the north and the Sumatra-Andaman oceanic trench in the east. Great earthquakes have occurred all along this plate boundary; the 2004 earthquake that triggered a massive transoceanic tsunami being the latest and most destructive event. In my talk I would cover the important processes that have given rise to the geophysical environment of the Indian sub-continent and discuss on

	some of the recent earthquakes and tsunamis. I will also touch up on how scientific and technological advances in geophysical imaging and computational methods can be used to forecast the magnitude and outcome of at some of these events help to mitigate damages.
Samriddhi Sankar Ray	We study the dynamics of droplets in fully developed turbulent flows and examine the rate of collisions and coalescence amongst them in a polydisperse suspension. We show the rate of growth of large aggregates and the nature of their settling under gravity. The implications of these theoretical and numerical investigations in the context of warm clouds will be discussed.
Sylvain Mangiarotti	Global modeling – A deterministic technique for modeling chaotic behaviors from observational data-The global modeling technique allows obtaining Ordinary Differential Equations directly from time series. It is very well adapted to model chaos because its main object is not to reproduce an observed signal (which is specific to some initial conditions), but rather to reproduce the dynamical behavior of the observed system (which is independent to the initial conditions). Initiated in the early 1990s, it is only recently that this technique was proven to be applicable to environmental data under real conditions. In the present talk, the global modeling technique will be introduced. Several examples of applications will thus be presented to illustrate the potential of the approach, concerning cereal crops cycles, hydrology and epidemiology.
Sanjay Puri	We discuss the dynamical properties of granular matter. This system loses energy (cools) continuously because of the inelastic collisions between particles. We focus on freely-evolving granular gases. The gas initially cools in a homogeneous cooling state (HCS), but a clustering instability drives it into an inhomogeneous cooling state (ICS). We present results for the HCS and ICS of granular gases where (a) the restitution coefficient is constant; (b) the restitution coefficient depends on the relative collision velocity. We discuss the analytical and numerical techniques used to study granular gases.