Book of Abstracts

Dynamics Days Europe

Bremen, July 29 – August 2, 2024

Plenaries

Forcing of teleconnections among tipping elements in the climate system
Jürgen Kurths (PIK Potsdam Institute for Climate Impact Research)
Monday, July 29, 08:30–09:30, SCC Conference Hall

Abstract: Tipping elements are components of the Earth system that may shift abruptly and irreversibly from one state to another at specific thresholds. An important aspect is how different tipping points are interrelated and how the corresponding teleconnections are changing due to external forcing. Here, we propose a climate network approach to analyse the global impacts of a prominent tipping element, the Amazon Rainforest Area (ARA). We find that the ARA exhibits strong correlations with regions such as the Tibetan Plateau (TP) and the West Antarctic ice sheet. Models show that the teleconnection propagation path between the ARA and the TP is rather robust under climate change. We further uncover that various climate extremes are synchronized between the ARA and the TP. Then we analyze how different ENSO regimes influence this specific teleconnection and find that there is indeed a substantial dependence on the ENSO state. Hence, this interaction of ARA and TP can only be understood as a non-autonomous system. The implications of this basic feature will be discussed in detail.

On some Impact-like Hamiltonian systems
Vered Rom-Kedar (The Weizmann Institute of Science)
Monday, July 29, 09:30–10:30, SCC Conference Hall

Abstract: The dynamics associated with mechanical Hamiltonian systems with smooth potentials that include sharp fronts is traditionally modeled by Hamiltonian impact systems: a class of generalized billiards by which the dynamics in the domain's interior are governed by smooth potentials and at the domain's boundaries by elastic reflections. I will first discuss the properties of this singular limit, culminating in the recent work with D. Turaev in which we established the non-ergodicity of smooth N repelling particles in a box at arbitrarily high energy. Then, I will introduce the class of quasi-integrable Hamiltonian impact systems, where the motion on some level sets is conjugated to a directed motion on a translation surface of a genus larger than one. We propose mechanical realizations of such systems, analyze ergodic properties and quantum properties of classes of such systems, and study their behavior under perturbations (in joint works with L. Becker, S. Elliott, B. Firester, S. Gonen Cohen, I. Pazi, M. Pnueli, K. Fraczek, O. Yaniv and A. Zobova).

Dynamics on homogeneous spaces: a quantitative viewpoint
Amir Mohammadi (University of California, San Diego)
Monday, July 29, 16:00–17:00, SCC Conference Hall

Abstract: Rigidity phenomena in homogeneous spaces have been extensively studied over the past few decades with several striking results and applications. We will give an overview of activities pertaining to the quantitative aspect of the analysis in this context with an emphasis on recent developments.

Multi-dimensional Riemannian spaces to the Navier-Stokes system of equations
Valerii Dryuma (IMI, Rep.Moldova .Kishinev)
Thursday, August 1, 16:00–18:30, Campus Center (IRC) Foyer

Abstract: Geometrical properties of the metrical tensor of 14D = 4D+4D+6D Riemannian space, associated with the Navier-Stokes systems of equations are studied. From this point of view the components of velocity and pressure of non-compressible and viscous liquid depend on conditions on the curvature tensor of the corresponding space. In the case of considered 14D space the Riemann tensor of curvature R_{ijkl} has big number components but the Ricci-tensor R_{ik} of the space has only four components that are equal exactly to zero on solutions of the NS-equations. Conditions of compatibility of the system of NS-equations are studied on base of special six-dim metric having 15 non-zero components depending on the functions of velocities and pressure $U(x, y, z, t)$, $V(x, y, z, t)$, $W(x, y, z, t)$, $P(x, y, z, t)$ of liquid .The behaviour of geodesics of considered metrics can be as regular wherine chaotic and may be of use to studies of the properties of liquid-flows.

Modelling phenotypic plasticity in dryland vegetation
Induja Pavithran (Ben Gurion University of the Negev, The Jacob Blaustein Institute for Desert Research), Michel Ferré (Ben Gurion University of the Negev, The Jacob Blaustein Institute for Desert Research), Ehud Meron (Ben Gurion University of the Negev, The Jacob Blaustein Institute for Desert Research)
Thursday, August 1, 16:00–18:30, Campus Center (IRC) Foyer

Abstract: Due to global climate change, ecosystems are at increasing risk of irreversible tipping to dysfunctional states. Examples include rainforests becoming savannas, grasslands becoming deserts, and thawing of icy tundra. Understanding tipping phenomena and ways to evade them calls for the study of alternative pathways of ecosystem response that may culminate in functional ecosystem states. An essential response element is phenotypic changes at the individual plant level. Plants invest in adapting to stressful environments by changing their phenotypic traits, such as altering the shoot or root structure, changing leaf surface area, closing stomata, or growing thorns. Phenotypic changes in plants have been observed in response to light stress (phototropism), water stress (hydrotropism), grazing stress from herbivores and insects, etc. In this work, we construct a general dynamic model for phenotypic transitions under water stress. The model consists of vegetation-biomass and water variables, and a third variable (an order parameter) is introduced to quantify different phenotypes. Functional phenotype dependencies of the vegetation growth and mortality rates are introduced to account for the general tradeoff between tolerance to water stress and biomass production. Using this model, we study the bifurcation structure along the rainfall gradient and how phenotypic plasticity helps evade or delay tipping. As the precipitation rate decreases, we find that a solution branch describing stress-tolerant plants bifurcates from a solution describing fast-growing plants, and extends to significantly lower precipitation values. We further analyze the flow in phase space to understand the conditions for early tipping to the dysfunctional bare-soil state and whether such tipping can be evaded. Our results indicate that sudden severe droughts can cause early collapse to bare soil when the unstable solution representing the fast-growing phenotype no longer exists. However, at higher precipitation rates where this solution exists, its unstable manifold changes the phase-space flow and prevents the tipping to bare soil. The results further suggest that managing ecosystems so as to include a small portion of the stress-tolerant phenotype at high precipitation can evade tipping to bare soil following severe droughts by directing the flow in phase space toward the functional stress-tolerant vegetation state.

State estimation of high-dimensional nonlinear systems
Kota Shiozawa (Ritsumeikan University), Inga Kottlarz (Max Planck Institute for Dynamics and Self-Organization), Sebastian Herzog (Georg-August Universität Göttingen), Isao Tokuda (Ritsumeikan University), Ulrich Parlitz (Max Planck Institute for Dynamics and Self-Organization)
Thursday, August 1, 16:00–18:30, Campus Center (IRC) Foyer

Abstract: In many physical systems, the equation of motion is available, but not all state variables can be measured. For such systems, state estimation methods are used to determine the unknown state vari-