ECOLE D'ETE

Nonlinear Dynamics in Peyresq

Alpes de Haute-Provence, France

23 - 30 August 2012

Objectives

This CNRS thematic summer school aims to provide a multidisciplinary lecture program to enable the understanding, the study, and the development of research in the field of nonlinear dynamics. The focus is on describing the field from numerous viewpoints including physics, mathematics, mechanics, chemistry, biology, optics, electronics, signal processing,...

3 specialised lectures

Alice in stretch and squeeze land: The marvels of topology and chaos

Prof. Robert Gilmore (Drexel Univ., Philadelphia, USA)

Suppose you have data from a physical system that is behaving chaotically. What do you do? How do you analyze these data? What should you look for? What is the mechanism that generates chaos? For a large class of systems an algorithm now exists for addressing each of these questions successively and successfully. We will go through the steps of this algorithm, showing how each works using experimental data and pointing out the connection with topology. In the process we will develop a classification scheme for strange attractors.

Dynamics of cellular regulatory networks

Prof. Marc Lefranc (Lab. PhLAM, Univ. of Lille I, France)

Inside our cells, essential biological functions rely on complex interaction networks where molecular actors regulate each other so as to generate appropriate biochemical signals. Real-time monitoring in living cells has revealed that these networks are dynamic, spatially organized and highly nonlinear. In particular, typical nonlinear behavior such as bistability and oscillations is harnessed to multiplex cellular information, build clocks, memories or decision circuits. In this course, we will discuss a few case studies representative of systems biology. We will illustrate how nonlinear dynamics is essential to understand the design principles of most cellular regulatory networks.

Reservoir computing: employing dynamical systems for computation

Dr. Mantas Lukoševičius (Jacobs Univ. Bremen, Germany)

Reservoir computing is a recent paradigm of employing dynamical systems for purposeful computation by means of machine learning. While originating in artificial neural networks, it is applicable to a broad range of dynamical systems. The course will contain a quick introduction to the basic concepts of machine learning and artificial neural networks, the origins of reservoir computing, different learning methods and perspectives on it, examples of computation with different types of dynamical systems, applications, some practical aspects, and trends of current research.

2 general lectures

Local bifurcations and reduction methods in reversible systems. Application to water waves and lattices

Prof. Gérard Iooss (Lab. Dieudonné, Univ. of Nice, France, IUF)

1. Center manifold reduction for infinite dimensional systems and normal form theory. Application to elementary bifurcations of reversible systems in small dimensions.
2. Traveling waves in the water wave problem. Spatial dynamics formulation.
3. Traveling waves in infinite lattices. Spatial dynamics formulation.
4. Analytic systems - Analytic center manifold up to exponentially small term. Remarks on "limiting" cases, where the reduction method does not apply.

Nonlinear dynamics: a physics introductory viewpoint

Dr. Chaouqi Misbah (DR CNRS, LIPhy, Grenoble, France)

The lecture wil aim at introducing the notions of bifurcation from simple examples in mechanics (spring, pendulum). The basic concepts of the seven elementary catastrophes will be described. Morphogenesis will be addressed from Turing example, together with its potential role in living systems. The next lecture will be dedicated to the amplitude equation in both cases of a stationnary bifurcation and a Hopf bifurcation. Finally I will describe the dilemna of the determination of the invasion speed of a stable solution by an unstable one.

4 introductory short lectures

Nonlinear models in cancer and immunology (S. Wilson, INRIA Rhône-Alpes)
Front instabilities in reaction diffusion boundary value problem (S. Métens)
Dynamical systems and chaos: Matlab demo (L. Pastur)
Multiple time scales in delay dynamics (Y. Chembo, CNRS, FEMTO-ST)

An experimental demonstration

Photonic Reservoir Computing with delay dynamics (L. Larger)

Organisation

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Information

http://nonlineaire.univ-lille1.fr/SNL

registration: 100€ (lectures + lodging + food)

No fees for CNRS staff

Pre-registration

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