PARTICIPANTS CONTRIBUTIONS
LIST OF ABSTRACTS

- *Iryna Sushko (University of Urbino, Italy)*
  Bistability and border-collision bifurcations for a family of unimodal piecewise smooth maps (L)

  We consider a two-parameter family of piecewise smooth unimodal maps with one break point. Using superstable cycles and their symbolic representation we describe the structure of the periodicity regions of the 2D bifurcation diagram. Particular attention is paid to the bistability regions corresponding to two coexisting attractors, and to the border-collision bifurcations.

- *Massimiliano Sanvito (University of Bristol, UK)*
  Stick-slip systems (P)

- *Hans True (Technical University of Denmark)*
  On the Dynamics of a Railway Freight Wagon with UIC Standard Suspension (L)

  The UIC Standard Suspension consists of a leaf spring (5) - see the figure - which rests on the axle box (6), which can move horizontally and vertically between the guidances (4). In the horizontal the guidance provides an end stop for the translations and the yaw of the wheelset (7). In the vertical direction the motion of the wheelset is restricted by the leaf spring with its nonlinear dry friction characteristic and the weight of the car body (1). The car body is suspended from the leaf spring by links (3). Damping is provided by the dry friction forces in the leaf spring and in the elements of the link suspension. See the figure. We investigate the dynamics of the wagon on a straight track independence on the speed, which is the bifurcation parameter in the dynamical problem. The stick-slip interacting with the nonlinear wheel-rail contact forces gives rise to an interesting sequence of bifurcations and chaos that may be one or more attractors or a transient.

- *Bruno Picasso and Antonio Bicchi (University of Pisa, Italy)*
  Some relations between ergodicity and minimality properties of invariant sets in quantized control systems. (P)

  Linear dynamical systems controlled by quantized inputs exhibit phenomena which are typically non-linear, including chaotic behaviours. We consider discrete-time single-input models of the type $x(k+1)=Ax(k)+bu(k)$. The construction of invariant sets for this class of hybrid systems is of utmost importance for the stabilization problem. We first review a technique to construct invariant sets when an arbitrary quantized input set is assigned. We hence study minimality properties for invariant sets when inputs take integer values. There is a relation between a so-called strong minimality property and ergodicity of the closed-loop dynamics, in particular, ergodicity implies strong minimality. A condition ensuring strong minimality is given in terms of the coefficients of the characteristic polynomial of the matrix 'A'. Two examples are presented: the first one shows that strong minimality does not imply ergodicity. The second one shows that our condition for strong minimality is only sufficient: this is done by exhibition of an ergodic dynamics for which our condition is not satisfied.

- *Victoriano Carmona (University of Seville, Spain)*
  Periodic Orbits in Symmetric 3D Observable Noncontrollable Piecewise Linear Systems (L)

  We analyse the structure of periodic orbits for a specific symmetric 3D piecewise linear system with three zones. Under the hypothesis of observability, the system is noncontrollable if their matrices share some eigenvalue. When these matrices share a pair of imaginary eigenvalues, the

system possesses a continuum of invariant cylinders and the dynamical behaviour on each cylinder can be studied by means a periodic one dimensional equation. Now, depending on the sign of traces of the matrices, we show that the one dimensional equation can have five periodic solutions and this fact shapes the dynamical structure of the system considered. Finally, some simulations are done for perturbations of the studied system and very complex behaviour is detected.

- *Jean-Marc Ginoux (University of South-Toulon Var, France)*
  Manifolds of Slow-Fast Autonomous Dynamical Systems in the Phase Plane (L)

  Mathematical methods provide the implicit or explicit equation of slow manifolds of Slow-Fast Autonomous Dynamical Systems as Van der Pol, Lorenz, Lorenz-Haken, ... Particularly, this method applied to a new predator-prey model that we have called Volterra-Gause model, because it combines the original model of V. Volterra and a limitation of the G.F. Gause type on the intensity of predation of the predator on the prey and of the top-predator on the predator, has higlighted several Hopf bifurcations and a period doubling cascade generating a snail shell-shaped chaotic attractor. Moreover, under certain conditions, this model presents slow-fast dynamics and its attractor is lying on a slow manifold surface, the equation of which is given. At last, a new approach propose to shed light on to the slow manifold method in order to go forward in the slow manifold expression.

- *Enrique Ponce (University of Seville, Spain)*
  Limit cycle bifurcation from infinity in planar symmetrical non-smooth systems (L)

  A bifurcation from infinity in non-smooth systems coming from elementary control systems with a rate-limiter is studied. As the main result, the existence of one unstable limit cycle that bounds the attraction basin of the origin is shown. Analytical expressions for the amplitude and period of the bifurcating limit cycle are provided. The study is made by using a Poincaré compactification.

- *Javier Ros (University of Seville, Spain)*
  Limit Cycle Bifurcation in 3D Continuous Piecewise Linear Systems with Two Zones. The onset of asymmetric oscillations in Chua's circuit (L)

  The generic case of three dimensional continuous piecewise linear systems with two zones is analyzed. From a bounded linear center configuration we prove that the periodic orbit which is tangent to the separation plane becomes a limit cycle under generic conditions. Expressions for the amplitude, period and characteristic multipliers of the bifurcating limit cycle are given. The obtained results are applied to the study of the onset of asymmetric periodic oscillations in Chua's oscillator.

- *Manuel Inarrea (Universidad de La Rioja, Spain)*
  Chaos in the libration motion of an asymmetric non-rigid spacecraft. (P)

  We study the libration motion dynamics of an asymmetric spacecraft in circular orbit under the influence of a gravity gradient torque. The spacecraft is perturbed by a small aerodynamic drag torque proportional to the angular velocity of the body about its mass center. We also suppose that one of the moments of inertia of the spacecraft is a periodic function of time. Under both perturbations, we show that the system exhibits a transient chaotic behavior by means of the Melnikov method. This method give us an analytical criterion for heteroclinic chaos in terms of the system parameters. The dynamical behaviour of the libration motion is also numerically investigated by means of time histories, Poincare' maps, power spectra and atraction basins. These computer numerical simulations confirm the analytical results provided by the Melnikov method.

- *José Pablo Salas Ilarraza (Universidad de la Rioja, Spain)*
  On the dynamics of orbiting charged dust particles: Equilibria, stability and bifurcations (P)

  We study the dynamics of a charged particle orbiting a rotating magnetic planet. The system is modelled by the Hamiltonian of the two—body problem perturbed by an axially--symmetric potential. The perturbation consists in a magnetic dipole field and a corotational electric field. We average the system with respect to the mean anomaly up to first order in terms of a small parameter defined by the ratio between the magnetic and the Keplerian interactions. We use reduction theory to simplify the averaged system, in the corresponding reduced phase space. Then, we study the flow of the resulting system in the reduced phase spaces describing all equilibria, stability and bifurcations

- *Marco Airaudo (LUISS, Rome)*
  Forward-Looking Interest Rate Rules and Hopf Bifurcations in Open economies (L)

- *Antonino Serri (University of Cagliari, Italy)*
  Experimental evaluation of chua's circuit as threshold detector (L)

  A novel application of the Chua's circuit is presented. By proper design and tuning of circuit parameters it is possible to use bifurcations or chaotic transitions to detect the presence of ferromagnetic material close to a probe coil. Modeling of the system behaviour is discussed and experimental results are reported.

- *Lucia Russo (University of Salerno, Italy)*
  Complex dynamics of a controlled reverse flow reactor: Zeno executions, limit cycles bifurcations and routes to strange attractors (L)

  Catalytic processes can be enhanced in a reverse flow reactor (RFR) (Matros and Bunimovich, 1996), which is a catalytic fixed bed reactor where the flow direction is periodically inverted. A control policy (Barresi and Vanni, 2002) can be adopted to avoid the extinction of the reaction and the hot spots formation: a feedback controller reverses the flow direction when the temperature at the first layer of catalyst falls below a fixed value. The mathematical model of the controlled reactor is a hybrid system: discrete events (the inversions of the flow direction) and continuous dynamics characterize the system evolution in time. Typical behaviours of hybrid systems, like Zeno phenomena (Zhang et al., 2001), are found coexisting with limit cycles and quasi-periodic solutions. Construction of impact maps, continuation of limit cycles and computation of Floquet multipliers are employed to understand the influence of Zeno phenomena on bifurcation scenario and on routes to strange attractors.