EDITORIAL

Bifurcation, chaos and their correlates are by now key words of today's scientific vocabulary. They signal the existence of generic classes of unexpected global-scale behaviors encountered in many different contexts across traditional scientific disciplinary divisions and constitute basic building blocks in the emerging field of complexity research.

Despite, or perhaps because of these undisputed facts, there is currently an enormous range of problems where bifurcation, chaos and complexity have become basic issues and, in parallel, a marked heterogeneity of the audiences concerned. Although highly desirable and rewarding by itself, such a phenomenon carries also the danger of blurring fundamental mechanisms and quantitative aspects in favor of analogies and soft approaches, and thus of losing track of the logical and methodological unity of the field.

On July 12–16, 2010 an international conference on *Nonlinear Dynamics and Complexity*: *Theory, Methods and Applications* was organized in Thessaloniki, Greece by the Aristotle University of Thessaloniki, the University of Patras and the Technological Educational Institute of Messolongi. The present special issue of IJBC, and an additional one to follow, are based on contributions presented in this conference. We hope that their contents reflect adequately the multiple facets of nonlinear dynamics and chaos theory and their ramifications across a wide spectrum of scientific disciplines and that, at the same time, they bring out the unity of the concepts and tools put forward and the universality of the mechanisms underlying large classes of, at first sight, very diverse phenomena.

The issue starts with a review paper by Epitropakis and Vrahatis studying the basin of convergence of methods for computing periodic orbits. The authors construct and display the "geometry" of the basins of convergence of several numerical methods. In particular, starting from the well-known Newton's fractal, they were able to find methods for which the corresponding basins of convergence do not exhibit a fractal-like structure, both for periodic orbits of nonlinear mappings, as well as for Hamiltonian flows.

A second review paper by Bodyfelt *et al.* deals with waves in lattices, a field in which nonlinear dynamics found some of its early applications, with emphasis on the role of nonlinearities arising from wave interactions in the occurrence of localized states. Further aspects of nonlinear dynamics on lattices are considered in three subsequent papers by Aubry, Lazarides *et al.* and Cuevas *et al.*

The following six papers by Baltagiannis and Papadakis, Hadjidemetriou and Voyatzis, Antoniadou *et al.*, Harsoula *et al.*, Dvorak and Bazsó, Kalvouridis and Hadjifotinou, deal with nonlinear dynamics and chaos in many-body systems of interest in celestial mechanics. As early as in the turn of the 20th century, Henri Poincaré, the founding father of nonlinear dynamics and chaos, devoted a considerable part of his work on precisely this topic. It is an indication of the richness of the field that many questions remain open to the present day and still constitute subjects of active research. On an even larger scale, the nature of orbits in a model dynamical system arising in the context of general relativity and cosmology is analyzed in a paper by Contopoulos *et al.*

Many-body systems, albeit in the limit of a large number of interacting subunits, are also of central interest in statistical mechanics. The advent of chaos and complexity theories brought a fresh look, and provided new opportunities to make substantial progress in some longstanding problems in this area in connection with ergodicity, the approach to

equilibrium, or the nature of probability densities and invariant measures descriptive of nonequilibrium states. These issues are addressed in three papers by Di Cintio and Ciotti, Antonopoulos and Christodoulidi, Diakonova and MacKay.

The final seven papers of the issue by Kanellopoulos and van der Weele, Katsanikas *et al.*, Zhusubaliyev *et al.*, Volos *et al.*, Mahmoud and Mahmoud, and Sfyrakis address a variety of nonlinear dynamics, chaos and complexity related problems arising in, among others, condensed matter physics and electrical engineering: pattern formation, the bifurcation of complex orbits, and synchronization.

The July 2010 conference, the present issue and the one to come are meant to be a tribute to our colleague and friend Tassos Bountis on the occasion of his 60th birthday. Those who have known Tassos since his post-doctoral and junior faculty member years in the early 80's, the "golden years" during which the impact of nonlinear dynamics and chaos was beginning to be universally recognized, were impressed by his passionate involvement in these developments and by his early contributions. Thirty years later, the passion remains intact and Tassos is a respected international player in the field. His research, from fundamental questions in nonintegrability to localized solutions and propagating waves in lattices or methods for detecting chaos, addresses a wide range of problems of concern in the mathematical, physical and life sciences. He trained dozens of students and young researchers. He promoted national and international cooperation through his participation or coordination of several research projects. And he marked the Greek scientific space by the creation of the Nonlinear Systems Center in Patras and by the organization of no less than 23 summer schools and workshops on nonlinear science, chaos, complexity and related topics, thanks to which large numbers of young researchers were introduced in the field. He also was very active abroad, especially in Slovenia, as a Member of the Organizing Committee of the so far seven international Summer Schools and Conferences "Let's Face Chaos through Nonlinear Dynamics", and as regular charismatic invited lecturer, also at other numerous conferences in Slovenia, Germany, Italy and Croatia, organized by CAMTP — Center for Applied Mathematics and Theoretical Physics, of the University of Maribor. We wish him continuing success and happiness in his professional and personal life.

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