

Foreword

In the past decades, the advent of electronic computers and, later, of the network of such computers, presently known as the World Wide Web, has exponentially increased the amount of data exchanged among the most diverse people, areas and organizations, all over the world. This has brought about many advantages to the academic institutions, to the military structures to the financial institutions, to banks and corporations of all sizes, to the public administrations, governments etc. A detailed list of all those interested in the exchange of information over the internet is presently impossible. One simply observes that practically everybody in the industrialized world is directly or indirectly interested in that, while larger and larger fractions of the populations from the emerging economies are rapidly becoming interested in that. In particular, sensitive information and information protected by privacy laws constitute a large fraction of the total information being transmitted by all forms of telecommunication equipments. Therefore, the development of secure communication has become impelling, in order to prevent unauthorized people from intercepting and embezzling information meant to others. The most obvious way of achieving this goal is to encrypt the data that is to be transmitted. Among the most promising encrypting techniques, we find those based on chaotic synchronized dynamics, which constitute the subject of the present timely collection of research chapters. Chaos is one type of deterministic, hence in principle fully predictable, dynamic behaviour, which, however, turns out to be as unpredictable as a stochastic process, in practice. This is related to the impossibility of knowing with infinite precision the initial state of the system at hand. Also, a chaotic signal enjoys the characteristics of e.g. aperiodicity.

Interacting chaotic oscillators are of interest in many areas of physics, biology, and engineering. For instance, one challenging problem, faced by the current biological sciences, concerns our understanding of the emergence of collective coherent behaviours, from groups of interacting functional units, separately displaying complicated behaviours. In particular, it is remarkable that chaotic systems can be synchronized letting them communicate only a part of the information concerning their state. When this phenomenon was discovered, it became immediately clear that it could have been used to create keys for cryptography using the unsent state spaces. Indeed, by using the proper keys, or interactions, the sender may be synchronized with the receiver, and only part of the data needs to be transmitted, for the whole message to be delivered. This significantly reduces the possibility that the message be understood by unauthorized people. As perfect, 100% secure, ways of encrypting a message may not

be realizable, even chaotic synchronization needs to be tested and further developed, while remaining one of the most promising tools for secure communication in the years to come. This makes the present collection of chapters especially timely and useful.

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Lamberto Rondoni received his “Laurea” in nuclear engineering in 1986, from University of Bologna. He received a Masters in Physics and a Masters in Mathematics in 1990 from Virginia Tech, where he earned his PhD in Mathematical physics, in 1991. He was awarded a postdoctoral position at Virginia Tech, in academic year 1991-1992, before accepting a Research Associate position at University of New South Wales. From 1995 to 1999 he held a *Ricercatore Universitario* position, at Politecnico di Torino, where he is a *Professore Associato*, and leads a nonequilibrium statistical mechanics research group. His research activity concerns the Boltzmann equation and transport of particles; applications of the theory of stochastic processes to chemical kinetics and pattern formation; applications of dynamical systems theory to understand nonequilibrium phenomena, including fluctuations in nanoscale as well as macroscopic objects, like gravitational waves detectors. He has written about 80 papers, several popularization articles and two books.