Politecnico di Torino
Department of Electronics and Telecommunications

Italian Society for Chaos and Complexity
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Colloquium on

Nanodevices and Networks for Brain-Inspired Computing

WHERE	WHEN
Energy Center Auditorium **Politecnico di Torino** **Via Paolo Borsellino 38/16** **10138 Torino, ITALY**	**Wednesday 3rd of July 2024** **from 14:45 to 18:00**

While being unable to store information, certain solid-state memristive nanodevices are blessed with the capability to act as sources of infinitesimal or local energy under appropriate bias conditions, similarly as the sodium and potassium ion channels in neuronal axon membranes. Memristors of this kind stand out as ideal candidates to build energy-efficient brain-inspired computing machines in the years to come. Very recently memristive devices of this kind have been employed to design simple circuits, which capture bifurcation phenomena occurring in physical systems, including reaction-diffusion systems from cellular biology and neuronal axon membranes, through half the number of dynamical states. Moreover, several scientists have recently revealed how certain electronic circuits and systems, they recently designed, achieve peak performance, while operating at the Edge of Chaos. These studies clearly motivate further theoretical and experimental research on the principles of Local Activity and Edge of Chaos.
This workshop, taking place at the **Energy Center Auditorium** (see map), sponsored by the Italian Society for Chaos and Complexity (SICC), and organized within the Long-Term Visiting Professor Programme, established by Politecnico di Torino, and providing us with the privilege to host Prof. R.S. Williams at the Department of Electronics and Telecommunications, intends to highlight the major role, which locally-active nanodevices shall play in bio-inspired electronics in the years to come.

The program of the workshop, scheduled for **Wednesday 3rd of July 2024**, includes the following talks:

14:45-15:00	**Rector Prof. Stefano Paolo Corgnati**, ***Welcome address***
15:00-16:00	**R. Stanley Williams**, ***"Brain-Inspired Computing with Nonlinear Dynamical Materials"*** Department of Electrical and Computer Engineering, Texas A&M University, USA
16:00-16:30	Coffee break
16:30-17:00	**Gianluca Milano**, ***"Unconventional computing with nanowire networks"*** Advanced Materials Metrology and Life Sciences Division, INRiM (Istituto Nazionale di Ricerca Metrologica), Torino, Italy
17:00-17:30	**Alon Ascoli**, ***"The Simplest Ever Reported Bio-Inspired Circuit Supporting the Same Three-Bifurcation Cascade Emerging in the Hodgkin-Huxley Neuron"*** Department of Electronics and Telecommunications, Politecnico di Torino, Italy
17:30-17:50	**Fernando Corinto**, ***"Computing with Resistive Networks"*** Department of Electronics and Telecommunications, Politecnico di Torino, Italy
17:50-18:00	***Closing***

The event is open to all professors, researchers and students. Participation to the Colloquium is free of charge but registration is welcome by sending a message with subject "Colloquium – Brain-Inspired Computing" to fernando.corinto@polito.it and/or alon.ascoli@polito.it.

For further information please contact fernando.corinto@polito.it and/or alon.ascoli@polito.it.

Brain-Inspired Computing with Nonlinear Dynamical Materials

R. Stanley Williams
Department of Electrical and Computer Engineering, Texas A&M University, USA

rstanleywilliams@tamu.edu

We have entered an era to find new modes of computation that will continue to advance exponentially with time even though transistor circuits only improve modestly. Much of the inspiration for new ways of computing comes from what little we understand about the brain. Since the brain itself is a highly nonlinear dynamical system, an appropriate area to investigate is the Principle of Local Activity, which provides a basis for inventing and building new generations of nanoscale oscillators and amplifiers that emulate the integrate and fire dynamics of neurons for signal processing, learning and computation. We need to design neuromorphic circuits that are biased at the Edge of Chaos, where the emergence of complex patterns and behavior in a homogeneous medium are found. However, this is not sufficient. We also need to understand how thermal fluctuations and entropy production minimization contribute to the optimization of brain-like computation. We are just now starting to understand these issues, and I will provide an overview of these concepts.

Short Bio – R.S. Williams

R. Stanley Williams is a Professor in the Department of Electrical and Computer Engineering and Director of the US DOE Energy Frontier Research Center reMIND at Texas A&M University, and an Associate Professor at the University of Southern California. Prof. Williams has performed research in nano-electronics, -ionics and -photonics, and how to utilize the nonlinear dynamical properties of matter to perform computation efficiently. Prior to A&M, he was a Senior Fellow and Senior Vice President at Hewlett Packard Labs, where he led the group that developed the first intentional solid-state version of Leon Chua's memristor. He was named one of the top ten visionaries in the field of electronics by EETimes, and has received major awards in chemistry, applied physics and nanotechnology. Dr. Williams has been issued more than 230 US patents and published more than 480 peer-reviewed research papers with a current Google Scholar h-index of 128.