Friday, Sept. 09, 2016 – 11:15 h am
CFEL Seminar room V (Bldg. 99)

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Memcomputing: a brain-inspired topological computing paradigm

Which features make the brain such a powerful and energy-efficient computing machine? Can we reproduce them in the solid state, and if so, what type of computing paradigm would we obtain?

I will show that a machine that uses memory to both process and store information, like our brain, and is endowed with intrinsic parallelism and information overhead - namely takes advantage, via its collective state, of the network topology related to the problem - has a computational power far beyond our standard digital computers [1]. We have named this novel computing paradigm "memcomputing" [2]. As an example, I will show the polynomial-time solution of prime factorization and the NP-hard version of the subset-sum problem using polynomial resources and self-organizing logic gates, namely gates that self-organize to satisfy their logical proposition [3]. I will also show that these machines are described by a Witten-type topological field theory and they compute via an instantonic phase where a transient long-range order develops due to the effective breakdown of topological supersymmetry [4]. The digital memcomputing machines that we propose are scalable and can be easily realized with available nanotechnology components, and may help reveal aspects of computation of the brain.

[1] F. L. Traversa and M. Di Ventra, Universal Memcomputing Machines, IEEE Transactions on Neural Networks and Learning Systems, 26, 2702 (2015).

[2] M. Di Ventra and Y.V. Pershin, Computing: the Parallel Approach, Nature Physics, 9, 200 (2013).

[3] F. L. Traversa and M. Di Ventra, Polynomial-time solution of prime factorization and NP-hard problems with digital memcomputing machines, arXiv:1512.05064.

[4] M. Di Ventra, F. L. Traversa and I.V. Ovchinnikov, Topological field theory and computing with instantons (in preparation).

Host: Angel Rubio