

PHYSICS, COMPUTATION, AND THE MIND — ADVANCES AND CHALLENGES AT INTERFACES

Proceedings of the 12th Granada Seminar on
Computational and Statistical Physics

La Herradura, Spain 17 – 21 September 2012

EDITORS

Pedro L. Garrido
Joaquín Marro
Joaquín J. Torres
J. M. Cortés

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Garrido
Marro
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Cortés

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Preface: Physics, Computation, and the Mind — Advances and Challenges at Interfaces

This volume originated at the 12th Granada Seminar, and contains the main lectures and a selection of contributed papers in that conference. This is the twelfth of a series of Granada Lectures previously published by:

- World Scientific (Singapore 1993),
- Springer Verlag (*Lecture Notes in Physics* volumes 448 and 493),
- Elsevier (*Computer Physics Communications* volumes 121 and 122), and
- American Institute of Physics (*Conference Proceedings Series*, volumes 574, 661, 779, 887, 1091 and 1332).

These books and the successive editions of the Seminar since 1990 are described in detail at <http://ergodic.ugr.es/cp/>. This *web* also contains updated information on the next edition.

The Granada Seminar is defined as a small topical, interdisciplinary conference whose pedagogical effort is especially aimed at young researchers. In fact, one interesting aspect of this meeting is the opportunity given to the youngest to present their results and to discuss their problems with leading specialists. There were in this edition a total of 57 lectures and 39 poster contributions. One hundred twenty participants came from 23 countries: Spain contributed with 35%, the rest of Europe including Iran, Israel, Russia and Turkey with 39%, and America with 21% (the rest came from Japan and Australia); half the participants received some, either total or partial support from the organization.

The 12th Granada Seminar was organized and mostly financed by the Institute *Carlos I* for Theoretical and Computational Physics, sponsored by the European Network for Scientific Computation CECAM, the European Physical Society and the University of Granada, and endorsed by the Spanish Physics Society and the American Physical Society.

We also wish to express gratitude to all those who have collaborated in making this event a success. In particular, we mention the remarkably high quality and friendly cooperation of invited speakers and other participants, whose personal effort enabled us to accomplish the goals of the Seminar, the Steering Committee's help in designing format and contents, and further *in situ* priceless collaboration from Joaquín J. Torres, J. Cortés and other colleagues, and from the Ph.D. students and postdocs in our group. This edition of the Seminar was held from 17 to 21 of September 2012 in the charming village of La Herradura, a remarkable spot of the *Tropical Coast* of Granada, Spain, where the participants enjoyed a paradisiacal setting.

Following the welcome speech, it is to be highlighted that this edition of the Granada Seminar is a straight consequence of the evolution and popularization of technologies such as encephalography, magnetic resonances, and positron emission tomography, which produce detailed static and dynamic pictures of the brain and its processes, and tiny electrodes and probes which detect and accurately measure the electric pulses generated in areas that are well localized and so small that include ideally only one or at most a few neurons and synapses today. While developing to so highly sophisticated standards, these technologies are becoming very widely used, so much so that are now familiar tools not only in specialized research laboratories but also in many hospitals. Therefore, myriads of valuable data concerning the structure and function of the nervous system are constantly becoming easily available to many scientists.

The old challenge of trying to understand what consciousness is, how intelligence can emerge from relatively unintelligent neurons, and why there are different levels of intelligence can therefore be accepted now. The data from laboratories and hospitals are certainly feeding scientists in neurobiology but also in the apparently distant mathematics and physics; particularly statistical physics which nowadays masters the modeling of complex systems is eager to handle good data on the brain, which is a paradigm of complexity.

But this is not the only justification for looking at the interfaces between disciplines. This meeting was also motivated by the fact that there is a slow though observable convergence between biology systems and digital ones which, in addition to intriguing, is a field with infinite applications that should prove be most relevant to humanity.

Finally, let me notice that an effort has been made by authors and editors to offer pedagogical notes here; in particular, each topic is comprehensively described within its scientific context. We try to mold the *Granada Lectures* into a series of books that help introduce the beginner to novel advances in statistical physics and to the creative use of computers in scientific research, as well as to serve as a work of reference for teachers, students and researchers.

Pedro L. Garrido and Joaquín Marro

Granada, 21 November 2012

List of Participants

12th Granada Seminar

L. Acedo	<i>Spain</i>	S. Grossberg	<i>U.S.A.</i>
E.J. Agnes	<i>Brazil</i>	D. Grytskyy	<i>Germany</i>
J. Aguilá	<i>Spain</i>	S.D. Gunay	<i>Turkey</i>
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D. Battaglia	<i>France</i>	J. Hidalgo	<i>Spain</i>
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G. Bolat	<i>Romania</i>	P.I. Hurtado	<i>Spain</i>
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J. Brooke	<i>United Kingdom</i>	S. Iglesias-Parro	<i>Spain</i>
R.R. Carrillo	<i>Spain</i>	J.J. Jaramillo	<i>Germany</i>
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S. Dolev	<i>Israel</i>	L. Lyra-Gollo	<i>Spain</i>
V. Domínguez	<i>Spain</i>	E. Madrid	<i>Spain</i>
A.J. Duggins	<i>Australia</i>	J.A. Magro	<i>Spain</i>
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J.A. Garrido	<i>Italy</i>	J.M. Martín	<i>Spain</i>
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X.S. Gonzalo-Cogno	<i>Argentina</i>	J. Mejías	<i>Canada</i>
J. Goñi	<i>U.S.A.</i>	A.F. Meyer	<i>Germany</i>
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M.A. Muñoz	<i>Spain</i>	F. Selingardi Matias	<i>Spain</i>
F. Naveros	<i>Spain</i>	A.M. Skulimowski	<i>Poland</i>
A. Negrean	<i>The Netherlands</i>	J. Soriano	<i>Spain</i>
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C. Sánchez-Ferreira	<i>Spain</i>	L-S Young	<i>U.S.A.</i>
M.V. Sánchez-Vives	<i>Spain</i>		

List of Selected Contributions Presented at the Conference

NEUROSCIENCE

- **A computational model for preplay in the hippocampus**
A. H. Azizi and S. Cheng
- **Synchronization phenomena in networks of spiking neurons with a correlated scale-free topology**
S. de Franciscis, J. Mejias, S. Johnson and J. J. Torres
- **Crossover from synchronous firing to population burst statistics**
M. di Volo and R. Livi
- **Homeostatic mechanisms at cerebellar parallel fiber-Purkinje cell connections through deep cerebellar nuclei LTD and LTP**
J. A. Garrido, N. R. Luque, E. Ros and E. D'Angelo
- **Signal integration shapes the dynamics and enhances the dynamic range of neural networks**
L. L. Gollo, C. Mirasso and V. M. Eguíluz
- **Stochastic amplification of fluctuations in cortical UP-states**
J. Hidalgo, L. F. Seoane, J. M. Cortés and M. A. Muñoz
- **Dimensional analysis of EEG plots**
A. J. Ibáñez-Molina, F. J. Esteban and S. Iglesias-Parro
- **The minimal complexity of adapting agents increases with fitness**
N. J. Joshi, G. Tononi and Ch. Koch
- **Potential control implications of the inferior olive→deep cerebellar nuclei pathway in a distributed plasticity cerebellar model**
N. R. Luque-Sola, J. A. Garrido, R. R. Carrillo and E. Ros
- **Robust and efficient receptive field inference from binary responses with stochastic gradient descent**
F. Meyer and J. Anemüller
- **dHAN model of neural networks in the light of experimental neuroscience**
A. Montakhab and S. Sepehri
- **The glutamate receptor interacting protein Shisa-9 alters hippocampal neuronal network synchronization**
M. Rui Pérez-Alonso, R. Klaassen, A. B. Smit and H. D. Mansvelder
- **Prefrontal theta oscillations track the time course of interference during selective memory retrieval**
C. Sánchez-Ferreira, A. Marful, T. Staudigl, T. Bajo and S. Hanslmayr
- **Stochastic coherence in UP and DOWN states. Experiments and modeling**
B. San Cristóbal, M. V. Sanchez-Vives and J. Garcia-Ojalvo

OTHER TOPICS

- **Excess molar volumes of binary mixtures (alkyl benzene + an alkyl propionate) at 298.15 K**
G. Bolat and S. C. I. Strugaru

- **Dynamic electrochemical impedance spectroscopy study for NiTi and NiTiNb in physiological solution**
G. Bolat , D. Mareci, S. Iacoban and C. Munteanu
- **Volume swelling of by irradiation of alpha particles and lattice recovery by molecular dynamics simulation**
S. D. Günay and Ç. Taşseven
- **Kinetic study in Ar-N₂-H₂ plasma discharge at low pressure:density profiles of NH_x radicals**
S. Hajiji, I. Jauberteau, J. L. Jauberteau, J. Aubreton and M. F. Elchinger
- **Radiation Damage in LiO₂ and Recovery During Thermal Annealing**
F. Kayadibi and S. D. Günay
- **Vortex configuration in granular thin superconducting film: Monte Carlo study**
L.V. Belevtsov and A. A. Kostikov
- **Blue-violet photonic emission from human bodies by will in healing Qi practice**
H. Matsueda
- **Hydrodynamics modes in shallow granular fluids**
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- **Origin of Hund's multiplicity rule in singly-excited two-electron systems**
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