MAP-fis Essay Proposal, 2013-2014

(*please write in English*)

Supervisor

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Title

Nonlinear dynamics of neuronal networks, mechanisms of memory and learning in the brain

Area

(*Materials, Optics, Condensed Theory, High Energy Theory,....*);

Theoretical and computational neuroscience

Summary of Proposal

Overview.

Theoretical and computational neuroscience is a rapidly growing field at the forefront of science. It uses theoretical approaches from physics, mathematics, computer science, and biology in order to explain function, memory, learning, and information processing in the brain.

The mission of the Ph.D. Program in the Physics Department of the University of Aveiro is to train students to address dynamics of neuronal networks, mechanisms of memory and learning, computation and information processing in the brain.

The MAP-fis Program offers an advanced interdisciplinary curriculum and provides students with the opportunity to conduct ground-breaking research.

The Program benefits from the long experience of the Physics Department of the Aveiro University in training generations of highly competent researchers who lead interdisciplinary research programs which successfully engage theoreticians and experimentalists from diverse domains of inquiry. The supervisors of the proposal are leading scientists in the world working in the complex network theory and its applications to real networks and brain. They have a large expertise in supervising PhD students and PostDocs.

Topics.

The program provides students with expertise in:

-- Physics – theory of nonlinear dynamical systems and complex networks with applications to dynamics of neuronal networks.

-- Computational neuroscience – simulations of large neuronal networks
-- Neuroscience – with an emphasis on structure and dynamics of neuronal networks, mechanisms of brain rhythms, memory, and information processing in the brain.

Students will address fundamental issues in theoretical and computational neuroscience such as:

--How does interaction among neurons determine nonlinear dynamics of neuronal networks in the brain?

--What mechanisms underline memory and learning in the brain?

--What role do structure and noise play in the brain dynamics?

--What computational problems does the nervous system face?

--How can our understanding of neuronal dynamics lead to better treatments of brain dysfunction such as epilepsy or schizophrenia?

References

(*to allow students first look at topic*)

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S. H. Strogatz, "Nonlinear Dynamics And Chaos: With Applications To Physics, Biology, Chemistry, And Engineering." (Perseus Books Group, N.Y., 1994)

J. A. S. Kelso, "Dynamic Patterns: The Self-Organization of Brain and Behavior", (The MIT Press, Cambridge, 1995).

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