



PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Salvatore Perna

XXIX Cycle

Training and Research Activities Report – First Year

Tutor: Claudio Serpico



Information :

My name is Salvatore Perna and I'm a graduate student in electrical engineering. I've obtained my bachelor and master at University of Naples Federico II . Actually, I'm a PHD student in Information Technology and Electrical Engineering at the same University and my tutor is Prof. Claudio Serpico.

Study and Training Activities

Courses :

- “Corso Introduttivo alla Meccanica Quantistica” , 3 Credits

Seminars :

- “Opportunities and challenges in two dimensional magnetic recording”, J. Cocker (0.2 Credits)
- “Plasmon resonances and Riemann hypothesis”, Prof. Isaak Mayergoyz, (0.4 Credits)
- “Quantum Teleportation”, Prof. G Miano , (0.2 Credits)
- Scuola Nazionale di Dottorandi in Elettrotecnica “Ferdinando Gasparini”, Stage, Napoli, 20-24 October, 32 hours (DIETI) (??)
- “Smoothed Particle Machine Perception : a proposed method for sensor diffusion and physical-spacial perception” , (0.2 Credits)
- “Mechanics of Solids : From beam theory to rapid prototyping for surgery planning” , (0.2 Credits)
- “Joint location and design optimization from resource allocation in software defined virtual networks” , (0.5 Credits)
- “Risk Management meets and modeling based testing via games” , (0.4 Credits)
- “State of the Art in Power Converters for high Voltage DC Transmission Systems” , (0.4 Credits)

Research Activities :

My research studies are focused on Nanomagnetism and Spintronics which are two topics of great interest in the field of magnetic recording and in the information and communication technology in general.

Nanomagnetism can be defined as the study of the evolution of the magnetic property of ferromagnetic nanoparticle (spatial dimension on nanometric scale) when excited by external field (magnetic field or spin-polarized current) . When the external source of excitation is a flow of spin-polarized current we can speak also of Spintronics.

Although my studies are theoretical , the results obtained can be used to design memory devices, spintronic oscillators, switching strategies and so on.

In this first year of PHD I've worked on the following problems :

- A. Study of probabilistic aspects emerging in the magnetization relaxation process
- B. Design of sub-nanosecond switching strategies
- C. Dynamical interactions between magnetization dynamics and microwave external excitations
- D. Magnetization dynamics of a nanomagnet in contact with a thermal bath
- E. Study of second order anisotropy effect in the switching process of a spin-valve element (in collaboration with the University of Messina)

The methodology used to deal with each of this problems is the systematic use of the nonlinear dynamical system theory in combination with statistical mechanics, the theory of stochastic process and chaos theory, depending on the solved problem type.

The main results obtained are :

- A. Control of the relaxation probability [1]
- B. Proposed novel switching strategies [2],[3]
- C. Analytical and numerical study of the erosion basin [4]
- D. Definition of analytical tool to study in a deterministic way the stochastic process and so the magnetization switching [5]
- E. Analytical model of the switching current dependence by the physical and geometrical parameters of nanopillar considered [6]

Published Conference Paper :

- [1] [Phase-Flow Interpretation of Magnetization Relaxation in Nanomagnets](#)
G.Bertotti, ID Mayergoyz, M d'Aquino, S Perna, C Serpico
Magnetics, IEEE Transactions on 50 (11), 1-4, 2014
- [2] [Analysis of Reliable Ultrafast Precessional Switching in the Presence of Transverse Applied Magnetic Fields](#)
M d'Aquino, S Perna, C Serpico, G Bertotti, ID Mayergoyz Magnetics, IEEE Transactions on 50 (11), 1-4, 2014
- [5] [Noise-induced bifurcations in magnetization dynamics of uniaxial nanomagnets](#)
C Serpico, S Perna, G Bertotti, M d'Aquino, A Quercia, ID Mayergoyz
Journal of Applied Physics 117 (17), 17A709, (2015)

Accepted Conference paper

- [3] Analysis of reliable sub-ns spin-torque switching under transverse bias magnetic fields
M d'Aquino, S Perna, C Serpico, G Bertotti, ID Mayergoyz Magnetics, accepted for publication in the Journal of Applied Physics.
- [4] Heteroclinic tangle phenomena in nanomagnets subject to time-harmonic excitations,
C. Serpico, A.Quercia, S. Perna, G.Bertotti, M. d'Aquino and I.D. Mayergoyz, accepted for publications on Journal of Applied Physics.

- [6] Switching properties of perpendicular STT-MRAMs with second order anisotropy S. Perna, R. Tomasello, C. Serpico, M. d'Aquino, and G. Finocchio, accepted for presentation for poster presentation at the Intermag 2015 conference.

Participation to a Conference

1. Oral presentation of the work : [*Phase-Flow Interpretation of Magnetization Relaxation in Nanomagnets*](#) in IEEE International Magnetism Conference, Dresden (Germany), May 4-8 (2014)
2. Poster presentation of the work : [*Phase-Flow Interpretation of Magnetization Relaxation in Nanomagnets*](#) in ET2014, XXX Riunione Annuale dei Ricercatori in Elettrotecnica , 19-20 June (2014), Sorrento (Italy).
3. Oral Presentation of the work : [*Noise-induced bifurcations in magnetization dynamics of uniaxial nanomagnets*](#) in Magnet 2015, the 4th italian conference on magnetism, Bologna (Italy), February 17-19 , (2015).
4. Poster presentation of the work : *Analysis of reliable sub-ns spin-torque switching under transverse bias magnetic fields*, in Magnet 2015, the 4th italian conference on magnetism, Bologna (Italy), February 17-19 , (2015).