



Valentino Scalera

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XXXII Cycle - I year presentation

Micromagnetics and Spintronics

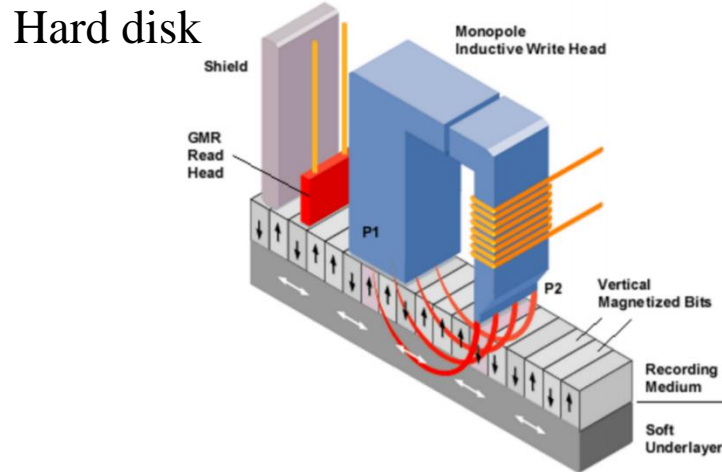
Master's Degree in Electrical Engineer (cum laude)
University of Naples "Federico II"



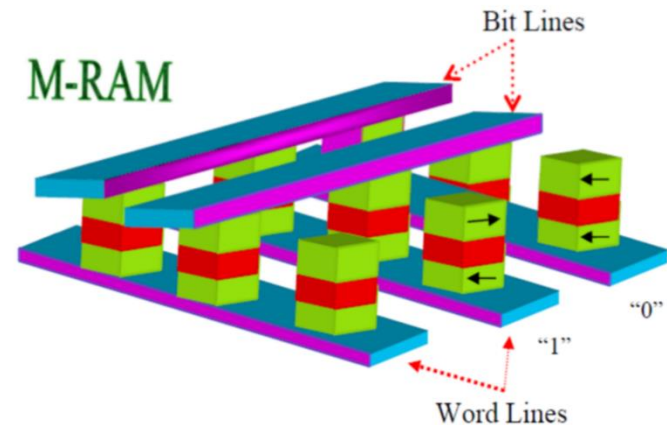
DIE UNIVERSITA' DEGLI STUDI DI
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Micromagnetics and Spintronics

Micromagnetics and Spintronics are widely applied for data storage technologies



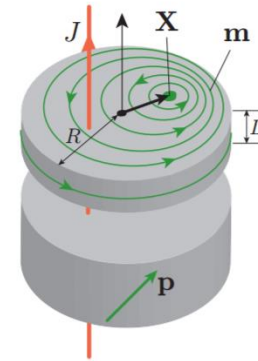
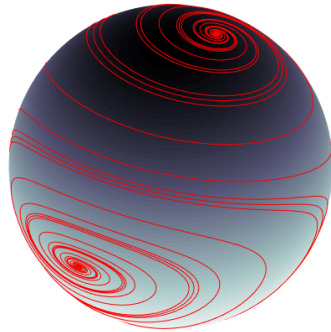
MRAM



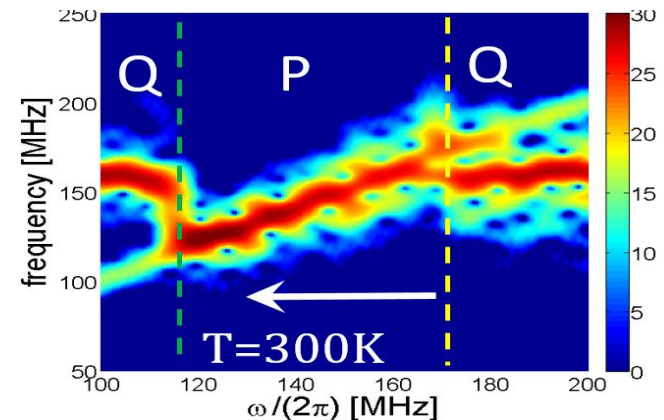
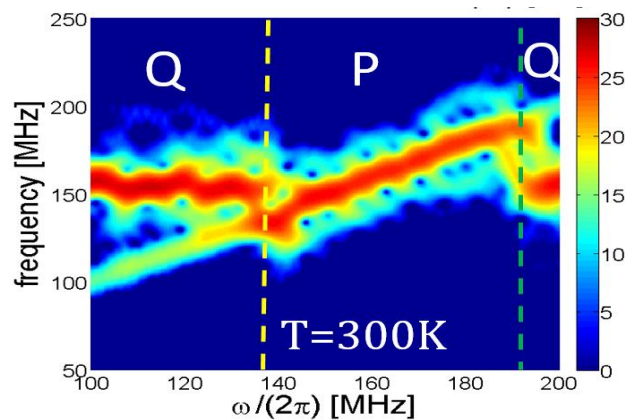
Another interesting application, still in development, are the spin valve nano oscillator, which claim to be much more tunable than semiconductor oscillators

Micromagnetics and Spintronics

Dynamics of uniformly magnetized particles and magnetic vortices and synchronization with external AC sources

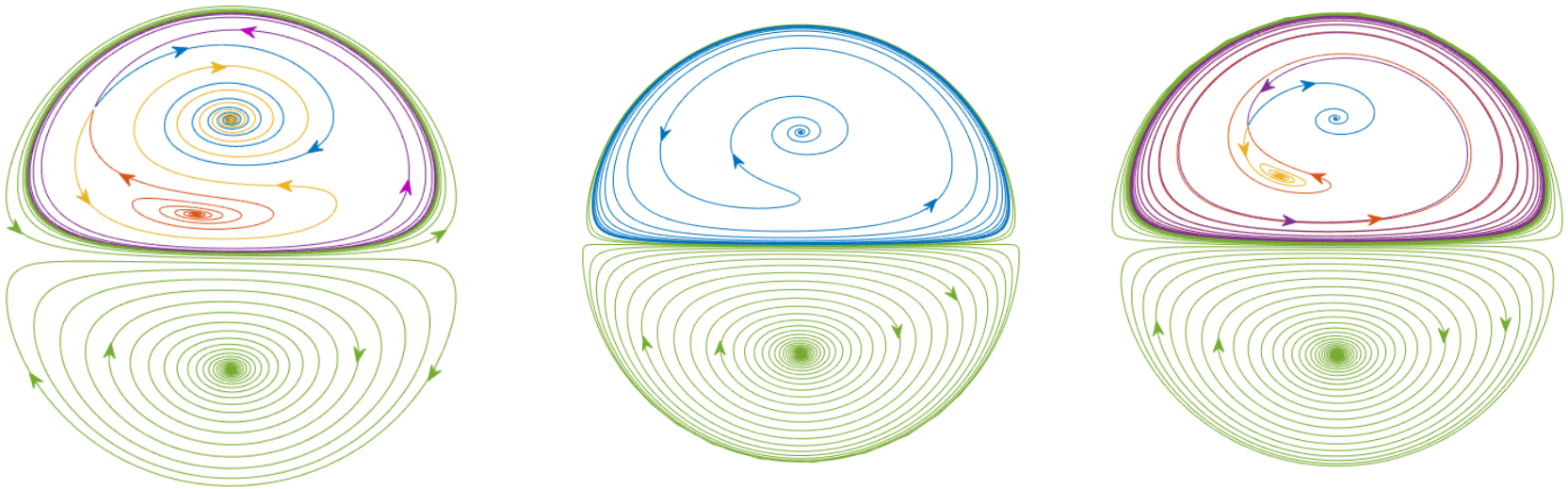


Effect of temperature on devices (magnetic memories and nano oscillator)



Research Activity

Non Linear Dynamics: Bifurcation Theory



Bifurcation is a qualitative change of the phase portrait of a system that change its topological structure

As consequence of a bifurcation equilibrium points or limit cycle of the system may appear, disappear or change their stability.

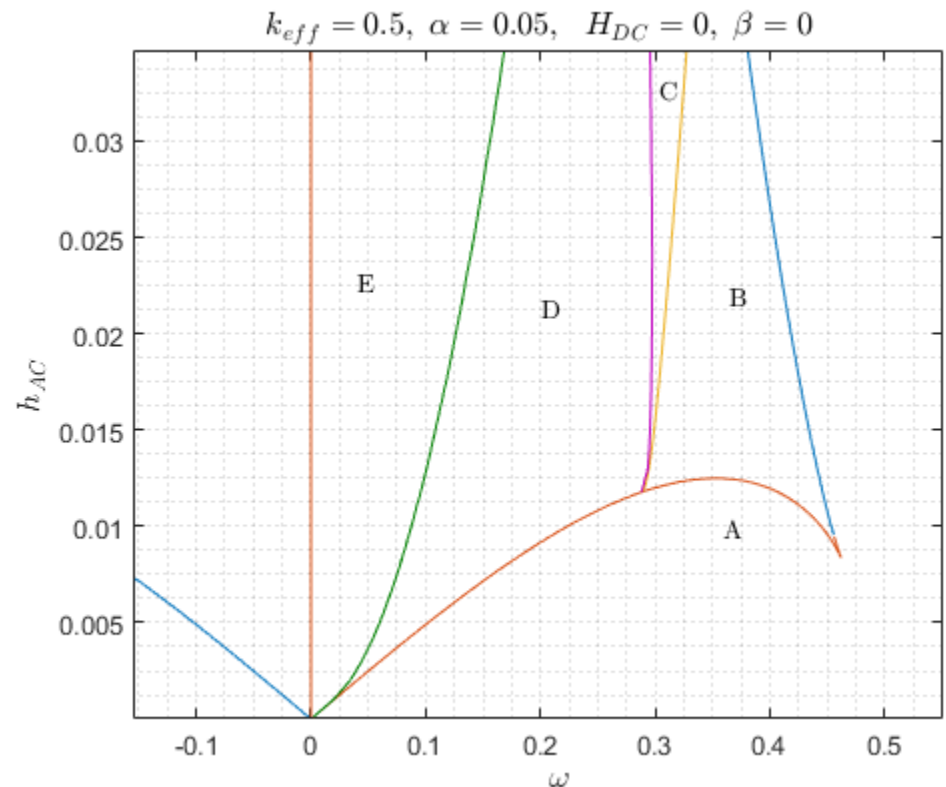
Bifurcation may take place when a parameter of the system changes its value

Research Activity

Ferromagnetic Resonance Bifurcation Diagram

Bifurcation diagrams resumes the behaviour of the nanomagnet and identifies the condition for which the phase portarait of the magnetization are topologically equivalent.

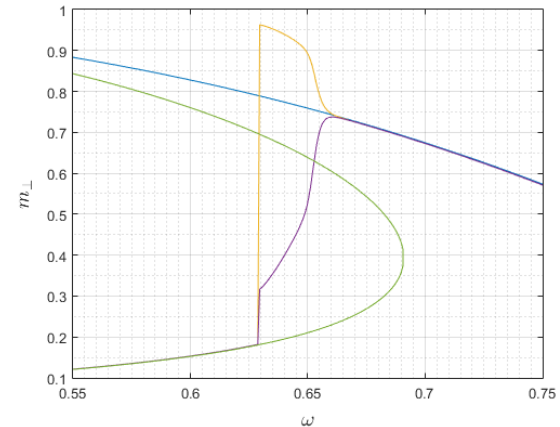
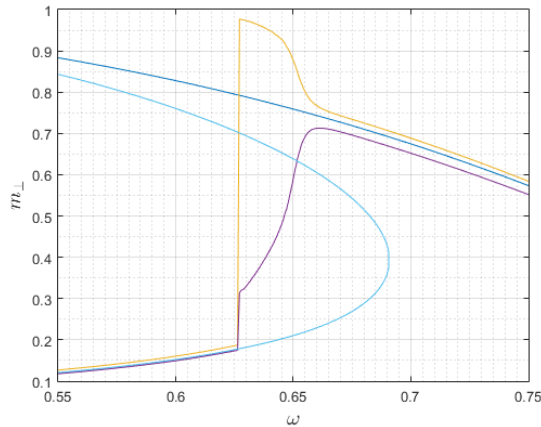
Bifurcation diagrams are also useful to understand the hysteresis in the synchronization mechanism of uniformed magnetized particles or magnetic vortices



Research Activity

Averaging Technique and Normal forms

The Averaging Technique is an analytical method to analyze an asymmetric system by using a symmetric one that can approximate it



Normal Forms are simplified forms of a nonlinear dynamical system useful for determining local bifurcation

$$\dot{x} = \Gamma(x)x - b\mu^2(x) \sin \psi$$

$$\dot{\psi} = [\Omega(x) - \omega] - \frac{b}{x} \cos \psi$$

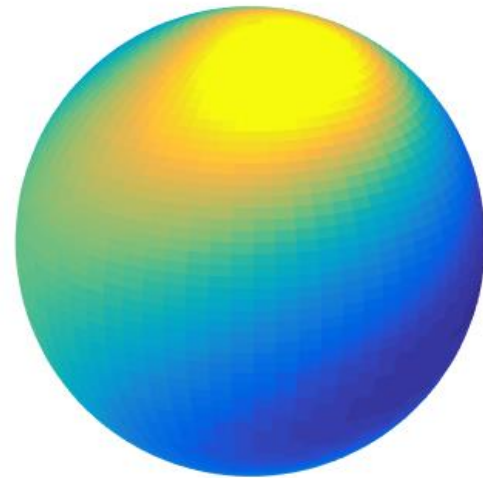
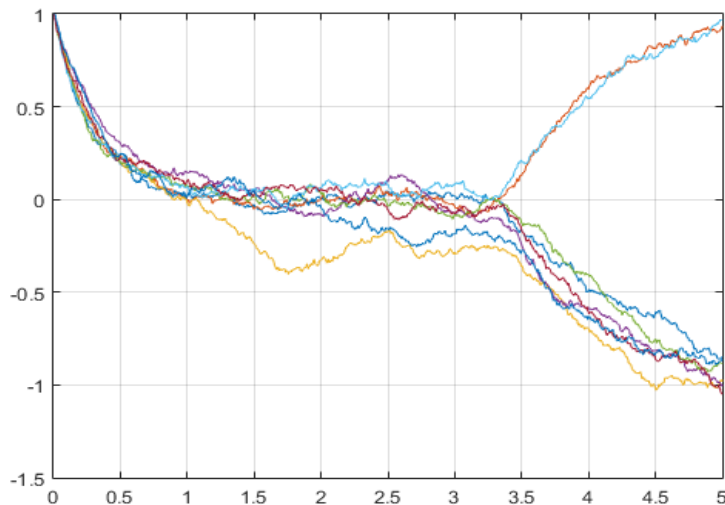
Research Activity

Effect of temperature on the Magnetization Dynamics

Thermal fluctuation can cause most of nanotechnologies (including magnetic ones) to not working properly

In the magnetic recording the thermal fluctuation are directly related to the probability of error in the writing process or in the reading process

In the magnetic nano oscillator the temperature may cause the synchronization to fail

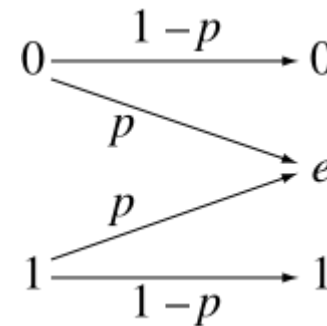
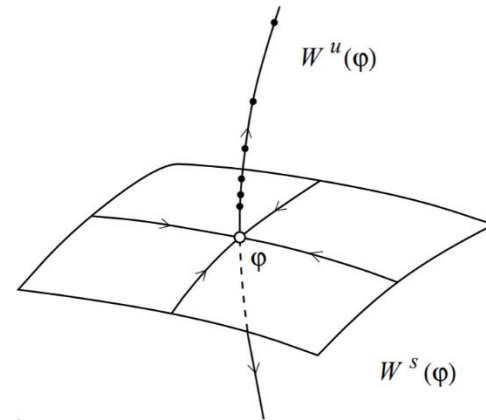


Future Research Activity

Central Manifold and Information Theory

The central manifold is a useful tool for analyzing nonlinear dynamical system with a high dimension state space

Since the magnetic technologies are commonly employed for data storage it is interesting to analyze the channel capacity of the writing and reading process in term of information theory



Publications

- ***“Current-driven hysteretic synchronization in vortex nanopillar spin-transfer oscillators”***
D'Aquino M., Perna S., Quercia A., Scalera V., Serpico C.
IEEE Magnetics Letters
- ***“Normal form of nonlinear oscillator model relevant to spin-torque nano-oscillator theory”***
Quercia A., d'Aquino M., Scalera V., Perna S., Serpico C.
Physica B: Condensed Matter
- ***“Effect of Temperature in Hysteretic Synchronization of Magnetic Vortex Spin-Torque Nano Oscillators”***
D'Aquino M., Perna S., Quercia A., Scalera V., Serpico C.
IEEE Transactions on Magnetics
- ***“Analytical Treatment of Nonlinear Ferromagnetic Resonance in Nanomagnets”***
D'Aquino M., Quercia A., Scalera V., Perna S., Bertotti G., Mayergoyz I.D., Serpico C.
IEEE Transactions on Magnetics

Table of Training

	Credits year 1								Credits year 2								Credits year 3								Total	Check
	Estimated	1	2	3	4	5	6	Summary	Estimated	1	2	3	4	5	6	Summary	Estimated	1	2	3	4	5	6	Summary		
Modules	12	0	3	0	9	0	0	12	12															0	12	30-70
Seminars	5	0	0	0,8	1	2	1,2	5	5															0	5	10-30
Research	43	10	7	9,2	0	8	8,8	43	43															0	43	80-140
	60	10	10	10	10	10	10	60	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	180