II BWMD

II Brazilian Workshop on Magnetization Dynamics
November 28-30, 2012
Natal, RN, Brazil
www.cbpf.br/~magdin

WORKSHOP PROGRAM AND BOOK OF ABSTRACTS

II BWMD

II Brazilian Workshop on Magnetization Dynamics
November 28-30, 2012
Natal, RN, Brazil

WORKSHOP PROGRAM AND BOOK OF ABSTRACTS

Brazilian Workshop on Magnetization Dynamics

Dear Colleagues!

Welcome to Natal and to the II Brazilian Workshop on Magnetization Dynamics (II BWMD).

In the last decades, the number of scientists and research groups working on magnetization dynamics has increased considerably. Thus, BWMD aims to put together the Brazilian community of students and scientist working on magnetization process and magnetization dynamics, as well as invited renowned foreign specialists in the field. In this sense, the Workshop program consists of a number of invited speakers who will give lectures on important recent advances in the field, as well as a contributed oral presentations and poster session.

The area of the magnetization dynamics involves a wide range of topics, such as dynamic behavior of nanostructured magnetic systems, statistical aspects of the processes of magnetization, magnetotransport at high frequencies, non-destructive magnetic measurements, computational techniques, sensors and electronic applications, among others. In particular, this is an area of wide application and technology of great interest for fundamental research.

The workshop is expected to cover the following topics:

1. Basic problems, magnetization processes, domains studies, and micromagnetics
2. Magnetization dynamics and magnetization process in nanostructures
    - Spintronics and spin nanoscillators
    - Magnetoimpedance and broadband ferromagnetic resonance
    - Magnetization dynamics on nanoparticles
    - Barkhausen noise in nanostructures
3. Magnonics
4. Magnetization dynamics in magnetic materials
    - Electrical steels and losses
    - Fe-Ni, Fe-Co, nanocrystalline and amorphous alloys
    - Thin films, metamaterials, novel and special materials
5. Magnetization dynamics under high magnetic fields
6. Statistical aspects of magnetization dynamics
7. Scientific instrumentation and techniques for ultra-short times and high frequencies
8. Non-destructive magnetic measurements and instrumentation
    - Barkhausen noise
    - Magnetoacoustic emission
    - Other techniques to analyse magnetic materials
9. Sensors, high frequency and electronic applications
10. Computational Techniques Applied to Magnetization Dynamics
11. Others

The I Brazilian Workshop on Magnetization Dynamics took place in Rio de Janeiro, RJ, Brazil, on May 6-7, 2010.

The II Brazilian Workshop on Magnetization Dynamics is held at the Praiamar Natal Hotel & Convention in Natal, RN, Brazil, on November 28-30, 2012. II BWMD is organized by Universidade Federal do Rio Grande do Norte, in collaboration with Centro Brasileiro de Pesquisas Físicas.

The II BWMD will be located by the beautiful view of the most prestigious beach in Natal: Ponta Negra. This beach is internationally famous by its warm water cove with the famous dune Morro do Careca. In Natal, the City of the Sun, the sun shines all year but the heat is also assuaged by the winds. While Brazil is frequently associated to incredible beaches, first-class soccer, surfing, carnaval and vibrant nightlife, Natal is also blessed with natural beauty and scenery which words alone cannot describe. In this scenario, you may find hotels, bars, restaurants, shopping malls, the beach, and many other interesting options are a few minutes or even steps away from you. And, of course, you find excellent options to enjoy the well known Brazilian Caipirinha and the delicious Potiguar Shrimps.

In this booklet you will find the abstracts submitted to the II BWMD, as well as useful information for your stay in Natal.

We wish you a fruitful workshop a pleasant stay in Natal.
After all, we hope to see you again in our next edition!

Felipe Bohn and Marcio Assolin Corrêa
II BWMD Chairs

II BWMD

II Brazilian Workshop on Magnetization Dynamics
November 28-30, 2012
Natal, RN, Brazil

Venue
Praiamar Natal Hotel & Convention
Rua Francisco Gurgel, 33
Bairro Ponta Negra
Natal, RN, Brazil
CEP 59090-050
Telephone: +55-84-3219-2230

Workshop website
http://www.cbpf.br/~magdin/

Contact
bwmd@dfte.ufrn.br

Local Committee
Claudionor Gomes Bezerra, UFRN
Felipe Bohn (Chair), UFRN
Marcio Assolin Corrêa (Chair), UFRN
Suzana Nóbrega de Medeiros, UFRN

Program Committee
Alexandre Da Cas Viegas, UFSC
Antonio Azevedo da Costa, UFPE
Julian Geshev, UFRGS
Kleber Pirota, UNICAMP
Luiz Sampaio, CBPF
Marcos André Carara, UFSM
Roberto Bechara Muniz, UFF
Rubem Luis Sommer (Chair), CBPF
Sérgio L. A. de Queiroz, UFRJ
Sergio Machado Rezende, UFPE

Financial support

II Brazilian Workshop on Magnetization Dynamics is financially supported by the following institutions: CAPES, CNPq, CBPF, INEspaço, UFRN, DFTE/UFRN, EC&T/UFRN, PPG Física/UFRN, and FAPERN.

Useful information for visitors

The II BWMD is held at the Praiamar Natal Hotel & Convention, located by the beautiful view of the most prestigious beach in Natal: Ponta Negra. This beach is internationally famous by its warm water cove with the famous dune Morro do Careca. Please, see Natal city maps in figure 1 and 2.

The Praiamar Natal Hotel & Convention is located in the Ponta Negra neighbourhood. It can be easily accessed by taxi from the airport or any Natal neighbourhoods. We do not recommend the use of public transport.

As a general comment, Natal is not a big city, although it is a tourist city. Thus, you should have the same care and attention with security as in any big city around the world. Always plan your trips around the town and ask your hotel front desk for services as taxi or special van services to do sightseeing around town. In general there are many offers that can help you to have a pleasant stay in Natal.

In the scenario of Ponta Negra, you may find bars, restaurants, shopping malls, the beach, and many other interesting options are a few minutes or even steps away from you. Follow, in the next pages, some suggestions of restaurants and bars, which can be localized in the map presented in figure 2.

Further information on Natal can be found at http://www.visitnatalbrazil.com/pt/ and http://www.guianatal.com.br/.

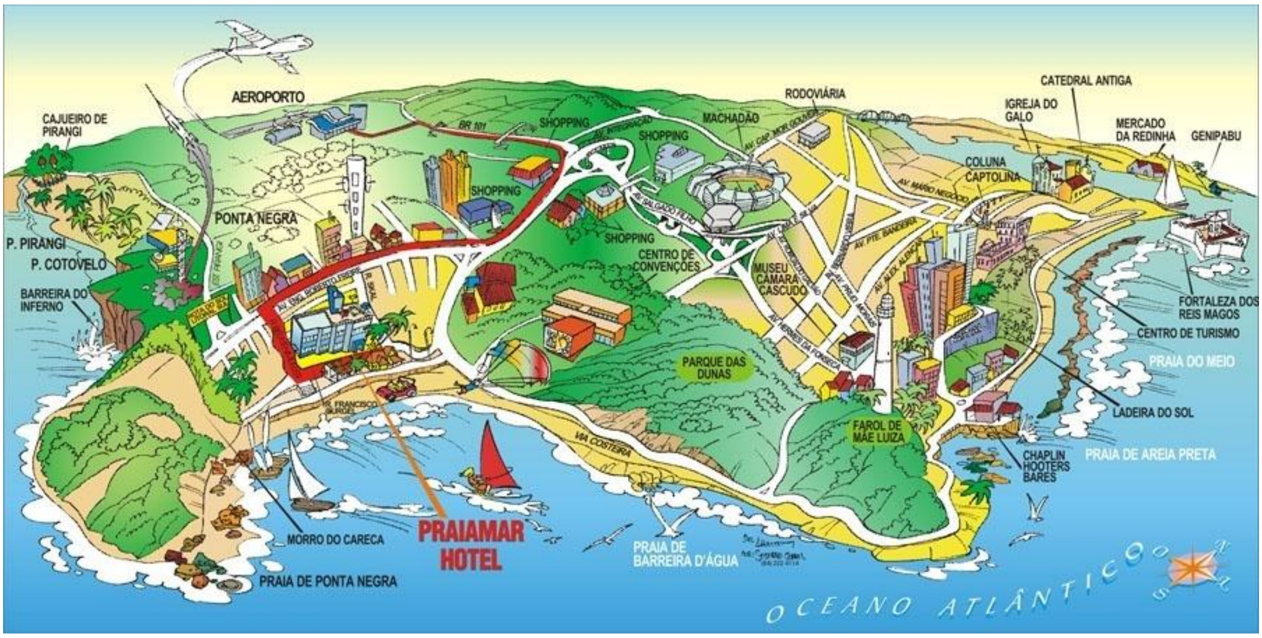


Figure 1: Natal city map.

1. **Pinga Fogo** ☆☆☆☆☆

(Buffet service and Japanese cuisine)
Avenida Engenheiro Roberto Freire, 8956
Bairro Ponta Negra
Telephone: +55-84-3236-3507
Site: www.restaurantepingafogo.com.br/
Open hours: daily from 11 am until 4 pm and from 7 pm until 11 pm
Price: $, R$ 40,00
Credit cards:

2. **Praiamar Natal Hotel & Convention restaurant** (Buffet service)

Rua Francisco Gurgel, 33
Bairro Ponta Negra
Telephone: +55-84-3219-2230
Site: www.praiamarnatal.com.br
Open hours: daily from 11 am until 3 pm and 7 pm until 11 pm
Price: $, R$ 35,00
Contact the II BWMD Secretariat to obtain further information

3. **Praia Shopping** (Buffet service)

Avenida Engenheiro Roberto Freire, 8790
Bairro Ponta Negra
Telephone: +55-84-4008-0800
Site: http://www.praiashopping.com.br/
Open hours: daily from 11 am until 10 pm
Credit cards:
The shopping has a broad range of restaurants in the food courts
We suggest you take a taxi to go to the Praia Shopping

4. **Camarões Potiguar** ☆☆☆☆☆

(Fish and seafood)
Rua Pedro Fonseca Filho, 8887
Bairro Ponta Negra
Telephone: +55-84-3209-2425
Site: www.camaroes.com.br
Open hours: daily from 11 am until 5 pm and from 7 pm until 11 pm
Price: $$, R$ 41,00 to R$ 65,00
Credit cards:

5. **Restaurante dos Mares** ☆☆☆☆☆

(Fish, seafood and international cuisine)
Rua Francisco Gurgel, 10
Bairro Ponta Negra
Telephone: +55-84-3219-3504
Open hours: daily from 11 am until 11 pm
Price: $$, R$ 41,00 to R$ 65,00
Credit cards:

6. **Manary** (Fish and seafood)

Rua Francisco Gurgel, 9067 - Hotel Manary
Bairro Ponta Negra
Telephone: +55-84-3204-2900
Site: www.manary.com.br
Open hours: daily from 7 pm until 11 pm
Price: $$$$, R$ 90,00
Credit cards:

7. **Galo do alto** (Fish and seafood)

Rua Dr. Manoel Augusto Bezerra de Araújo, 142
Bairro Ponta Negra
Telephone: +55-84-3236-2330
Open hours: daily from 6 pm until 1 am
Price: $, R$ 40,00
Credit cards:

8. **Cook & Luxo** (International cuisine)

Avenida Praia de Ponta Negra, 9045
Bairro Ponta Negra
Telephone: +55-84-3219-6648
Open hours: daily from 6 pm until 11 pm
Price: $$, R$ 41,00 to R$ 65,00
Credit cards:

9. **Guinza** (International cuisine)

Rua Ana Porto, 4
Bairro Ponta Negra
Telephone: +55-84-3219-2002
Site: www.guinza.com.br
Open hours: daily from 11 am until 3 pm and 7 pm until 11 pm
Price: $$$, R$ 66,00 to R$ 90,00
Credit cards:

10. Abade (International cuisine)
Rua Hélio Galvão, 8828
Bairro Ponta Negra
Telephone: +55-84-3219-4469
Open hours: daily from 11 am until 3 pm and 7 pm until 11 pm
Site: www.restauranteabade.com
Price: $$$$, R$ 90,00
Credit cards:

11. Mazzano ☆☆☆☆☆
(Italian cuisine)
Avenida Engenheiro Roberto Freire, 9034
Bairro Ponta Negra
Telephone: +55-84-3219-5151
Site: www.mazzano.com.br
Open hours: daily from 11 am until 11 pm
Price: $$, R$ 41,00 to R$ 65,00
Credit cards:

12. Famiglia Reis Magos ☆☆☆☆☆
(Pizzeria and Italian cuisine)
Avenida Engenheiro Roberto Freire, 1482
Bairro Capim Macio
Telephone: +55-84-3642-2600
Open hours: daily from 6 pm until 11 pm
Site: www.reismagos.com.br
Price: $, R$ 40,00
Credit cards:
We suggest you take a taxi to go to the Famiglia Reis Magos pizzeria

13. Piazzale Italia (Italian cuisine)
Avenida Deputado Antônio Florêncio de Queiroz, 12 - Rota do Sol
Bairro Ponta Negra
Telephone: +55-84-3236-2697 and +55-84-3236-4424
Site: www.piazzaleitalia.com.br
Open hours: daily from 6 pm until 11 pm and Thursday to Sunday also from 11 am until 3 pm
Price: $$, R$ 41,00 to R$ 65,00
Credit cards:
The restaurant is not far from Praiamar Natal Hotel & Convention, however we suggest you take a taxi to go to Piazzale Italia

14. Pizzaria Cipó Brasil (Pizzeria)
Rua Aristides Porpino Filho, 3111
Bairro Ponta Negra
Telephone: +55-84-3219-5227
Site: www.cipobrasil.com.br
Open hours: daily from 6 pm until 11 pm
Price: $, R$ 40,00
Credit cards:

15. Mangai ☆☆☆☆☆
(Brazilian and regional cuisine)
Avenida Amintas Barros, 12
Bairro Lagoa Nova
Telephone: +55-84-3206-3344
Site: www.mangai.com.br
Open hours: daily from 11 am until 10 pm
Price: $, R$ 40,00
Credit cards:
It is far from Ponta Negra neighborhood, so we suggest you take a taxi to go to Mangai

16. Casa de Taipa (Regional cuisine)
Rua Dr. Manoel Augusto Bezerra de Araújo, 130-A
Bairro Ponta Negra
Telephone: +55-84-3219-5798
Open hours: daily from 5 pm until 11 pm
Price: $, R$ 40,00
Credit cards:

17. Sal e Brasa ☆☆☆☆☆ (Steak house)
Avenida Engenheiro Roberto Freire, 1426
Bairro Capim Macio
Telephone: +55-84-3217-5919
Site: www.salebrasa.com.br
Open hours: daily from 11 am until 11 pm
Price: $$, R$ 41,00 to R$ 65,00
Credit cards:
The restaurant offers transfer from the hotel

18. Tábua de carne ☆☆☆☆☆
(Steak house)
Avenida Engenheiro Roberto Freire, 3241
Bairro Capim Macio
Telephone: +55-84-3642-1236
Site: www.tabuadecarne.com.br
Open hours: daily from 11 am until 3 pm and from 6 pm until 11 pm
Price: $, R$ 40,00
Credit cards:

19. Picanha e CIA (Steak house)
Avenida Erivan França, 3176
Bairro Ponta Negra
Telephone: +55-84-3219-3279
Open hours: daily from 11 am until 11 pm
Price: $, R$ 40,00
Credit cards:

20. Decky Bar (Bar, snacks)
Avenida Engenheiro Roberto Freire, 9100
Bairro Ponta Negra
Telephone: 3219-2471
Site: www.deckybar.com.br
Open hours: Wednesday - Saturday, from 7 pm until the last client
Credit cards:

21. Só mais uma (Bar, snacks)
Avenida Engenheiro Roberto Freire, 8750, quiosque 5, praça do ponto 7
Bairro Ponta Negra
Telephone: 3242-1746
Open hours: Tuesday - Sunday, from 7 pm until 1 am
Credit cards:

22. Botequim Tá na Hora (Bar, snacks)
Rua Francisco Gurgel, 47
Bairro Ponta Negra
Telephone: 2010-0034
Open hours: daily from 6 pm until 1 am
Credit cards:

23. Paprika (Bar, pizzeria and Italian food)
Rua Pedro Fonseca Filho, 9001
Bairro Ponta Negra
Telephone: 3219-3865
Open hours: daily from 6 pm until 1 am
Credit cards:

24. Galo do alto (Bar, fish and seafood)
Rua Dr. Manoel Augusto Bezerra de Araújo, 142
Bairro Ponta Negra
Telephone: +55-84-3236-2330
Open hours: daily from 6 pm until 1 am
Price: $, R$ 40,00
Credit cards:

25. K-21 (Beach bar)
Calçadão de Ponta Negra, s/nº, close to Hotel Esmeralda
Bairro Ponta Negra
Open hours: daily from 7 am until the last client
Credit cards: Probably, credit cards are not accepted

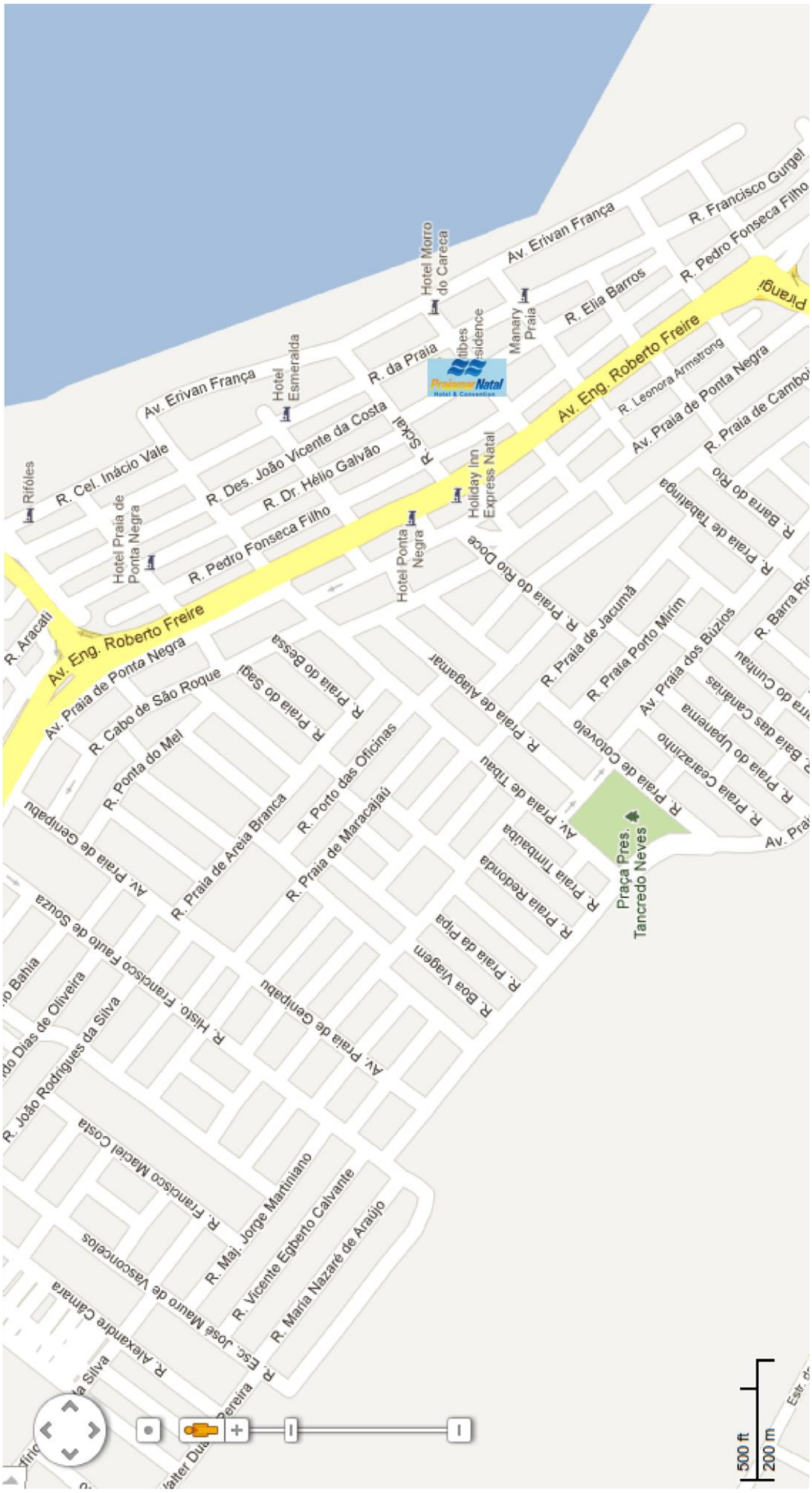


Figure 2: Ponta Negra neighbourhood map.

II BWMD Workshop Dinner

The II BWMD Organizing Committee is delighted to invite you to participate of the Workshop Dinner. This will be held on November 29, 2012, at the Churrascaria Sal e Brasa (http://www.churrascariasalebrasa.com.br/), where you will experience the delicious Gaúcho Barbecue while drink the traditional Brazilian Chopp.

The costs of attending the II BWMD Workshop Dinner is R$ 25,00 per participant.

We suggest you take a taxi to go to the Workshop Dinner. Figure 3 shows the map where the Praiamar Hotel & Convention and Churrascaria Sal e Brasa can be localized.

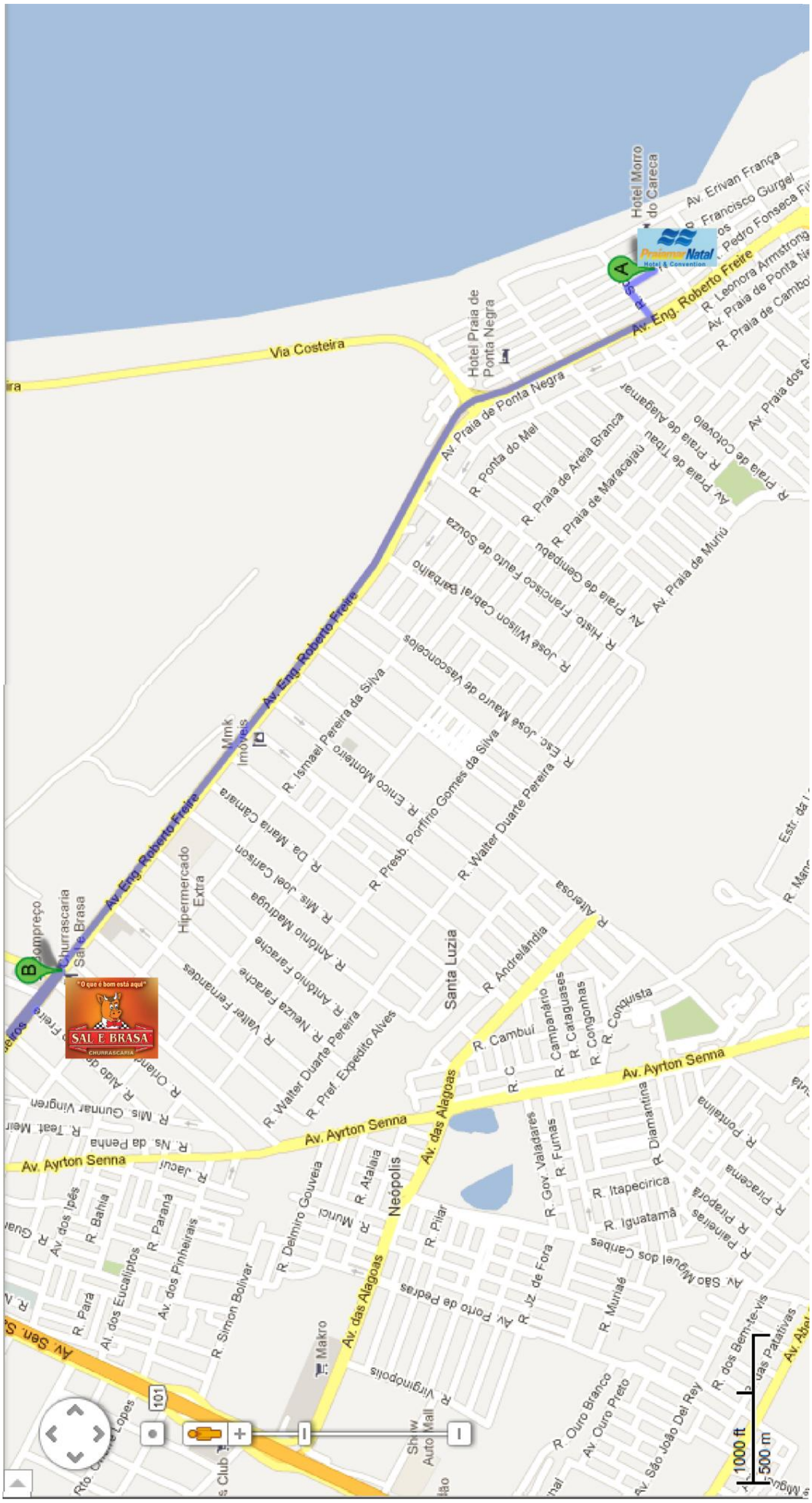


Figure 3: Ponta Negra neighbourhood map, where Praiamar Hotel & Convention (Rua Francisco Gurgel, 33) and Churrascaria Sal e Brasa (Avenida Eng. Roberto Freire, 1426) can be localized.

Presentations

The workshop language is English. No simultaneous interpretation service will be provided during the meeting.

The Workshop presentations will consist of invited lectures, oral talks and poster sessions, selected by the Program Committee. A single plenary session is planned for all invited and oral presentations.

Invited talks are 1 hour or 30 minutes long, including 5 minutes for questions and discussion, according the II BWMD program presented in table 1. Oral contributions are 30 minutes or 15 minutes long, including 5 minutes for questions and discussion. Both, invited and oral presentations are to be made either using personal laptop or the PC that will be available in the session room (Windows system + Powerpoint and Acrobat Reader). Please, come to the session room 15 minutes before the session start to upload your presentation to the PC or to set up your laptop connection.

For contributed poster presentations, the available board area for poster presentations is 90 cm (width) x 100 cm (height). You must provide your own printout of the title, authors and poster itself. Scotch tape and the session paper designation sign will be provided by the Workshop staff. You are requested to set up your poster on Wednesday or on Thursday morning, and remove it at the end of the Workshop.

II BWMD Program

Several distinguished scientists and researchers have been invited by the II BWMD Program Committee to give a lecture and to present their work. The complete list of invited speakers is composed by

- ✓ Andreas Heinrich, IBM Almadén Research Center, USA;
- ✓ Gianfranco Durin, L'Istituto Nazionale di Ricerca Metrologica, Italy;
- ✓ Manuel Vázquez Villalabeitia, Instituto de Ciencia de Materiales/CSIC, Spain;
- ✓ Yaroslav Tserkovnyak, University of California-LA, USA;
- ✓ Antonio Azevedo da Costa, UFPE, Brazil;
- ✓ Antonio Tavares da Costa Junior, UFF, Brazil;
- ✓ Artur da Silva Carriço, UFRN, Brazil;
- ✓ Flávio Garcia, LNLS, Brazil;
- ✓ Julian Geshev, UFRGS, Brazil;
- ✓ Kleber Roberto Pirota, UNICAMP, Brazil;
- ✓ Sidiney de Andrade Leonel, UFJF, Brazil.

The II BWMD will feature diverse and up-to-date lectures on several topics. The program, detailed in Table 1, is composed by invited lectures, oral presentations and contributed posters. The list of all contributions to II BWMD is presented in the next pages.

Table 1: II BWMD program. Please, pay attention in the duration time for each talk, since all the present similar sizes in the table, irrespective the duration time they represent.

Time	November 28 (Wed)	November 29 (Thu)	November 30 (Fri)
9:00 - 9:30		Talk 1 - A. J. Heinrich	Talk 11 - M. Vázquez
9:30 - 10:00			
10:00 - 10:30		Talk 2 - G. Durin	Talk 12 - Y. Tserkovnyak
10:30 - 11:00			
11:00 - 11:15		Talk 3 - S. A. Leonel	Talk 13 - A. T. Costa
11:15 - 11:30			
11:30 - 11:45		Talk 4 - M. A. Campos	Talk 14 - F.S. Guimarães
11:45 - 12:00		Talk 5 - A. Drehmer	Talk 15 - T. Dumelow
12:00 - 14:00		Lunch	Lunch
14:00 - 14:15		Talk 6 - K. R. Pirota	Talk 16 - A. Azevedo
14:15 - 14:30			
14:30 - 14:45		Talk 7 - R. Dutra	Talk 17 - J. Geshev
14:45 - 15:00		Talk 8 - D. E. G.-Chavez	
15:00 - 15:15		Talk 9 - J. C. Denardin	Talk 18 - A. Carriço
15:15 - 15:30		Talk 10 - F. S. Vannucchi	
15:30 - 15:45		Poster session	Talk 19 - F. Garcia
15:45 - 16:00			
16:00 - 16:30	Registration		Coffee Break
16:30 - 17:00			Round table
17:00 - 17:30			
17:30 - 18:00			Closing
18:00 - 19:00			
19:00 - 19:30	Opening		
19:30 - 20:00	Welcome reception		
20:00 - 20:30			
20:30 - 21:00		Workshop Dinner	
21:00 - 21:30			
21:30 - 22:00			
22:00 - 22:30			
22:30 - 23:00			

Wednesday, November 28 (Wed)

16:00 - 19:00	Registration
19:00 - 19:30	Opening
19:30 - 21:00	Welcome Reception

Thursday, November 29 (Thu)

09:00 - 10:00	Talk 1 (Invited) - Probing the energetics and dynamics of atomic spins on surfaces *A. J. Heinrich, IBM Almaden Research Center, San Jose, CA, USA*
10:00 - 11:00	Talk 2 (Invited) - Domain wall dynamics in disordered media: universal features from ribbons to nanostrips *G. Durin, Istituto Nazionale di Ricerca Metrologica, Torino, Italy*
11:00 - 11:30	Talk3 (Invited) - The influence of magnetic impurities in the magnetization dynamics in nanomagnets *S. A. Leonel, UFJF, Juiz de Fora, MG, Brazil*
11:30 - 11:45	Talk 4 - Magnetic Barkhausen Noise: Concepts, Models, Industrial Applications, Technologies and New Paradigms *M. A. Campos, USP, São Paulo, SP, Brazil*
11:45 - 12:00	Talk 5 - Case depth determination in SAE 1020 steel using Barkhausen noise *A. Drehmer, UCS, Caxias do Sul, RS, Brazil*
12:00 - 14:00	Lunch
14:00 - 14:30	Talk 6 (Invited) - Dynamic properties of magnetization probed by first-order reversal curves method (FORC) *K. R. Pirota, UNICAMP, Campinas, SP, Brazil*
14:30 - 14:45	Talk 7 - Broadband FMR and magnetic study of exchange-biased multilayers *R. Dutra, CBPF, Rio de Janeiro, RJ, Brazil*
14:45 - 15:00	Talk 8 - FMR dispersion relation of a single spin-valve *D. E. Gonzalez-Chávez, CBPF, Rio de Janeiro, RJ, Brazil*
15:00 - 15:15	Talk 9 - Ferromagnetic Resonance Investigation in Permalloy Magnetic Antidot Arrays on Alumina Nanoporous Membranes *J. C. Denardin, Universidad de Santiago de Chile, Santiago, Chile*
15:15 - 15:30	Talk 10 - Monochromatic Radiation Emission from a BEC of Excited Magnons *F. S. Vannucchi, UNICAMP, Campinas, SP, Brazil*
15:30 - 17:30	Poster Session
20:30 - 23:00	Workshop Dinner

Friday, November 30 (Fri)

09:00 - 10:00	Talk 11 (Invited) - Depinning and propagation modes of single domain walls in cylindrical magnetic wires *M. Vázquez, Institute of Materials Science of Madrid, CSIC, Madrid, Spain*
10:00 - 11:00	Talk 12 (Invited) - Magnon transport, condensation, and topology in insulators *Y. Tserkovnyak, University of California, Los Angeles, CA, USA*
11:00 - 11:30	Talk 13 (Invited) - Microscopic theory of spin dynamics in transition metal nanostructures and the role of spin orbit *A. T. Costa, UFF, Niterói, RJ, Brazil*
11:30 - 11:45	Talk 14 - Spin currents and spin-orbit coupling in multilayered structures *F. S. M. Guimarães, UFF, Niterói, Brazil*
11:45 - 12:00	Talk 15 - Tunable All-Angle Negative Refraction from the Magnon Response in Antiferromagnets *T. Dumelow, UERN, Mossoró, RN, Brazil*
12:00 - 14:00	Lunch
14:00 - 14:30	Talk 16 (Invited) - Dynamics of spin wave under action of spin currents in ferromagnetic/non-magnetic structures *A. Azevedo, UFPE, Recife, PE, Brazil*
14:30 - 15:00	Talk 17 (Invited) - Magnetic interactions and anisotropies in polycrystalline antiferromagnet/ferromagnet systems *J. Geshev, UFRGS, Porto Alegre, RS, Brazil*
15:00 - 15:30	Talk 18 (Invited) - Tailoring magnetic vortices and walls of confined nanoelements *A. S. Carriço, UFRN, Natal, RN, Brazil*
15:30 - 16:00	Talk 19 (Invited) - Study of dynamically coupled pair of magnetic vortices *F. Garcia, LNLS, Campinas, SP, Brazil*
16:00 - 16:30	Coffee Break
16:30 - 17:30	Round Table - Magnetization Dynamics in Brazil *F. Missell, UCS, Caxias do Sul, RS, Brazil* *R. L. Sommer, CBPF, Rio de Janeiro, RJ, Brazil* *S. M. Rezende, UFPE, Recife, PE, Brazil*
17:30 - 18:00	Closing

Poster Session

IIBWMD-004A	Study of magnetic anisotropy and rotational hysteresis in exchange bias systems *J. N. Rigue*
IIBWMD-005A	Effect of electric current on domain wall dynamics *F. Beck*
IIBWMD-009A	Fabrication and magnetic properties of chemically sensitized magnetic nanowires *P. T. de Almeida*
IIBWMD-014A	Magnetic dynamics behaviour in non-magnetistrictive multilayer thin films grown on flexible substrates *K. Agra*
IIBWMD-017A	Influence of structural and magnetostrictive properties in dynamic behavior of multilayer CoFeB / (Ta, Ag, Cu) thin films *V. M. Escobar*
IIBWMD-018A	Coupling between magnetic field and curvature in Heisenberg spins on surfaces with rotational symmetry *V. L. de Carvalho-Santos*
IIBWMD-020A	Effect of magnetic impurities on the domain wall dynamics in magnetic nanowires *V. A. Ferreira*
IIBWMD-021A	Effect of a ring of magnetic impurities on the dynamics of the vortex core in magnetic nanodisks *D. Toscano*
IIBWMD-022A	Gyrotropic frequency shift in nanodisks with pointlike magnetic impurity *J. H. Silva*
IIBWMD-024A	Complex switching resistance induced by spin polarized current through contact-points *L. C. Benetti*
IIBWMD-026A	FMR linewidth and the crystallization in Co-based amorphous microwires *M. Carara*
IIBWMD-027A	A novel method for identifying the local magnetic viscosity process of heterogeneous magnetic nanostructures *F. Béron*
IIBWMD-030A	Irradiation driven nanocrystallization of FeCuNbSiB amorphous thin films *T. L. Marcondes*
IIBWMD-034A	Magnetoimpedance in multilayered Ni81Fe19/Cu films electrodeposited on Cu microwires *B. Silva*
IIBWMD-043A	High sensitivity magnetoelastic sensors applied to drying of ceramic films *C. D. Tormes*

IIBWMD-044B	Magnetic and ferromagnetic resonance Investigation in Nickel Nanohills thin films with different thickness *J. C. Denardin*
IIBWMD-045A	Terahertz Band Gaps in Onedimensional Magnonic Quasicrystals *C. H. Costa*
IIBWMD-049A	Magnetic interactions in exchange-coupled unbiased IrMn/NiCu films *K. D. Sossmeier*
IIBWMD-050A	Magnetic reversal modes in dome-like nanostructures *J. L. Palma*
IIBWMD-052A	Static and dynamic magnetic properties of films of FeNbCuSiB *M. J. P. Alves*
IIBWMD-053B	Dynamics of a Bose-Einstein Condensate of Excited Magnons *F. S. Vannucchi*
IIBWMD-063A	Tuning the exchange bias and coercivity in FM1/FM2/AF systems *A. M. H. de Andrade*
IIBWMD-064A	Magnetic fringe fields in Nickel micro-contacts system *J. I. Avila*
IIBWMD-065A	Coercivity and magnetization of ultrathin cobalt films *R. Checca*
IIBWMD-071A	Model for domain wall avalanches in ferromagnetic thin films *D. Muraca*
IIBWMD-072A	FORC method used to analyze the hysteretic effect of GMI in high frequency range *L. Costa*
IIBWMD-084A	Evaluation of external magnetic field during the synthesis of magnetite by Transmission Electron Microscopy and Vibrating Sample Magnetometry *K. L. Silva*
IIBWMD-087A	Synthesis and magnetic properties of strontium doped cobalt ferrite prepared by microwave-assisted combustion method *A. C. Lima*

Abstracts

Invited and contributed oral presentations

Talk 1

Probing the energetics and dynamics of atomic spins on surfaces

A. J. Heinrich[1]

[1]*IBM Almaden Research Center, San Jose, CA, USA*

The scanning tunneling microscope has been an extremely successful experimental tool because of its atomic scale spatial resolution. In recent years this has been combined with the use of low temperatures, culminating in microvolt energy resolution. However the time resolution of typical STM experiments is limited to about one millisecond for spectroscopy on a single atom. In this talk we will discuss the use of inelastic tunneling spectroscopy with low-temperature STM for the study of spins, a technique coined spin-excitation spectroscopy. With this approach it is possible to measure the energy eigenstates of the quantum spin Hamiltonian that describes spins on surfaces with very high precision. We will briefly discuss its application to the measurement of the Zeeman energy and to magneto-crystalline anisotropy. We will then focus on a new way of achieving fast time resolution based on an all-electrical pump probe spectroscopy. In this approach, a strong voltage pulse applied between tip and sample drives a spin out of thermal equilibrium (the pump pulse) [1]. A short time later (typically a few nanoseconds) a smaller voltage pulse (the probe pulse) is applied which probes the state of the system. I will demonstrate this technique for the measurement of the spin relaxation time of individual magnetic atoms [2] and chains of atoms on a surface.

[1] S. Loth, C.P. Lutz, and A.J. Heinrich, Nature Physics **6**, 340 (2010).
[2] S. Loth, M. Etzkorn, C.P. Lutz, D.M Eigler, and A.J. Heinrich, Science **329**, 1628 (2010).

Talk 2

Domain wall dynamics in disordered media: universal features from ribbons to nanostrips

G. Durin[1]

[1]*Istituto Nazionale di Ricerca Metrologica, strada delle Cacce 91, Torino, Italy*

Domain wall dynamics has been a never-ending field of research in condensed matter physics, both for a theoretical and an experimental, practical point of view. In particular, a particular attention has been addressed to the role of disorder in the dynamics, which is the base of the hysteresis behavior of any magnetic material. Since the discovery of the Barkhausen effect in 1919, it was clear that the randomness was an essential element of the magnetization dynamics, as a bulk (3D) system responds to a smoothly varied magnetic field with a jerky noise, in terms of pulses or 'avalanches'. Only much more recently, it was clarified that the origin of this jerky behavior is due to the transition across a depinning point, and the overall effect started to be understood as a critical phenomena, explaining the occurrence of power law distributions and scaling properties [1]. Remarkably, despite the large variety of magnetic systems under study, the scaling properties could be classified using only two universal classes, which depend on the occurrence of long or short interactions in the domain wall dynamics. Such universal features were further explored beyond power-law scaling, focusing on the average functional form of avalanches, i.e., the average temporal avalanche shape. This shape revealed several unexpected properties, and showed sometime signatures of non-universal effects, as in the presence of eddy currents. In thin (2D) films, these universal properties are much less understood. On one side, the experimental determination of the spatial and temporal avalanches is not completely fulfilled, as it is complicated, for instance in optical MOKE methods, by the limited field-of-view which radially changes the power-law scaling [2]. On the other side, the precise nature of universality classes, and the possible cross-over between them by varying a material property or the geometry, is far from being completely clear. Magnetic systems with further reduced dimensions, such as nanostrips and wires, promise to be, between the others, the future non-volatile memories. Also in these systems, it is essential to understand the role of disorder, both under field and/or spin-polarized currents, and of any thermal effect. As expected, the domain wall dynamics appears to be highly affected by even a small amount of disorder, namely edge roughness or local point-like defects. Surprisingly, not all the properties deteriorate, as the disorder tends to stabilize the internal domain wall structure, and increases the maximum speed by suppressing the Walker breakdown [3]. This suggests to deliberately engineer disorder, to accurately control the dynamics, and limiting the effects of thermal fluctuations.

[1] G. Durin, and S. Zapperi, "The Barkhausen effect", in: *The Science of Hysteresis: Physical Modeling, Micromagnetics, and Magnetization Dynamics*. Academic Press, **vol. II**, 181-267, (2006).
[2] Y.-J. Chen et al., Phys. Rev. E **84**, 061103 (2011).
[3] B. van der Wiele, L. Laurson, G. Durin, Phys. Rev. B (2012), in press.

Talk 3

The influence of magnetic impurities in the magnetization dynamics in nanomagnets

S. A. Leonel[1], D. Toscano[1], J. H. Silva[1], V. A. Ferreira[1], F. Sato[1], R. A. Dias[1], P. Z. Coura[1], B. V. Costa[2]

[1]*Departamento de Física, Laboratório de Simulação Computacional, Instituto de Ciências Exatas, Universidade Federal de Juiz de Fora, 36036-330, Juiz de Fora - MG, Brazil*
[2]*Departamento de Física, Laboratório de Simulação, Instituto de Ciências Exatas, Universidade Federal de Minas Gerais, 30123-970, Belo Horizonte - MG, Brazil*

It was discovered recently that some magnetic nano-structures present interesting properties that can be used to build efficient new storage devices, to applications in logic devices and in the high speed random access memories. Magnetic nano-device like a nanodisk shows a magnetic vortex configuration in ground state. In magnetic nanowires the relation between the thickness and width provides two types of domain walls, the vortex domain wall (VDW) and transverse domain wall (TDW). The competition between magnetostatic energy and the exchange interaction is the responsible for the formation of the magnetic vortex configuration in nanodisks and for the predominance of one of the two types of domain walls in nanowires. The presence of defects in the material can affect the magnetization dynamics, then, the study of the influence of impurities and defects on the magnetization is of paramount importance. We use spin dynamics simulations and micromagnetic approach to study and propose a model for magnetic impurities. In the model we developed the interaction between the magnetic sites and the defects depends only on the exchange energy [1]. We observed that the magnetic impurities can behave both as a pinning (attractive) or scattering (repulsive) cells. Using the known values of the parameters for Permalloy-79 we have calculated the interaction energy of the vortex core with a single defect in nanodisks and estimated the interaction range as approximately 10nm. Both results agree quite well with experimental results of reference [2]. In another work we studied, in detail, the gyrotropic mode behavior in nanodisks of Permalloy-79 with a single magnetic impurity. In our simulations, we have considered a magnetic impurity inserted near the vortex core gyrotropic trajectory [3]. We have observed that the gyrotropic frequency shift depends on the exchange constant strength and the relative position between the impurity and the vortex core gyrotropic trajectory. Our results agree with the analytical model and experimental behavior for the gyrotropic frequency shown in the reference [2]. We also studied the effect of a ring of magnetic impurities on the vortex core dynamics in nanodisks of Permalloy-79. The presence of the ring allowed us not only to modulate the gyrotropic frequency but also provided us a way to confine the vortex core. We observed that the gyrotropic frequency depends on the ring parameters. Moreover, we have noticed that the switching of the vortex core polarity can be obtained from the vortex core-impurity interaction under peculiar conditions, in particular, when the ring works for pinning the vortex core. Recently we have been studying the behavior of domain wall in magnetic nanowires in the presence of magnetic impurities.

[1] D. Toscano et al., J. Appl. Phys. **109**, 076104 (2011).
[2] R. L. Compton, T. Y. Chen and P. A. Crowell, Phys. Rev. B **81**, 144412 (2010).
[3] J. H. Silva et al., J. Magn. Magn. Mater. **324**, 3083 (2012).

Talk 4

Magnetic Barkhausen Noise: Concepts, Models, Industrial Applications, Technologies and New Paradigms

M. A. Campos[1], L. R. Padovese[1]

[1]*Laboratório de Dinâmica e Instrumentação – LADIN www.ladin.usp.br Departamento de Engenharia Mecânica Escola Politécnica – USP Av. Prof. Mello Moraes 2231 05508-970 São Paulo SP*

The most important concepts as well as the most used models for describing the Magnetic Barkhausen Noise (MBN) phenomena are revised. The main results of non-destructive material characterization with the MBN and the main technologies develop over more than a decade of work in the Laboratory of Dynamic and Instrumentation of the Polytechnic School of the University of São Paulo are also presented in this paper. Finally, are commented the new possibilities of this technique in industry and material science.
[1] R.W. Leep., Rev. Proc Symp on Physics and NDT, Gordon and Breach (1967).
[2] G.V. Lomaev. Sov J NDT **13**, 425 (1977).
[3] D.C. Jiles, NDT International **21**, **5**, 311 (1960).

Talk 5

Case depth determination in SAE 1020 steel using Barkhausen noise

A. Drehmer[1], G. J. L. Gerhardt[1], F. P. Missell[1]

[1]*Centro de Ciências Exatas e Tecnologia – CCET, Universidade de Caxias do Sul, Cidade Universitária/Bloco V, 95070-560 Caxias do Sul, RS, Brazil*

The most widely used thermochemical process for surface hardening of steels is case hardening. Using standard heat treatments, martensitic surface layers were formed on SAE 1020 steel into which carbon had been diffused. Case depths were measured by traditional destructive techniques. Barkhausen noise and hysteresis loop measurements were made and both the RMS Barkhausen pulse envelope and the fast Fourier transform (FFT) were obtained from numerical calculation. The areas of the Barkhausen pulses lend themselves to the construction of a calibration curve for determining the case depths. The FFT amplitudes can be obtained as a function of frequency, and were associated with distance from the sample surface via the classical skin depth equation. We define a normalized power index NPI which can be related to case depths [1]. The NPI will be discussed in relation to the microstructure of the hardened layer and the sample core. Several samples were treated at liquid nitrogen temperatures to transform retained austenite into martensite. Measured magnetic properties are consistent with increased martensite content.

[1] C. C. H. Lo, J. Appl. Phys. **103**, 07E918 (2008).

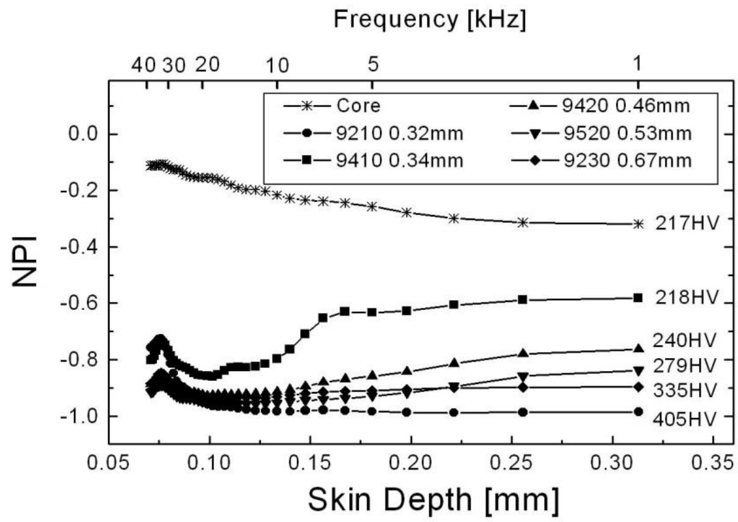


Figure 1: Normalized power index NPI vs. frequency and skin depth for several samples of SAE 1020 steel. The thickness of the martensitic surface layer is given as well as the Vickers hardness of the sample core.

Talk 6

Dynamic properties of magnetization probed by first-order reversal curves method (FORC)

F. Béron[1], L. A. S. de Oliveira[1], L. C. Arzuza[1], G. Soares[1], L. Valenzuela[1], K. R. Pirota[1]

[1]*Instituto de Física Gleb Wataghin, Universidade Estadual de Campinas, Campinas, Brazil*

First-order reversal curves (FORC) method is generally used to characterize mainly the static properties of local irreversible magnetization processes. This technique consists in the measurement of minor magnetization curves cycling between saturation and a reversal field lower than the saturation, which gives the statistical distribution of local magnetostatic properties [1]. In this work we demonstrate that the proper adaptation of the method, combined with the development of sensitive experimental set-ups, is an effective tool for the study of some dynamic characteristics of magnetization. In this picture, we will analyze two phenomena related to the time evolution of magnetic moment characterized by different time scales: i) hysteretic behavior of giant magnetoimpedance (GMI), which consists in the abrupt change of complex electric impedance of a soft magnetic material under application of external magnetic field; and ii) magnetic viscosity, which corresponds to energy losses mechanisms due to time variation of magnetization and that may be spatially non-homogenous in a nanostructured soft magnetic sample. In the case of the giant magnetoimpedance, FeCoSiB amorphous ribbons with transversal anisotropy tuned by the Fe content were used. The FORCs were measured in a broad range of high frequency (10 MHz to 1 GHz), using a vector network analyzer (VNA). An interlinked hysteron/anti-hysteron model is proposed to interpret it, which allows analyzing the influence of frequency and magnetic anisotropy upon the hysteretic GMI effect [2]. For the magnetic viscosity effect, we consider a soft nanocrystalline magnetic ribbon ($Fe_{86}Zr_7Cu_1B_6$, 25 μm thick) that consists of two ferromagnetic phases with different predominant viscous processes [3]. In this case, FORCs were acquired using a high-precision AC induction magnetometer, previously adapted to this particular type of measurement [4].

[1] I. D. Mayergoyz, Phys. Rev. Lett. **56**, 1518 (1986).
[2] F. Béron, L. A. Valenzuela, M. Knobel, L. G. C. Melo and K. R. Pirota, J. Magn. Magn. Mater. **324**, 1601 (2012).
[3] F. Béron, G. Soares and K.R. Pirota, Rev. Sci. Instr. **82**, 063904 (2011).
[4] F. Béron, L.A.S. de Oliveira, M. Knobel and K.R. Pirota, J. Phys. D: Appl. Phys. (accepted for publication).

Talk 7

Broadband FMR and magnetic study of exchange-biased multilayers

R. Dutra[1], D.E. Gonzalez-Chavez[1], T. L. Marcondes[1], A. M. H. de Andrade[2], J. Geshev[2], R. L. Sommer[1]

[1]*Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro RJ 22290-180, Brazil*
[2]*Instituto de Física, UFRGS, Porto Alegre, RS, Brazil*

In this work, we experimentally investigated the unidirectional and rotatable anisotropy of NiFe/IrMn multilayer as a function of the IrMn thickness using vector network analyzer ferromagnetic resonance (VNA-FMR) method. Multilayered films with structure $Ni_{81}Fe_{19}$(20nm)/$Ir_{20}Mn_{80}$(t_{AFM})/Ta(2nm) x 10 where t_{AFM} = 4nm and 15nm were produced onto a Si(100) substrate using a magnetron sputtering upon magnetic field in order to induce EB during deposition. We have performed dynamic measurements by means of a broadband ferromagnetic-resonance setup using a Rhode&Shwarz ZVA24 Vector Network Analyzer combined with a coplanar waveguide for frequencies in the range of 0.1 GHz – 7 GHz and magnetic fields of ± 300 Oe. Static magnetization curves were obtained using VSM in the same field range. The resonant spectra is obtained by measuring the S21parameter [1] with respect to a reference obtained when the sample is saturated along the direction of the RF field. From these measurements we extracted the resonance frequencies as a function of the applied external field. The experimental data are compared to numerical calculations obtained from Geshev and Harres' exchange-bias model [2] combined with the Smith-Beljers procedure to obtain the dispersion relations [3]. We have determined the rotatable anisotropy in exchange-coupled by broadband ferromagnetic resonance (FMR) measurements employing a VNA-FMR for magnetic field applied at 0, 45 and 90 degrees away from the exchange bias direction. The estimated rotatable anisotropy fields are significantly increased when the AFM films thickness is decreased, this is correlated to the change in the anisotropy distribution of the uncompensated spins (UCSs) in the FM/AFM interface due AFM quality. Our results confirm the influence of the rotatable anisotropy on the coercivity enhancement and on the upward shift of the resonance frequency.

[1] C. Bilzer, T. Devolder, P. Crozat, C. Chappert , S. Cardoso and P. P. Freitas, J. Appl. Phys. **101**, 074505 (2007).
[2] A. Harres and J. Geshev, J. Phys.: Matter **24**, 326004 (2012).
[3] J. Smith and H. G. Beljers, Philips Res. Rep. **10**,113 (1955).

Talk 8

FMR dispersion relation of a single spin-valve

R. Dutra[1], D. E. Gonzalez-Chavez[1], T. L. Marcondes[1], W. O. Rosa[1], A. G. Vieira[1], R. L. Sommer[1]

[1]*Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro RJ 22290-180, Brazil*

A spin-valve is a microelectronic device in which high- and low-resistance states are realized by using both the charge and spin of carriers. Multiple resonant spectra have been observed in a spin-valve-like configuration measured using a broadband ferromagnetic resonance experiment. In the present case, our sample is consisted by having a free ferromagnetic layer and pinned layer system ferromagnetic/antiferromagnetic separated by a non-magnetic spacer, which such layers present a composition as follow NiFe(20nm)/Ta(1nm)/NiFe(20nm)/IrMn(20nm). The sample were produced using a magnetron sputtering onto a Si(100) substrate and under an in-plane applied magnetic field of 200 Oe in order to induce the unidirectional anisotropy (exchange bias) in the pinned layer. Moreover, this field also induces a small uniaxial anisotropy in the both layers. Static and dynamic magnetic measurements were performed using a conventional VSM and ferromagnetic resonance (FMR) measurements employing a vector network analyzer FMR (VNA-FMR). The measurements have been performed at 0º and 90º degrees away from the exchange bias induced axis (in-plane measurements). Static hysteresis loop measured in the easy axis direction shows the typical spin-valve behavior, displaying a shifted response for the pinned layer and a centered response for the free layer, which indicates that there is no coupling field in the among the free and pinned layers. From the VNA-FMR measurements we can observe that the dispersion curve also present two different components. One, which is centered in zero, is assigned to the free layer and at the same time the other one, which display some shifting field, is correlated with the pinned layer having the same displacement foreseen in the hysteresis loop We have also compared our experimental data with numerical calculations using as a model an FM/AFM pinned layer with a single FM layer obtaining a good agreement between them. From such calculations we were able to extract some important features as, for example, anisotropy field.

Talk 9

Ferromagnetic Resonance Investigation in Permalloy Magnetic Antidot Arrays on Alumina Nanoporous Membranes

R. L. Rodriguez-Súarez[1], J. L. Palma[2], S. Michea[2], J. Escrig[2,3], J. C. Denardin[2,3], C. Aliaga[3,4]

[1]*Facultad de Física, Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860 Casilla 306, Santiago, Chile*
[2]*Departamento de Física, Universidad de Santiago de Chile (USACH), Avda. Ecuador 3493, 917-0124 Santiago, Chile*
[3]*Center for the Development of Nanoscience and Nanotechnology CEDENNA, Avda. Ecuador 3493, 917-0124 Santiago, Chile*
[4]*Facultad de Química y Biología, Universidad de Santiago de Chile, Casilla 40, Correo 33, Santiago, Chile*

Patterned nanomagnets systems have been the object of intense interest in recent years due to their potential applications. Among these systems, magnetic antidot arrays consisting of periodically arranged holes in continuous magnetic films have been proposed for high-density storage media. The presence of ordered nonmagnetic holes, induces a demagnetization field distribution, which can dramatically affect both, the static and dynamic properties of the magnetic system. From the static point of view it has been observed that the presence of holes affects the magnetization reversal, the coercive field and the intrinsic magnetic anisotropy of the film. From the dynamical point of view it has observed the presence of resonance modes whose frequencies can be tuned by varying the holes dimensions, symmetry of the lattice and external magnetic field [1]. Here, using the ferromagnetic resonance (FMR) technique we investigate the magnetic properties of $Ni_{80}Fe_{20}$ nanometric antidot arrays with hole diameters of 15 nm and 70 nm fabricated using porous anodic aluminum oxide (AAO) membrane as template. We study the effect of the increase in the hole diameter and the presence of defects on the angular dependence of the FMR field and show that although the SEM images reveal a quite regular hexagonal arrangement of the pores, the angular dependence of the FMR field (H_R) do not exhibits the six-fold symmetry expected. Instead of that, the azimuthal dependence of H_R shows a clear two-fold anisotropy. To explain the experimental results, micromagnetic simulations performed on a perfect hexagonal lattice was compared with those made on a real system taken from a SEM image. The simulations qualitatively agree with the experimental findings and indicate that in samples with defects, the micromagnetic simulations must be performed on images extracted from the real systems.

[1] V. N. Krivoruchko, and I. Marchenko, J. Appl. Phys. **109**, 083912 (2011).

Talk 10

Monochromatic Radiation Emission from a BEC of Excited Magnons

F. S. Vannucchi[1], A. R. Vasconcellos[1], R. Luzzi[1]

[1]*Condensed Matter Physics Department, Institute of Physics "Gleb Wataghin", State University of Campinas - UNICAMP, 13083-859 Campinas, SP, Brazil*

The experimental observation of monochromatic emission of radiation from excited thin films of Yttrium-Iron Garnet [1] has stimulated the proposal of a monochromatic microwave generator pumped by incoherent broadband sources, in which the emitted frequency is possibly tunable as a function of the applied constant magnetic field. [2]. In this communication, we present the analysis of the mechanisms of interaction between the condensate of magnons and emitted photons and the possibilities of effective tunability of the process. The evolution equations for the emitted photon populations were obtained resorting to a Non-Equilibrium Statistical Ensemble Formalism. And, as also shown by S. M. Rezende along other approach [3], we elucidate how the particular form of the dispersion relation of ferromagnetic thin films and the magnon-photon interaction leads to a kind of resonance, where the emitted power (that depends on the square of the largely enhanced population of magnons in the condensate) is maximum when are fulfilled the conditions (Fig. 1a):

(i) the frequencies of the emitted radiation are around the ones of the magnons at the center of the Brillouin zone;

(ii) the intensity of the applied constant magnetic field is such that the minimum frequency of magnons is half of the one at the center.

Finally, we describe the dependence of the phenomenon on the thickness of the sample and on the magnetic field intensity (Fig. 1b), showing the conditions for the emergence of the resonance.

[1] O. Dzyapko et al. , Appl. Phys. Lett. **92**, 162510 (2008).
[2] V. Kruglyak, S. Demokritov and D. Grundler, J. Phys. D: Appl. Phys. **43**, 264001 (2010).
[3] S. M. Rezende, Phys. Rev. B **79**, 060410R (2009).

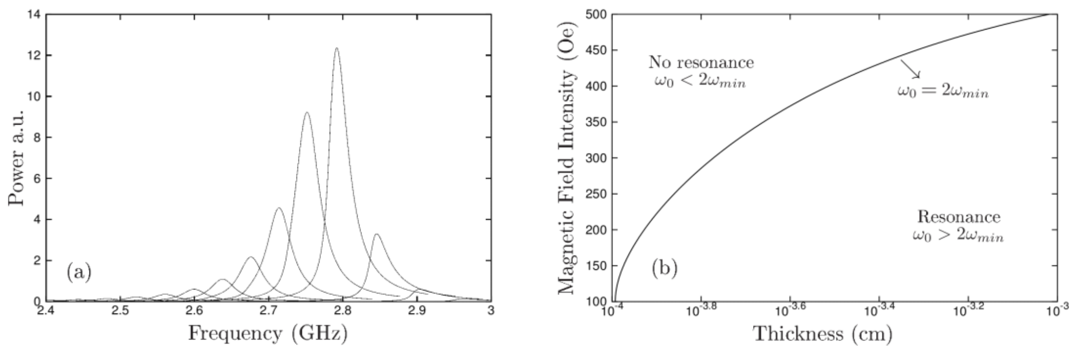


Figure 1: (a) Microwave power in terms of the frequency of the emitted radiation for different values of magnetic field intensity [curves are in accordance with conditions (i) and (ii) above described]. (b) The regions for which resonance does and does not occur are displayed as a function of the magnetic field intensity and the thickness of the thin film.

Talk 11

Depinning and propagation modes of single domain walls in cylindrical magnetic wires

M. Vázquez[1], A. Jiménez[1], R. P. del Real[1]

[1]*Institute of Materials Science of Madrid, CSIC. 28049 Madrid, Spain*

Studies on the magnetization reversal in magnetic wires are attracting increasing interest in connection with advanced spintronics and logic devices [1]. Reversal process has been mostly investigated in lithography nanostrips, while less attention has been paid to cylindrical wires. Magnetization reversal of micro and submicrometer magnetostrictive amorphous cylindrical wires takes place by depining & propagation of a single domain wall, DW [2]. These wires are model systems for fundamental studies about the dynamics of single DWs reaching velocities of km/s under few Oe applied field whose mobility and motion damping depend on various parameters (see [3] for updated state-of-the-art). In this seminar, we introduce recent work on the control the DW position and velocity by suitable application of local field. We make use of multiple pick-up coils in a Sixtus&Tonks-like experiment to follow the motion and position of single DW under the simultaneous action of homogeneous and local fields. Tuning the local field between antiparallel and parallel configuration to homogeneous field enables the trapping of DW, and the injection of head-to-head and tail-to-tail DW pairs. In addition, and depending on the way the walls are nucleated, we distinguish among three different walls namely, standard wall, DW_{st}, depinned and propagating from the wire's end under homogeneous field which motion is the first one to switch on; reverse wall, DW_{rev}, propagating from the opposite end under non-homogeneous field, and defect wall, DW_{def}, nucleated around local defect [4]. We also study the propagation of a wall under applied field smaller than the switching field. Finally, the shape of induced signals in the pickup coils upon the crossing of the walls is analyzed and correlated to the domain walls shape. We conclude that length and shape of the wall are significantly distorted by the fact that the wall is typically as long as the measuring coils.

[1] Parkin et al., Science **320**, 190 (2008); Allwood et al., Science **309**, 1688 (2005).
[2] Vazquez et al., Phys. Stat. Sol.A **208**, 493 (2011).
[3] Vazquez et al., Phys. Rev. Letters **108**, 037201 (2012).
[4] Jimenez et al., (invited JEMS, EPJB, in press).

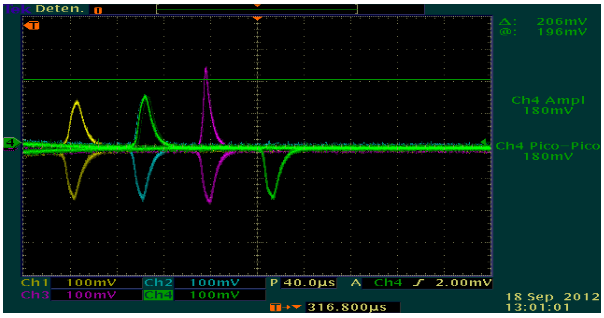


Figure 1: The colour sequence of peaks induced on pickup coils indicates the propagation of a standard DWst from the left wire's end (bottom). Under critical field, a second reverse wall, DWrev, propagates in opposite direction. Both walls collapse just in the position of a pickup coil (upper).

Talk 12

Magnon transport, condensation, and topology in insulators

Y. Tserkovnyak[1]

[1]*Department of Physics and Astronomy, University of California, Los Angeles, CA 90095, USA*

In this talk, I will discuss several new topics in spintronics dealing with electrically insulating magnetic media. While lacking Ohmic dissipation, these systems are promising for a range of interesting collective phenomena, quantum correlations, topological properties, and even useful devices: all in insulating systems driven far out of equilibrium. Specifically, I will discuss our recent ideas on magnetocaloritronic "nanomachines" [1], steady-state Bose-Einstein condensation of magnons [2], thermal Hall effect [3], and magnetic dynamics in topological insulator heterostructures [4].

[1] A. A. Kovalev and Y. Tserkovnyak, Europhys. Lett. **97**, 67002 (2012).
[2] S. A. Bender, R. A. Duine, and Y. Tserkovnyak, Phys. Rev. Lett. **108**, 246601 (2012).
[3] K. A. van Hoogdalem, Y. Tserkovnyak, and D. Loss, arXiv:1208.1646.
[4] Y. Tserkovnyak and D. Loss, Phys. Rev. Lett. **108**, 187201 (2012).

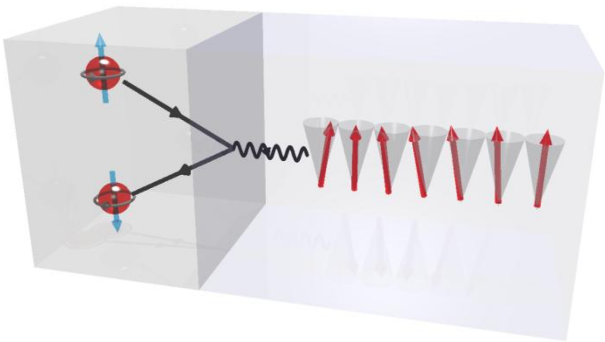


Figure 1: Spin transfer between a metal and magnetic insulator.

Talk 13

Microscopic theory of spin dynamics in transition metal nanostructures and the role of spin orbit

A. T. Costa[1], R. B. Muniz[1]

[1]*Instituto de Física, Universidade Federal Fluminense, Campus da Praia Vermelha, Av. Litorânea s/n, 24210-346 Niterói - RJ - Brazil*

I will review our recent work on the theory of spin dynamics in ultrathin films and adatoms of transition metals from the point of view of microscopic models. Our approach relies on a realistic description of the systems' electronic structures. The only parameters we use are provided by DFT-based *ab initio* calculations. Thus we hope to extract the values of quantities relevant to spin dynamics directly from a system's electronic structure. We are also able to take into consideration the effects of spin-orbit coupling on spin dynamics within the same theoretical framework. This means that phenomenological effects such as magneto-crystalline anisotropy and Dzyaloshinskii-Moriya anti-symmetric coupling emerge naturally from our formalism using essentially the electronic structure of the system as input.

Talk 14

Spin currents and spin-orbit coupling in multilayered structures

F. S. M. Guimarães[1], A. T. Costa[1], R. B. Muniz[1], D. L. Mills[2]

[1]*Instituto de Física, Universidade Federal Fluminense, Niterói, Brazil*
[2]*Department of Physics and Astonomy; University of California, Irvine; Irvine, California; 92697 U.S.A*

In ultrathin ferromagnets deposited on metallic substrates, excitation of precessional motion of the spins produces a spin current in the substrate that transports angular momentum out of the film. This phenomenon is referred to as spin pumping, and is a source of damping of the spin motion. Spin pumping enters importantly in the description of spin dynamics in other nanoscale and subnanoscale systems as well. Here we present an approach based on the Kubo formalism [1] that enable us to calculate explicitly the AC spin current [2] and its spatial variation. We use the formalism to explore features of the spin current generated by spin motions in multilayered systems. We also present a generalization of the model that includes the spin-orbit interaction to describe the spin dynamics in various systems [3].

[1] F.S.M. Guimarães, A. Costa, R. Muniz, and D. Mills, Phys. Rev. B **84**, (2011).
[2] H. Jiao, G.E.W. Bauer, arXiv:1210.0724 [cond-mat.mes-hall].
[3] A.T. Costa, R.B. Muniz, S. Lounis, A. Klautau, and D.L. Mills, Phys. Rev. B **82**, 014428 (2010).

Talk 15

Tunable All-Angle Negative Refraction from the Magnon Response in Antiferromagnets

R. Macêdo[1], T. Dumelow[1], J. A. P. da Costa[1]

[1]*Departamento de Física, Universidade do Estado do Rio Grande do Norte - UERN, 59610-090 Mossoró, RN, Brazil*

All-angle negative refraction occurs if an obliquely incident beam of electromagnetic radiation, passing from one medium to another, bends back to the same side of the surface normal regardless of the incident angle. Although most work on this phenomenon has concentrated on artificial metamaterial structures, it also accurs in the case of a far infrared beam passing from air to a simple nonmagnetic crystal such as quartz [1]. This is related to the fact that the dielectric tensor components of polar crystals may become negative near their phonon frequencies. In the case of anisotropic crystals, these components may take on opposing signs, resulting in the required negative refraction, and it may be possible to construct lenses from plane slabs of such crystals as a result [2]. We anticipate a similar type of negative refraction at the interface between vacuum and a uniaxial antiferromagnet, whose easy axis lies parallel to the crystal surface, at terahertz frequencies. An incident s-polarized beam, whose plane of incidence includes the antiferromagnet easy axis, should then undergo negative refraction within the frequency region, close to the magnon resonance, in which the appropriate permeability tensor component is negative. Simulation of such negative refraction in an MnF_2 crystal is shown in Figure 1(a). If an external magnetic field is now applied perpendicular to the incident plane, the resonance frequency will increase, changing the permeability value at any given frequency [3]. This results in a change in the refracting angle, which may even change sign, as shown in Figure 1(b). Thus, tunable all-angle negative refraction, and possibly even tunable slab lensing, appears perfectly possible.

[1] R. Rodrigues da Silva, R. Macêdo da Silva, T. Dumelow, J. A. P. da Costa, S. B. Honorato and A. P. Ayala, Phys. Rev. Lett. **105**, 163903 (2010).
[2] R. Estevâm da Silva, R. Macêdo, T. Dumelow, J. A. P. da Costa, S. B. Honorato, and A. P. Ayala, Physical Review B, in press (arXiv:1207.3531).
[3] N. S. Almeida and D. L. Mills, Phys. Rev. B **37**, 3400–3408 (1988).

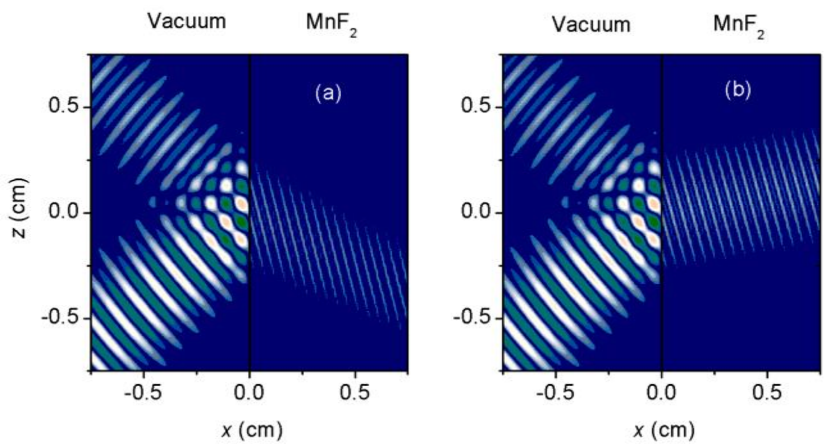


Figure 1: Simulation of the instantaneous electric field of a Gaussian beam incident obliquely on a MnF_2 crystal at a frequency of 8.98 cm^{-1} at 5 K. (a) B = 0, (b) B =1.73 T.

Talk 16

Dynamics of spin wave under action of spin currents in ferromagnetic/non-magnetic structures

A. Azevedo[1], **E. Padrón-Hernández**[1], **L. H. Vilela-Leão**[1], **G. L. da Silva**[1], **M. M. Soares**[1], **S. M. Rezende**[1]

[1]*Departamento de Física, Universidade Federal de Pernambuco, 50670-901, Recife, PE, Brazil*

Generation, manipulation and detection of spin currents are essential ingredients in order to make spintronics a feasible technology. Ferromagnetic (FM) metals are the well known source of spin-polarized current in which a majority of electrons are in quantum states such that their spins are oriented with the local magnetization. By using different schemes the injection of spin–polarized current from FM metals into different materials has given rise to devices such as spin valves and spin tunnel junctions. Lately, different concepts of spin current generation have been proposed. In the spin pumping effect, a spin current is injected from a FM into a normal-metal, by the precession of the magnetization under action of an external oscillating field. A second technique is to use the spin Hall effect in which a spin current is generated in a direction transversal to the charge current in the presence of spin-orbit interaction. A more striking effect, named spin Seebeck effect, has been recently proposed in which a spin current is generated by applying thermal gradients in ferromagnetic materials. The interplay between spin current and spin waves has led to the discovery of fascinating phenomena. In particular, as spin wave oscillations in yttrium iron garnet (YIG) can propagate coherently over centimeter distances, the interaction between spin waves and spin currents in hybrid YIG/normal-metal structures is of current interest. For instance, it has been demonstrated that spin-wave excitation and amplification can be achieved by the injection of spin current generated by either spin Hall or spin Seebeck effects in YIG/Pt. In this presentation we will review the basic concepts of the phenomena above described as well present experimental results obtained in our group in Recife.

Talk 17

Magnetic interactions and anisotropies in polycrystalline antiferromagnet/ferromagnet systems

J. Geshev[1], S. Nicolodi[1], D. Schafer[1], A. Harres[1], R. Cichelero[1], L. G. Pereira[1], P. L. Grande[1], J. E. Schmidt[1]

[1]*Instituto de Física, UFRGS, Porto Alegre, RS, Brazil*

The exchange coupling between a ferromagnet (FM) and partially uncompensated interfacial spins in an adjacent antiferromagnet (AF) gives rise to exchange bias (EB), i.e., a shift of the hysteresis loop along the field axis. Although this phenomenon has been discovered more than 50 years ago and despite the intense research efforts, understanding its mechanisms has remained a challenging task and EB still continues to receive great deal of attention. The thriving studies on nanostructures together with emerging new fields for EB manifestation, such as at the interface with multiferroic materials (where a purely magnetic EB could be controlled by an electrical field), are expected to further stimulate the research on EB. In the present talk three distinct topics concerning recent studies of members of our group on polycrystalline AF/FM systems will be addressed and discussed. (i) The modifications of the magnetic parameters of IrMn/Cr/Co films as a function of the Cr spacer layer thickness were investigated [1]. A general trend of decrease of the EB field and a considerable and non-monotonous enhancement of the coercivity with the Cr thickness were observed. The anisotropy parameters were extracted from the experimental angular variations of the ferromagnetic resonance field via numerical simulations. Together with significant raise the rotatable anisotropy, ascribed to Cr interface coupled antiferromagnetically with the Co atoms, it was obtained that the rotatable anisotropy field is always *antiparallel* to the external magnetic field. On the other hand, the non-zero EB, observed even for rather thick Cr spacers, was attributed to uncompensated spins at the topmost IrMn interface. (ii) The remanence plots technique has been adapted for use in biased systems, where the shift of the loops makes the method unfeasible in its original form [2]. We propose the change the reference frame in a manner that its origin coincides with the center of the shifted loop leading to new remnant magnetizations with equal values and opposite signs. Since in many cases biased loops are intrinsically asymmetric, two pairs of IRM and DCD curves coexist thus increasing the number of distinct δM and Henkel plots. The routine proposed here was applied to polycrystalline IrMn/Co bilayers. Results obtained on initially ac or dc demagnetized samples will be presented. Numerical simulations based on Landau-Lifshitz-Gilbert equation of magnetization motion were performed in order to obtain the respective theoretical remanence plots. Possible sources for the experimentally obtained deviations from the theory are pointed out and discussed. (iii) Ultraslow temporal increase of the EB in ion-irradiated samples has been recently reported [3]. In order to bear out this effect in IrMn/NiFe systems, we irradiated such films with 40 keV He ions at different fluences and measured the EB as a function of the time for three different sample storage temperatures. A logarithmic drift of EB with time was observed for all samples, leading to an increase of up to 50 %. The mechanisms responsible for the EB enhancement are still unclear and require further investigations.

[1] S. Nicolodi et al., Phys. Rev. B **85**, 224438 (2012).
[2] E. P. Wohlfarth, J. Appl. Phys. **29**, 595 (1958); O. Henkel, Phys. Stat Sol. **7**, 919 (1964).
[3] A. Ehresmann, D. Junk, D. Engel, A. Paetzold and K. Röll, Journ. Phys. D: Appl. Phys. **38**, 801 (2005).

Talk 18

Tailoring magnetic vortices and walls of confined nanoelements

A. S. Carriço[1]

[1]*Universidade Federal do Rio Grande do Norte, Campus Universitário, 59072 Natal-RN, Brazil*

Nano-patterning soft ferromagnetic materials lead to an enhancement of demagnetizing field effects. Under appropriate size limits, the competition between the dipolar and the intrinsic exchange fields may favor the formation of flux closure states or domain walls. Interface exchange coupling requires larger areas with spins parallel to the interface field. Thus, there are good chances of breaking the intrinsic balance between dipolar and exchange energies, leading to new magnetic states. Contrary to common intuition, the interface exchange field favors the nucleation of vortices along the hysteresis loop of flat iron and permalloy nanoelements [1]. For lateral dimensions in the sub-100 nm range, vortex nucleation in iron nanoelements requires smaller values of the interface field strength. For both materials, strong values of the interface field strength leads to double loop curves, with the magnetization driven by vortex motion. Elliptical nano-elements may display vortex pairs at remanence (see Figure 1). The core-to-core distance as well as the chirality of each vortex core may be tailored by the interface field strength [2]. Domain wall arrays of flat Fe nanowires, exchange coupled to vicinal antiferromagnetic substrates, alternates head-to-head and tail-to-tail domain walls, and may form a structure with alternate chirality or with the same chirality [3]. The chirality sequence is tunable by the geometrical constraints and the strength of the interface exchange field. The depinning field of 10nm thick, 1 μm long wires, with widths of 100 and 200 nm, is of the order of the interface field strength, and the depinning process involves domain wall motion and the transversal displacement of a periodic array of vortices. We are currently investigating thermal hysteresis of dipolar coupled exchanged biased pairs of elliptical iron nanoelements. Our preliminary results indicate that the strong dipolar interaction leads to large difference between the thermal stability of the parallel state, with both nanoelements aligned with the interface field direction, and the antiparallel state. We are also investigating the vortex states of pairs of coaxial nanocilinders. Our preliminary results indicate a strong correlation between core chiralities, favoring opposite chirality of the vortex cores. These results may be relevant for the design of spin transfer magnetic tunnel junction memory cells and nano-oscillators.

[1] A. L. Dantas, G. O. G. Rebouças and A. S. Carriço, IEEE Trans. Magn. **46**, 2311 (2010).
[2] F. Oliveira et al., J. Appl. Phys. **111**, 07D102 (2012).
[3] Ana L. Dantas, G. O. G. Rebouças, and A. S. Carriço, J. Appl. Phys. **105**, 07C116 (2009).

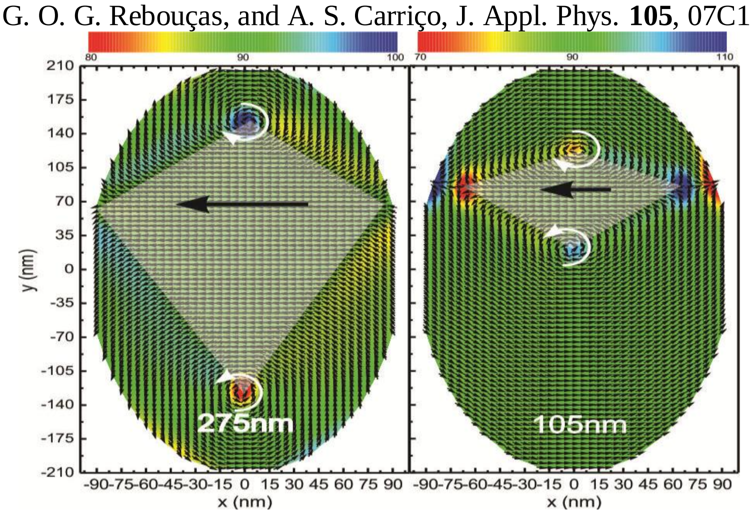


Figure 1: Vortex pairs of 195nmx 425nm x 20nm iron nanoelements. The numbers indicate the core-to core distance (for interface fields of 2.5kOe at opposite directions).

Talk 19

Study of dynamically coupled pair of magnetic vortices

G. Fior[1], H. C. Vigo[1], J. P. Sinnecker[1], E. R. P. Novais[1], F. Garcia[2], A. P. Guimarães[1]

[1]*Centro Brasileiro de Pesquisas Físicas, 22290-180, Rio de Janeiro, RJ, Brazil*
[2]*Laboratório nacional de Luz Síncrotron, 13084-971, Campinas, SP, Brazil*

There is a marked interest nowadays in the dynamic behavior of magnetic nanodisks that present magnetic vortices [1]. The tailoring of features and characterization of individual vortices or arrays, including their gyrotropic frequency, critical vortex core switching velocity, strength of the coupling between nanodisks, inhomogeneity, are very desirable for future applications, such as vortex magnetic memories (VRAMs) and spin transfer nanooscillators (STNOs) [2]. An original way to control some of the static vortex properties (specially the vortex core diameter) is simply to introduce a uniaxial perpendicular magnetic anisotropy, as has been recently shown [3]. In this sense, we will present two works related to the characterization and control of the dynamic properties of the vortices. The first is the study of the coupling between pair of vortices as a function of the magnetic properties of the individual disks and their separation, using micromagnetic simulation. We analyzed the motion of a vortex core caused by a dynamic coupling with a second excited disk. A splitting of the gyrotropic frequency is obtained from this analysis. In the second study, we have investigated an ensemble of interacting pairs of nanodisks presenting magnetic vortex. The disk diameters follow a Gaussian distribution centered at 250 nm and standard deviation that can be varied. In order to verify the magnetic coupling strength between the disks of each pair, we have used a recently developed tool, the magnetic vortex echoes (MVE). The MVE effect, analogous to the NMR spin echoes, arises from the gyrotropic motion of the vortex cores in arrays of inhomogeneous disks. An analytical model of the MVE is presented. The analysis of the MVE is used to obtain information about interactions between the nanodisks, diameter distribution and Gilbert damping constant [2]. We determined that the dependence of this strength goes with d^{-n}, and also found in studies employing other techniques [4, 6]. In addition, we have developed an analytical model based on Thiele's equations of motion, to describe the trajectory of the interacting pairs of cores in the MVE framework. This model enables us to obtain relevant information about the ensemble of pairs of disks, such as overall gyrotropic frequencies and magnetic coupling.

[1]. Ruotolo et al. Nat Nano **4(8)**, 528 (2009).
[2]. Jung et al. Sci. Rep. 1,59;DOI:10.1038/ srep00059 (2011).
[3]. Garcia et al., Appl. Phys. Lett. **97**, 022501 (2010).
[4] H. Jung, et al. Sci. Rep. **59**, 1 (2011/08/10/online).
[5] ArXiv:1201.3553.
[6] Sukhostavets et al., Appl. Phys. Express, **4(6)**, 065003 (2011).

Abstracts

Contributed poster presentations

IIBWMD-004A

Study of magnetic anisotropy and rotational hysteresis in exchange bias systems

J. N. Rigue[1], A. M. H. de Andrade[1], T. J. A. Mori[1], R. D. Della Place[1], F. Beck[1], M. Carara[1]

[1]*Departamento de Física, Universidade Federal de Santa Maria, 97105-900, Santa Maria, RS, Brazil*

The exchange bias phenomenon occurs when a ferromagnetic material is exchange-coupled to an antiferromagnetic. The subject is still attracting the attention because the existence of open questions about phenomenon and its potential technological application. The main manifestations of the phenomenon are the field displacement of the magnetic hysteresis loop, the increase of the coercive field and the appearing of a rotational hysteresis in torque measurements, even above the sample's anisotropy field [1, 2]. The bias field is associated to the appearance of an unidirectional anisotropy, due to the coupling between the layers, while the rotational hysteresis it is associated with the stability of the domains or interfacial spins. In order to understand how the interface roughness and the change in the anisotropy axis of antiferromagnetic material contribute to the anisotropy and rotational hysteresis, we have used the torque magnetometry technique [3] to investigate two kind of samples, grown by magnetron sputtering technique, NiFe/FeMn and NiFe/IrMn. We present results showing a distinct behavior between the systems in terms of the coupling and rotational hysteresis. We also present calculations of the energy curves in order to explain such behavior.

[1] O' Gadry et al., J. Magn. Magn. Mater. **322**, 883 (2010).
[2] Tsunoda et al., J. Magn. Magn. Mater. **239**, 149 (2002).
[3] J. Rigue et al., J. Magn. Magn. Mater. **324**, 1561 (2012).

IIBWMD-005A

Effect of electric current on domain wall dynamics

F. Beck[1], J. N. Rigue[1], M. Carara[1]

[1]*Departamento de Física, Universidade Federal de Santa Maria, 97105-900, Santa Maria, RS, Brazil*

Fast domain-wall propagation in magnetic microwires has attracted great attention along the last few years, because of a great demand for fast response and high-density data storage devices as well as from the fundamental physics point of view [1]. In this work, we determine the domain wall velocity in the low field regime and study the domain wall dynamics in Joule-annealed amorphous glass-covered microwires with positive magnetostriction. As a result of the combination of magnetoelastic and shape anisotropy, this kind of material presents a domain structure composed by a large, axially oriented, domain and a closure one near the extreme of the sample [2]. This domain structure is responsible by the magnetic bi-stability, meaning that the magnetization process in the axial direction runs through the single quasi-planar domain-wall propagation, under the influence of the applied magnetic field. The domain wall dynamics was studied using the Sixtus–Tonks like modified method, where the domain wall velocity is determined by the time of flight of the domain wall between two sensing coils, separated by a known distance and at a constant driving field [3]. Moreover, an electrical current was applied to the wire simultaneously to the driving magnetic field. Without applied current the domain wall moves in an adiabatic regime verified by a power-law dependence of the domain wall velocity with the driving field, with the critical exponent $\alpha = 0.5$. When the DC current is applied to the sample, an increase or a decrease on the domain wall velocity, depending on the current direction is verified. These results are explained in terms of the change of the length of the domain wall promoted by the additional Oersted field.

[1] T. A. Óvári et al., IEEE Trans. on Magnetics **40**, 10 (2011).
[2] R. Varga et al., Phys. Status Solidi A **208**, 3 (2011).
[3] K. J. Sixtus, L. L.Tonks, Phys. Review **42**, 419 (1960).

IIBWMD-009A

Fabrication and magnetic properties of chemically sensitized magnetic nanowires

P. T. de Almeida[1], K. R. Pirota[1]

[1]*Instituto de Física Gleb Wataghin, Universidade Estadual de Campinas (UNICAMP), 13083-970, Campinas (SP), Brazil*

Magnetic nanowires play a very important role in the frontiers of nanoscience and nanotechnology due to the interesting new physics behind and the potential technological variety of applications, including interconnections in nanoelectronics, spintronic based devices, and magnetic, chemical, optical or biological sensors[1-4]. In this regard, a deeper understanding of the magnetic behavior of such nanowires represents an important challenge for the future development of these new technologies. Among the various methods used to fabricate magnetic nanowires (i.e., lithography techniques, molecular beam epitaxy, magnetron sputtering, etc.), an alternative approach based on the electrodeposition of desired magnetic metal into the pores of anodic alumina membranes (AAM) has been increasingly employed [5]. These systems generally present a large number of magnetic entities and any global magnetic or electronic transport measurements give information about the average behavior, which is strongly influenced by the magnetic interactions among the nanowires. In this work we will present the magnetization properties of Co/Cu multilayer nanowire arrays changing systematically the length of the magnetic Co layer keeping fixed the Cu spacer layer and the nanowire diameter (35 nm). The segmented nanowire presents enhanced longitudinal easy axes mainly due to the interaction among the magnetic layers mediated by the copper spacer. From the magnetization curves it is possible to identify the effect of dipolar interactions among different nanowires in the array as well as among different magnetic layers in a same nanowire.

[1] D. Routkevitch, A.A. Tager, J. Haruyama, D. Almawlawi, M. Moskovits and J.M. Xu, IEEE Transactions on Electron Devices **43**, 1646 (1996).
[2] Z. Zhong, D. Wang, Y. Cui, M.W. Bockrath, and C.M. Lieber, Science **302**, 1377 (2003).
[3] F. Patolsky and C.M. Lieber, Materials Today **8**, 20 (2005).
[4] G. Zheng, F. Patolsky, Y. Cui, W.U. Wang, and C.M. Lieber, Nature Biotechnology **23**, 1294 (2005).
[5] M. Hernandez-Velez, K. R. Pirota, F. Paszti, D. Navas, A. Climent and M. Vazquez, Appl. Phys. A **80**, 1701 (2005).

IIBWMD-014A

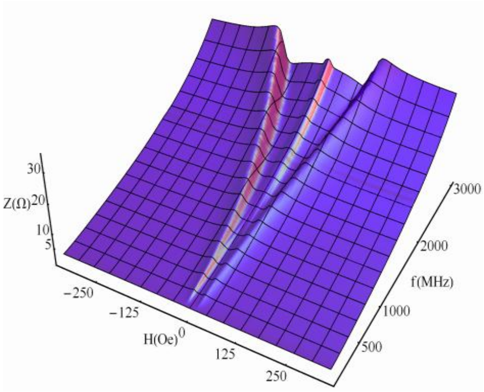
Magnetic dynamics behaviour in non-magnetistrictive multilayered thin films grown on flexible substrates

K. Agra[1], T. Mori[2], C. G. Bezerra, T. Freire[1], F. Bohn[1] , M. A. Corrêa

[1]*Departamento de Física, Universidade Federal do Rio Grande do Norte, Natal-RN 59072-970, Brazil*

[2]*Departamento de Física, Universidade Federal de Santa Maria, 97105-900 Santa Maria, RS, Brazil*

This work investigated the structural, magnetic and dynamic magnetization (Magnetoimpedance (MI) effect) proprieties in multilayer thin films (Py / Cu, Ag, Ta) on flexible. The samples were grown using a magnetron sputtering technique to induce a uniaxial anisotropy in plane of the sample, the substrates were submitted to 1 kOe external magnetic field inside the chamber during the grown. To obtain the quasi-static magnetic behavior a VSM system was used, the magnetic measurements were performed at room temperature using a maximum magnetic field of ±250 Oe in two directions: In main axis (Hard induced axis) and perpendicular to it (Easy induced axis) to verify the induced anisotropy in these samples. The dynamics behavior was obtained through the magneto impedance response using an Impedance Analizer Agilent (E4991A – RF) with head kit model (E4991A – TEST READ) in a frequency range of 0.5 GHz up to 3 GHz. In this case, a 0 dBm (1mW) constant power was applied to the sample, characterizing a liner regime of driving signal. At a given field value, the frequency sweep was made and the real, imaginary and the impedance results were simultaneously acquired. Here we use the Z(Hmax) in MI% definition because represent a magnetic field where the magnetization is known, in other words, where the sample magnetization is saturated Figure(1a e 1b). We show the recently results obtain in magnetic dynamics through MI effect for multilayer samples of Py/(Cu, Ag, Ta) grown on glass and flexible substrates. We present the results comparing the dynamics response in function of the substrate (glass and flexible) for a wide range of frequency. The results show a similar behavior in MI effect between these substrates, opening new possibilities to use flexible substrates in integrated devices and sensor heads.



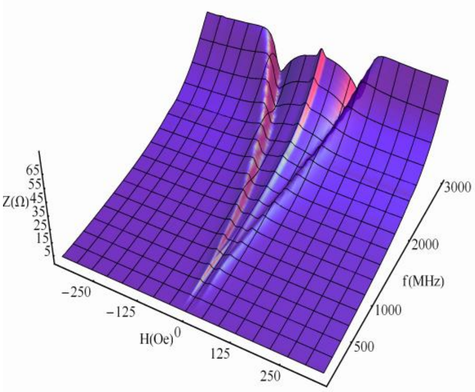


Figure 1: (a) Impedance Z as function of the magnetic field and frequency for the Py/Ag on flexible. (b) Impedance Z as function of the magnetic field and frequency for the Py/Ag on glass.

IIBWMD-017A

Influence of structural and magnetostrictive properties in dynamic behavior of multilayer CoFeB / (Ta, Ag, Cu) thin films

V. M. Escobar[1], M. S. Marques[2], F. Bohn[1], T. Mori [3], M. A. Corrêa[1]

[1]*Departamento de Física Teórica e Experimental, UFRN, Natal, RN, Brazil*
[2]*Instituto Nacional de Pesquisas Espaciais,DGE, São José dos Campos, SP, Brazil*
[3]*Departamento de Física, UFSM, Santa Maria, RS, Brazil*

In this work we studied the magnetic dynamics properties through magnetoimpedance (MI) effect of multilayer [$Co_{40}Fe_{40}B_{20}$ (10 nm)/NM (2nm)] × 50, produced by magnetron sputtering, were NM is a metallic non-magnetic layer of Ta, Ag or Cu. The MI effect consist in changes of impedance of a sample immerse in an external magnetic field. The structural behavior was performed by X-ray reflectivity (XRR) and the magnetic behavior was performed by AGM and magnetostriction measurements for quasi-static characterization, and MI effect for dynamics characterization. The magnetrostriction results, obtained by the cantilever technique, turned possible to explain the magnetic dynamic behavior through MI effect performed in a wide frequency range of 10 MHz to 1800 MHz. The results show that CoFeB/Ta and CoFeB/Ag samples presented good bilayer uniformity, on the other hand, the CoFeB/Cu sample show a irregular uniformity with CoFeB layers interspersed with Cu islands. These structural behaviors are reflected in dynamics results. In particular, for the CoFeB/Cu sample, the contribution of FMR to the MI was observed starting at low frequency (420 MHz). This behavior may be associated with the presence of random local anisotropies induced by stress. Therewith, in this sample, the weak magnetic anisotropy favors the appearance of localized resonances, contributing to MI variations staring at lower frequency levels. Finally, we conclude CoFeB/Cu sample, presents behavior relevant to the use of sensor elements requiring constant variations in the MI within a wide frequency range [1].

[1] M. S. Marques, T. J. A. Mori, L. F. Schelp, C. Chesman, F. Bohn, M. A. Corrêa. Thin Solid Films **50**, 2173 (2012).

IIBWMD-018A

Coupling between magnetic field and curvature in Heisenberg spins on surfaces with rotational symmetry

V. L. Carvalho-Santos[1], R. Dandoloff[2]

[1]*Instituto Federal de Educação, Cência e Tecnologia Baiano - Campus Senhor do Bonfim 48970-000 Senhor do Bonfim, Bahia, Brazil*
[2]*Laboratoire de Physique Théorique et Modélisation, Université de Cergy-Pontoise 95302 Cergy-Pontoise, France*

The interplay between geometry and physical properties of condensed matter systems has demanded large attention in last decades. In part, this is associated to the growing capacity for fabricating and manipulating nanoscale devices with different geometries. For instance, recent developments in nanotechnology made it possible to produce quasi two-dimensional exotic shapes like the Möbius stripe, torus and asymmetric nanorings. On the other hand, there is a growing theoretical interest in this subject due the fact that particle-like excitations, like vortices and skyrmions, for example, interact not only with each other, but also with the curvature of the substract. Vortices and skyrmions appear in several condensed matter systems, e.g. superconductors, BEC, nematic liquid crystals, ferro and antiferromagnets. In the case of ferromagnetic materials, cylindrical nanomagnet with a vortex as the magnetization groundstate have been considered as candidates to be used in logic memory, data storage, highly sensitive sensors and cancer therapy. The energy of these topological excitations depends on the curvature of the ferromagnetic nanoparticle [1] and their dynamical properties are affected by the interaction with curve defects appearing during the fabrication of the nanomagnets. In this context, an important issue is the control and manipulation of the shape and physical properties of nanoparticles. Indeed, several works have already devoted attention on this issue, e.g., theoretical works have shown that the application of a constant external magnetic field in a circular elastic cylinder surface coated by magnetic material must cause a deformation at the region where the spins are pointing in the opposite direction of the magnetic field [2]. At the same time, the concept of magnetoelastic metamaterials, which respond by being compressed by electromagnetic forces in the presence of an external magnetic or electric field, leads to a new generation of metamaterials that can be useful for the design of artificial media. In addition, the curvature of graphene bubbles can be controlled by applying an electric field [3] and still, by combining the curvature effects with magnetic fields, the molecular alignment of flux lines of the nematic director of nematic liquid crystals can be reoriented or switched between two stable configurations. Here, we study the nonlinear σ-model in an external magnetic field applied on curved surfaces with rotational symmetry. The Euler-Lagrange equations derived from the Hamiltonian yield the double sine-Gordon equation (DSG) provided the magnetic field is tuned with the curvature of the surface. A 2π skyrmion appears like a solution for this model and surface deformations are predicted at the sector where the spins point in the opposite direction to the magnetic field. We also study some specific examples by applying the model on three rotationally symmetric surfaces: the cylinder, the catenoid and the hyperboloid. This work was accepted for publication in Phys. Lett. A.

[1] V. L. Carvalho-Santos et al., J. Appl. Phys. **108**, 094310 (2010).
[2] R. Dandoloff, and A. Saxena, Eur. Phys. J. **B 29**, 265 (2002).
[3] T. Georgiou et al., Appl. Phys. Lett. **99**, 093103 (2011).

IIBWMD-020A

Effect of magnetic impurities on the domain wall dynamics in magnetic nanowires

V. A. Ferreira[1], D. Toscano[1], P. Z. Coura[1], S. A. Leonel[1]

[1]*Departamento de Física, Laboratório de Simulação Computacional, Instituto de Ciências Exatas, Universidade Federal de Juiz de Fora, 36036-330, Juiz de Fora - MG, Brazil*

We used spin dynamic simulations to study the behavior of domain wall in magnetic nanowires in the presence of magnetic impurities. The relation between the thickness and width of the magnetic nanowires provides two types of DWs, the vortex domain wall (VDW) and transverse domain wall (TDW) [1]. The competition between exchange energy and magnetostatic energy is responsible for the predominance of one of the two structures. The manipulation of DWs in the nanowire is made using applied magnetic fields or spin-polarized currents. For technological applicability of DW present in magnetic nanowires, their mobility should be large and can be controlled. We consider in our simulations nanowires made of Permalloy with length L=1300 nm and head-to-head transverse domain wall (TDW). We introduce a cluster of magnetic impurity near the domain wall and using the known values of the parameters for Permalloy-79, we have calculated the interaction energy behavior of the domain wall with the cluster of impurities. In the model we developed the interaction between the magnetic sites in the nanowire and the magnetic impurities depends only on the exchange energy. J is considered the exchange coupling between the magnetic sites in nanowire and J' is considered the exchange coupling between the magnetic impurities with the magnetic sites in nanowires. We observed that the magnetic impurities can behave both as a pinning (attractive, $J'<J$) or scattering (repulsive, $J'>J$) cells [2]. We also observed that the interaction energy increases when the impurity is located near the edge of the nanowire, which agrees with experimental results [3]. Finally we show the relationship between the interaction energy and the width of the nanowire. We noticed that a potential technological application can be the use of magnetic impurities lithographically inserted in magnetic nanowires to pinning the TDW, which would allow the fabrication of TDW based memory and logic devices.

[1] G. S. D. Beach, M. Tsoi., J. L. Erskine; J. Magn. Magn. Mat. **320**, 1272 (2008).
[2] D. Toscano et al. , J. Appl. Phys. **109**, 076104 (2011).
[3] S.-M. Ahn, K.-W. Moon, D.-H. Kim, S.-B. Choe; J. Appl. Phys. **111**, 07D309 (2012).

IIBWMD-021A

Effect of a ring of magnetic impurities on the dynamics of the vortex core in magnetic nanodisks

D. Toscano[1], F. Sato[1], P. Z. Coura[1], B. V. Costa[2], S. A. Leonel[1]

[1]*Departamento de Física, Laboratório de Simulação Computacional, Instituto de Ciências Exatas, Universidade Federal de Juiz de Fora, 36036-330, Juiz de Fora - MG, Brazil*
[2]*Departamento de Física, Laboratório de Simulação, Instituto de Ciências Exatas, Universidade Federal de Minas Gerais, 30123-970, Belo Horizonte - MG, Brazil*

In this work we have shown how the dynamics of the vortex core can be managed in a pure nanodisk, the usage of the ring was proposed to control the gyrotropic mode and the vortex core magnetization. The ring of magnetic impurities, consisting of an exchange constant local variation (J'/J) along a circumference concentric to the disk, works for pinning or scattering the vortex core [1]. It is well known that gyrotropic frequency strongly depends on the aspect ratio [2, 3]. In the present work we have reported that fine tuning in the gyrotropic frequency can be obtained through inserting of magnetic impurities, symmetrically distributed around the disk center. When the gyrotropic trajectory is described inside the ring, the effect of an attractive ring ($J'/J < 1$) is to reduce the gyrotropic frequency, whereas the effect of a repulsive ring ($J'/J > 1$) is to increase the gyrotropic frequency. Moreover, we have communicated an alternative mechanism to switch the vortex polarity, mediated by interaction between vortex core and attractive magnetic impurity. The control of the polarity occurs in a well defined range of ring parameters and also depends on the external agent. Using the external agent as an oscillating magnetic field pulse, the polarity switching was performed by an amplitude of ~ 10 mT and the switching time took about 1.5 ns. The great differential of this polarity switching process is that it does not require a high excitation amplitude. We consider here only one possible realization of the vortex core dynamics controllability with a very single ring. We believe that the usage of others magnetic impurity distributions lithographically inserted will be promising for different applications of nanomagnets.

[1] D. Toscano et al., J. Appl. Phys. **109**, 076104 (2011).
[2] K. Yu. Guslienko et al. , J. Appl. Phys. **91**, 10 (2002).
[3] V. Novosad et al., Phys. Rev. B **72**, 024455 (2005).

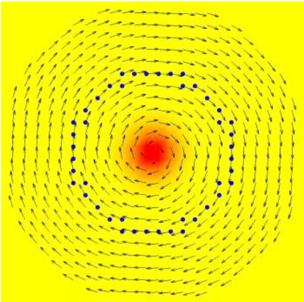


Figure 1: Schematic of the modified nanodisks. The blue circles represent small clusters containing impurities, they define the ring of magnetic impurities.

IIBWMD-022A

Gyrotropic frequency shift in nanodisks with pointlike magnetic impurity

J.H. Silva[1], D. Toscano[1], F. Sato[1], P. Z. Coura[1], B. V. Costa[2], S. A. Leonel[1]

[1]*Departamento de Física, Laboratório de Simulação Computacional, Instituto de Ciências Exatas, Universidade Federal de Juiz de Fora, 36036-330, Juiz de Fora - MG, Brazil*
[2]*Departamento de Física, Laboratório de Simulação, Instituto de Ciências Exatas, Universidade Federal de Minas Gerais, 30123-970, Belo Horizonte - MG, Brazil*

In an early work, we have presented a Hamiltonian model describing two types of pointlike magnetic impurities that can behave as pinning and scattering sites for the vortex core [1]. There, it was pointed out that the gyrotropic frequency is affected by magnetic impurities, consisting of an exchange constant local variation (J'/J). In this work, we have used spin dynamics simulations to study, in detail, the gyrotropic mode in nanodisks of Permalloy-79 with a single magnetic impurity. In our simulations, we have considered a magnetic impurity inserted at a distance r_{imp} from the center of the nanodisk, near the vortex core gyrotropic trajectory with radius r_{mode}, as shown schematically in Fig. 1. The following situations were studied : (1) $r_{imp} < r_{mode}$ and $J' < J$; (2) $r_{imp} < r_{mode}$ and $J' > J$; (3) $r_{imp} > r_{mode}$ and $J' < J$; (4) $r_{imp} > r_{mode}$ and $J' > J$. We have observed that the gyrotropic frequency shift depends on the exchange constant strength and the relative position between the impurity and the vortex core gyrotropic trajectory [2]. Our results agree with the analytical model and experimental behavior for the gyrotropic frequency shown in the literature [3].

[1] D. Toscano et al., J. Appl. Phys. **109**, 076104 (2011).
[2] J. H. Silva et al., J. Magn. Magn. Mater. **324**, 3083 (2012).
[3] R. L. Compton et al., Phys. Rev. B **81**, 144412 (2010).

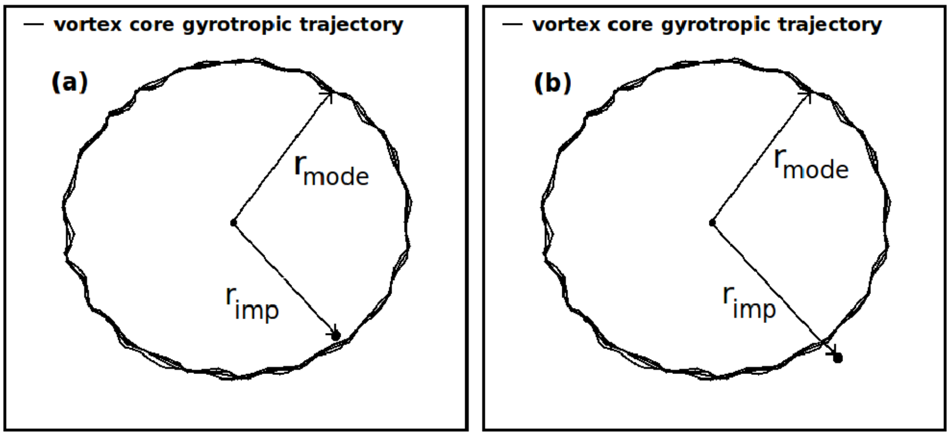


Figure 1: Schematic view of the relative position of the impurity and the vortex core gyrotropic trajectory.

IIBWMD-024A

Complex switching resistance induced by spin polarized current through contact-points

L. C. Benetti[1], S. Nicolodi[1], A. A. Pasa[1], A. D. C. Viegas[1]

[1]*Universidade Federal de Santa Catarina, Florianópolis, SC, Brazil*

The phenomenon of torque transfer by spin-polarized current enables control of the magnetization without the use of large magnetic fields. Due to this has been the subject of many studies, is of great potential for applications in devices of magnetic memories and microwave generator [1]. In this work we have investigated spin transfer torque phenomena [2, 3] by spin polarized current injected by contacts point on continuous films. The tips where produced by electrochemical etching of tungsten wires resulting in points with diameters around 200nm. Spin valves nanostructures IrMn(10 nm)/ Co(15 nm)/ Cu(t_{Cu})/ Co(15 nm), with t_{Cu} = 2, 5, 8 and 11 nm, were produced by magnetron sputtering on n-Si (100) substrates with magnetic field of 130 Oe applied in plane of film during deposition. The IrMn was used to pin the ferromagnetic cobalt layer (FM1) in order to spin-polarize the injected current. Different copper spacer thicknesses were used in order to investigate the role of the coupling between ferromagnetic layers on spin transfer effect. Spin transfer torque phenomena were investigated by current voltage measurements using the tungsten tips produced. The electrical measurements shows complex response with characteristic switching resistance associated to magnetic reorientation, characterizing a noisily current dependent response, that suggest successive transitions among dynamical and/or static magnetic states. From a statistics analysis we try identify average critical currents and variations of the resistance.

[1] S. Tehrani et al. J. Appl. Phys. **85**, 8, (1999).
[2] M. Tsoi et al. Phys. Rev. Lett. **19**, 4281 (1998).
[3] Mark D. Stiles and Jaques Miltat. Spin Dinamics in confined magnetic structures III. Springer-Verlag. Berlin: Heildelberg (2006).

IIBWMD-026A

FMR linewidth and the crystallization in Co-based amorphous microwires

D. S. Chriscon[1], F. Beck[1], K. D. Sossmeier[2], M. Carara[1]

[1]*Depto. de Física, Universidade Federal de Santa Maria, 97105-900, Santa Maria, RS, Brazil*
[2]*UNILA Po. Box 2044, CEP 85867-970, Foz do Iguaçu, PR, Brazil*

The Ferromagnetic Resonance technique has been used for many years as a tool to characterize the dynamic magnetic properties of bulk, thin film magnetic materials and microwires. Also, it is well known that FMR linewidth can be associated to dissipative processes involved on the magnetization dynamics. Such dissipative channels may be separated in two groups: intrinsic and extrinsic ones. While the first one is related mainly to the Landau-Lifshitz (LL) and eddy-currents damping mechanisms, the second one take in to account contributions coming from the inhomogeneities in the sample. Each one of these relaxation processes contributes to the FMR linewidth in a different frequency and/or magnetic field range and they can be separated by an appropriate FMR linewidth measurement. This work presents FMR measurements, obtained by the impedance method, ranging from 100 KHz to 1.8 GHz, in Joule annealed Co-based amorphous microwires. It is shown that the crystallization process can be followed by the evaluation of the extrinsic magnetization damping terms, specifically analyzing contributions from inhomogeneities to the FMR linewidth. From the fitting of models which consider LL damping term, Anisotropy Dispersion and Magnon Scattering to the experimental data, three ranges of annealing temperatures can be distinguished on the studied samples: annealing temperatures lower than the Curie temperature, a temperature range between the Curie and the crystallization temperature and another temperature range above the crystallization temperature.

IIBWMD-027A

A novel method for identifying the local magnetic viscosity process of heterogeneous magnetic nanostructures

F. Béron[1], **L. A. S. de Oliveira**[1], **K. R. Pirota**[1]

[1]*Instituto de Física Gleb Wataghin, Universidade Estadual de Campinas, Campinas, Brazil*

Usual viscosity measurement techniques lead to a global characterization of the viscosity properties, because they are derived from the measurement of the global magnetization of the system. While they are not problematic for homogeneous systems, especially hard magnetic ones, these procedures may conduct to inaccurate results when dealing with soft magnetic nanostructures, where the magnetic viscosity may be spatially non-homogenous in the system. In this work we developed an experimental procedure that allows one to probe the local magnetic viscosity effects, *i.e.* to obtain the specific viscosity properties of each phase present in a non-homogeneous system. It is based on the evolution of the coercivity depending on the field sweep rate of the measurement. Instead of extracting the coercivity from major hysteresis curve measurements, we applied the first-order reversal curve (FORC) method, *i.e.* minor curves cycling between saturation and a reversal field lower than the saturation, which gives the statistical distribution of local magnetostatic properties [1]. Thus, the local coercivity of each phase is accessed, as well as their local interaction fields. Using this procedure it is possible to distinguish, for each phase, between the two main viscosity processes, *i.e.* thermal relaxation and presence of eddy currents. This is possible by means of the knowledge of additional information through FORC measurements. We demonstrated experimentally the effectiveness of the proposed technique on a soft nanocrystalline magnetic ribbon ($Fe_{86}Zr_7Cu_1B_6$, 25 μm thick) that consists of two ferromagnetic phases with different predominant viscous processes. FORCs were acquired using a high-precision AC induction magnetometer, previously adapted to this particular type of measurement [2], for a range of applied field sweep rate (*dH/dt* = 50-6000 Oe/s). We succeeded to obtain the respective fluctuation field value (for the thermal relaxation) of each phase. Finally, reducing the ribbon length in order to artificially induce a demagnetizing field allowed us to conclude that, according to the local viscosity model elaborated, the amorphous matrix is dominated by thermal relaxation, whereas eddy currents are preponderant for the metallic nanocrystals.

[1] I. D. Mayergoyz, Phys. Rev. Lett. **56**, 1518 (1986).
[2] F. Béron, G. Soares, K.R. Pirota, Rev. Sci. Instr. **82**, 063904 (2011).
[3] F. Béron, L.A.S. de Oliveira, M. Knobel, K.R. Pirota, J. Phys. D: Appl. Phys. (accepted)

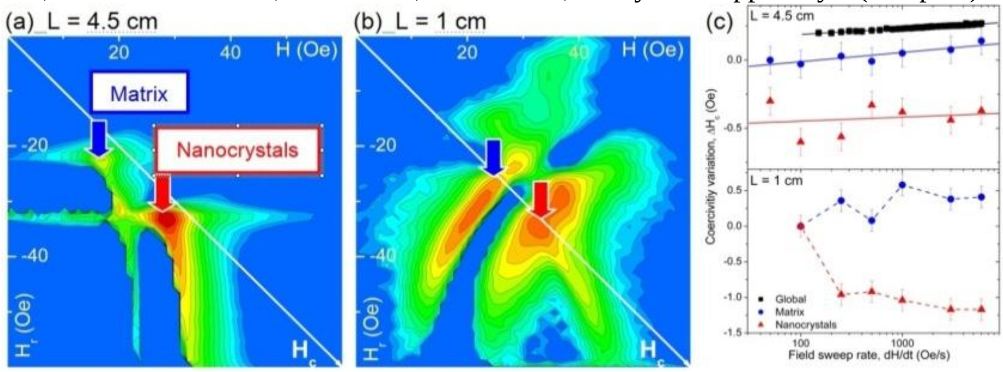


Figure 1: Dynamic FORC diagrams (*dH/dt* = 6000 Oe/s) (a) *L* = 4.5 cm, (b) *L* = 1 cm, and (c) evolution of the different coercivities with the field sweep rate.

IIBWMD-030A

Irradiation driven nanocrystallization of FeCuNbSiB amorphous thin films

T. L. Marcondes [1], A. M. H. de Andrade [2], F. Bohn [3], W. O. Rosa [1], D.E. Gonzalez-Chavez[1], P.F.P. Fichtner [2], L. Amaral [2], R. L. Sommer [1]

[1]*Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro RJ, Brazil*
[2]*Instituto de Física, Universidade Federal do Rio Grande do Sul, PoA RS, Brazil*
[3]*Escola de Ciências e Tecnologia, Universidade Federal do Rio Grande do Norte, Natal RN, Brazil*

FeSiB based nanocrystalline ferromagnetic materials are known for its high magnetic permeability and low noise characteristics, owed to the quenching of the magnetocristalline anisotropy of the nanometric particles of crystalline materials embedded in an amorphous magnetic matrix. In bulk materials, there are several routes to obtain the nanocrystalline state, e.g. thermal annealing, ion irradiation. In the case of magnetic films the route to nanocristallization is still an open question. Ion irradiation of the amorphous precursor films could be an interesting method to drive the nanocrystallization [1]. In particular, irradiation with Ar ions can be an useful tool to establish the nanocrystalline FINEMET state in FeSiB based alloys. In this work, we explore this route by irradiating 100 nm thick Fe73.5Cu1Nb3Si13.5B9 films produced by RF magnetron sputtering deposition on silicon substrates under an applied magnetic field. The samples have been subjected to a 1x1012 cm-2 dose irradiation of Ar ions accelerated at 380 kV under temperatures from room to 250 ^{o}C. All films structure were characterized by XRD and TEM, the magnetic properties by VSM and ferromagnetic resonance linewidths were measured by VNA-FMR. The sample as prepared exhibit small coercive field and an uniaxial anisotropy. With the irradiation at room temperature coercive fields in both the easy and hard axis increased significantly, we ascribed this effect to irradiation damage. As the irradiation temperature increases the evolution in the magnetization curves shows a decrease in the defects in the sample as expected due recovery. This recovery is also observed in the reduction of the measured resonance linewidth. We also observed the increase of the saturation magnetization with the irradiation temperature. Complementary TEM images were used to verify the effect of irradiation in the evolution of the crystallization with the substrate temperature.

[1] R. Sanz et al, JNCS **353**, 879 (2006).

IIBWMD-034A

Magnetoimpedance in multilayered $Ni_{81}Fe_{19}$/Cu films electrodeposited on Cu microwires

<u>B. Silva</u>[1], D.E. Gonzalez-Chavez[1], J. Gomes Filho[1], R. L. Sommer[1]

[1]*Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro/RJ, 22290-180, Brazil*

Electrodeposited cylindrical magnetic films deposited on non-magnetic wires are good candidates to produce magnetoimpedance (MI) based devices as they allow to tailor the MI ratio as well the Z vs. H curves yet making use of the convenient cylindrical geometry. In this work, multilayered $Ni_{81}Fe_{19}$/Cu films were produced by electrodeposition on copper microwires with a diameter of 120um. The thickness of magnetic layers varies from 80 nm to 950 nm and copper thickness varies from 0.7 nm to 3.8 nm, while the number of bilayers was kept between 40 and 80. The static magnetic properties for these samples were investigated with a VSM magnetometer operating in a field range of -300 Oe to 300 Oe. The magnetization dynamics and magnetoimpedance were studied with a coaxial waveguide, where the sample plays the role of the inner conductor, using a Rohde & Schwarz ZVA24 Vector Network Analyzer, in the frequency range of 0.1 GHz to 7 GHz and fields from -300 Oe to 300 Oe. A de-embedding procedure was used for extract the sample impedance and remove the effects of the sample holder from the data. Magnetization measurements showed low coercive fields in all samples, in the order of 2 Oe. The shapes of the curves show an increase in the demagnetizing field with increasing thickness of $Ni_{81}Fe_{19}$ layers. The high-frequency measurements showed a strong dependence of the magnetoimpedance with skin effects and ferromagnetic resonance. It was measured magnetoimpedance ratios in the order of 125%. The linewidths obtained from ferromagnetic resonance spectra were large for all the samples, indicating a high anisotropy dispersion, which decreases with an increment of the $Ni_{81}Fe_{19}$ thickness. The increase of copper thickness resulted in a small increase in the linewidth, possible related to the increase of the roughness at permalloy/Cu interfaces.

IIBWMD-043A

High sensitivity magnetoelastic sensors applied to drying of ceramic films

C. D. Tormes[1], E. S. Bastos[1], A. de Souza[1], R. C. D. Cruz[1], F. P. Missell[1]

[1]*Centro de Ciências Exatas e Tecnologia – CCET, Universidade de Caxias do Sul, Cidade Universitária/Bloco V, 95070-560 Caxias do Sul, RS, Brazil*

Magnetoelastic sensors vibrate mechanically in a time-varying magnetic excitation field and these mechanical vibrations of the magnetoelastic material produce a magnetic field which can be used to remotely monitor the sensor [1]. We report the use of L = 30 mm strips of Metglas 2826MB3 amorphous alloy as sensors to detect the stress developed in the drying of Al_2O_3 films. The drying kinetics was characterized by measuring the weight loss of the drying films. To measure the resonant frequency of the Metglas strips, Helmholtz coils were used to generate the excitation field, while the pickup coil signal was examined with a lockin amplifier. A dc magnetic field was used to offset demagnetizing effects and the ΔE effect. The samples consisted of a 30 vol.% Al_2O_3 aqueous suspension (pH= 9.0) with 600 nm particle diameter (d_{50}) which was spread evenly over the amorphous strip at temperatures around 20ºC and at a relative humidity of 60%. Immediately the water began evaporating from the films and the latter lost 20-30% of their weight in 30 minutes. In the same time interval, the sensor resonant frequencies increased by approximately 7-10%. See figure 1. The aim of our work is to study the relation between lateral drying and stress development in the films [2] as a function of the initial water content as well as of the size, morphology and the degree of dispersion of ceramic particles in water.

[1] C. A. Grimes, S. C. Roy, S. Rani, Qingyun Cai, Sensors **11**, 2809 (2011).
[2] W. Lan, P. Xiao, Journal of the European Ceramic Society **27**, 3117 (2007).

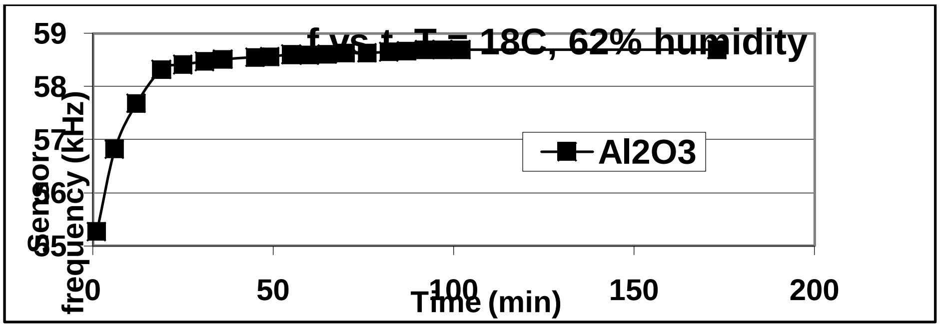


Figure 1: Frequency of magnetoelastic sensor vs. time for aqueous solution of Al_2O_3.

IIBWMD-044B

Magnetic and ferromagnetic resonance Investigation in Nickel Nanohills thin films with different thickness.

S. Michea[1], J. Briones[1,2], C. Gallardo[1,2], J.M. Vargas[3], J. C. Denardin[1,2], R. L. Rodriguez-Suarez[4], L. Spinu[3]

[1]*Departamento de Fisica, Universidad de Santiago, Santiago, Chile*
[2]*Center for the Development of Nanoscience and Nanotechnology (CEDENNA), Universidad de Santiago, Santiago, Chile*
[3]*Advanced Materials Research Institute, University of New Orleans, New Orleans, LA, United States*
[4]*Facultad de Física, Pontificia Universidad Catolica de Chile, Santiago, Chile*

Angular dependence of the magnetic properties of nickel nanohill thin film arrays with 20, 40, 60 and 100 nm of thickness, and fabricated by sputtering over the closed porous sides of anodic aluminum membranes, were studied using the ferromagnetic resonance (FMR) technique and vibrating sample magnetometer (VSM). The structures were synthesized from a homemade porous alumina membranes hexagonally ordered and the magnetic material was deposited on the bottom side of the alumina pores, forming nanohills. A widening of the resonance line in FMR measurement appears when the magnetic field is applied out of the plane and with the increasing of the film's thickness. Cohercivity field shows a symmetrical behavior with a maximum value out of the film plane indicating that there is possible to get a thin film with a perpendicular anisotropy due to the magnetization pinning in the interstitial hills space of the sample.

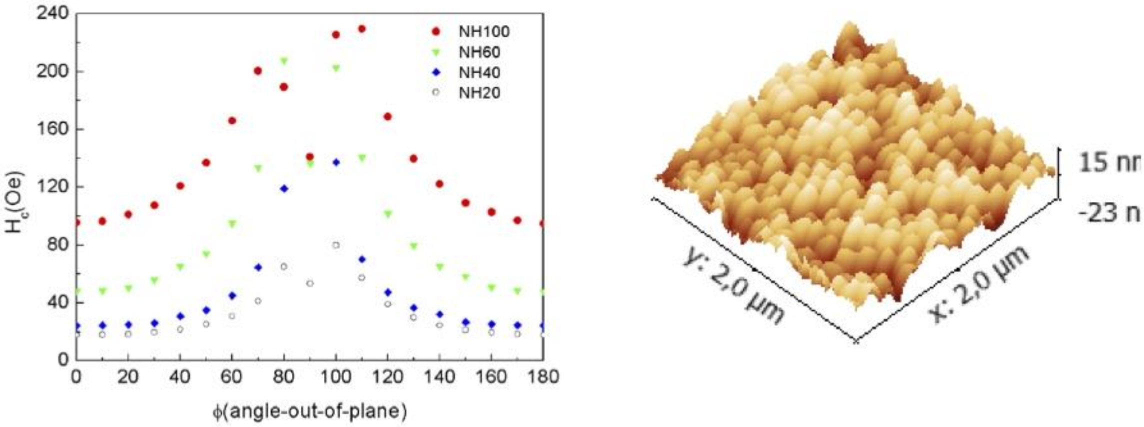


Figure 1: Left. Angular dependence of the cohercivity of nickel nanohills thin films with 20 nm (NH20), 40 nm (NH40), 60 nm (NH60) and 100 (NH100) nm of thickness. Right. AFM image of NH 60 Sample.

IIBWMD-045A

Terahertz Band Gaps in One dimensional Magnonic Quasicrystals

C. H. Costa[1], M. S. Vasconcelos[2], E. L. Albuquerque[3]

[1]*Departamento de Física Teórica e Experimental, Universidade Federal do Rio Grande do Norte, 59072-970, Natal-RN, Brazil*
[2]*Escola de Ciências e Tecnologia, Universidade Federal do Rio Grande do Norte, 59072-970, Natal-RN, Brazil*
[3]*Departamento de Biofísica e Farmacologia, Universidade Federal do Rio Grande do Norte, 59072-970, Natal-RN, Brazil*

Magnetic periodic layered structures have been studied for more than a decade, including the discovery of the giant magneto-resistance effect in a three layer system containing magnetic and nonmagnetic layers [1]. However, *magnonic crystals* (MCs), the magnetic counterpart of photonic crystals (PCs), were only recently have gained detach with the experimentally works of Kruglyak *et al.* [2]. They have observed that, similar to PCs, the spectrum of MCs is strongly affected by the presence of magnonic band gaps (MBGs), in which magnon propagation is forbidden. In such systems the magnons (quantized spin waves) move through these crystals, analogous to photons in PCs. In MCs, spin waves are the quasiparticles that are responsible by the transport and process of information. Considerably effort, theoretical and experimental, has been made to investigate the MCs in the last years. However, few efforts had been done to investigate magnonic structures in exchange regime. The principal aim of this work is try to fill this gap. Therefore, we investigate MBGs, in the terahertz (THz) frequency range, in MCs organized in periodic and quasiperiodic generalized Fibonacci fashion. Due to the quasiperiodic design, this last structure is called by *magnonic quasicrystals* (MQCs). The theoretical model adopted here is based on the Heisenberg Hamiltonian in the exchange regime, together with a transfer-matrix treatment within the random-phase approximation (RPA) [3]. In this regime, the exchange terms of the magnetic layers play the same role of electric permittivity in PCs. For periodic arrangements the bulk band structure is analogous to those found in PCs, while for quasiperiodic multilayers it presents additional pass bands similar to those found in doped semiconductor materials.

[1] M.N. Baibich, et al., Phys. Rev. Lett. **61**, 2472 (1988).
[2] V.V. Kruglyak, et al., J. Phys. D: Appl. Phys. **43**, 264001 (2010).
[3] C.H.O. Costa, et al., Solid State Commun. **150**, 2325 (2010); C. H. O. Costa, et al., J. Magn. Magn. Mater. **324**, 2315 (2012).

IIBWMD-049A

Magnetic interactions in exchange-coupled unbiased IrMn/NiCu films

K. D. Sossmeier[1], R. Cichelero[2], J. E. Schmidt[2], J. Geshev[2]

[1]*Instituto Latino-Americano de Ciências da Vida e da Natureza, UNILA, Foz do Iguaçu, PR, Brazil*
[2]*Instituto de Fisica, UFRGS, Porto Alegre, RS, Brazil*

Systems composed of a ferromagnet (FM) exchange-coupled to an antiferromagnet (AF) have shown a great potential for technological applications. These normally evidence exchange bias (EB), i.e., a shift of the magnetization curve along the magnetic field axis, often accompanied by a coercivity enhancement. Recently, we showed that unconventional AF/FM (NiO/NiCu) bilayers exhibit EB [1] despite that their Curie temperature is lower than the AF's Neel temperature. We also explored NiCu coupled to a stronger AF, i.e., IrMn (unpublished) and showed that although the respective hysteresis loops are unbiased their coercivity could be tailored via ion irradiation or magnetic annealing. We found that the coercivity enhancement in this system results from the presence of the AF in accordance with theoretical predictions that the AF breaks the FM layer into domains and the FM domain size is smaller than that of a FM layer alone [2]. To verify the nature of the interactions in this exchange-coupled though unbiased system, we employed isothermal remanence magnetization (IRM) and dc demagnetization (DCD) curves. We compared data acquired on the as-made film with those of a film irradiated with Ge ions, both showing isotropic in-plane magnetic behavior. The remanence plots obtained from the DCD and IRM curves showed several distinct and interesting characteristics. E.g., the Henkel plots of the as-made and irradiated samples obtained after dc demagnetization appear to be practically identical despite the great difference in coercivity, indicating that the irradiation-induced coercivity enhancement should not be associated with interactions. However, the plots obtained after ac demagnetization, though rather different, indicate strong (magnetizing) exchange interactions. Systematic research is needed to clarify the role and type of interactions present in this unconventional system.

[1] K. D. Sossmeier et al, J. Appl. Phys. **109**, 083938 (2011).
[2] Z. Li and S. Zhang, Phys. Rev. B **61**, R14897 (2000) on November 28-30 2012.

IIBWMD-050A

Magnetic reversal modes in dome-like nanostructures

J. L. Palma[1], C. Gallardo[1], J. Escrig[1, 2], J. C. Denardin[1,2]

[1]*Departamento de Física, Universidad de Santiago de Chile, Santiago, Chile.*
[2]*Center for the Development of Nanoscience and Nanotechnology (CEDENNA)*

The dependence between the geometry and the magnetic properties of arrays of domes like nanostructures, was studied by means of magnetometry techniques (AGM Aleternating Gradient Magnetometer) and micromagnetic simulation was made using Oommf package [1]. The structures were synthesized from homemade porous alumina membranes and aluminum with nano-valley both with hexagonally ordered and the last one is obtained after remove the oxide layer of alumina. Structures composed by Permalloy and Cobalt were investigated systematically for different diameters and separation between elements. We see that the geometry of an individual element influence strongly on their magnetic properties and reversal mode mechanism, depends on the direction of the applied field and the geometry. We observe two kinds of magnetic reversion, coherent reversion and vortex reversion of the magnetization in the micromagnetic simulation of one isolated element. Finally we observe a monodomain structure with a highly magnetostatic interaction between elements.

[1] math.nist.gov/oommf/.

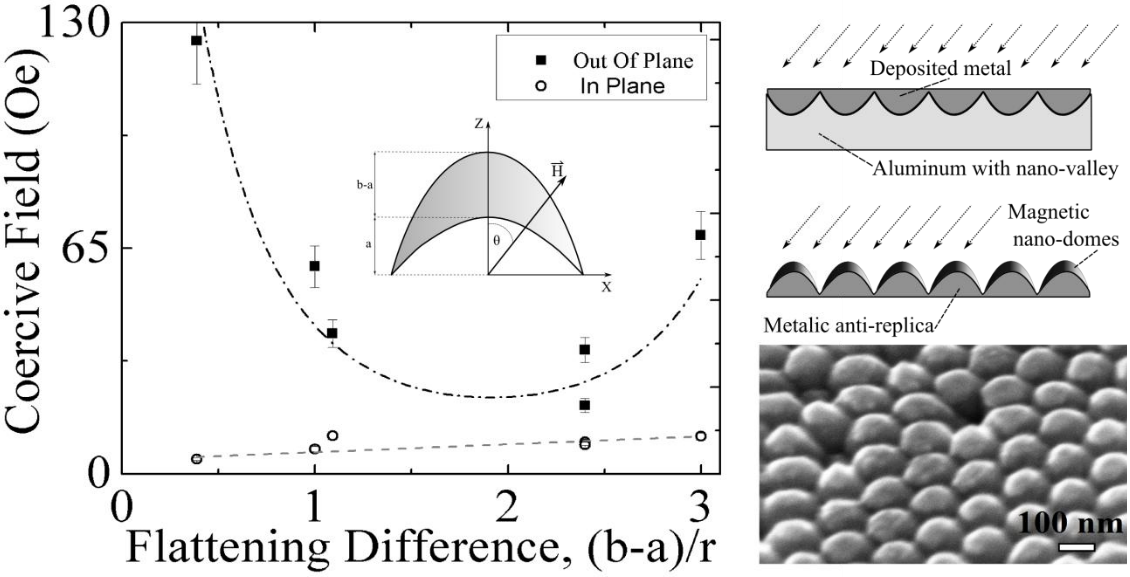


Figure 1: Coercive field as a function of geometry, synthesis process and SEM image for domes- like nanostructure.

IIBWMD-052A

Static and dynamic magnetic properties of films of FeNbCuSiB

M. J. P. Alves[1], D. E. Gonzalez-Chavez[1], F. Bohn[2], R. L. Sommer[1]

[1]*Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro, RJ, Brazil*
[2]*Escola de Ciências e Tencologia, UFRN, Natal, RN, Brazil*

Nanocrystalline magnetic films are good candidates for high frequency applications that demand very high signal/noise ratio [1]. In general, these nanocrystalline magnetic materials have the structure of magnetic nanograins immersed in an amorphous magnetic matrix [2]. For bulk nanocrystalline materials $Fe_{73.5}Nb_3Cu_1Si_{13.5}B_9$, sample has high saturation (about 103 emu/cm3), low coercivity and anisotropy quenching [3]. In this work we investigated the effect of annealing temperature and thickness on the magnetic and structural properties of films $Fe_{73.5}Nb_3Cu_1Si_{13.5}B_9$. The amorphous films with thickness of 100, 200 and 500nm were produced by RF Magnetron Sputtering and were treated for 1 hour under high vacuum. The structural and static magnetic properties of the films as deposited and heat treated were made by X-ray diffraction (XRD) and vibrating sample magnetometer (VSM), respectively. The high-frequency magnetic response of all samples was measured using a coplanar waveguide connected to a Rohde Schwarz ZVA24 vector network analyzer (VNA-FMR). Broadband permeability measurements show typical ferromagnetic resonance phenomena, with several resonant modes associated with the magnetic inhomogeneities and, possibly, spin-wave modes. The dispersion relations were obtained from the experimental data via fittings to lorenzian functions. The relaxation mechanisms of the magnetization were analyzed through the behavior of the FMR linewidth. It was observed that the crystallization process of thinner films results in an increased contribution of two-magnon scattering process to the linewidth, while for thicker films the linewidth is dominated by the terms associated with inhomogeneities and the constant Gilbert damping. The results are discussed in terms of the nanocristallized granular structure, effective magnetic anisotropy and residual stress in the samples.

[1] A. D. C. Viegas, et al., J. Appl. Phys. **101**, 033908 (2007).
[2] G. Herzer, Physica Scripta T **49**, 307, (1993).
[3] Y. Yoshizawa et al., J. Appl. Phys. **64**, 6044 (1988).

IIBWMD-053B

Dynamics of a Bose-Einstein Condensate of Excited Magnons

F. S. Vannucchi[1], A. R. Vasconcellos[1], R. Luzzi[1]

[1]*Condensed Matter Physics Department, Institute of Physics "Gleb Wataghin", State University of Campinas - UNICAMP, 13083-859 Campinas, SP, Brazil*

The emergence of a non-equilibrium Bose-Einstein-like condensation of magnons, in a rf-pumped magnetic thin film embedded in a thermal bath, has recently been experimentally observed [1]. We present here a complete theoretical description of the non-equilibrium processes involved alternative to the one by S. M. Rezende based on coherent states [2]. Resorting to a Non-Equilibrium Statistical Ensemble Formalism, the evolution equations for the magnon populations are obtained and studied [3]. The nonlinear contribution arising out of the spin-lattice interaction transfers the energy in excess of equilibrium from the pumped modes to those with lower frequencies, and, in a cascade down process, occurs a large enhancement in the magnon populations of the lowest in frequency modes - a phenomenon we call Fröhlich Condensate. In opposition to this contribution, there is another one, generated by the magnon-magnon interaction, that tends to lead the system to a state of non-equilibrium internal thermalization. We introduce a treatment consisting in a kind of "two-fluid model", in which the kinetic equations for the magnon populations are contracted in only two, representing the modes lowest in frequency and the ones that are pumped by the external source. A quantitative study is performed through numerical integration of the two related evolution equations and a good agreement of theory and experiment is obtained (shown in Fig 1a). The emergence of the condensate is evidenced for a range of source power. With increasing pumping power, the contribution originated by the magnon-magnon interaction becomes dominant and the emergence of the condensate is inhibited (Fig. 1b). Finally, the several relaxation processes in the condensate leading to equilibrium are analyzed.

[1] S.O. Demokritov et al., Nature **443**, 430 (2006).
[2] S. M. Rezende, Phys. Rev. B **79**, 174411 (2009).
[3] F.S. Vannucchi, A.R. Vasconcellos and R. Luzzi, Phys. Rev. B **82**(14), 140404 (2010).

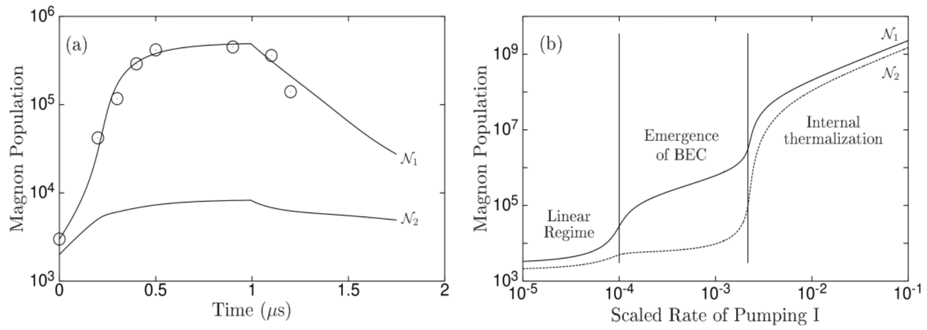


Figure 1: Magnon populations associated with minimum energy (N_1) and with the pumped modes (N_2). (a) Time evolution and comparison with experiment (circles represent data for the low energy magnon population from [1]), with the pumping being switched off after 1μs. (b) Steady-state magnon populations as a function of the scaled rate of pumping. It can be noticed the existence of a window for the emergence of BEC, which follows at a certain threshold of intensity.

IIBWMD-063A

Tuning the exchange bias and coercivity in FM1/FM2/AF systems

A. M. H. de Andrade[1], M. G. Gomes[1], J. Geshev[1], J. E. Schmidt[1]

[1]*Instituto de Física, UFRGS, Porto Alegre, RS, Brazil*

The exchange bias (EB) phenomenon is associated with magnetic exchange coupling between a ferromagnet (FM) and a small fraction of partially uncompensated interfacial spins in an adjacent antiferromagnet (AF) [1-3]. Its most important characteristics is the exchange bias field (H_{EB}), i.e., the magnetization curve shift along the magnetic field axis. With the aim to enhance H_{EB} and decrease the coercive field (H_C) in polycrystalline EB systems, we produced and studied a series of Cr/FM1/FM2/IrMn/Cr films where FM1 and FM2 denote either NiFe (permalloy®), or Co, or NiFeCo. The IrMn layer thickness was set at 15 nm and the Cr layers thicknesses were set at 3 nm (buffer layer) and 5 nm (cap layer), respectively, and the thicknesses of the FM1 and FM2 layers were varied between 0.5 and 5 nm. The samples were grown at room temperature (RT) under 2 mTorr argon pressure (base pressure 1×10^{-8} Torr) onto Si(100) substrates by magnetron sputtering. After deposition, the films were annealed for 30 min at 210 ºC upon 2 kOe magnetic field applied along the EB direction in vacuum with a pressure better than 10^{-6} Torr. Figure 1 shows representative RT in-plane magnetization curves, traced using an alternating gradient-field magnetometer, for different FM1/FM2 configurations. Sample R479 [NiFe(5 nm)/NiFeCo(0.5 nm)/IrMn], showed the best results, i.e., high H_{EB} and low H_C values. This shows that one can controllably engineer the important magnetic parameters of such EB systems.

[1] W. H. Meiklejohn and C. P. Bean, Phys. Rev. **102**, 1413 (1956); **105**, 904 (1957).
[2] J. Nogues and I. K. Schuller, J. Magn. Magn. Mater., **192**, 203 (1999); A. E. Berkowitz and K. Takano, J. Magn. Magn. Mater. **200,** 552 (1999).
[3] K. O'Grady, L. E. Fernandez-Outon, and G. Vallejo-Fernandez, J. Magn. Magn. Mater. **322**, 883 (2010).

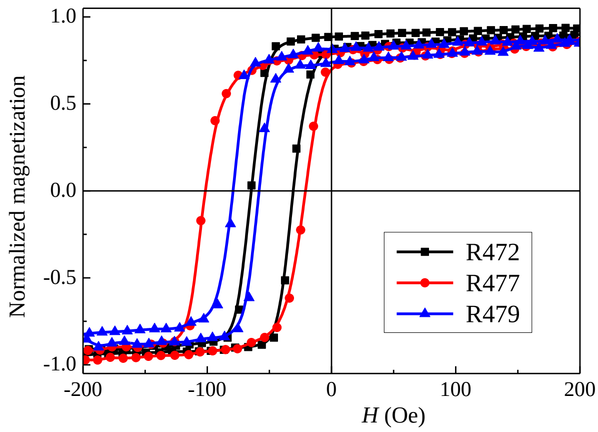


Figure 1: RT in-plane magnetization curves traced for R472 [NiFe(5nm)/IrMn(15nm], R477 [NiFe(2.5 nm)/Co(2.5 nm/IrMn], and R479 [NiFe(5 nm)/NiFeCo(0.5 nm)/IrMn] samples.

IIBWMD-064A

Magnetic fringe fields in Nickel micro-contacts system

J. I. Avila[1], **A. A. Pasa**[1], **A. D. C. Viegas**[1]

[1]*Laboratório de Filmes Finos e Superfícies, Departamento de Física Universidade Federal de Santa Catarina Florianópolis, 88040-900, Brazil*

The magnetization of 2 rectangular nickel contacts separated by 100 nm for several external fields was calculated by solving de Landau-Lifshitz-Gilbert equation with the boundary element method solver Nmag [1]. The hysteresis curve of the system, and also the fields in the space surrounding the contacts are obtained. The fringe fields are seen to be close to 1000 Oe, in agreement with the results obtained by previous experiments using nanolithographed hall probes in similar geometries [2]. These results reveal the necessity of enclosing the fields paths in experiments with ferromagnetic contacts were strong local magnetic fields can obscure magnetoresistive measurements, as in the case of spin injection in semiconductors.

[1] T. Fischbacher, M. Franchin, G. Bordignon, H. Fangohr, IEEE Tran. on Magn, **43(6)**, 2896 (2007).
[2] F.G. Monzon, D.S. Patterson, M.L. Roukes , J. Magn. and Magn. Mat. **195**, 19 (1999).

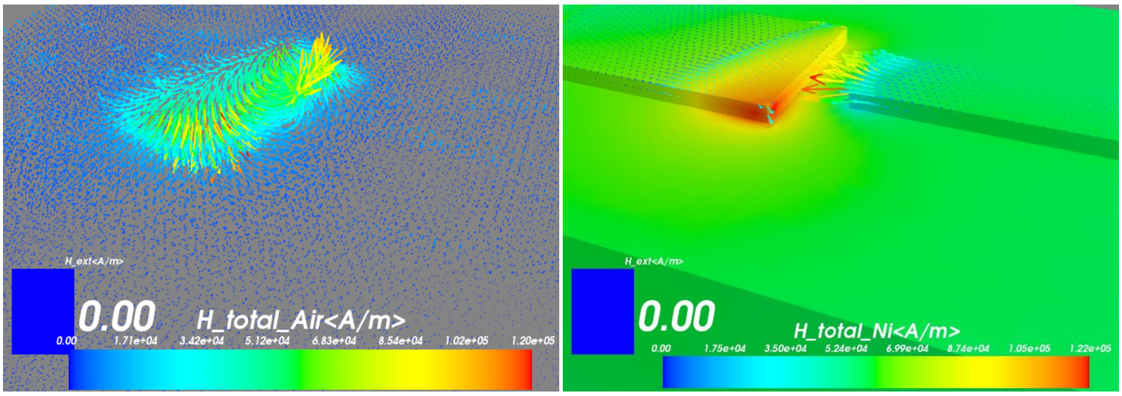


Figure 1: Left: Field vectors for nickel contacts and scalar potential. Right: Field vectors for space under the contacts, were there is no magnetic material. No external field applied. The size of the contacts is 5000nm x 320 nm x 30 nm and 5000nm x 140 nm x 30nm and they are separated by 100 nm.

IIBWMD-065A

Coercivity and magnetization of ultrathin cobalt films

R. Checca[1], J. Quispe-Marcatoma[2], M. A. de Sousa[3], W. Alayo[4], E. Baggio Saitovitch[2], F. Pelegrini[3], Y. T. Xing[1]

[1]*Instituto de Física, Universidade Federal Fluminense, Rio de Janeiro, 24210-346, Brazil*
[2]*Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro, 22290-180, Brazil*
[3]*Instituto de Física, Universidade Federal de Goiás, Goiânia, 74001-970, Brazil*
[4]*Depto. de Física, Univ. Federal de Pelotas, Pelotas, RS, 96010-900, Brazil*

Cobalt is a ferromagnetic 3d transition metal presenting two stable phases: hcp and fcc. However, the acquired metastable phase (bcc) is very suitable for several practical applications and for basic research as well [1], although it does not appear in the phase diagram of bulk Co. The two cubic phases have been observed in Co thin films deposited at room temperature by sputtering on certain substrates [2]. In fact, the epitaxial thin Co films are not exactly cubic, but distorted tetragonal: FCT or BCT, although the main magnetic aspect can be described by models assuming a cubic structure of it [3]. In this work, we study the magnetic properties of Co thin films with thickness of 5 nm, grown by RF magnetron sputtering on Si substrates (111). A buffer layer of MgO with thickness of 25 nm was employed to stabilize the cubic phase of Co and a 2 nm W capping layer were deposited on top of Co layers to prevent oxidation. The deposition rates for Co, W and MgO were approximately 0.10 Å / sec, 0.14 Å / sec and 1.40 Å / sec, respectively. Heat treatment at temperatures of 400° C and 600°C for two hours on the as-prepared samples were carried out in order to decrease the roughness of the MgO / Co interface. The magnetic properties were investigated by vibrating sample magnetometry (VSM) and ferromagnetic resonance spectroscopy (FMR). The results clearly show the influence of heat treatment on the coercivity and saturation magnetization of ultrathin Co films.

[1] A.D.C. Viegas, J. Geshev, J.E. Schmidt, E.F.J. Ferrari, J. Appl. Phys. **83**, 7007 (1998).
[2] M. Lezaic, Ph. Mavropoulos, and S. Blugel. arXiv:Cond-mat/0612497v1(2006).
[3] M.J.M. Pires, A.A.C. Cotta, M.D. Martins, A.M.A. Silva, W.A.A. Macedo, J. Magn. Magn. Mater. **323,** (2011).

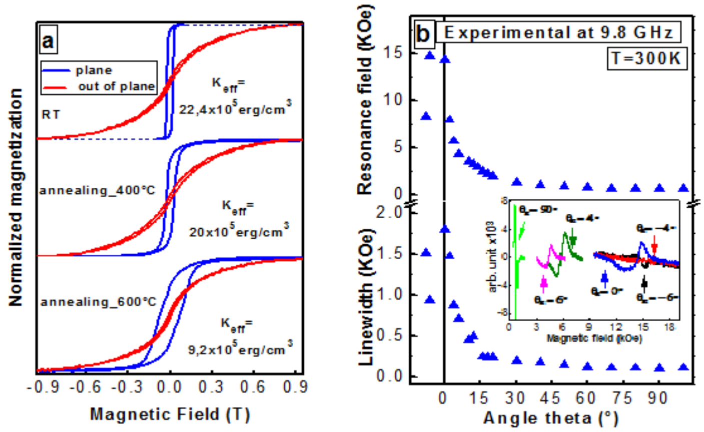


Figure 1: (a) Magnetization curves for a sample at RT, annealing 400ºC and annealing 600°C. (b) Angular dependence of resonance field and linewidth for a sample at annealing 600°C.

IIBWMD-071A

Model for domain wall avalanches in ferromagnetic thin films

D. Muraca[1]

[1]*Instituto de Fisica Gleb Wataghin, Universidade Estadual de Campinas (UNICAMP) Campinas, 13.083-970, SP, Brazil*

The Barkhausen jumps or avalanches in magnetic domain-walls motion between successive pinned configurations, due the competition among magnetic external driving force and substrum quenched disorder, appear in bulk materials and thin films. We introduce a model based in rules for the domain wall evolution of ferromagnetic media with exchange or short-range interactions, that include disorder and driving force effects [1]. We simulate in 2-dimensions with Monte Carlo dynamics, calculate numerically distributions of sizes and durations of the jumps and find power-law critical behavior. The avalanche-size ex- ponent is in excellent agreement with experimental results for thin films and is close to predictions of the other models, such as like random-field and random-bond disorder, or functional renormalization group. The model allows us to review current issues in the study of avalanches motion of the magnetic domain walls in thin films with ferromagnetic inter- actions and opens a new approach to describe these materials with dipolar or long-range interactions.

[1] R.C. Buceta, D. Muraca, Physica A **390**, 4192 (2011).

IIBWMD-071A

FORC method used to analyze the hysteretic effect of GMI in high frequency range

L. Costa[1], F. Béron[1], K. R. Pirota[1]

[1]*Instituto de Física Gleb Wataghin, Universidade Estadual de Campinas, Campinas, Brazil*

Soft amorphous ribbons with transversal anisotropy generally present (quasi) anhysteretic axial magnetization curve. On the other hand, the measurement of the giant magnetoimpedance (GMI) effect yields to a well-defined hysteresis area for the same configuration. This effect, related to the magnetization process of the magnetic system, consists of the variation of the electric impedance of soft magnetic materials in the presence of static magnetic field. Finally, first-order reversal curve (FORC) method represents a powerful experimental technique to probe the irreversible processes occurring in a system [1]. Mainly applied to magnetization curves, a proper FORC analysis gives the statistical distribution of the parameters from elementary (local) hysteretic process. We previously applied the FORC formalism to low frequency (kHz) hysteretic giant magnetoimpedance (GMI) curves of FeCoSiB amorphous ribbons with transversal anisotropy [2]. Our results showed that the FORCs can be separated into three groups, based on their behavior. An interlinked hysteron/anti-hysteron model was proposed to interpret the hysteresis behavior. In this work, we extended and raised the frequency range (10 MHz - 1 GHz), using a vector network analyzer. The FORC distributions exhibit an abrupt change when increasing the frequency, passing from the hysteron/anti-hysteron model (a) to the succession of a negative (black) and positive (white) peaks along a given reversal field value (b). The FORC distribution modification reflects a transformation of the irreversible processes occurring in the area probed by GMI and therefore, an inhomogeneous magnetization structure along the ribbon thickness. It can be described by the penetration depth associated to the modification frequency, which exhibits a relation with the ribbons anisotropy constant.

[1] I. D. Mayergoyz, Phys. Rev. Lett. **56**, 1518 (1986).
[2] F. Béron, L. A. Valenzuela, M. Knobel, L. G. C. Melo and K. R. Pirota, J. Magn. Magn. Mater. **324**, 1601 (2012).

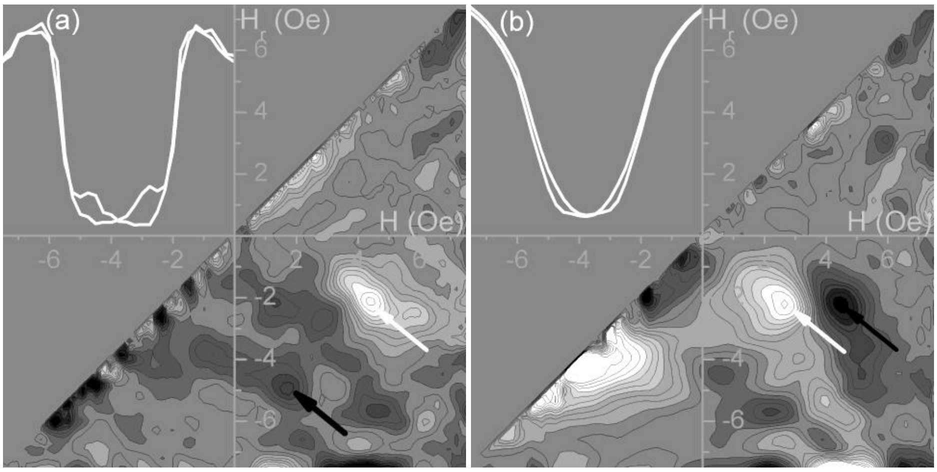


Figure 1: FORC diagrams of GMI real part (a)10 MHz (b)1 GHz

IIBWMD-084A

Evaluation of external magnetic field during the synthesis of magnetite by Transmission Electron Microscopy and Vibrating Sample Magnetometry

K. L. Silva[1], E. L. S. Freitas[1], T. R. F. Pontes[1], R.P. Araujo Neto[1], J. F. Carvalho[1], I. H. M. Damasceno[1], A. S. Carriço[2]

[1]*Laboratório de Sistemas Dispersos(LASID), Departamento de Farmácia, Universidade Federal do Rio Grande do Norte (UFRN)*
[2]*Departamento de Física Teórica e Experimental, Universidade Federal do Rio Grande do Norte (UFRN)*

Magnetic particles (MP) have been widely used in biomedical application for improve therapeutic procedure. Magnetic drug targeting, hyperthermia and magnetic resonance imaging (MRI) are the most used techniques. Furthermore, MP are nontoxicity, biocompatibility, and could be target for a specific tissue or organ decreasing side effects [1]. Growing magnetite microparticles by co-precipitation involves the formation of nanocrystallites and their aggregation. It is possible to interfere in the magnetic structure of the micro-particles. The object of this work was tailoring the nano-structure of magnetic microparticles, particularly the relative an orientation and size of nano-crystals, to obtain particles with improved properties for drug targeting. Besides, evaluate by Transmission Electron Microscopy (TEM) and Vibrating Sample Magnetometry (VSM) of morphology and magnetization of the MP. Magnetite was prepared by chemical co-precipitation method of ferrous chloride and ferrous sulphate (2:1) with NaOH in the presence of external magnetic field (MF), an in the absence of external field, generated from a pair of Nd-magnets. Moreover, the samples were analyzed by VSM and TEM. The results of saturation magnetization showed an increase from 49 emu/g (the control sample) to 61 emu/g for the one grown in the presence of a 172mT MF (Figure 1). The TEM image permitted to confirm the internal structure layout of nano-crystallites inside the magnetic microparticles. In conclusion, this work allowed to show the increase of saturation magnetization of microparticles and their higher initial susceptibility, even as proved the layout of nanocrystallites inside the microparticles.

[1] A . Ito, M. Shinkai, H . Honda, T. Kobayashi, Journal of Bioscience and Bioengineering **100(1)**, 1 (2005).

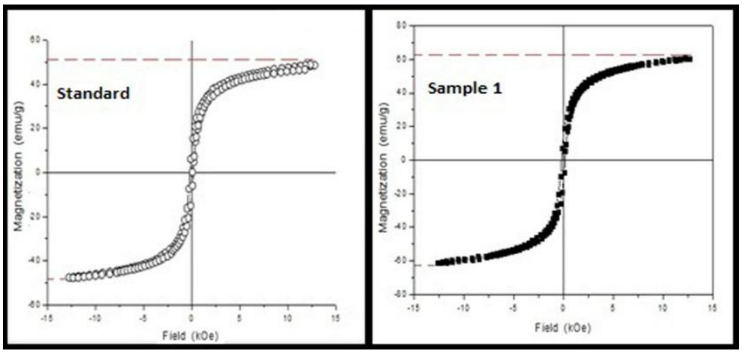


Figure 1: Curves of magnetization (VSM).

IIBWMD-087A

Synthesis and magnetic properties of strontium doped cobalt ferrite prepared by microwave-assisted combustion method

A. C. Lima[1], A. S. Carriço[1], J. H. Araújo[1], S. N. Medeiros[1], J. M. Soares[2], D. M. A. Melo[1]

[1]*Federal University of Rio Grande do Norte, CEP 59078-970, Natal, RN, Brazil*
[2]*State University of Rio Grande do Norte, CEP 59610-210, Mossoró, RN, Brazil*

Magnetic nanoparticles have been widely studied due to their potential applications such as magnetic recording, ferrofluids, magnetic drug delivery and hyperthermia for cancer treatment [1, 2, 3]. Cobalt ferrite ($CoFe_2O_4$) is a well known hard magnetic material with high coercivity, moderate magnetization, good mechanical hardness and chemical stability, which makes it a good candidate for many applications. However, the final properties of the material are very sensitive to the synthesis method and the heating conditions. In this paper, nanocrystalline magnetic ferrites $Co_{1-x}Sr_xFe_2O_4$ (x = 0, 0.1, 0.3 and 0.5) were prepared by microwave-assisted combustion method. The purpose of this study was to investigate the solubility of the strontium and its influence on the structural and magnetic properties of cobalt ferrite. The powders produced were characterized by X ray Diffraction (XRD), Scanning electron microscopy (SEM) and Mössbauer spectroscopy. Magnetic measurements were performed at room temperature using a vibrating sample magnetometer (VSM). The XRD patterns showed the formation of cubic spinel phase to cobalt ferrite ($CoFe_2O_4$). However, a small amount of cobalt oxide (CoO) was also identified as a secondary phase. In doped materials, the introduction of the strontium in the spinel lattice caused the segregation of other undesirable phases such as strontium carbonate ($SrCO_3$) and an oxygen deficient strontium ferrite ($SrFeO_{2.96}$) as it observed by Mössbauer spectroscopy and Rietveld refinement. The materials exhibited ferrimagnetic behavior where the magnetic parameters varied depending of strontium content. The study indicated a low solubility of the strontium in the cobalt ferrite structure, which was expected since the ionic radius of Sr^{2+} (118 pm) is larger than Co^{2+} (75 pm). On the other hand, the small amount of strontium incorporated in the spinel phase caused significant changes on the magnetic properties. We have found an increase in the coercive field of all samples and an increase of saturation magnetization for the sample x = 0.1.

[1] Y. Cedeño-Mattei, O. Perales-Pérez, Microelect. J. **40**, 673 (2009).
[2] J. Li, Y. Lin, X. Liu, B. Wen, T. Zhang, Q. Zhang, H. Miao, Optics Commun. **283**, 1182 (2010).
[3] D.H. Kim, D. E. Nikles, D.T. Johnson, C.S. Brazel, J. Magn. Magn. Mater. **320,** 2390 (2008).

Author index

Notes

II Brazilian Workshop on Magnetization Dynamics
November 28-30, 2012
Natal, RN, Brazil

Organized by

Universidade Federal do Rio Grande do Norte
Centro Brasileiro de Pesquisas Físicas