

# ***CURRICULUM VITAE***

***Name: Mario Carpentieri***

***Date: February 11, 2019***

## GENERAL DATA

Birth's city and Birth's day	Locri (RC), Italy December 6, 1973
Position held	Ph.D. – Associate Professor – SSD: Ing-Ind/31 Department of Electrical and Information Engineering – Polytechnic University of Bari
Address	Via E. Orabona, 4 I-70125 Bari, Italy
Phone	+39.080.5963254
Fax	+39-080.5963410
e-mail	<a href="mailto:mario.carpentieri@poliba.it">mario.carpentieri@poliba.it</a>
Registry office	Married

## EDUCATION AND PROFESSIONAL EXPERIENCE

April 2017	<b>National Qualification for Full Professor</b> of Electrical Engineering. Scientific Sector: 09/E1 – Elettrotecnica (ING-IND/31). (Call 2016 (DD n. 1532/2016)). <a href="https://asn16.cineca.it/pubblico/miur/esito-abilitato/09%252FE1/1/1">https://asn16.cineca.it/pubblico/miur/esito-abilitato/09%252FE1/1/1</a>
From January 2016	<b>Scientific Head</b> of the Research Unit of Electrical Engineering of Bari inside the national group. <a href="http://www.gruppoelettrotecnica.it/index.php?who=dettunita&amp;id=2">http://www.gruppoelettrotecnica.it/index.php?who=dettunita&amp;id=2</a>
From October 2015	<b>Associate Professor</b> of Electrical Engineering (09/E1) at the Department of Electrical and Information Engineering of the Technical University of Bari, Bari (Italy).
February 2014	<b>National Qualification for Associate Professor</b> of Electrical Engineering. Scientific Sector: 09/E1 – Elettrotecnica (ING-IND/31). (Call 2012 (DD n. 222/2012)). <a href="https://abilitazione.cineca.it/ministero.php/public/esitoAbilitati/settore/09%252FE1/fascia/2">https://abilitazione.cineca.it/ministero.php/public/esitoAbilitati/settore/09%252FE1/fascia/2</a>
From May 2012 to October 2015	<b>Assistant Professor</b> of Electrical Engineering (09/E1) at the Department of Electrical and Information Engineering of the Technical University of Bari, Bari (Italy).
From February to March 2012	<b>Research contract</b> at the Department of Electronics, Computer and System Sciences of the University of Calabria (Italy). Topic: energetic efficiency of GAN devices for power electronics applications.

November 2011	<p><b>Visiting Researcher</b> at the Department of Physics – Laboratory of Atomic Physics and Solid State, <b>Cornell University</b>, Ithaca, NY, USA.  Topic of the research: “Theoretical study and modeling of spin-hall nano-devices”. Scientific Supervisor: Prof. Daniel C. Ralph.</p>
July 2011	<p><b>Leader of a post-doc research fellowship</b> at the University of Calabria.</p>
From February 2010 to April 2012	<p><b>Research Fellowship</b> at the Department of Electronics, Computer and System Sciences of the University of Calabria (Italy).  Title of the research activity: “<b>Study of memory devices on micromagnetic scale</b>”.  The research activity concerns the modeling of nanometer devices for Spintronic applications. Scientific Supervisor: Prof. Felice Crupi.</p>
September 2009	<p><b>Visiting Researcher</b> at the Department of Applied Physics – <b>University of Salamanca</b>, Salamanca, SPAIN.  Topic of the research activity: “Micromagnetic simulations of spintronic nano-devices”. Scientific Supervisor: Prof. Luis Torres.</p>
May 2009	<p><b>Visiting Researcher</b> at the Department of Applied Physics – Laboratory of Atomic and Solid-State Physics, <b>Cornell University</b>, Ithaca, NY, USA.  Topic of the research activity: “Designing and modeling of spintronic nano-devices”. Scientific Supervisor: Prof. Daniel C. Ralph.</p>
September 2008	<p><b>Visiting Researcher</b> at the Department of Applied Physics – <b>University of Salamanca</b>, Salamanca, SPAIN.  Topic of the research activity: “Nanoscale Modeling of Magnetization Dynamics excited by Spin Polarized Currents”. Scientific Supervisor: Prof. Luis Torres.</p>
From February 2008 to January 2010	<p><b>Research Fellowship</b> at the Department of Electronics, Computer and System Sciences of the University of Calabria (Italy).  Title of the research activity: “<i>Micromagnetic modeling of magnetization dynamics in nanostructures for Spintronic applications</i>”.  The research activity concerns the modeling of nanometer devices for Spintronic applications. Scientific Supervisor: Prof. Felice Crupi.</p>
From November 2005 to October 2007	<p><b>Research Fellowship</b> at the Department of Industrial Engineering of the University of Perugia (Italy). The research activity is carried out at the “Center for Electric and Magnetic Applied Research”, Scientific Pole of Terni (Italy). Scientific Supervisors: Prof. Ermanno Cardelli and Prof. Pietro Burrascano.</p>
February 2005	<p><b>Final defense</b> for the PhD degree in “<i>Advanced Technologies for optoelectronics, photonics and electromagnetic modeling</i>” from the University of Messina, Italy. Thesis’s title: “Micromagnetic study of magnetic multilayers for spintronic applications” (in English).</p>

From February 2005 to October 2005	<b>Ph.D. Research activity</b> at the “ <i>Department of Applied Physics</i> ” of the <i>University of Salamanca</i> (Spain) and at the “ <i>Department of Matter Physics and Electronics Engineering</i> ”. Scientific Supervisor: Prof. Luis Torres (University of Salamanca) and Prof. Bruno Azzerboni (University of Messina). The topics of the investigation are Spintronic Technology and micromagnetic simulations of magnetization dynamics in magnetic nanostructures. The research group has introduced the effect of the Spin Polarized currents in micromagnetic code.
From September 2004 to December 2004	<b>ERASMUS for PhD</b> student at the Department of Applied Physics (University of Salamanca). Scientific Supervisor: Prof. Luis Torres (University of Salamanca).
From August to September 2002	<b>Visiting Researcher</b> at the Microelectronic Institute of Madrid (CNM-CSIC), Tres Cantos, Madrid, SPAIN. Research topic: “Monitoring the spatial and intensity distribution on CCD patterns applied to in situ characterization”. Scientific Supervisor: Dr. Juan Pedro Silveira.
From November 2001 to October 2004	<b>Ph.D. Student</b> in “ <i>Advanced Technologies in Optoelectronic, Photonic and Electromagnetic Modeling</i> ”. Scientific Supervisor: Prof. Bruno Azzerboni (University of Messina). The research activity has been carried out at the “Department of Matter Physics and Electronics Engineering” of the University of Messina. Member of the evaluation committee for the Courses of Electrical Engineering.
From September 2000 to August 2001	<b>Specialization School</b> in “ <i>Analogical and Digital Electronic Design</i> ”. Scientific Supervisor: Prof. Romano Giannetti (Comillas University of Madrid - Spain). The research activity has been carried out at the ICAI of the associated center of the University of Madrid - Spain.
December 1999	<b>Master’s degree</b> in <i>Electronic Engineering</i> from the University of Messina, Italy. Thesis’s title: “Suppression of shot noise in thin oxide MOS devices”. Advisors: Prof. Bruno Neri (University of Pisa) and Prof. Carmine Ciofi (University of Messina); Co-Advisors: Dr. Felice Crupi (University of Pisa).
July 1992	“Diploma di maturità scientifica” from the “Liceo Scientifico La Cava” of Bovalino (RC), Italy.

## **PROFESSIONAL ACTIVITIES**

March 2020	<b>General Chair</b> of the international conference “ <b>Advances in Magnetism</b> ” (AIM 2020).
July 2019	<b>General Chair</b> of the international conference “ <b>Magnonics 2019</b> ” ( <a href="http://www.magnonics2019.poliba.it">www.magnonics2019.poliba.it</a> ).
From January 2019	<b>Associate Editor</b> of the international journal “Magnetism and Magnetic Materials Research (MMMR)” – Hapres.
July 2019	<b>Chair</b> of the session U16 “Vortex and skyrmion dynamics II” of the international conference ICM 2018 San Francisco, USA, July 15-20, 2018.
From February 2018	<b>Associate Editor</b> of the international journal “IEEE Transactions on Magnetism”.
From June 2017	<b>Member</b> of the doctoral board in “Electrical and Information Engineering”. Technical University of Bari. Courses: XXXIII-XXXIV.
June 2017	<b>Visiting professor</b> for the program Mobility for Teaching (SMT) Erasmus+ KA103 - Higher education student and staff mobility within Programme Countries, University of Salamanca (SPAIN).
From May 2017	<b>Member</b> of the “Presidio della Qualità di Ateneo” of the Technical University of Bari. <a href="http://www.poliba.it/it/Q%26S/presidio-della-qualit%C3%A0-di-ateneo">http://www.poliba.it/it/Q%26S/presidio-della-qualit%C3%A0-di-ateneo</a> .
May 2017	<b>Chair</b> of the session MoA2 “Hysteresis modelling” of the international conference HMM 2017 Barcelona, SPAIN, May 29-31, 2017.
April 2017	<b>Chair</b> of the session CN “Spin currents, switching and Spin Seebeck Effect II” of the international conference INTERMAG 2017 Dublin, IRELAND, April 25-29, 2017.
From February 2017	<b>Associate Editor</b> of the international journal “SCIENTIFIC REPORTS”, NATURE, ( <a href="http://www.nature.com/srep/about/editorial-board">www.nature.com/srep/about/editorial-board</a> ).
September 2016	Invited paper: topical review “ <b>Magnetic skyrmions: from fundamental to applications</b> ” for Journal of Physics D: Applied Physics (IOP).
From August 2016	<b>Associate Editor</b> of the international journal IEEE Transactions on Magnetism – Conferences.
August 2016	<b>Invited talk</b> “ <i>Giant spin-torque diode sensitivity in the absence of bias magnetic field</i> ” for the international conference BalticSpin 2016, Jurmala – LATVIA, August 9-13, 2016.

July 2016	<b>Member of the publication committee</b> of the international conference EMSA 2016 Torino – ITALY, July 12-15, 2016.
March 2016	<b>Member of the program committee and chair</b> of the session “Nanomagnetism and Spintronics” of the international conference AIM 2016 Bormio – ITALY, March 14-16, 2016.
November 2014	<b>Chair</b> of the session CW “Skyrmion I” of the international conference MMM 2014 Honolulu, Hawaii - USA, November 3-7, 2014.
From October 2014	<b>Member of the PhD Committee</b> in “Information and Communication Technologies”. University of Calabria.
From February 2014	<b>Senior Member</b> della <i>IEEE</i> # 90557910.
September 2013	<b>Lecturer of the course for PhD students</b> “Micromagnetism and spintronics for MRAM and nano-oscillator applications” (2 credits), for the PhD in “Systems and Information Science Engineering” of the University of Calabria.
July 2013	<b>Member of the Committee of European doctorate</b> at the University of Salamanca (Spain) for the doctoral thesis “Spintronic Micromagnetic Simulations Using Parallel Computations” presented by the PhD student David Aurelio.
November 2012	<b>Leader of the ANASSILAOS 2012</b> award.
From October 2012 to September 2013	<b>Member of the PhD Committee</b> in “Ingegneria Elettrica e dell’Informazione”. Technical University of di Bari.
From October 2012	<b>Member of the Editorial Board</b> of the IEEE Transactions on Magnetics.
July 2012	Invited paper: topical review “ <i>Micromagnetic simulations using Graphics Processing Units</i> ” for the international Journal of Physics D: Applied Physics (IOP).
From September 2011	<b>Member</b> of <i>IEEE</i> and <i>IEEE Magnetic Society</i> # 90557910.
February 2011	<b>PATENTS</b> P. Burrascano, <b>M. Carpentieri</b> , M. Ricci. Patent number: TR2011A000001 of 18.02.2011.

	Ministry of the Sviluppo Economico, brevetto N. 0001406955 del 14.03.2014 “Method for increasing the writing efficiency in MRAM nanodevices”.
From December 2009	<b>Member</b> of the committee of the Study Team “ <b>Energy and research</b> ” of the Research Italian Society.
May 2009	<b>Chair</b> of the session PB of the international conference HMM 2009 Gaithersburg, Maryland - USA, May 11-14, 2009.
February 2007	<b>PATENTS</b> P. Burrascano, <b>M. Carpentieri</b> , M. Ricci. Patent number: MI2007A000381 del 27.02.2007 “Method and related apparatus to the non-destructive test of conductor materials”.
July 2006	<b>Lecturer</b> of the NATO-ASI School in “ <i>Magnetic nanostructures for micro-electromechanical systems and spintronic applications</i> ” Catona, Calabria (Italy), July 2-15, 2006.
January 2006	<b>Member</b> of the Local Organizing Committee of the NATO-ASI School in “ <i>Magnetic nanostructures for micro-electromechanical systems and spintronic applications</i> ” Catona, Calabria (Italy), July 2-15, 2006.
May 2005	<b>Invited talk</b> “ <i>Ferromagnetic Relaxation Modes in Permalloy Nanostructures and its Excitation by Spin Polarized</i> ” for the international conference HMM 2005, Budapest – Hungary.
From October 2003	Different times spent as <b>Visiting Researcher</b> at the Department of Applied Physics – <b>University of Salamanca</b> , Salamanca, SPAIN: October – November 2003, May 2004, September – December 2004, May 2005, January 2006, September – October 2008, September 2009, June 2010. Topic of the research activity: “Nanoscale Modeling of Magnetization Dynamics excited by Spin Polarized Currents”. Scientific Supervisor: Prof. Luis Torres.
November 2002	Attendance at the XX Course of theoretical-practical education in “ <b>Measurements and Magnetic Materials</b> ” at the <b>INRIM (National Institute of Metrologic Research)</b> .
June 2002	<b>Member</b> of the Local Organizing Committee of the ET 2002 “ <i>Italian conference of the Electrical Engineering Researcher</i> ” Messina, Sicily (Italy), June 27-29, 2002.
June 2001	Job qualification as Engineer and registration to the Order of Engineering of Reggio Calabria.

### **PROJECT MANAGEMENT**

From January 2019 to December 2020	Italian Coordinator of the project “Rad-hard spintronics diodes with giant sensitivity (DIOSPIN), funded by the Agenzia Spaziale Italiana (ASI). The project aims to realize a detector rad-hard device for space applications based on a Magnetic Tunnel Junction (MTJ) cell. 3 research groups from different academia are involved in the project. Total project budget: 220 kEuro.
December 2017	Winner of the FFABR call (MIUR) following an evaluation of the scientific activity of the last 5 years. Total project budget: 3 kEuro.
From June 2012 to December 2017	Coordinator of the project FRA – Study and simulations of magnetization dynamics for spintronics nano-oscillator applications, founded by the Technical University of Bari, 2012-2017. Total project budget: 20 kEuro.
From January 2012 to December 2015	Responsible of the project PON Res Novae, Reti Edifici Strade, Nuovi Obiettivi Virtuosi per l’Ambiente e l’Energia”. Research Unit of Electrical Engineering of the Technical University of Bari, 2012-2105. Local project budget: 80 kEuro.

### **TEACHING**

From September 2018 to January 2019	Lecturer of the course of Electrical Circuits (6 credits) for the Degree in Medical Systems Engineering – Polytechnic University of Bari.
From September 2018 to January 2019	Lecturer of the course of Fundamental of Circuits Theory (6 credits) for the Degree in Electronic and Telecommunication Engineering – Polytechnic University of Bari.
From September 2018 to January 2019	Lecturer of the course of Electrical Engineering Principles (6 credits) for the Degree in Mechanical Engineering – Polytechnic University of Bari.
From September 2017 to January 2018	Lecturer of the course of Electrical Circuits (6 credits) for the Degree in Medical Systems Engineering – Polytechnic University of Bari.
From September 2017 to	Lecturer of the course of Fundamental of Circuits Theory (6 credits) for the Degree in Electronic and Telecommunication Engineering – Polytechnic University of Bari.



January 2018	
From September 2017 to January 2018	Lecturer of the course of Electrical Engineering Principles (6 credits) for the Degree in Mechanical Engineering – Polytechnic University of Bari.
From October 2016 to January 2017	Lecturer of the course of Fundamental of Circuits Theory (6 credits) for the Degree in Electronic and Telecommunication Engineering – Polytechnic University of Bari.
From October 2016 to January 2017	Lecturer of the course of Electrical Engineering Principles (6 credits) for the Degree in Mechanical Engineering – Polytechnic University of Bari.
From October 2015 to January 2016	Lecturer of the course of Fundamental of Circuits Theory (6 credits) for the Degree in Electronic and Telecommunication Engineering – Polytechnic University of Bari.
From October 2015 to January 2016	Lecturer of the course of Electrical Circuits (6 credits) for the Degree in Civil Engineering – Polytechnic University of Bari.
From March to June 2015	Lecturer of the course of Electrical Circuits (6 credits) for the Degree in Computer Science Engineering – University of Calabria.
From October 2014 to January 2015	Lecturer of the course of Electrical Circuits (6 credits) for the Degree in Civil Engineering – Polytechnic University of Bari.
From March to June 2014	Lecturer of the course of Electrical Circuits (6 credits) for the Degree in Computer Science Engineering – University of Calabria.
From October 2013 to January 2014	Lecturer of the course of Electrical Circuits (6 credits) for the Degree in Civil Engineering – Polytechnic University of Bari.
From October 2013 to January 2014	Lecturer of the course of Fundamental of Circuits Theory (6 credits) for the Degree in Electronic and Telecommunication Engineering – Polytechnic University of Bari.
From March to June 2013	Lecturer of the course of Electrical Circuits (9 credits) for the Degree in Electronic Engineering – University of Calabria.
From March to June 2013	Lecturer of the course of Electrical Circuits (6 credits) for the Degree in Computer Science Engineering – University of Calabria.
From October	Lecturer of the course of Electrical Circuits (6 credits) for the Degree in

2012 to January 2013	Civil Engineering – Polytechnic University of Bari.
From October to December 2012	Lecturer of the course of Electrical Engineering Principles (6 credits) for the Degree in Mechanical Engineering – Polytechnic University of Bari.
From March to June 2012	Lecturer of the course of Electrical Circuits (9 credits) for the Degree in Electronic Engineering – University of Calabria.
From March to June 2012	Lecturer of the course of Electrical Circuits (6 credits) for the Degree in Computer Science Engineering – University of Calabria.
From March to June 2011	Teaching assistant of the course of Electrical Circuits (36 hours) for the Degree in Electronic Engineering – University of Calabria. Teaching assistant of the course of Electrical Circuits (21 hours) for the Degree in Computer Science Engineering – University of Calabria.
From January to May 2007	Lecturer of the course of Electrical Drives for the Technological Class A035 of the SSIS at the University of Perugia.
From November 2002 to October 2007	Tutoring for students and educational seminars for Electrotechnics, Circuit Theory and Electrical Systems at the University of Messina and at the University of Perugia.

### **JOB EXPERIENCE**

From July 2010	<p>Founding member of the SpinOff Company “GoParallell S.R.L.” (<a href="http://www.goparallel.net/">http://www.goparallel.net/</a>). Environment Park of the University of Salamanca, Spain. “GoParallel” is specialized on improving the performance of scientific simulation programs, with particular attention to the calculation models for micromagnetic simulations. To date, the main purpose of this spin-off is precisely the development of a micromagnetic simulator implemented on multi-GPUs. The two main advantages are the possibility of simulating a large number of calculation cells and the high calculation speed. The spin-off has obtained the following funds and prizes:</p> <ul style="list-style-type: none"> <li>- 2013-2016 - Funding ID: SEP210059242. Marie Curie Initial Training Networks (ITN) Call: FP7-PEOPLE-2013-ITN. Title: “Controlling domain wall dynamics for functional devices”. As consulting company of the University of Salamanca.</li> <li>- 2010-2012 - Funding ID: 20110231 - CDTI (Centro para el Desarrollo Tecnológico Industrial) - <a href="http://www.cdti.es/">http://www.cdti.es/</a> - Spain. Funding given to the startup company “GoParallel” (<a href="http://www.goparallel.net/">http://www.goparallel.net/</a>) “Implementation of a parallel (GPU-based) micromagnetic solver”. €200.000.</li> <li>- 2012: Award ‘Premios Sociedad Civil 2012’ from the Universidad</li> </ul>
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	de Salamanca.
From November 2007 to July 2014	Activities of Senior Consultant for the “Supervisory and Control Systems” Competence Center of the SIGLA Group. Database design, configuration in Dvdraw, on site installation and commissioning with validation of the RFI Sicilia front-to-back remote-control system.
From May 2006 to May 2012	Maintenance contract for the remote-control software of the “Ferrovie dello Stato” in Sicily, at the “DOTE” electric traction operational management of Messina.
From September 2002 to July 2003	External Consultant assignment at the Sigla Group of Genova (GE) for the configuration of the remote-control software system of the Italian State Railways, at the “DOTE” electric traction operational management of Messina.
From July 2001 to December 2011	Design of Electrical Distribution Systems and Special Conditioning Systems.

### **INFORMATICS KNOWLEDGE**

- *Operative systems:* **Windows (all the versions), Linux, OpenVMS.**
- *Software commerciale:* **Office, Autocad, Software for the design of electric systems, OriginLab.**
- *Software - Programming:* **C, C++, Matlab, Visual Basic, Fortran, Cuda.**
- *Software - Simulation:* **Orcad Capture CIS, OOMMF, Code Composer, eCOS.**
- *Hardware description languages:* **VHDL.**

### **MISCELLANEOUS INFORMATION**

- Computer networks.
- Digital electronics, programmable logic, digital system design.
- Artificial Intelligence Techniques: Fuzzy Logic, Neural Networks.
- Numerical Signal Processing: Traditional Techniques, ICA, PCA, Wavelet, Neural Techniques, HHT.
- *Languages:*
- Spanish (excellent).
- English (excellent).
- French (scholastic).

### **RESEARCH ACTIVITY**

- Research activity at the Department of Electrical Engineering and Information of the Polytechnic University of Bari.
- Collaboration with the Department of Applied Physics of the University of Salamanca (SPAIN), Prof. Luis Torres. The topics of the collaboration concern the investigation and the micromagnetic characterization of ferromagnetic materials used for the realization of non-volatile magnetic memories (MRAM) and nanoscillators at microwave frequencies.

- Collaboration with the Department of Physics - Laboratory for Atomic Physics and Solid State of Cornell University (USA), Prof. Daniel C. Ralph. The topics of the collaboration concern the modeling and design of nano-spintronic devices, the modeling of the spin-hall effect for the creation of memories and nano-oscillators.
- Attendance of International Conferences (HMM, ICM, SCM, INTERMAG, COMPUMAG, CEFC, MMM, EMRS) and Workshops whose main theme is magnetism and its applications.
- Member of the EDITORIAL BOARD of the COMPUMAG – “International Conference on the Computation of Electromagnetic Fields”.
- Member of the CEFC EDITORIAL BOARD – “Conference on Electromagnetic Field Computation”.
- Member of the EDITORIAL BOARD of the international journal IEEE TRANSACTIONS ON MAGNETICS.
- Member of the EDITORIAL BOARD of the international journal SCIENTIFIC REPORTS, NATURE.
- Member of the EDITORIAL BOARD of the international journal Magnetism and Magnetic Materials Research (MMMR), HAPRES.
- Member of the Advisory Committee of the Italian Association of Magnetism.
- Advisor of 1 Ph.D student in “Information and Communication Engineering for Pervasive Intelligent Environments”, XXVIII cycle, University of Calabria.

**Reviewer** for the following international journals:

- Scientific Reports (NATURE).
- IEEE Transactions on Magnetics (IEEE).
- IEEE Magnetics Letters (IEEE).
- IEEE Transactions on Nanotechnology (IEEE).
- IEEE Transactions on Electron Devices (IEEE).
- Physical Review Letters (APS).
- Physical Review Applied (APS).
- Physical Review B (APS).
- Applied Physics Letters (AIP).
- Journal of Applied Physics (AIP).
- AIP Advances (AIP).
- Electric Power Systems Research (Elsevier).
- Journal of Magnetism and Magnetic Materials (Elsevier).
- Physica B (Elsevier).
- Solid-State Electronics (Elsevier).
- Journal of Physics D: Applied Physics (IOP).
- Journal of Physics (IOP).
- New Journal of Physics (IOP).

**Reviewer** of scientific projects:

- Prin and Firb financed by the Ministry of Education, University and Research.
- Projects of the Government of Romania through the National Research Council (CNCS - <http://www.cncs-uefiscdi.ro/home/>).
- Projects of the French Government through the National Research Agency (ANR - <http://www.agence-nationale-recherche.fr/>).

- Projects of the German Government through the Deutsche Forschungsgemeinschaft (DFG) - [https://elan.dfg.de/dana-na/auth/url\\_3/welcome.cgi](https://elan.dfg.de/dana-na/auth/url_3/welcome.cgi)).

#### **Scientific collaborations:**

- University of Salamanca (SPAIN) - Department of Applied Physics. Prof. L. Torres, Prof. L. Lopez-Diaz, Dr. E. Martínez.
- Bogazici University (TURKEY) - Department of Physics. Prof. Ozhan Ozatay.
- Cornell University (USA) - Department of Physics. Prof. D. Ralph, Prof. R. Buhrman.
- Oakland University (USA) - Department of Physics. Prof. A. Slavin.
- Suzhou Institute of Nanotech and Nanobionics - Suzhou (CHINA). Prof. Z. Zeng.
- Kyoto University (JAPAN) - Division of Materials Chemistry - Nanospintronics. Prof. Takahiro Moriyama.
- University of Gothenburg (SWEDEN) - Department of Physics. Prof. J. Åkerman.
- Johannes Gutenberg-Universität Mainz (GERMANY) - Institute of Physics. Prof. M. Kläui.
- University of California (USA) - School of Physical Sciences. Prof. I. Krivorotov.
- Institute of Magnetism, National Academy of Sciences of Ukraine (UKRAINE) - Dr. R. Verba.
- University of Perugia - Department of Industrial Engineering. Prof. E. Cardelli.
- University of Perugia - Department of Physics and Geology. Prof. G. Carlotti, Dr. G. Gubbiotti.
- University of Perugia - Terni Scientific and Didactic Center. Prof. P. Burrascano.
- University of Messina - Department of Electronic Engineering, Chemistry and Industrial Engineering. Prof. B. Azzerboni.
- University of Messina - Department of Mathematics and Computer Science, Physical Sciences and Earth Science. Dr. Giovanni Finocchio.
- University of Reggio Calabria - Department of Civil Engineering, Energy, Environment and Materials. Prof. F. C. Morabito.
- University of Calabria - Department of Computer Engineering, Modeling, Electronics and Systems. Prof. F. Crupi, Dr. M. Lanuzza.
- Polytechnic University of Turin - Department of Energy. Prof. C. Ragusa.
- University of Naples Federico II - Department of Electrical Engineering and Information Technology. Prof. C. Serpico.
- University of Naples Parthenope - Department of Engineering. Prof. M. d'Aquino.
- Inrim of Torino – Department of Advanced materials metrology and life sciences. Dr.ssa Paola Tiberto.

### **RESEARCH TOPICS**

#### **Micromagnetism and Spintronics**

##### **Outline**

The research activity is focused on the study of magnetic nanodevices through the development and use of numerical analysis and analytical formulations, compared with the experimental data coming from the collaboration with different world research groups. Micromagnetism is the point of connection between magnetism at the atomic level and the macroscopic behavior of magnetic materials. The theoretical demonstration of Slonczewski has opened up a whole new research topic in the field of micromagnetism aimed at the study of spintronics and its possible applications. Initially the spintronics was born with the aim of realizing passive devices based on

the GMR effect, such as MRAM (Magnetic Random-Access Memory), sensors and switches. During the first period of research activity it was necessary to develop an “ad hoc” simulation code for the study of these nanodevices; a micromagnetic simulation code was realized in fortran and tested with the standard problems of the micromagnetism of the mumag (world company of micromagnetics). In the field of spintronics and nanomagnetism, the research contributions concerned the pioneering demonstration of the inversion of the magnetization of nanostructured devices and the possibility of exciting magnetic structures at the nanometer scale by means of persistent oscillations at microwave frequencies. The research work also involved demonstrating that the spin torque can be used in magnetic tunnel junction structures, although quite high current densities are required. This research has made a valuable contribution to the industrial launch of magnetic memories based on the effect of high-performance spin transfer torque, which in the near future could replace the classic CMOS semiconductor memories.

During the research in the spintronics field, an important activity concerned the study of the giant spin-Hall effect in Pt, Ta and W, where the spin-orbit interaction gives rise to the generation of spin currents transverse to the direction of the current applied, also applied to devices with 3-terminals that can have a potential application as memory and spintronic oscillators. A recent and important research activity concerns the study of a new topologically protected magnetic structure called “skyrmion”. This structure finds application as a racetrack memory, oscillator and diode. In the last period, the research activity is focusing on the study of the high sensitivity spintronic diode effect also for energy harvesting application. Finally, from the collaboration with other research groups the antiferromagnetic devices for applications at terahertz frequencies and the hybrid CMOS / MTJ structures for application as non-volatile memory are being studied.

### **Main results**

- ✓ Development of the numerical code that describes the spintronic behavior and its validation with the four Standard Problems of Micromagnetism [J33].
- ✓ Description of the switching depending on the thermal field, Ampere range and Anti-free coupling field [J6, J9, J11, J12, J13, J14, J17, B3].
- ✓ Study of different strategies for fast-switching in non-volatile magnetic memory cells (MRAM) [J26, J28, J36, B6].
- ✓ Study of the micromagnetic behavior of nanostructures when polarized spin currents and a radiofrequency field are applied [J18, J25].
- ✓ Elaboration of phase diagrams that depend on the geometry of the nanostructure and general theoretical study of phase diagrams. Angular and spatial dependence of the polarization function of Slonczewski [J27, J31].
- ✓ Study of film thin magnetic nanodevices: Magnetic Tunnel Junction and Nano Point Contact [J23, J30, J32, J34].
- ✓ Spectral analysis of ferromagnetic resonance modes in spin-valves, use of alternating currents and radiofrequency magnetic fields [J29, J35].
- ✓ Theory based on first principles for the implementation of the thermal field.
- ✓ Micromagnetic study of interface conductance and effective damping [J39, J41].
- ✓ Studies of magnetic vortexes and domain wall movement [J37, J38, J49].
- ✓ Application of spintronic nanodevices as oscillators at microwave frequencies: study of quality parameters and magnetization dynamics [J42, J43, J44].
- ✓ Nanopillar study with perpendicular anisotropy: strategies to reduce switching times and analysis of dynamic structure behavior (injection locking and linewidth) [J45].
- ✓ Study of stochastic resonance in magnetic structures [J46].

- ✓ Numerical implementation of a semi-implicit algorithm for the solution of the Landau-Lifshitz-Gilbert-Slonczewski equation [J50].
- ✓ Theoretical study and experimental realization of magnonic crystals [J48].
- ✓ Use of particular numerical sequences in magnetic nanopillars to obtain fast-switching in magnetic memories applications [J47, J51, J56].
- ✓ Theoretical and experimental study of double-free-layer devices for zero-field nano-oscillator applications [J54, J57].
- ✓ Study of the synchronization of spintronic nano-oscillators [J52, J55].
- ✓ Study of the dynamics of magnetic vortices for nano-oscillator devices [J59, J68]
- ✓ Study of the magnetization dynamics in MTJ devices [J60, J67].
- ✓ Study of 3-terminal devices based on the combined spin-torque and spin-hall effect [J61].
- ✓ Study of the effect of the electric field for “fast-switching” in MTJ devices [J70].
- ✓ Study of new generation nanodispersives based on the spin-hall effect: switching and magnetization dynamics [J58, J65, J72, J84].
- ✓ “Skyrmion” magnetic configuration for application in racetrack memories [J66].
- ✓ Spin-wave study in nanowire structures based on the VCMA effect [J79].

### **Research in progress**

- ✓ Study of the diode effect in new generation spintronic devices [J64, J78].
- ✓ Study of nanowire structures as spintronic oscillators [J69, J71, J89].
- ✓ Effect of diode and nano-oscillators based on “skyrmion” [J75, J73, J82, J83, J86].
- ✓ Study of oscillators at terahertz frequencies in antiferromagnetic materials [J106].
- ✓ Energy harvesting in spintronic devices [J107].
- ✓ Study of CMOS/MTJ hybrid systems for applications such as non-volatile memory [J87, J93, J98-J100].

## **OTHERS RESEARCH TOPICS**

### **Non-destructive test**

- ✓ Development of an experimental measurement system for non-destructive tests characterized by induced currents.
- ✓ Development and use of a new type of excitation signal of the measurement system to realize multi-frequency measurements and simultaneously improve the signal/noise ratio [J22, J24].
- ✓ Use of new data analysis techniques.
- ✓ Application of methodologies to investigate defects in on-site metals on the production process.

### **Design and operation of smart-grid**

- ✓ Characterization of distribution lines of electric power signals in active and passive distribution lines [J77, J85, J95].
- ✓ Study and data analysis through innovative mathematical tools [J80, J94].

## **SCIENTIFIC PUBLICATIONS:**

- *Researcher ID (ISI Web of Science):* I-9414-2012
- *International journals:* **108**
- *Citations number (from ISI Web of Science, Journals):* **1624**
- *h-index (from ISI Web of Knowledge, Journals):* **23**
- *Average citation per items (from ISI Web of Science, Journals):* **15**

- *Book chapters*: **7**
- *International conferences*: **189**
- *International conferences as lecturer*: **65**
- *Selected papers for “Virtual Journal of Nanoscale Science & Technology”*: **8**
- *Selected papers for “Virtual Journal of Ultrafast Science”*: **1**
- *Selected papers for “Research Highlights”*: **1**
- *Patents*: **2**
- *National conferences*: **48**

Bari, February 11, 2019

Autorizzo il trattamento dei miei dati personali ai sensi del Decreto Legislativo 30 giugno 2003, n. 196 “Codice in materia di protezione dei dati personali”, assumendomi la piena responsabilità relativamente alla veridicità di tutte le informazioni riportate.

In fede