MINISTERIO DE CIENCIA E INNOVACIÓN

AGENCIA ESTATAL DE INVESTIGACIÓN

DESCRIPTION OF THE GROUP

The **Group of Nanomagnetism and Magnetization Processes** (GNMP) is a highly productive research team of the Instituto de Ciencia de Materiales de Madrid (ICMM) from the Consejo Superior de Investigaciones Científicas (CSIC). Our group has obtained the **maximum calification (A-Excellent)** in the last internal evaluation of all the CSIC groups. The evaluators highlight the good Spanish and International funding as well as the funding obtained from technological companies. It is also remarked the scientific and technological activity together with a high level scientific training of PhD students.

Additionally to nanofabrication, research is focused on magnetic domain observation, magnetization reversal process (i.e., controlled domain wall motion), and magnetotransport properties, with particular emphasis on the study of this phenomena through magnetic imaging via Magnetic Force Microscopy and the development of novel measurement modes. The group members are, as well, frequent users of the CIRCE and MISTRAL beamline in ALBA synchrotron, where they perform X-ray magnetic circular dichroism photoemission electron microscopy (XMCD-PEEM) and Transmission X-ray Microscopy. On the other hand, the group possesses acknowledged expertise on the multiscale modelling of magnetic materials and in particular, on micromagnetic simulations (i.e., mumax3 and oommf software), as well as fundamental studies on high frequency magnetization dynamics.

Regarding facilities, the research team has different laboratories and measurement techniques of its own, additionally to other available techniques in the Institute and the Campus:

-Sample preparation: Anodization & electrodeposition laboratory; Magnetron sputtering and evaporation growth laboratory; ultrafast solidification laboratory.
-Magnetic characterization: Magnetometry & magnetotransport laboratory (Vibration Sample Magnetometry (VSM), Anisotropic Magnetic Resistance (AMR), Giant Magnetic Impedance (GMI) & Ferromagnetic Resonance measurements); Scanning probe microscopy & surface magnetism laboratory (Variable Field Magnetic Force Microscopy (VF-MFM), Magneto-optic Kerr effect magnetometry).
-Technical magnetism laboratory: Fluxmetric induction technique, switching field fluctuations measurement. Time-resolved domain wall speed.

Facilities at the ICMM-CSIC: The material science institute has some support laboratories where different characterization techniques are available for the researchers, as well as a clean room, workshop, informatics service, etc. https://www.icmm.csic.es/institute/techniques-equipment.php and https://www.icmm.csic.es/institute/support_labs/index.php Additional facilities are available on the UAM-CSIC Campus, such as the micro and nanofrabrication NanoFabLab from IMDEA Nanociencia.

Students:

Name	Position	Type of contract/fellowship
Jorge Marqués Marchán	Predoctoral researcher	FPU research fellow
Elías Saugar Gotor	Predoctoral researcher	Ascribed to Project
Zengxin Wei	Predoctoral researcher	Temporary position
Jesús Nevado	Predoctoral researcher	Programa Garantía Juvenil CAM
Joao de Quiros Fradet	Predoctoral researcher	FPI research fellow
Paul Gavriloaea	Predoctoral researcher	Ascribed to European Project
Cantia Belloso	Predoctoral researcher	FPU research fellow

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GUIDANCE AND TRAINING EXPERIENCE (2016-2020)

The members of the Research Group have a large experience in the training of scientific personnel, since 2016,:

- the scientific staff has supervised 8 PhD students and 7 postdoctoral researchers, most of them nowadays working in the most prestigious Research Centers and Universities (http://www.icmm.csic.es/gnmp/).
- There are currently 4 ongoing PhD thesis.
- We supervise regularly Master and Bachelor students, namely 14 in this period.
- The scientific staff participate in different Masters offered by prestigious Universities and in the postgraduate course of the ICMM-CSIC "Fronteras en Ciencia de Materiales" https://wp.icmm.csic.es/fronteras/cursos-fronteras-en-ciencia-de-materiales/
- We regularly participate in outreach activities (R.P del Real and A. Asenjo belong to the Outreach Committee of the ICMM-CSIC) as Guided Visits to the ICMM, *Feria de la Ciencia*, *Festival de Nanotecnología*, *La Noche de los Investigadores*.
- A Asenjo participates also in the Equality Gender Committee.

PhD supervision

PhD student	Date	Supervisor	Title
Esther Calle Ramirez	April 2021	Rafael Perez del Real Manuel Vázquez	Time-resolved dynamics of a single domain wall in amorphous microwires.
Ana Sofia Silva	Nov 2020	David Navas and Helder Crespo	Ultrafast Magnetization Dynamics in Multilayered Films Down to Few-cycle Regime
Nikita Kulesh Alexandrovich	June 2020	Manuel Vázquez Villalabeitia Vladimir Vas'kovskiy Olegovich	Continuous and Nanopatterned TbCo-based Heterostructures with In-plane and Perpendicular Anisotropy
José Ángel Fernández Roldan	June 2019	Oksana Chubykalo Fesenko Rafael Perez del Real Manuel Vazquez Villalabeitia	Micromagnetism of cylindrical nanowires with compositional and geometric modulations
Eider Berganza Eguiarte	June 2018	Agustina Asenjo Barahona Miriam Jaafar Ruiz-Castellanos	A study of complex magnetic configurations using magnetic force microscopy
David González Trabada	September 2017	Manuel Vázquez Villalabeitia David Navas Otero	Plantillas Nanoestructuradas por impresión y anodización para el crecimiento de redes ordenadas de nanohilos y nanotiras de Co
Roberto Moreno Ortega	June 2017	Oksana Chubykalo Fesenko	The ultrafast magnetization dynamics and the role of the exchange interactions
Ester María Palmero Rodríguez	December 2016	Manuel Vázquez Villalabeitia Cristina Bran Rafael Pérez del Real	Magnetization processes in mnodulated magnetic nanowires

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Bachelor supervision:

Student	Degree	Institution	Supervisor	Year
Alex Armengod Martinez	Grado Ingenieria Química	Universidad Autónoma de Madrid	Cristina Bran	2019
María de la Concepción Pérez Carmona	Grado de Ingeniero de Materiales	Universidad Politécnica de Madrid	Agustina Asenjo	2019
Natalia de la Torre Gordo	Chemistry	Universidad de Alcalá	Rafael Perez	2018
Carlos Gutiérrez Álvarez	Physics	Universidad Complutense de Madrid	Rafael Perez	2018
Marta Izquierdo	Physics	Universidad Autónoma de Madrid	Miriam Jaafar Julio Gomez (UAM)	2018
Miguel Angel Pulido Lendínez	Physics	Universidad Autónoma de Madrid	Miriam Jaafar Agustina Asenjo	2018
Raul Chamorro Carrasco	Materials engineering	Universidad Complutense de Madrid	Rafael Perez	2017
Ana Díaz Quijada	Materials engineering	Universidad Complutense de Madrid	Rafael Perez	2017
Raúl Izquierdo	Physics	Universidad Autónoma de Madrid	Miriam Jaafar Agustina Asenjo	2017
Diego Escribano	Physics	Universidad Autónoma de Madrid	Miriam Jaafar Julio Gomez (UAM)	2017
Ángel Ibabe	Physics	Universidad Complutense de Madrid	Agustina Asenjo/ Miriam Jaafar	2017

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SCIENTIFIC PRODUCTION (2016-2021)

The Scientific Results of Group of Nanomagnetism and Magnetization Processes during the last 5 years can be summarized in :

- 98 papers published in journals included in JCR in this period with around 1066 citations, the H index=19.
- 60 of the 87 articles (69%) are published in Q1 journals.
- 40 papers are Open Access
- 1 book has been published by M. Vázquez as Editor and with the participation of different members of the group in four Chapters.
- We have published 4 patents (one of them was exploited by a company in 2018)
- We have presented around 80 contributions to international congress, 20 of them as invited talks.

Books

"Magnetic Nano and Microwires" M. Vazquez ed., Elsevier, Cambridge, 2020 Second edition, ISBN: 978-0-08-102832-

Research Papers:

1. S. Catalán-Gómez, C. Bran, M. Vázquez, L. Vázquez, J.L. Pau and A. Redondo-Cubero
   Plasmonic coupling in closedpacked ordered gallium nanoparticles
   Scientific Reports (2020) 10:4187

2. Muñoz-Menendez, C., Serantes, D., Chubykalo-Fesenko, O., Ruta, S., Hovorka, O., Nieves, P., Livesey, L., Baldomir, D., Chantrell, R. Disentangling local heat contributions in interacting magnetic nanoparticles
   Physical Review B, 2020, 102(21), 214412

3. Otxoa, R.M., Atxitia, U., Roy, P.E., Chubykalo-Fesenko, O.
   Giant localised spin-Peltier effect due to ultrafast domain wall motion in antiferromagnetic metals
   Communications Physics, 2020, 3(1), 31. *Cited 2 times.*

4. Vedmedenko, E.Y., Kawakami, R.K., Sheka, D.D., Gambardella, P., Kirilyuk, A., Hirohata, A., Binek, C.Chubykalo-Fesenko, O., Sanvito, S., Kirby, B.J.
   The 2020 magnetism roadmap
   Journal of Physics D: Applied Physics, 2020, 53(45), 453001. *Cited 10 times.*

5. Bran, C., Fernandez-Roldan, J.A., Del Real, R.P., Asenjo, A., Chen Y.S., Zhang, J., Zhang, X., Fraile-Rodríguez, A., Foerster, M., Aballe, L., Chubykalo-Fesenko, O., Vazquez, M
   Unveiling the origin of multidomain structures in compositionally modulated cylindrical magnetic nanowires
   ACS Nano, 2020, 14(10), pp. 12819–12827

6. Berganza, E., Jaafar, M., Fernandez-Roldan, J.A., Chubykalo-Fesenko, O., Asenjo, A.
   Half-hedgehog spin textures in sub-100 nm soft magnetic nanodots
   Nanoscale, 2020, 12(36), pp. 18646–18653. *Cited once.*

7. Dieny, B., Prejbeanu, I.L., Garello, K., Chubykalo-Fesenko, O., Bortolotti, P. Gambardella, P., Freitas,P, Lehndorff, R.,Raberg, W.,Ebels, U., Demokritov, S. O., Akerman, J., Deac, A., Pirro, P., Adelmann, C., Anane, A., Chumak, A. V., Hirohata, A., Mangin S., Valenzuela, S. O., Cengiz Onbaşlı, M., d'Aquino, M., Prenat, G., Finocchio, G.,Lopez-Diaz, L., Chantrell, R., Chubykalo-Fesenko, O., Bortolotti, P.
   Opportunities and challenges for spintronics in the microelectronics industry
   Nature Electronics, 2020, 3(8), pp. 446–459.

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8. Olleros-Rodríguez, P., Guerrero, R., Camarero, J.,.Chubykalo-Fesenko, O., Perna, P.
Intrinsic Mixed Bloch-Néel Character and Chirality of Skyrmions in Asymmetric Epitaxial Trilayers
ACS Applied Materials and Interfaces, 2020, 12(22), pp. 25419–25427
IF: 8.758

9. Torche, P., Munoz-Menendez, C., Serantes, D., Baldobir, D.,Livesey, K.L., Chubykalo-Fesenko, O., Ruta, S., Chantrell, R., Hovorka, O.
Thermodynamics of interacting magnetic nanoparticles
Physical Review B, 2020, 101(22), 224429

10. Simeonidis, K., Martinez-Boubeta, C., Serantes, D., Ruta, S., Chubykalo-Fesenko, O., Chantrell, R., . Oró-Solé, J.,Balcells, L.I., Kamzin , A.S.,Nazipov, R.A., Makridis, A., Angelakeris, M.
Controlling Magnetization Reversal and Hyperthermia Efficiency in Core-Shell Iron-Iron Oxide Magnetic Nanoparticles by Tuning the Interphase Coupling
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11. Cacilhas, R., de Araujo, C. I. L., Carvalho-Santos, V. L., Moreno, R., Chubykalo-Fesenko, O., Altbir, D.
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Physical Review B , 2020, 101, 184418. *Cited once.*

12. Algueró, M., Pérez-Cerdán, M., del Real, R.P., Ricote, J., Castro, A.
Novel Aurivillius Bi4Ti3−2xNbxFexO12phases with increasing magnetic-cation fraction until percolation: a novel approach for room temperature multiferroism
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Structural, morphological and magnetic properties of GaSbMn/Si(111) thin films prepared by radio frequency magnetron sputtering
Thin Solid Films, 2020, 705, 137971

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15. Fernandez-Roldan, J.A., Del Real, R.P., Bran, C., Vazquez, M., Chubykalo-Fesenko, O.
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16. Kaidatzis, A., del Real, R.P., Alvaro, R., Niarchosa, D., Vázquez, M., García-Martín, J.M.
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Soft Matter, 12 (43), pp. 8815-8818. (2016) *Cited 6 times.*

Funded projects

Project title	Funded by	Period	Main researcher(s)
Cold Opto-Magnetism for Random Access Devices (COMRAD)	H2020-MSCA-ITN-2019	Jun 2020-May 2024	Spain: Oksana Fesenko
Estudio de magnetism 3D en geometría cilíndrica Para tecnologías emergentes con ahorro energético Dinamica inducida por corriente y de altas frecuencias	MINECO (PID2019-108075RB-C31)	Jun. 2019 – May. 2022	Oksana Fesenko, Agustina Asenjo
Solutions from Nanomagnetism to the Society Challenges (NANOMAGCOST)	Autonomous Goverment of Madrid (P2018/NMT-4321)	Jan 2019-Dec 2022	Rodolfo Miranda/ Manuel Vázquez Villalabeitia and Agustina Asenjo
Nanorobots and Magnetic sensors based on Nanowires	CSIC (i-LINKA0052)	Jan 2019-Dec 2020	Manuel Vázquez
Towards a personalized medicine: a proof of concept	CSIC (i-LINKA0783)	Jan 2019-Dec 2020	Rafael Pérez del Real
Optimización de las técnicas electroquímicas para el crecimiento de nanohilos magnéticos y su caracterizacion mediante efecto Kerr magneto-óptico	CSIC (I-COOP-B20307)	Jan 2018 - Dec 2019	Paula Bercoff/ Manuel Vázquez Villalabeitia
MAGNETOFON, Ultrafast opto-magneto-electronics for non-dissipative information technology	COST Action CA17123	Oct 2018-: Oct 2022	Coordinator: A.Kirilyuk (Holanda) Coordinator in Spain and manager of the Stays O.Fesenko
Spanish Network on Spintronics	MINECO (MAT2017-90771-REDT)	Jan 2018-Dec 2020	F. Bartolomé/IP nodo campus UAM: Oksana Fesenko
Theory and multiscale modelization of systems based on magnetic skyrmions for spintronic applications in low consuming technologies.	MINECO (FIS2016-78591-C3-3-R)	Jan 2017-Dec 2019	J. Camarero/ Oksana Fesenko
Engineering magnetic nanowires for green technologies	MINECO (MAT2016-76824-C3-1-R)	Jan 2017-Dec 2019	Agustina Asenjo / Rafael Pérez del Real
Modos avanzados en microscopía de fuerzas magnéticas: aplicación en biomateriales	MINECO (MAT2015-73775-JIN)	Jan 2016-Dec 2018	Miriam Jaafar
Development of a new technology for the application in wireless battery charging in the range of 20-150 kHz.	MINECO (RTC-2016-4820-4)	Sept-2016 – Dec 2018	Rafael Pérez del Real
Magnetic nanowires and their tridimensional arrays for advanced technologies	MINECO (MAT2013-48054-C2-1-R)	Jan 2015-Dec 2017	Manuel Vázquez Villalabeitia/ Agustina Asenjo Barahona
Nuevas fronteras del nanomagnetismo fundamental y	Autonomous Government of	Oct 2013-Sept 2017	Rodolfo Miranda/ Manuel Vázquez Villalabeitia

aplicado, NANOFRONTMAG	Madrid (S2013/MIT-2850)		
Study of new types of magnetization dynamics and materials for applications in low consuming spintronics and magnetic recording.	MINECO (MAT2013-47078-C2-2-P)	Jan 2014-Dec 2017	Oksana Fesenko

Contracts with companies

Title	Company	Period	Main researcher
Magnetic Microwire as Core Material	Bartington	Sept 2021-July 2022	Manuel Vazquez
Electromagnetic sensing for multifunctional clinical intracranial	Ortho Baltic (Lithuania)	Jul 2020-Jun 2021	Manuel Vazquez
Collaborative agreement based on “Ultrafast magnetization dynamics”	Hitachi Cambridge, UK	Feb 2018-	Oksana Fesenko
Development of antennas using pke technology	PREMO	May 2016-Dec 2017	Rafael Pérez del Real
Study on EM protection of electrical bundles to fast EM transients	EADS France	Sept 2013-Sep 2016	Rafael Pérez del Real

Patents

Authors	Title	Country	Reference
M. Vazquez, David Gonzalez, David Navas	Nanostructured materials fabricated combining soft lithography imprint, anodization and sputtering	Europe	PCT16411475 (2019)
M. Jaafar, A. Asenjo, J.M. de Teresa, J. Pablo-Navarro, J. Gómez-Herrero, P. Ares, C. Magén	System for an atomic forces microscope	Spain	P201731292
M. Vázquez, R. ElKammouni, V. Rodionova, K. Chichay, I. Baraban, N. Perov	Microactuator based on bimagnetic coated core/shell microwires with asymmetric external shell and the use of it	Europe/ Russia	EP17382418.6
M. Vázquez, V. Kolesar	Temperature sensor for electromechanical systems and its fabrication procedure	Spain	PES1641.1023CT /ES2015/070752

INTERNATIONALIZATION OF THE GROUP

The GNMP group has a **considerable international visibility** and a tradition to **collaborate and /or supervise visitors** from research groups and universities from all over the world. Apart from the foreign people that have joined the group in the last years, the following researchers have visited us:

Visiting Senior Researchers

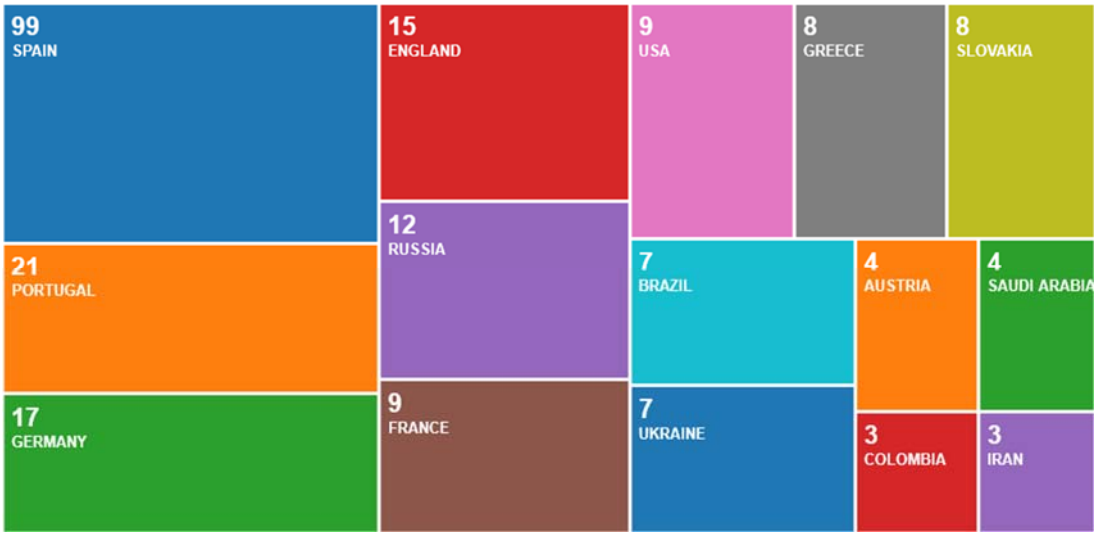
Visitor researcher	Institution	Country	Period	Funding
Prof. Laura H. Lewis	Northeastern University, Boston	USA	May-Jul 2015, 2016, 2017, 2018, 2019	Fulbright- Spain
Prof. Paula G. Bercoff	Faculty of Mathematics, Astronomy and Physics, National University of Córdoba	Argentina	Feb - Mar 2016	i-COOP project (CSIC)
Ass. Prof. Mattia Butta	Czech Technical University, Prague	Czech Republic	Jan- Dec 2019	Bilateral program Czech Technical University / CSIC
Dr. Margarida Fernandes	Universidade do Minho, Braga	Portugal	Oct- Dec 2018	Un. Do Minho

Visiting PhD and Master Students:

Visitor researcher	Institution	Position	Country	Period
Soledad Aprea	National University of Cordoba	PhD student	Argentina	Apr -Sep 2019
Nikita V. Kulesh	Urals Federal University, Ekaterinburg	PhD Student	Russia	Jun-Sep 2017, Apr-May 2018, May-Jun 2019
Fernando Meneses	National University of Cordoba	PhD student	Argentina	Oct- Dec 2018
Juan Pablo Mesa Taborda	Northeastern University, Boston	Master student	USA	Jun- July 2018
Alex Jiménez	Northeastern University, Boston	Master student	USA	Jun- Jul 2018
Alejandro Riveros	Universidad Central de Chile	PhD student	Chile	Jun- Jul 2018
Felipe Tejo	Universidad Central de Chile	PhD student	Chile	Dec 2017-Oct 2018
Irina Machay	Immanuel Kant Baltic Federal University	PhD student	Russia	Sep-Dec 2017

Jonathan Zamora	Universidad Nacional Autónoma de México	PhD student	Mexico	Sep 2016- Feb 2017
Yu-Sheng Chen	Yuan-Ze University	PhD student	Taiwan	Jul- Dec 2016
Majid Peighambari	Sahand University of Technology,Tabriz	PhD student	Iran	Feb- Dec. 2016

Moreover, as a result of the collaboration with other international groups and research centers, the papers published during this period (2016-2020) have around 300 international co-authors among the more than 400 co-authors (WOS). This Treemap shows the distribution of the origin of some of the co-authors of the papers during this period.



Some of these collaborations are supported by different projects as i-Coop, i-Link, COST action and ETN projects.

The members of the Group have intensively participated in international activities and societies. Particularly, M. Vázquez has been the President of the IEEE Magnetics Society in 2017-2018; O. Chubykalo-Fesenko has been member of the Administrative Committee and Chapters Chair of the IEEE MagSoc, 2017-2020; Agustina Asenjo has been recently elected member Spain representative to the General Council of the European Magnetic Association; Rafael P. del Real is the Chair of the next European Magnetic Sensor and Actuators conference to be held in Madrid.
M. Vazquez has been recipient of the S. Velayos Award, 2017, for his international promotion of Spain's Magnetism.

In addition, members of the group have participated systematically in international activities giving over 30 Invited Talks at National and International Conferences, Summer Schools and Seminars in well acknowledged international research centres within the period 2016-2020. These achievements have allowed the group to gain international reputation and settle number of collaborations with international groups (S. Parkin, O. Gutfleisch, R. Cowburn, O. Kazakova, K. Nielsch, E. Snoeck, K.Y.Guslienko, M. Farle, M. Groenefeld, R. Ibarra, J.M. de Teresa, J. Kosel, A. Labarta, X. Battle, J. Gómez–Herrero, L. Aballe, O. Fruchart, R. Chantrell or P. Grutter).