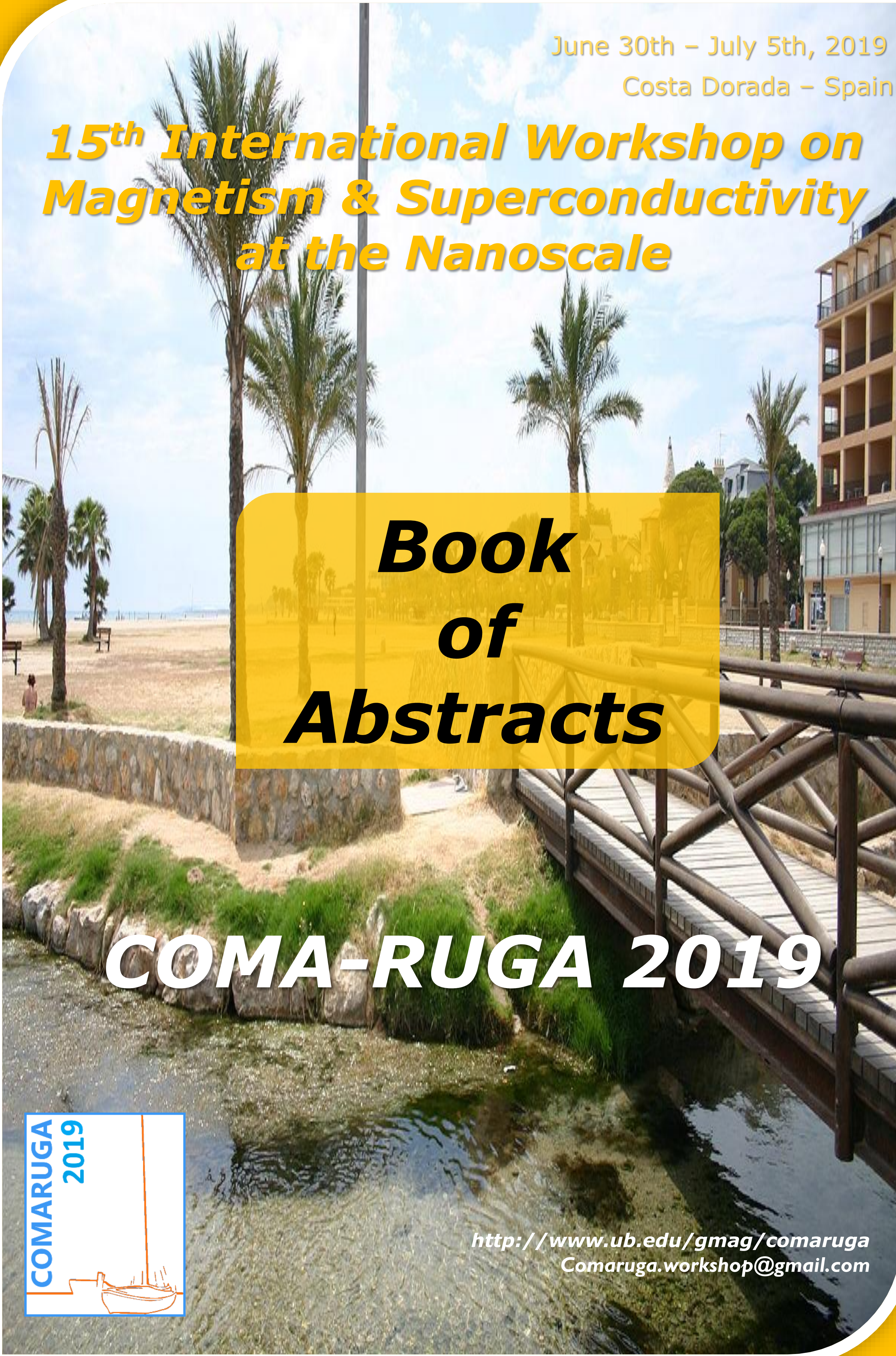
June 30th – July 5th, 2019

Costa Dorada – Spain

15th International Workshop on Magnetism & Superconductivity at the Nanoscale



Book of Abstracts

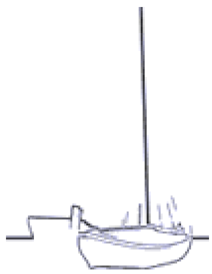
COMA-RUGA 2019

COMARUGA 2019

http://www.ub.edu/gmag/comaruga
Comaruga.workshop@gmail.com

15th Internacional Workshop on Magnetism and Superconductivity at the Nanoscale

Book of Abstracts



Coma-ruga (el Vendrell)

June 30th – July 5th, 2019

Organizing committee:
E. M. Chudnovsky
J. Tejada
V. Vinokour
S. Alcalá
C- Chen

Edited by

S. Alcalá

Welcome to

Bienvenidos a

Benvinguts a

Добро пожаловать в

Willkommen bei

Benvenuti

Сардэчна запрашаем у

Vítejte na

स्वागत

Bienvenue

Witamy w

Welkom op

欢迎来到

Fáilte go dtí

Coma-ruga 2019

ברוכים הבאים

へようこそ

에 오신 것을 환영합니다

Index

LOCATION

The site of the Workshop, **Nuba Hotel Coma-ruga**, is located in one of Spain's most famous beaches of the Costa Dorada (Tarragona) region.

Coma-ruga (town of El Vendrell), 70 km south of Barcelona, provides safe and enjoyable environment for the Workshop.

The town of El Vendrell

According to the geographical situation, El Vendrell (population ca. 36,000) is a cosy town where people come to live or to do tourism.The beaches of El Vendrell are a good tourist offer, which come together with a great cultural activity. The Casa Museu Àngel Guimerà (house museum), la Casa nadiua de Pau Casals (parents house), the Museu Arqueològic, the Museu Deu, the Fundació Apel·les Fenosa and the Vil·la Casals form a rich museum route. Under the slogan "El Vendrell. La Música", the town offers many musical activities that have the main base in the Festival Internacional de Música Pau Casals. In addition to the rest of musical series that the Auditori Pau Casals organizes all year, El Vendrell has a traditional music series, "sardanes" (traditional dance), organ concerts and many other acts that are carried out by music groups of the village. This tradition lives together with other cultural manifestations of groups that arrived outside Catalonia. The music, the culture, the beaches, the climate, the gastronomy…, make this village an attractive destination, with modern services of quality in order that everyone feels at ease.

<u>Beach of Coma-ruga</u>

The beach of Coma-ruga has the marine reserve of La Masia Blanca. This zone is a typical biomass of sand beaches with a little slope. The physiography and protected flora are representative of half the catalan coast.

LENGTH : 2.300 m
MAXIMAL WIDTH OF THE BEACH AT HIGH TIDE: 100 m
MAXIMAL WIDTH OF THE BEACH AT LOW TIDE: minimal variations.
SAND: soft

OTHER INTERESTING PLACES TO VISIT

Sitges

Modern Sitges (population ca. 28,000), preserving important references from the Middle Ages and the old farmers' and fishermen's town, offers visitors an impressive architectural and cultural heritage, the result of initiatives by artists, cultural energizers and patrons like Santiago Rusiñol, Ramon Casas, Miquel Utrillo or Charles Deering. Thanks to them, Sitges was a reference point for writers, musicians and other intellectuals and became an important center for disseminating Modernism and the "Americanos", who, after returning with their "fortune" from their American adventure, commissioned large mansions from Modernist and Noucentista (post Art Nouveau) architects.

The museums, guided tours or walks around the old quarter allow us to visit and relive this important legacy.

This creative impetus has made it possible to create new projects like The International Barcelona-Sitges Vintage Car Rally, the International Film Festival, the International Jazz Festival or the Summer Concerts Series.

Tarragona

Tarragona (population ca. 140,000), the former capital of the Roman province of Tarraconense and the see of the metropolitan archibishop of Catalonia, is nowadays an important cultural and administrative centre providing services to the surrounding Camp de Tarragona region.

The old city is built on the southern side of a rocky hill, 67 meters high, wich slopes gently down to the sea on the left bank of the Francolí river. The old quarter, known as the Part Alta, is surrounded by Roman walls on three of its four sides. It is here that most of the city's historic monuments, religious and government buildings are located.

The ancient Roman port city of **Tarragona,** on a rocky bluff above the Mediterranean, is one of the grandest but most neglected sightseeing centers in Spain. Despite its Roman and medieval remains, it's merely the second oldest city of Catalonia.

The Romans captured Tarragona in 218 B.C., and during their rule the city sheltered one million people behind 64-km-long (40-mile) city walls. One of the four capitals of Catalonia when it was an ancient principality and once the home of Julius Caesar, Tarragona today consists of an old quarter filled with interesting buildings, particularly the houses with connecting balconies. The upper walled town is mainly medieval, while the town below is newer.

A pleasant broad avenue, the Rambla Nova, runs through the middle of the modern area, the last stretch commanding a fine view over the sea. It is part of the Eixample or "extension" district, built from the mid-19th century onwards following the demolition of part of the old walls. At the southern end, round the Port of Tarragona, which handles very large amounts of commercial cargo, is the harbour area and beyond this we may found El Serrallo, a district of sailors and fishermen. The urban area has spread out beyond the edge of the city centre, mostly towards the east and west.

Vilanova i la Geltrú

A major Catalonian fishing port with a growing population of approximately 66,000, Vilanova i la Geltrú is the capital of El Garraf and is situated 40 km south-west of Barcelona, with the more famous coastal resort of Sitges some 10 km to the north-east. The town has a long and colourful history, reaching its heyday during the Romantic period. In 1274 it was awarded the Carta Pobla (City Charter) by King Jaume I.

Vilanova i la Geltrú is a busy modern town, with well-established textile and paper industries. It also has iron foundries and an important agricultural sector. The harbour affords safe and deep anchorage; it is a lifeboat station and the headquarters of a large fishing fleet. The coasting trade is also considerable. Vilanova has a museum, founded by the Catalan poet, historian and diplomat, Víctor Balaguer (1824-1901), which contains collections of Roman, Egyptian and prehistoric antiquities, as well as paintings, engravings, sculptures, coins and a large library.

As a city, it has polarized the attention of a great area even beyond its own boundaries, and has always boasted a dynamic economy, originally based on its agriculture and wine shipping commerce (in the 18th and 19th centuries), and later on, its textile industry. In recent years industry has diversified, with the presence of large metal, chemical and textile factories (since the first half of the 20th century). The city still maintains a certain amount of agricultural commerce and one of the most important fishing fleets in Catalonia. There has also been an important development in the sector of tourism and leisure facilities.

Vilanova i la Geltrú has a complex for water sports within the port, beaches, seafront promenade, golf course. There are wide number of cultural activities, including nationally important museums such as The Victor Balaguer (romantic Catalanonian art), or technology, The Railway Museum, as well as an annual programme of theatre, music and cinema, music festivals such as the FIMPT (International Popular and Traditional Music Festival). The town has one of the most intense calendars of traditional celebrations in Catalonia, especially Els Tres Tombs, Carnival and Festa Major.

Vilafranca del Penedès

Vilafranca del Penedès (population ca. 38,000) is the capital of Alt Penedès and is located in the middle of the Penedès plain. It is a strong communication hub, an important wine production centre (INCAVI enologic station), and a commercial and industrial town. Formed around the Dela Tower (s. XII), its fairs and markets -that have kept their vitality until nowadays- were soon the most important of the country, and the municipality extended through a vast territory. The city was surrounded by a wall. The Catalano-Aragonese Kings had a palace in the city, where King Pere el Gran died in 1285.

From this ancient past, there are still some outstanding monuments: Romanesque church of Sant Joan (Gothic interior); gothic basilica of Santa Maria (neogothic facade); ancient monastery of Sant Francesc, now a hospital, with the Gothic church where the magnificent altarpiece of Sant Jordi made by the master Lluís Borrassà is preserved (the cloister conserves remarkable medieval graves); Baltà Palace (s. XVI); the ancient Royal Palace, location of the important Vilafranca Museum; stately mansions; art nouveau works like the City Hall, Casa de la Vila (1912); industrial architecture and other buildings; and the monument to Milà i Fontanals (sculptures by Arnau).

Barcelona

Unlike many monumental European cities, the Catalan capital's charm lies in a sum of many small parts. You could fall in love with the city over an encounter with the mélange of street performers along the famous boulevard Les Rambles or at your first close encounter with a fanciful work of the master architect Antoni Gaudí. It could be the fact that fine city beaches, splendid Gothic palaces, elegant green parkland, cutting edge cafes, and sophisticated shopping are all within arm's length in this compact metropolis and its inherent easygoing nature means that as much time can be spent on chilling as cultural pursuits. It could be the fact that Barcelona (and Catalonia) are truly distinct from the rest of Spain and therefore many pre-conceptions of what it *will* be like give way to the discovery of a language, landscape, and people you may have known little about.

The city's most powerful monuments open a window onto its history: the intricately carved edifices of the Barri Gòtic, the most intact Gothic Quarter in Europe; the florid, curvilinear *modernisme* (Catalan Art Nouveau); the seminal works of Picasso and Miró, plus daring new projects from national and international names of the ilk of Frank Gehry, Jean Nouvel, and Toyo Ito, Barcelona is a crucial incubator for 20th-century art and architecture. Gastronomy is another regional plus, with circa 35 Catalan restaurants having at least one Michelin star.

A revitalized Barcelona welcomed thousands of visitors to the 1992 Summer Olympic Games, but the action didn't end when the last medal was handed out. With a culturally savvy local government, the city has become a model for intelligent development. On any weekend, as locals enjoy a new park or promenade, an outdoor concert or *fiesta,* it is clear that this proud population has an enduring love affair with their city. Of course the downside of all this progress is that the sound of the jackhammer is never far off. But the Barcelonese believe that while the past must be respected, the future is to be embraced.

COMA-RUGA 2019

June 30th – July 5th, 2019
Costa Daurada – Spain

15th International Workshop on Magnetism & Superconductivity at the Nanoscale

	01/07/2019	02/07/2019	03/07/2019	04/07/2019	05/07/2019
HOUR					
9:00-9:25	Serghej Prischepa	Arkady Zhukov	Kacper Wrześniewski	Albert Fert	Pawel Skupiński
9:25-9:50	César Magén	Nikolay Chtchelkatchev	Elias Ferreiro-Vila	Albert Fert	Michael Baker
9:50-10:15	Joan Josep Suñol	Piotr Mazalski	Irene Lucas	Dmitry Garanin	Ali Gencer
10:15-10:45	*Coffee Break*	*Coffee Break*	*Coffee Break*	*Coffee Break*	*Coffee Break*
10:45-11:10	Masahiro Yamashita	Alexander Moskvin	Lior Klein	Oleg Tretiakov	Ferran Macià
11:10-11:35	Václav Drchal	Manuel Vázquez	Fernando Sols	Gervasi Herranz	Libor Smejkal
11:35-12:00	Álvaro Gómez-León	José Manuel Martín	Jose Maria De Teresa	Josep Fontcuberta	Rosa López
12:00-12:25	Pilar Marin Palacios	Amos Sharony	Aleksandra Petkovic	Milorad Milosevic	Rodolfo Miranda
12:25-16:00	*Lunch Break*	*Lunch Break*	*Lunch Break*	*Lunch Break*	*Lunch Break*
16:00-16:25	Alexander Buzdin	Dieter Koelle	Marcin Konczykowski	Boris Spivak	
16:25-16:50	Lucica Miu	Alexander Golubov	Victor Moshchalkov	Uwe C. Tauber	
16:50-17:15	*Coffee Break*	*Coffee Break*	*Coffee Break*	*Coffee Break*	
17:15-17:40	Angelo Di Bernardo	Adrian Crisan	Luis Brey	Valeriy Ryazanov	
17:40-18:05	Lorenzo Ceccarelli	Poster Session	Valerii Vinokur	Poster Session	
18:05-18:30		Poster Session	Alexander Gerber	Poster Session	
19:30-20:30					
20:30-22			Conference dinner		

Universitat de Barcelona

A welcome reception will be held at the hotel terrace on Sunday, June 30th at 19:30.
Conference Dinner will take place at the restaurant Cara al Mar on Wednesday, July 3rd at 20:30.

Scientific programme

Monday 1st of July, 2019

9:00-9:25	1.1.1	**Serghej Prischepa** *One ferromagnetic nanoparticle inside each CNT – anisotropy versus dipole interaction*	BSUIR
9:25-9:50	1.1.2	**César Magén** *Exploring ferromagnetism of 3D cobalt nanotubes grown by focused electron beam induced deposition*	Instituto de Ciencia de Materiales de Aragón, CSIC-Universidad de Zaragoza
9:50-10:15	1.1.3	**Joan Josep Suñol** *Magnetic properties and critical behavior of Ni51.82Mn32.37In15.81 shape memory alloy*	University of Girona
10:45-11:10	1.2.1	**Masahiro Yamashita** *New Quantum Molecular Spintronics Based on Single-Molecule Magnets: Kondo Effect, Single-Molecule Memory, Spin Qubits, and Rabi Nutation at RT*	Tohoku University
11:10-11:35	1.2.2	**Václav Drchal** *Longitudinal fluctuations of magnetic moments: a simple model*	Institute of Physics, Czech Acad. Sci.
11:35-12:00	1.2.3	**Álvaro Gómez León** *Quantum effects from spin bath environments*	CSIC
12:00-12:25	1.2.4	**Pilar Marin Palacios** *Magnetic field tunable metamaterials based on magnetic microwires*	Instituto de Magnetismo Aplicado (Universidad Compltense de Madrid)
16:00-16:25	1.3.1	**Alexander Buzdin** *Theory of Magnetic Domain Phases in Ferromagnetic Superconductors*	University of Bordeaux
16:25-16:50	1.3.2	**Lucica Miu** *Disappearance of the second magnetization peak in underdoped cuprate and pnictide superconducting single crystals*	National Institute of Materials Physics

17:15-17:40	1.4.1	**Angelo Di Bernardo**	University of Cambridge
	Nodal exchange coupling in oxide superconducting spin valves		
17:40-18:05	1.4.2	**Lorenzo Ceccarelli**	University of Basel
	Imaging superconducting vortex dynamics in amorphous MoSi thin films		

Scientific programme

Tuesday 2nd of July, 2019

9:00-9:25	2.1.1	**Arkady Zhukov**	Dept. Phys. Mater., UPV/EHU	*Tuning of domain wall dynamics in magnetic microwires*
9:25-9:50	2.1.2	**Nikolay Chtchelkatchev**	Moscow Institute of Physics and Technology	*Boson magnetism in strongly correlated cold atom system*
9:50-10:15	2.1.3	**Piotr Mazalski**	Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences	*Magnetic domains in ferromagnetic and ferro-/antiferromagnetic sandwich layers with perpendicular magnetization*
10:45-11:10	2.2.1	**Alexander Moskvin**	Ural Federal University	*Computer simulation of nontrivial phases and phase transitions in S=1 spin and pseudospin 2D systems*
11:10-11:35	2.2.2	**Manuel Vázquez**	ICMM/CSIC	*Modulated Cylindrical Magnetic Nanowires*
11:35-12:00	2.2.3	**José Manuel Martín**	Universidad del Pais Vasco	*Novel Fe-based amorphous powder alloys produced by gas atomizing technique*
12:00-12:25	2.2.4	**Amos Sharony**	Bar Iilan Univeristy	
16:00-16:25	2.3.1	**Dieter Koelle**	Universität Tübingen	*Nanoscale devices fabricated by focused ion beam irradiation of YBa2Cu3O7 thin films*
16:25-16:50	2.3.2	**Alexander Golubov**	University of Twente	*Evidence of Abrikosov Vortex Cores in a Nonsuperconducting Metal*
17:15-17:40	2.4.1	**Adrian Crisan**	National Institute of Materials Physics	*Models of current-dependent pinning potential in nanostructured YBa2Cu3O7 superconducting films*

Wednesday 3rd of July, 2019

Time	No.	Speaker	Affiliation	Title
9:00-9:25	3.1.1	**Kacper Wrześniewski**	Faculty of Physics, Adam Mickiewicz University	*Quench dynamics of spin in quantum impurity systems*
9:25-9:50	3.1.2	**Elias Ferreiro-Vila**	Ciqus-University of Santiago de Compostela (USC)	*AFM Electric Field-Induced Local Topotactic Transformation between Perovskite and Brownmillerite $SrFeO_{3-d}$.*
9:50-10:15	3.1.3	**Irene Lucas Del Pozo**	Universidad de Zaragoza-INA	*Influence of Co^{2+} redistribution on the apparent auxetic to non-auxetic crossover in $CoFe_2O_4$ thin films.*
10:45-11:10	3.2.1	**Lior Klein**	Bar-Ilan University	*A route towards magnetic memory with 6 bits per cell*
11:10-11:35	3.2.2	**Fernando Sols**	Universidad Complutense de Madrid	*Protected cat states in a superfluid boson gas*
11:35-12:00	3.2.3	**Jose Maria De Teresa**	CSIC-UNIVERSITY OF ZARAGOZA	*Magnetotransport properties of superconducting W-C nanowires grown by Ga^+ and He^+ Focused Ion Beam Induced Deposition (FIBID)*
12:00-12:25	3.2.4	**Aleksandra Petkovic**	Laboratoire de Physique Théorique, Université de Toulouse	*The Casimir-like effect in a one-dimensional Bose gas*
16:00-16:25	3.3.1	**Marcin Konczykowski**	Laboratoire des Solides Irradies, Ecole Polytechnique	*Superconductivity vs. spin or charge order: competing or intertwined orders*
16:25-16:50	3.3.2	**Victor Moshchalkov**	KU Leuven	*Exotic vortex matter in superconductors*
17:15-17:40	3.4.1	**Luis Brey**	ICMM-CSIC	*Charged topological solitons in zigzag graphene nanoribbons*

17:40-18:05	3.4.2	**Valerii Vinokur**	Argonne National Laboratory
	Bose metal as a bosonic topological insulator		
18:05-18:30	3.4.3	**Alexander Gerber**	Tel Aviv University
	Interpretation of experimental evidence of the topological Hall effect and the domain wall resistance.		

Thursday 4th of July, 2019

9:00-9:50	4.1.1-2	**Albert Fert**		*Recent advances on magnetic skyrmions*
9:50-10:15	4.1.3	**Dmitry Garanin**	Lehman College of the CUNY	*Skyrmion glass in systems with static randomness*
10:45-11:10	4.2.1	**Oleg Tretiakov**	UNSW	*Spintronics with (Anti)Skyrmions and Bimerons*
11:10-11:35	4.2.2	**Gervasi Herranz**	Institut de Ciencia de Materials de Barcelona ICMAB-CSIC	*Electric-field tunable magnetoplasmonic gratings*
11:35-12:00	4.2.3	**Josep Fontcuberta**	Institut de Ciència de Materials de Barcelona (ICMAB-CSIC)	*In-operando adjustable orbital polarization in nickelate perovskites*
12:00-12:25	4.2.4	**Milorad Milosevic**	University of Antwerp	*Hydrogen-induced high-temperature superconductivity in two-dimensional materials*
16:00-16:25	4.3.1	**Boris Spivak**	University of Washington	*Protected cat states in a superfluid boson gas*
16:25-16:50	4.3.2	**Uwe C. Tauber**	Department of Physics, Virginia Tech	*Non-equilibrium relaxation and critical aging of flux lines following current quenches*
17:15-17:40	4.4.1	**Valeriy Ryazanov**	Institute of Solid State Physics, Russian Academy of Sciences	*0-pi-transition controlled by spin-polarized injection*

Friday 5th of July, 2019

9:00-9:25	5.1.1	**Pawel Skupinski**	Institute of Physics, Polish Academy of Sciences	*Electrical and magnetic properties of magnetic topological materials of the (Bi,Sb)2(Te,Se)3 family*
9:25-9:50	5.1.2	**Michael Baker**	The University of Manchester	*The Dynamics of Exchange Coupled Toroic Moments within a Nanomagnet*
9:50-10:15	5.1.3	**Ali Gencer**	Ankara University	*Conduction Cooled Superconducting Magnet for 1.5 T MRI Applications; Design, Fabrication with Materials Processing and Performance Tests*
10:45-11:10	5.2.1	**Ferran Macià**	Universitat de Barcelona	*Acoustic Spin Waves*
11:10-11:35	5.2.2	**Libor Smejkal**	JGU Mainz	*Topological Antiferromagnetic Spintronics*
11:35-12:00	5.2.3	**Rosa López**	Institute for Complex and Interdisciplinary Physics IFISC	*The Kondo effect in Thermoelectrics*
12:00-12:25	5.2.4	**Rodolfo Miranda**	IMDEA Nanociencia UAM	*Mapping the spin distribution in molecules adsorbed on graphene*

SOCIAL PROGRAMME

On Sunday, July 1st, the welcome reception will be held at 19:30 at the hotel terrace.

On Wednesday, July 4th, the workshop dinner will be held at 20:30 at the restaurant ***Cara al Mar***. Price (25€/person) is not included in the conference fee.

ABSTRACTS

Serghej Prischepa

Mon 1.1.1

prischepa@bsuir.by

BSUIR

Belarus

One ferromagnetic nanoparticle inside each CNT – anisotropy versus dipole interaction

Serghej Prischepa,[a,b] Alexander Danilyuk,[a] Andrei Kukharev,[a] Francois Le Normand,[c]

[a]*Belarusian State University of Informatics and Radioelectronics, Minsk, Belarus*

[b]*National Research Nuclear University "MEPhI", Moscow, Russia*

[c]*CNRS and University of Strasbourg, Strasbourg, France*

Co ferromagnetic nanoparticles (NP) have been embedded both on the top of SiOxNy nanocones and inside carbon nanotubes (CNT) by plasma enhanced hot filament CVD method [1]. It has been demonstrated that in the former case Co NPs are strongly interact forming large magnetic domains of micrometer sizes. While in the latter case, despite the same density of NPs arrangement, they are magnetically isolated [2]. The role of CNTs in magnetic isolation is investigated and discussed. The evaluation of different contributions to the magnetic anisotropy has been performed. It has been demonstrated that the magnetoelastic anisotropy arising from the effect of CNT leads to the suppression of the dipole-dipole interaction between Co nanoparticles. Experimental data are in good agreement with the results of micromagnetic simulations. Further, the anisotropy of the NP has been tuned by adding Fe, Ni and Pt into Co. This leads to modification of both the crystalline lattice and magnetoelasticity. It is shown that in this way the magnetic structure of Co – based NP can be effectively controlled.

[1] A.L. Danilyuk, A.V. Kukharev, C.S. Cojocaru, F. Le Normand, S.L. Prischepa, Carbon, **139**, 1104 (2018).

[2] S.L. Prischepa, A.L. Danilyuk, A.V. Kukharev, F. Le Normand, C.S. Cojocaru, IEEE Trans. Magn., **55**, 8450623 (2019).

César Magén

Instituto de Ciencia de Materiales de Aragón, CSIC-
Universidad de Zaragoza

Mon 1.1.2
cmagend@unizar.es
Spain

Exploring ferromagnetism of 3D cobalt nanotubes grown by focused electron beam induced deposition

J. Pablo-Navarro[a,b], I.-M. Andersen[c], L. A. Rodríguez[d], D. Sanz-Hernández[e], A. Fernández-Pacheco[e], C. Gatel[c], E. Snoeck[c], J. M. de Teresa[a,b,f] and C. Magén[a,b,f]

[a]Laboratorio de Microscopías Avanzadas (LMA) - Instituto de Nanociencia de Aragón (INA), Universidad de Zaragoza, 50018 Zaragoza, Spain.
[b]Instituto de Ciencia de Materiales de Aragón (ICMA), Universidad de Zaragoza-CSIC, 50009 Zaragoza, Spain.
[c]Centre d'Élaboration de Matériaux et d'Etudes Structurales (CEMES), CNRS-UPR 8011, Université de Toulouse, 29 rue Jeanne Marvig, 31055, Toulouse, France.
[d]Departamento de Física, Universidad del Valle, A. A. 25 360, Cali, Colombia.
[e]Cavendish Laboratory, University of Cambridge, JJ Thomson Avenue, Cambridge CB3 0HE, UK.
[f]Departamento de Física de la Materia Condensada, Universidad de Zaragoza, 50009 Zaragoza, Spain.

Three dimensional (3D) magnetic nanostructures attract particularly keen interest because of their possibilities to be implemented in future spintronic devices such as high-density magnetic memories, nano-sensors or logic devices. Among these appealing architectures, 3D ferromagnetic nanotubes (NTs) are currently being investigated for their fast and low-power domain wall conduit properties, which are ideal for energy efficient data storage and processing [1]. In many cases, the development of new 3D architectures requires complex synthetic methods or sophisticated lithographic processes. In this work we have explored the use of Focused Electron Beam Induced Deposition (FEBID), a unique one-step nanolithography technique which has demonstrated great versatility, for the growth of 3D ferromagnetic nanostructures [2-3].

For the first time, we have successfully grown individual 3D ferromagnetic cobalt NTs grown by FEBID based on a core-shell method technology [3-4]. The heterostructured design is composed by a vertical Pt-C nanowire (≤100 nm in diameter) acting as a template, on which a thin cobalt coating is deposited. Transmission Electron Microscopy experiments indicate that these NTs present a thickness down to ~11 nm, a nanocrystalline structure and a metallic content of ~70 at. %. Magnetic characterization performed by Off-Axis Electron Holography and Magneto-Optical Kerr Effect (MOKE) magnetometry evidences the ferromagnetic behavior, detecting magnetic domain walls and estimating a remanent magnetic induction of ~1 T and coercivity of ~16 mT. Complex head-to-head magnetic domain walls have been detected and micromagnetic simulations have been performed for a better understanding of their magnetic structure.

[1] R. Hertel, J. Phys.: Cond. Mat. 28, 483002 (2016).
[2] J. Pablo-Navarro, J. Phys. D. Appl. Phys. 50, 18LT01 (2017).
[3] J. Pablo-Navarro et al., Nanotechnology *27*, 285302 (2016).
[4] J. Pablo-Navarro et al., in preparation.

Joan Josep Suñol

University of Girona

Mon 1.1.3

joanjosep.sunyol@udg.edu

Spain

Magnetic properties and critical behavior of $Ni_{51.82}Mn_{32.37}In_{15.81}$ shape memory alloy

K. Dadda[a,b], S. Alleg[a], J.J. Suñol[b], S. Souilah[a], L. Bessais[c], E.K. Hlil[d]

[a] *Laboratoire de Magnétisme et Spectroscopie des Solides (LM2S), Département de Physique, Université Badji Mokhtar Annaba, B.P. 12, Annaba 23000, Algérie*

[b] *Department of Physics, University of Girona (P II, EPS), Campus Montilivi s/n, 17071 Girona, Spain.*

[c] *Université Paris –Est, ICMPE (UMR 7182) CNRS-UPEC, Thiais, F-94320, France*

[d] *Institut Néel, CNRS, Université Grenoble Alpes, 25 Rue des Martyrs BP 166,*

F-38042 Grenoble Cedex 9, France.

The nanocrystalline Heusler ferromagnetic shape memory alloys are becoming an important topic of research due to their large magnetic-field-induced strain and shape memory effects [1]. The present study reports on the $Ni_{51.82}Mn_{32.37}In_{15.81}$ alloy produced by rapid solidification using melt spinning technique (master alloy was previously prepared by arc melting).The X-Ray diffraction analysis results revealed the coexistence of the $B2$ austenite (~50%) and $14M$ martensite (~50%) nanocrystalline structures. This alloy undergoes a second order magnetic transition at a Curie temperature $T_c^A = 194.2\ K$ as detected by magnetometry. The critical exponents β, γ and δ have been estimated using modified Arrott plots, Kouvel-Fisher curves and critical isothermal analysis. The respective values are $\beta = 0.500 \pm 0.015$, $\gamma = 1.282 \pm 0.055$ and $\delta = 3.003 \pm 0.002$. The critical behavior in ribbons is governed by the mean field model with a dominated long-range order of ferromagnetic interactions. The maximum entropy change, ΔS_M^{max} , for an applied magnetic field of 5 T reaches an absolute value ~1 J/kg.K. The experimental results of entropy changes are in good agreement with the calculated ones using Landau theory.

Keywords: Martensitic transformation; Magnetic properties; Phase transitions; Arrott plots; Heusler alloys.

[1] S. Louidi, J.J. Suñol, M. Ipatov, B.Hernando, Journal of Alloys and Compounds, 749, p. 305–310, (2018).

[2] R. Das, P. Alagarsamy, A. Srinivasan, Critical behavior and magnetic entropy change at magnetic phase transitions in Ni $_{50}Mn_{35}In_{14}Si_1$ ferromagnetic shape memory alloy, EPL (Europhysics Letters) 108, 66004, (2014).

Masahiro Yamashita

Tohoku University

Mon 1.2.1

yamasita.m@gmail.com

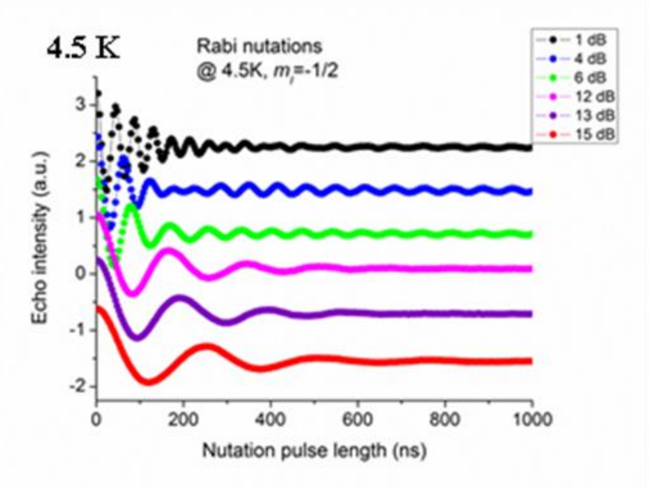
Japan

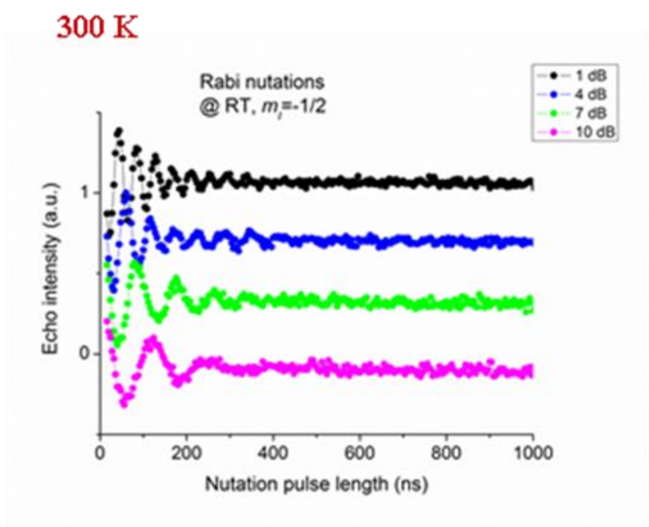
Quantum Molecular Spintroncs Based on Single-Molecule Magnets: Kondo Effect, Single-Molecule Memory, Spin Qubits, and Rabi Nutation at RT

Masahiro Yamashita

WPI-AIMR, Tohoku University, 2-1-1 Katahira, Aoba-Ku, Sendai 980-8578, Japan

Spintronics, based on the freedoms of the charge, spin, and orbital of the electron, is a key technology in the 21st century. Magnetic random access memory (MRAM), which uses giant magnetoresistance (GMR) or tunneling magnetoresitance (TMR), have several advantages over conventional systems, such as nonvolatile information storage, high operation speeds on the order of nanoseconds, high storage densities, and low power consumption. Although bulk or classical magnets composed of transition metal ions are normally used, in our study, we use single-molecule magnets (SMMs) to overcome "Moore`s Limitation". SMMs undergo slow magnetic relaxation due to the double-well potential, defined as |D|S^2, and quantum tunneling, making them excellent materials for quantum computers and high density memory storage devices. I will talk single-molecule memory, spin qubit, and Rabi nutation at RT.





We usually use the double-decker phthalocyaninato Tb(III) SMM (TbPc2) as a single-molecule memory. On Au(111) substrate, we sublimated TbPc2. Then, by tunneling magnetoresistance (TMR) using STM tip with one Co atom, we have succeeded to put the spin up and down on TbPc2 and read them. As for the quantum computer, we synthesized 0 ~ 3 dimensional V(TCPP) compounds. In the 3-D compounds, we have realized spin qubit and observed Rabi nutation even at RT. due to the rigid lattice as shown in the right.

Václav Drchal

Institute of Physics, Czech Acad. Sci.

Mon 1.2.2
drchal@fzu.cz
Czech Republic

Longitudinal fluctuations of magnetic moments: a simple model

V. Drchal,[a] **J. Kudrnovský,**[a] **I. Turek**[b]

[a] *Institute of Physics, Czech Acad. Sci., Na Slovance 2, 182 21 Praha 8, Czech Republic*

[b] *Institute of Physics of Materials, Czech Acad. Sci., Žižkova 22, 616 62 Brno, Czech Republic*

Studies of finite temperature properties of magnetic metals often employ the classical Heisenberg-type spin Hamiltonian with parameters derived from first principles calculations.
In itinerant electron systems, however, the atomic magnetic moments vary their magnitude with temperature and the theory should incorporate the effects of longitudinal spin fluctuations (LSF). The parameters of spin Hamiltonians describing LSF can be found in the framework of the constrained Local Spin Density Approximation (LSDA). Statistical mechanics of fluctuating moments face a fundamental problem concerning the integration in classical spin space as it is generally unknown how to integrate over the spin magnitude. At present various approaches are used including classical description of moments [1], paramagnetic lattice gas model [2] and possible improvements [3]. We employ a quantum-mechanical description and consider the energy of an atom as a function of the occupation of one-particle states by electrons. We analyze the role of individual factors, i.e., the temperature, form of the energy dependence, spatial orientation of the resulting moment, electron occupation, and the size of moments. We make comparison with other theoretical approaches and illustrate the theory on selected examples (Ni and Fe above T_C and Fe in Earth's core).

[1] A.V. Ruban, A.B. Belonoshko, N.V. Skorodumova: Phys. Rev. B **87** 014405 (2013).
[2] R.J. Weiss, K.J. Tauer: Phys. Rev. **102** 1490 (1956); G. Grimvall: Phys. Rev. B **39**, 12300 (1989).
[3] S. Khmelevskyi: J. Magn. Magn. Mater. **461** 14 (2018).

Álvaro Gómez León

CSIC

Mon 1.2.3

a.gomez.leon@csic.es

Spain

Quantum effects from spin bath environments

Álvaro Gómez-León[a], Tim Cox[b] and Philip Stamp[b]

[a]Instituto de Ciencia de Materiales de Madrid, CSIC, Spain.

[b]University of British Columbia, Canada.

The effect of coupling a quantum system to an environment has been studied in many different contexts, from solid state physics to models of the early universe. The understanding of the effect of the environment is crucial, as it can be related with thermalization, or the loss of coherence between the relevant quantum mechanical degrees of freedom. The canonical model for the environment couples the system to a set of harmonic oscillators, and their effect is typically assumed to be weak. Another possibility is that the bath consists on a set of localized spins, where no weak coupling assumption can be generally made. In this case the equilibrium and non-equilibrium properties of the system can be radically altered by the environment. In this talk I will discuss some of the properties of these environments, their ubiquity in real models and different ways to tackle their effect. Concretely I will address their effect on the critical properties of the phase diagram and the slaved dynamics between system and environment.

Pilar Marin Palacios

Instituto de Magnetismo Aplicado (Universidad Compltense de Madrid)

Mon 1.2.4
mpmarin@fis.ucm.es
Spain

Magnetic field tunable metamaterials based on magnetic microwires

D. Archilla, F. Gálvez, E. Navarro, <u>P. Marín</u>

Instituto de Magnetismo Aplicado. Nacional VI km 22,5 28230 Las Rozas (Madrid) SPAIN

Departamento de Física de Materiales. Facultad de Físicas. Universidad Complutense de Madrid

Cobalt-based amorphous magnetic microwires with low magnetostriction constant are well known for presenting helical magnetic anisotropy associated with giant magnetoimpedance in both the MHz and GHz ranges. This property, combined with its diameter of the order of microns, allows the design of magnetic field tunable antennas [1]. These magnetostrictive sensor elements can be used for the detection of wireless mechanical stress, very useful for certain biomedical applications [2], as well as for the development of security labels detectable over great distances [3]. Likewise, it has been also demonstrated its interesting properties for the development of paints to reduce the reflectivity of microwaves on metal surfaces [4]. They have even been used for tuning cooper based metamaterials [5].

The present work is related to the last experiments carried out in which it is shown how it is possible to obtain a wave attenuation of up to 50 dB by means of an array of amorphous magnetic microwires. Said attenuation can be modulated using magnetic field. The results obtained are of great interest since they allow the development of sensor surfaces for the control of liquid levels as well as for the detection of pollutant concentrations.

[1] A Hernando, V Lopez-Dominguez, E Ricciardi, K Osiak, P Marin, Scientific Reports, 64(3), 1112 (2015)

[2] AM Aragón, M Hernando-Rydings, A Hernando, P Marín, AIP Advances 5(8), 087132 (2015)

[3] P. Marín, A. Hernando, Label, system and method for long-distance detection of objects. ES2581127 (B2), EP3444743 (A1)

[4] P Marin, D Cortina, A Hernando, IEEE Transactions on Magnetics 44(11), 3934 (2008)

[5] V. López-Domínguez, M. A. García, P. Marín, A. Hernando, Scientific Reports, 7, 9394 (2017)

Alexander Buzdin

University of Bordeaux

Mon 1.3.1

alexandre.bouzdine@u-bordeaux.fr

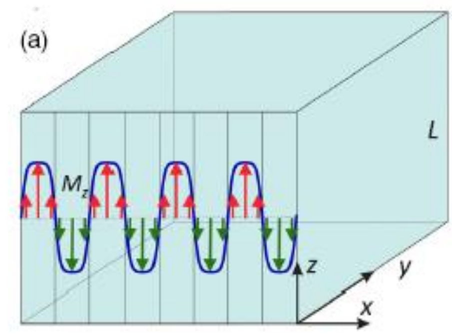
France

Theory of Magnetic Domain Phases in Ferromagnetic Superconductors

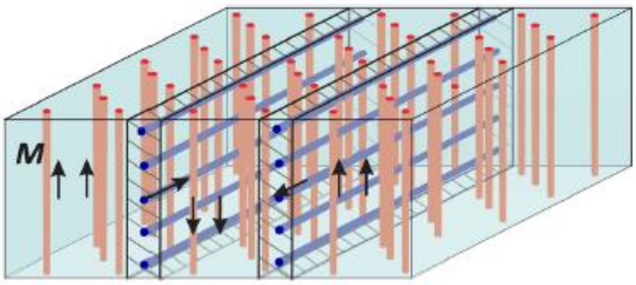
A. Buzdin,[a] Zh. Devizorova,[b] S. Mironov [c]

[a]University of Bordeaux, LOMA UMR-CNRS 5798, F-33405, France
[b]Moscow Institute of Physics and Technology, 141700 Dolgoprudny, Russia
[c]Institute for Physics of Microstructures, RAS, 603950 Nizhny Novgorod, Russia

The coexistence of magnetism and singlet superconductivity has always been of great interest because of their competing nature. Recently discovered superconducting P-doped $EuFe_2As_2$ compounds reveal the situation when the superconducting critical temperature substantially exceeds the ferromagnetic transition temperature. The main mechanism of the interplay between magnetism and superconductivity occurs to be an electromagnetic one, and a short-period magnetic domain structure was observed just below Curie temperature [1]. We elaborate a theory [2] of such a transition and demonstrate how the initial sinusoidal magnetic structure gradually transforms into a soliton-like domain one.



Further cooling may trigger a first-order transition from the short-period domain Meissner phase to the self-induced ferromagnetic vortex state, and we calculate the parameters of this transition. The size of the domains in the vortex state is basically the same as in the normal ferromagnet, but with the domain walls, which should generate the set of vortices perpendicular to the vortices in the domains.



[1] V. S. Stolyarov et al., Sci. Adv. **4**, eaat1061 (2018).

[2] Zh. Devizorova et al., Phys. Rev. Lett., **122**, 117002 (2019).

Lucica Miu

National Institute of Materials Physics

Mon 1.3.2
lucicamiu50@gmail.com
Romania

Disappearance of the second magnetization peak in underdoped cuprate and pnictide superconducting single crystals

Lucica Miu

National Institute of Materials Physics, Bucharest-Magurele, Romania

The occurrence of a second magnetization peak (SMP) on the DC magnetic hysteresis curves of superconducting single crystals with randomly distributed vortex pinning centres is a common phenomenon, and its sudden disappearance for some specimens can offer useful information about its nature. This is the case of underdoped $La_{2-x}Sr_xCuO_4$ (LSCO) [1] and 122-type pnictides [2]. It was found that the absence of an SMP in the whole temperature range for LSCO with $x \sim 0.12$ (at the 1/8 anomaly) and its reappearance for $x \leq 0.10$ follow the evolution of the spin density wave stripe-like order, as detected in small angle neutron scattering experiments. For static stripes, the real space competition between the intervortex spacing and the magnetic correlation length leads to the instability of the Bragg vortex glass, and no SMP develops. At the same time, the vanishing of the SMP in $Ba_{0.75}K_{0.25}Fe_2As_2$ at $T \geq T_c/2$ seems to be caused by the presence of a C_4-symmetric (tetragonal) magnetic phase. Thus, the observed behaviour can be explained through the existence of a new vortex-system disordering parameter, which is not related to the actual pinning structure. This supports the pinning-induced vortex system disordering as the actual origin of the SMP.

[1] L. Miu, A. M. Ionescu, D. Miu, I. Ivan, and A. Crisan, in Vortices and Nanostructured Superconductors (Ed. A. Crisan), Springer Series in Materials Science, Vol. 261, 2017, Chapter 6.

[2] S. Sundar, S. Salem-Sugui, Jr., H. S. Amorim, H. -H. Wen, K. A. Yates, L. F. Cohen, and L. Ghivelder, Phys. Rev. B **95**, 134509 (2017).

Angelo Di Bernardo

University of Cambridge

Mon 1.4.1
ad659@cam.ac.uk
United Kingdom

Nodal exchange coupling in oxide superconducting spin valves

A. Di Bernardo,[a] S. Komori,[a] P. Gentile,[b] M.Cuoco,[b] J.W.A. Robinson[a]

[a]*University of Cambridge, Department of Materials Science, Cambridge CB30FS (UK)*

[b]*CNR Spin, c/o University of Salerno, I-84084 Fisciano (Italy)*

Predating the discovery of giant magnetoresistance [1-2], in 1966 Pierre de Gennes [3] predicted the superconducting equivalent of a ferromagnet/normal metal/ferromagnet (F/N/F) spin valve (SV). In de Gennes system, the N layer is replaced by a conventional (*s*-wave) S and, by changing the alignment of the magnetizations of the Fs from parallel (P) to antiparallel (AP), it is possible to modulate the S critical temperature (T_c). The T_c modulation is due to the additive nature of the pair-breaking magnetic exchange (h_{ex}) fields at the two S/F interfaces, meaning that in the P state they sum up hence resulting in a lower T_c compared to the AP configuration. Such effect has been experimentally observed in a variety FI/S/FI (FI being a ferromagnetic insulator) and F/S/F systems [4-9], which have showed that the changed in T_c between P and AP state, ΔT_c, occurs for a S thickness (d_S) of the order of its superconducting coherence length (ξ). In particular, for FI/S/FI trilayers with d_S smaller than ξ, a S-mediated exchange coupling between the FIs is observed [5] with a full suppression of T_c in the P state [4-5], in agreement with de Gennes prediction [3].

More recently, I have designed and investigated a full-oxide FI/S/FI system, where S is the nodal (*d*-wave) S $YBa_2Cu_3O_{7-\delta}$ (YBCO) and FI is the manganite $Pr_{0.8}Ca_{0.2}MnO_3$ (PCMO). In this talk, I will show the results that I have recently obtained for this trilayer system [10], which demonstrate evidence for an unconventional S-mediated exchange coupling between the PCMO layers. This novel form of coupling goes beyond that predicted by the Gennes in the sense that it is mediated by nodal quasiparticle states near the YBCO Fermi surface. ΔT_c values as large as 2K and oscillating in sign with d_S up to length scales of the order of 100 ξ are observed as result of this coupling mechanism.

References

[1]. M.N. Baibich et al. *Phys. Rev. Lett.* **61**, 2472-2475 (1988).
[2] G. Binasch et al. *Phys. Rev. B* **39**, 4828-4830 (R) (1989).
[3] P.G. de Gennes. *Phys. Lett.* **23**, 10–11 (1966).
[4] B. Li et al. *Phys. Rev. Lett.* 110, 097001 (2013).
[5] Y. Zhu et al. *Nat. Mater.* 16, 195-199 (2017).
[6] I.C. Moraru et al. *Phys. Rev. Lett.* **96**, 037004 (2006).
[7] P. Cadden-Zimansky et al. *Phys. Rev. B* **77**, 184501 (2008).
[8] A. Potenza et al. *Phys. Rev. B* **71**, 180503 (R) (2005).
[9] Y. Gu et al. *Phys. Rev. Lett.* **115**, 067201 (2015).
[10] A. Di Bernardo et al. (Under review, 2019).

Lorenzo Ceccarelli

University of Basel

Mon 1.4.2
lorenzo.ceccarelli@unibas.ch
Switzerland

Imaging superconducting vortex dynamics in amorphous MoSi thin films

Lorenzo Ceccarelli[a], Denis Vasyukov[a], Marcus Wyss[a], Giulio Romagnoli[a], Lucas Moser[a], Martino Poggio[a]

[a]Department of Physics, University of Basel, 4056 Basel, Switzerland

Today, superconductors are widely used in many different fields, from quantum information to engineering applications like electromagnetic shielding for experimental setups in low loss signal transport. Non-dissipative current transport and the expulsion of magnetic field lines below Tc characterize these materials. In type-II superconductors, if not controlled, the presence of vortices and their motion are often detrimental to applications.

We use a scanning nanometer-scale superconducting quantum interference device (SQUID) [1-3] to image individual vortices in amorphous superconducting MoSi thin films. Spatially resolved measurements of the magnetic field generated by both vortices and Meissner screening satisfy the Pearl model for vortices in thin films and yield values for the Pearl length and bulk penetration depth at 4.2 K. Flux pinning is observed and quantified through measurements of vortex motion driven by both applied currents [4] and thermal activation. The effects of pinning are also observed in metastable vortex configurations, which form as the applied magnetic field is reduced and magnetic flux is expelled from the film.

The high flux sensitivity and resolution of our SQUID-on-tip scanning probe [2,3] provides an unparalleled tool for studying vortex dynamics, potentially improving our understanding of their complex interactions. Controlling these dynamics in amorphous thin films is crucial for optimizing devices such as superconducting nanowire single photon detectors (SNSPDs) – the most efficient of which are made from MoSi, WSi, and MoGe – because vortices are likely involved in both the mechanism used for the detection of photons and in the generation of dark counts [5].

Corresponding email: lorenzo.ceccarelli@unibas.ch

References

[1] A. Finkler, Y. Segev, Y. Myasoedov, M. L. Rappaport, L. Ne'eman, D. Vasyukov, E. Zeldov, M. E. Huber, J. Martin, A. Yacoby, Nano Lett. 10, 1046 (2010).
[2] D. Vasyukov, Y. Anahory, L. Embon, D. Halbertal, J. Cuppens, L. Neeman, A. Finkler, Y. Segev, Y. Myasoedov, M. L. Rappaport, M. E. Huber, and E. Zeldov, Nat. Nanotechnol. 8, 639 (2013).
[3] D. Vasyukov, L. Ceccarelli, M. Wyss, B. Gross, A. Schwarb, A. Mehlin, N. Rossi, G. Tütüncüoglu, F. Heimbach, R. R. Zamani, A. Kovács, A. Fontcuberta i Morral, D. Grundler, M. Poggio, Nano Lett. 18, 964 (2018).
[4] L. Embon, Y. Anahory, A. Suhov, D. Halbertal, J. Cuppens, A. Yakovenko, A. Uri, Y. Myasoedov, M. L. Rappaport, M. E. Huber, A. Gurevich & E. Zeldov, Sci. Rep. 5, 7598 (2015).
[5] A. Engel, J. Lonsky, X. Zhang, and A. Schilling, IEEE Transactions on Applied Superconductivity 25, 1 (2015)

Arkady Zhukov

Dept. Phys. Mater., UPV/EHU

Tue 2.1.1
arkadi.joukov@ehu.eus
Spain

Tuning of domain wall dynamics in magnetic microwires

A. Zhukov,[a,b,c] P. Corte-Leon,[a,b] J.M. Blanco,[b] M.Ipatov,[a,b] V. Zhukova[a,b]

[a]Dpto. Fisica de Materiales, Fac. Quimicas, UPV/EHU, 20009 San Sebastian, Spain
[b]Dpto. de Física Aplicada, EIG, UPV/EHU, 20018, San Sebastian, Spain
[c]IKERBASQUE, Basque Foundation for Science, 48011 Bilbao, Spain

Fast domain wall (DW) propagation of thin magnetic wires (planar and cylindrical) become a topic of intensive research during the last years owing to promising applications in data storage devices (magnetic random memory devices, logic devices)[1,2]. Cylindrical amorphous microwires with positive magnetostriction constant exhibit spontaneous magnetic bistability and fast DW propagation at relatively low magnetic fields [3,4]. Additionally, amorphous microwires presenting magnetically bistable character are characterized by quite fast DW dynamics: DW speed above 1000 m/s has been reported [4]. Therefore, amorphous glass coated microwires are quite interesting material for studies of the single domain wall dynamics.

These microwires have composite character. Glass coating surrounding metallic nucleus introduces internal stresses, increasing the magnetoelastic anisotropy of such microwires [3]. Such magnetoelastic anisotropy can be tailored by either tuning of the magnetostriction coefficient or internal stresses [4]. The most common systems in which the magnetostriction coefficient can be tailored are the Co-Fe and Ni-Fe systems: in Co-Fe alloys the magnetostriction coefficient takes nearly-zero values for Co/Fe content about 70/5 [4]. Similarly, the magnetostriction coefficient can be tailored in Fe-Ni alloys [5]. Additionally the magnetoelastic anisotropy can be modified controlling the strength of the internal stresses.

In this paper we present our recent studies of DW propagation in as-prepared and annealed Fe- and Fe-Ni-rich microwires and analyzed observed DW dynamics considering effect of magnetoelastic anisotropy, internal stresses relaxation and induced magnetic anisotropy. We found that annealing allows considerable improvement of DW velocity in Fe-rich microwires. In Fe-Ni- based microwires the DW velocity is considerably lower. At certain annealing conditions (short annealing times) we observed DW increasing in Fe-Ni based microwires, but increasing the annealing time a decrease of DW velocity is observed. Stress-annealing allows achievement of even higher DW velocity and mobility.

We attributed these changes to the stress relaxation and induced transverse magnetic anisotropy after appropriate annealing. For interpretation of more complex behavior of Fe-Ni-based microwires we must additionally consider the domain wall stabilzation [5].

Consequently from experimental dependences we assume that for increasing the DW velocity, v, special attention should be paid to minimizing the magnetoelastic energy. Annealing is the effective method for engineering of the DW dynamics in glass-coated microwires.

[1] D. A. Allwood, G. Xiong, C. C. Faulkner, D. Atkinson, D. Petit, and R. P. Cowburn, Science 309, 5741 1688-1692 (2005).

[2] Y. Nakatani, A. Thiaville, J. Miltat, Nature Mater. 2 521–523 (2003).

[3] A. Zhukov, Appl. Phys. Let. 78 3106-3108 (2001).

Nikolay Chtchelkatchev
Moscow Institute of Physics and Technology
Tue 2.1.2
n.chtchelkatchev@gmail.com
Russia

Boson magnetism in strongly correlated cold atom system

A.M. Belemuk[a,b], N.M. Chtchelkatchev[a,b], A.V. Mikheyenkov[a,b], K.I. Kugel[c]

[a]*Institute for High Pressure Physics, Moscow (Troitsk) 108840, Russia*
[b]*Moscow Institute of Physics and Technology (State University), Moscow 141700, Russia*
[c]*National Research Center "Kurchatov Institute", Moscow 123182, Russia*

Quantum state of cold atoms in optical lattices in the Mott insulator regime when hopping is suppressed is basically governed by density-density and (pseudo)spin-(pseudo)spin interactions, U_0 and U_s, that, in turn, might be tuned *in situ*, contrary to strongly correlated electrons in solids. We show, on the same unified footing, for a number of cold-atom systems, vector Fermions or Bosons, how tuning U_0 and U_s drives the sequence of quantum phase transitions (QPT) that involve (pseudo)spin state and particle ordering, Fig.1. These QPT originate from competing interactions.

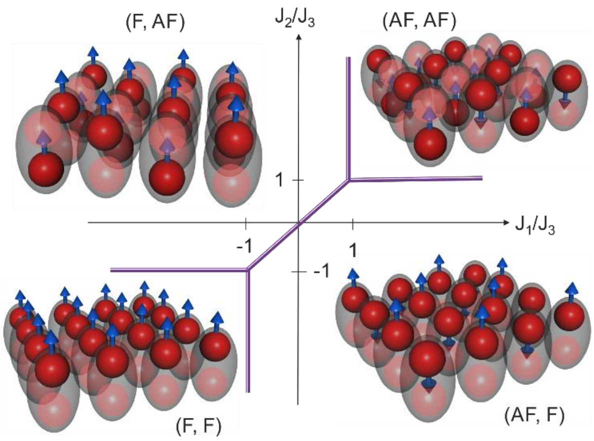


Figure 1. Phases of vector Bosons on optical lattice.

As an example, we analyze possible types of ordering in a boson--fermion model. The Hamiltonian is inherently related to the Bose--Hubbard model for vector two-species bosons in optical lattices. We show that such model can be reduced to the Kugel--Khomskii type spin--pseudospin model, but in contrast to the usual version of the latter model, we are dealing here with the case of spin S=1 and pseudospin 1/2. We show that the interplay of spin and pseudospin degrees of freedom leads to a rather nontrivial magnetic phase diagram including spin-nematic configurations. Tuning the spin-channel interaction parameter U_s gives rise to quantum phase transitions. We find that the ground state of the system always has the pseudospin domain structure. On the other hand, the sign change of U_s switches the spin arrangement of the ground state within domains from ferro to aniferromagnetic. Finally, we revisit spin (pseudospin)-1/2 Kugel-Khomskii model [1] and see inverse picture of phase transitions. We present new results for this system also when in addition to the standard parameters characterizing it, we are dealing with the ``degree of atomic nonidentity", manifesting itself in the difference of tunneling amplitudes and on-site Coulomb interactions. We obtain a cascade of quantum phase transitions occurring with the increase in the degree of atomic nonidentity. While in the system of nearly identical vector bosons, only one phase transition between two phases occurs with the evolution of the interparticle interaction, atom nonidentity increases the number of possible phases to six, while the resulting phase diagrams are so nontrivial that we can speculate about their evolution from the images similar to the "J.Miro-like paintings" to "K.Malewicz-like" ones [2]. This work was supported by Russian Science Foundation (Grant RSF 18-12-00438).

[1] K.I. Kugel, D.I. Khomskii, Sov. Phys. – Uspekhi 25, 231 (1982).
[2] A.M. Belemuk, N.M. Chtchelkatchev, A.V. Mikheyenkov, K.I. Kugel, Phys. Rev. B 96, 094435 (2017); J.Phys. 2019 (in press).

Piotr Mazalski

Jerzy Haber Institute of Catalysis and Surface Chemistry,
Polish Academy of Sciences

Tue 2.1.3
ncmazals@kinga.cyf-kr.edu.pl
Poland

Magnetic domains in ferromagnetic and ferro-/antiferromagnetic sandwich layers with perpendicular magnetization

P. Mazalski,[a,b] P. Kuświk,[c] B. Anastaziak,[c] I. Sveklo,[b] Z. Kurant,[b] A. Wawro,[d] A. Maziewski [b]

[a] Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Krakow, Poland
[b] Faculty of Physics, University of Bialystok, Bialystok, Poland
[c] Institute of Molecular Physics, Polish Academy of Sciences, Poznan, Poland
[d] Institute of Physics, Polish Academy of Sciences, Warszawa, Poland

Magnetic properties of ultrathin films are sensitive to atomic-scale order at the interface that can be tuned by growth conditions and/or a post-growth treatment, e.g. thermal annealing, light or ion irradiation. In ultrathin cobalt films, uniformly irradiated by ions, new effects, like an irradiation-induced increase in magnetic anisotropy or the appearance of an out-of-plane component of magnetization have been reported [1,2]. In this work the magnetic domain structure (DS) changes in ferromagnetic (Co/Pt) and ferro-/antiferromagnetic layers (Co/NiO) are investigated. A Pt/Co/Pt film was grown by MBE technique with a cobalt layer thickness favoring in-plane orientation of magnetization. Numerous square areas of the sample were irradiated by a focused ion beam (FIB) in a wide range of ion fluences and with various beam scanning directions. Detailed in-plane and out-of-plane magnetization investigations were carried out using magneto-optical technique exploiting Kerr effect, with a special illumination system [3] that enables simultaneous measurements in the polar (PMOKE) and longitudinal (LMOKE) configurations. Two fluence ranges of increased remanent perpendicular magnetization were observed by PMOKE. Interestingly, four triangular regions with inclined in different directions out-of-plane magnetization and an unexpected evolution of DS while applying an in-plane field were distinguished inside the squares irradiated spiral-wise from the center of the square to its edge [4]. Recently obtained results from sputtered ferro-/antiferromagnetic (Co/NiO) layers, where an asymmetric Dzyaloshinskii-Moriya exchange interactioninteraction was detected [5], are also discussed. The evolution of DS in this system was investigated as a function of temperature using magneto-optical techniques and X-ray magnetic circular dichroism assisted with photoemission electron microscopy (XMCD-PEEM). The annealing causes sample demagnetization (combined with magnetic anisotropy changes) leading to a submicrometer size skyrmion/bubble DS at room temperature.

This work is supported by the National Science Centre in Poland under the Beethoven 2 (DEC-2016/23/G/ST3/04196) and the Sonata-Bis (DEC- 2015/18/E/ST3/00557) projects.

[1] A. Maziewski, *et al.*, Phys. Rev. B 85, 054427 (2012).

[2] P. Mazalski, *et al.*, J.Synch. Rad. 22, 753 (2015).

[3] I.V. Soldatov, *et al.*, Phys. Rev.B 95, 014426 (2017).

Alexander Moskvin

Ural Federal University

Tue 2.2.1

alexander.moskvin@urfu.ru

Russia

"Unparticle" S=1 pseudospin description of the cuprate complexity

A.S. Moskvin

Ural Federal University, Ekaterinburg, Russia

The origin of high-T_c superconductivity (HTSC) and other unconventional properties of cuprates is presently still a matter of great controversy mainly due to a complex interplay of charge, orbital, spin, and lattice degrees of freedom. The phase T-x diagram of cuprates is full of puzzles, which clearly manifest the breakdown of the conventional Fermi-liquid picture, first of all it is a pseudogap behavior, the appearance of local superconductivity, charge and spin static and dynamic superstructures, unusual quantum oscillations, unusual T- dependence of resistance, the appearance of an unusual Curie-like paramagnetism for heavily overdoped cuprates etc. We argue that the principal features of parent cuprates, which makes them the basis for HTSC are: i) anomalous proximity to the "polarization catastrophe" [1] with the refractivity sum $\frac{4\pi}{3}\sum_i n_i\alpha_i \rightarrow 1$]; ii) strong electron-lattice polarization effects leading to anomalously small magnitude of a "thermal" (adiabatic) charge transfer (CT) gap, or the electron-hole (EH) dimer formation energy: $U_{th} \approx$ 0.4 eV [2] as compared with a rather large magnitude of the optical CT gap: $U_{opt} \approx 2.0$ eV. The EH dimers are (meta)stable coupled electron $[CuO_4]^{7-}$ and hole $[CuO_4]^{5-}$ centers with a "two-particle" interchange which look like a peculiar "quantum" of the diagonal site and/or bond charge order and off-diagonal (superfluid) order. Giant polarizability makes them as main candidates to resolve the polarization catastroph especially under non-isovalent substitution as the system of EH-dimers provides an effective screening of the impurity electric potential. Such a substitution shifts the phase equilibrium in the direction of condensation of EH-dimers and the formation of an inhomogeneous mixed valence system whose low-energy physics can be described as that of a system of charge triplets $[CuO_4]^{7-}$, $[CuO_4]^{6-}$, $[CuO_4]^{5-}$ (nominally $Cu^{1+,2+,3+}$, respectively) [2]. In a limit of large negative U we arrive at a system of only electron and hole centers we refer to as an EH-liquid, which is equivalent to a system of composite local (hard-core) bosons, which manifests both charge order (CO) and bosonic superfluidity (SF). Interestingly, the T-x phase diagram of cuprates is very similar to that of the EH-liquid,"disfigured" by coexistence with parent Cu^{2+}-centers. Strictly speaking, the system of charge triplets as many-electron strongly correlated atomic species in doped cuprates is just like the «boson-fermion» system, however, it does not admit a conventional particle interpretation [3]. We have introduced a minimal model to describe the charge degree of freedom in cuprates with the on-site Hilbert space reduced to a charge triplet formed by the three effective valence centers $[CuO_4]^{7-,6-,5-}$ (nominally $Cu^{1+;2+;3+}$), where the electronic and lattice degrees of freedom get strongly locked together, and made use of the S=1 pseudospin formalism [2]. Effective pseudospin Hamiltonian, resembling that of S=1 anisotropic spin-magnetic system, does include on-site and inter-site correlations, the three types of correlated "one-particle" and a "two-particle" transport. Making use of a spin-magnetic analogy (parent phase $\rightarrow$ quantum paramagnet, local correlation $\rightarrow$ single-ion anisotropy, inter-site correlation $\rightarrow$ Ising-type bilinear coupling, …) appears to be a very instructive tool for describing the phase diagram and electronic inhomogeneity of cuprates. The "unparticle" representation implying the low-energy on-site states are approached in terms of combinations of strongly correlated atomic-like electron configurations, rather than approximately independent electrons, has been shown to resolve many qualitative mysteries of the cuprates. The pseudogap regime is governed by the on-site and inter-site correlations, which fall heavily with doping [4] in favor of kinetic energy effects such as bosonic superconductivity, supported by the coexistence of electron and hole centers, and Fermi-type behavior.

Manuel Vázquez

ICMM/CSIC

Tue 2.2.2

mvazquez@icmm.csic.es

España

Modulated Cylindrical Magnetic Nanowires

C. Bran, J.A. Fernandez-Roldan, R.P. del Real, O. Chubykalo-Fesenko, A. Asenjo and M. Vazquez

Instituto de Ciencia de Materiales de Madrid, 28049 Madrid. Spain

Cylindrical magnetic nanowires offer novel spin phenomena. Topologically non-trivial magnetization structures and domain walls, as exotic vortices or Bloch-point and skyrmion tubes, as well as helical magnetic configurations are the consequences of their cylindrical curvature and geometrical confinement [1].

Co, Fe, Ni and alloys nanowires (15 to 200 nm diameter, 100 nm to 40 μm long) are prepared by less-expensive electrochemical route, and the careful control on the various growth parameters enables their engineered magnetic response. Of particularly emerging interest is the case of periodical modulations of the geometry (i.e., diameter) and composition (i.e., FM/FM and FM/Metal multisegments) or anisotropy (i.e., cubic/hexagonal symmetry) that enable the formation of specific domain structures and the manipulation of the domain walls motion, a matter of key technological interest for domain wall-based applications in new-generation spintronics and logic devices.

Here, we summarize most relevant achievements of the group on the topic. In geometry periodically modulated nanowires (i.e., diameter and antinotches) the transition regions determine the pinning/depinning mechanism for the propagating domain wall [2].

The magnetization ratchet has been recently reported in FeCo/Cu multisegmented nanowires where the unidirectional propagation of the magnetization reversal is experimentally observed by MOKE, MFM and PEEM/XMCD, irrespective of the field direction, and interpreted by complementary micromagnetic simulations as originating in the broken symmetry induced by the tailored length of FeCo segments, and promoted by the magnetostatic coupling between adjacent segments [3].

On the other hand, in CoNi/Ni multisegmented nanowires, alternating segments with low (Ni) and high anisotropy (Co-rich CoNi) magnetocrystalline anisotropy, the magnetization direction varies from in-plane to out-of-plane in neighboring segments, forming complex vortex magnetic structures separated by Block-point DWs [4]. By applying a field, these structures can transform into skyrmion tubes.

The engineered magnetization behavior in these modulated nanowires constitutes a promising simple route to control the transfer of magnetic carrier information in advanced 3D magnetic memories and shift registers.

[1] Streubel et al., J. Phys. D: Appl. Phys. 49, 363001 (2016); Grutter et al., ACS Nano 11, 8311 (2017)

[2] Fernández-Roldán et al., Nanoscale 10, 5923 (2018); Rodríguez et al., ACS Nano 10, 9669 (2016)

[3] Bran et al., ACS Nano 12, 5932 (2018); Nanotechnology 2, 095709 (2017)

[4] Berganza et al., Sci. Rep. 7, 11576 (2017); Bran et al., Phys. Rev B 96, 125415 (2017)

José Manuel Martín

Universidad del Pais Vasco

Tue 2.2.3
jmmartin@ceit.es
Spain

Novel Fe-based amorphous powder alloys produced by gas atomizing technique

Kenny L. Alvarez[1, 2], J. M. Martín[1], N. Burgos[1], M. Ipatov[3,4], A. Chizhik[3], L. Domínguez[5], J. González[3]

[1]*CEIT-IK4 and Tecnun (University of Navarra), San Sebastián, Spain*
[2]*Escuela de Ingeniería Mecánica, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile*
[3]*Dept. of Materials Physics, University of the Basque Country, San Sebastián, Spain*
[4]*SGIker (Magnetic Measurements), University of the Basque Country, San Sebastián, Spain*
[5]*Dept. Applied Physics I, Engineering School, University of the Basque Country, San Sebastián, Spain*

In this owrk we successfully report on the production of Fe-rich soft magnetic materials by using the gas atomizing method [1,2]. These powdered alloys are constituted by particles with size ranging from 10-150 μm. It is interesting to mention that particles with size below 20 μm exhibited amorphous character and, consequently, a softer magnetic character. Regarding the coercive field (H_C) value reported in [1] of one Fe-Si-B amorphous alloy obtained by gas atomizing process of around 2 Oe, which results to be around one order of magnitude larger as comparing with the Fe-rich amorphous ribbon obtained by melt-spinning technique.

In the case of powdered amorphous ferromagnetic alloys, magnetic properties should be influenced significantly by both internal stresses generated during production and surface irregularities. Internal stresses coupled with a nonzero magnetostriction may result in magnetic anisotropy. Attempts have been made to understand the effect of particle size, ranging from 10 to 150 μm, on magnetic properties. Research has also been conducted on the influence of controlled annealing treatment on magnetic properties [2], where the effect of the internal stress relaxation is associate to the significant magnetic softness (coercivity decreasing with thermal treatment) in FeSiB amorphous powdered alloys.

[1] K.L. Alvarez, J.M. Martin, M. Ipatov, and J. González, J. Alloys and Compounds, 735, (2018) 2646-2652.

[2] K.L. Alvarez, J.M. Martín, M. Ipatov, L. Dominguez, J. Gonzalez, IEEE Trans. Magn., 54, (2918) 2002405

Amos Sharony

Bar Iilan Univeristy

Tue 2.2.4

Amos.Sharoni@biu.ac.il

Spintronics with perpendicularly magnetization anisotropy Electrodes

Amos Sharoni, Bar Ilan University

Perpendicularly magnetization anisotropy (PMA) are widely used in various spintronics applications, as media for memory and electrodes in magnetic tunnel junctions. In this talk we will first present our measurements using multi-layered Co/Pd PMA as spin injection electrodes in a spin-valve geometry, and the thermomagnetic effects that arise from this geometry. Following, we look into the magneto-transport properties of the multi-layered structure, focusing on a simple system of thin Cobalt sandwiched between Pt electrodes. Here, we are able to isolate and observe magneto-resistance effects we attribute to the interfaces between the Pt and Co electrodes, possibly resulting from a magnetic proximity effect in the Pt.

Dieter Koelle

Tue 2.3.1

koelle@uni-tuebingen.de

Universität Tübingen

Germany

Nanoscale devices fabricated by focused ion beam irradiation of $YBa_2Cu_3O_7$ thin films

B. Müller,[a] M. Karrer,[a] J. Lin,[a] F. Limberger,[a] J. Linek,[a] M. Becker,[a,b] B. Schröppel,[b] C. J. Burkhardt,[b] B. Aichner,[c] W. Lang,[c] V. R. Misko,[d] J. Pedarnig,[e] R. Kleiner,[a] E. Goldobin,[a] D. Koelle,[a]

[a] *Univ. Tübingen, Physikalisches Institut & Center for Quantum Science (CQ) in LISA+, Auf der Morgenstelle 14, 72076 Tübingen, Germany*

[b] *NMI Natural and Medical Sciences Institute at the Univ. Tübingen, Markwiesenstr. 55, 72770, Reutlingen, Germany*

[c] *Univ. Vienna, Faculty of Physics, Boltzmanngasse 5, 1090 Wien, Austria*

[d] *Univ. Antwerp, Dept. of Physics, Universiteitsplein 1, 2610 Antwerpen-Wilrijk, Belgium*

[e] *Johannes-Kepler-Univ. Linz, Inst. f. Angew. Physik, Altenbergerstr. 69, 4040 Linz, Austria*

Recent advances in focused ion beam (FIB) techniques have opened new opportunities for nanoscale milling and local modification of thin film superconductors. We present various FIB-based approaches to produce devices in thin films of the cuprate superconductor $YBa_2Cu_3O_7$ (YBCO). By Ga FIB milling, we fabricated YBCO nanoSQUIDs on bicrystal substrates with ultra-low flux noise in the thermal white noise limit [1]. Such devices offer detection of magnetization reversal processes in individual magnetic nanoparticles or nanowires [1-3]. By He FIB irradiation, it is possible to locally drive YBCO from the superconducting to the insulating state, with high spatial resolution, and hence to "write" Josephson barriers into thin films [4]. We present here a comprehensive analysis of the electric transport properties at 4.2 K of He-FIB produced YBCO Josephson junctions [5]. The critical current density j_c can be adjusted by irradiation dose D, with an exponential decay of $j_c(D)$. A transition from flux-flow to Josephson behavior occurs when jc decreases below ~2 MA/cm^2. For Josephson devices we find an approximate scaling of the characteristic voltage $V_c \propto j_c^{1/2}$, and current-voltage characteristics that are well described by the resistively and capacitively shunted junction model, without excess currents for $V_c < 1$ mV. The He-FIB technique provides the possibility to place junctions at arbitrary location, with different orientation and shape, and even with different jc on the same chip. Moreover, He-FIB irradiation with high dose produces highly resistive walls or areas. We used this feature to produce dc SQUIDs with sub-µm loop sizes and very low flux noise. Altogether, the He-FIB technique provides a promising tool for nanoscale patterning of advanced devices, e.g. Josephson junction arrays, in YBCO thin films.

Alexander Golubov

University of Twente

Tue 2.3.2

a.golubov@utwente.nl

Netherlands

Evidence of Abrikosov Vortex Cores in a Nonsuperconducting Metal

A.A. Golubov[a,b], V. S. Stolyarov [b,c], T. Cren[d], Ch. Brun [d], I. A. Golovchanskiy [b], O. V. Skryabina[c], M. Khapaev[e], M. Yu. Kupriyanov[e], D. Roditchev[d]

[a] Faculty of Science and Technology and MESA+ Institute of Nanotechnology, University of Twente, The Netherlands

[b]Moscow Instiute of Physics and Technology, Dolgoprudny, Russia

[c] Institute of Solid State Physics, Chernogolovka, Russia

[d] Institut des Nanosciences de Paris, Universite Pierre et Marie Curie-Paris 6 and CNRS-UMR 7588, Paris, France

[e] Moscow State University, Russia

Vortices in quantum condensates exist owing to a macroscopic phase coherence. We show, both experimentally and theoretically, that a quantum vortex with a well-defined core can exist in a rather thick normal metal, proximized with a superconductor [1]. Using scanning tunneling spectroscopy we reveal a proximity vortex lattice at the surface of 50 nm thick Cu-layer deposited on Nb. We demonstrate that these vortices have regular round cores in the centers of which the proximity minigap vanishes. The cores are found to be ignificantly larger than the Abrikosov vortex cores in Nb, which is related to the effective coherence length in the proximity region (see Fig.1). We develop a theoretical approach that provides a fully selfconsistent picture of the evolution of the vortex with the distance from Cu/Nb interface, the interface impedance, applied magnetic field, and temperature. This work opens a way for tuning of the superconducting properties of quantum hybrids.

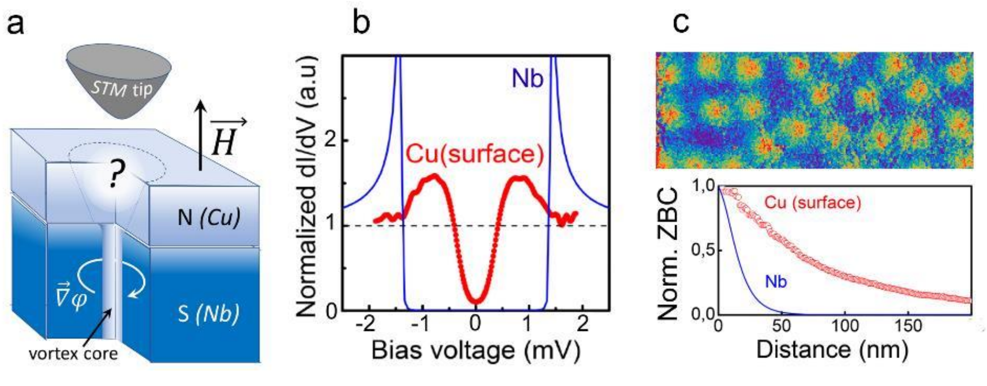


Figure.1. Local tunneling characteristics are probed at the surface of 50 nm thick Cu-film backed with a 100 nm-thick Nb. (b) tunneling conductance measured at Cu-surface exhibits a minigap 0.5 meV; (c) - upper image: 800 nm x 250 nm color-coded dI/dV (V = 0) map acquired in the magnetic field of 120 mT reveals proximity vortices; lower plot: radial variation of the ZBC from the vortex center defines the vortex core profile (red data points). The minigap vanishes in the vortex cores; blue line - expected radial ZBC evolution at the Abrikosov vortex core in Nb-film

Adrian Crisan

National Institute of Materials Physics

Tue 2.4.1
acrisan652@gmail.com
Romania

Models of current-dependent pinning potential in nanostructured $YBa_2Cu_3O_7$ superconducting films

Adrian Crisan,[a] Ion Ivan,[a] Lucica Miu,[a]

[a]*National Institute of Materials Physics, 405A Atomistilor Street, 077125 Magurele, Romania*

We have investigated several nanostructured YBCO films, having various thickness, various types and architectures of artificial pinning centers using frequency-dependent AC susceptibility measurements in high DC fields. In certain experimental windows, the dependence of out-of-phase susceptibility on the amplitude of the AC excitation field have a maximum, which, based on Brandt's calculations, can be related to the frequency-dependent critical current density J_c [1]. The exact frequency (time) dependence of J_c depends on the dependence of the pinning potential on the probing current, hence on the amplitude of the excitation AC field. We have analyzed the experimental data on various films, at various DC fields, using the well-known Collective Pinning model and the Kim-Anderson model, but both models proved to be unsuitable for describing our results. Instead, our data are very well described by a logarithmic dependence of the effective pinning potential on the current density proposed by Zeldov [2], $U_{eff}=U_0\ln(J^*/J)$, where J* is a "critical current" at which U_{eff} approaches zero (start of flux flow). Such relation leads to a linear dependence, in a double-logarithmic plot, of the J_c vs frequency, as shown in the example of Fig. 1, for a 1 µm-thick films having artificial pinning centres induced by BZO nanoinclusions and silver nanoislands on the substrate.

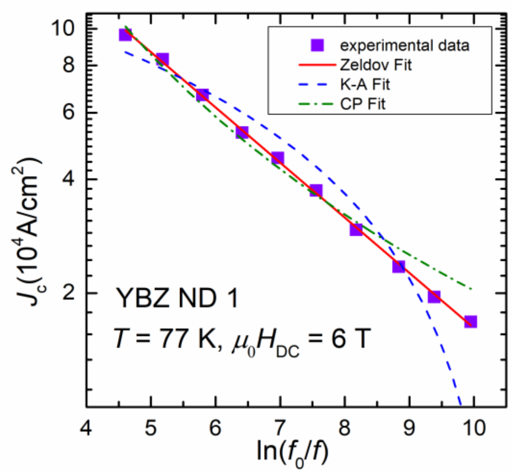


Fig. 1. Frequency dependence of critical current density at 77 K and 6 T for the film indicated in the text. The fits with the three models discussed are shown and indicated in the figure

We also showed theoretically that the slope b of the linear fit with Zeldov model in Fig. 1 can be related to the pinning potential, $U_0=k_BT(1+1/b)$. We have performed such analysis on several films with various pinning centers and obtained the values of pinning potential, which have remarkably high values even in high magnetic fields, at 77 and 65 K.

Kacper Wrześniewski

Faculty of Physics, Adam Mickiewicz University

Wed 3.1.1
wrzesniewski@amu.edu.pl
Poland

Quench dynamics of spin in quantum impurity systems

Kacper Wrześniewski and **Ireneusz Weymann**

Faculty of Physics, Adam Mickiewicz University, Uniwersytetu Poznańskiego 2, 61-614 Poznań

Research concerning quantum dynamics at the nanoscale is stimulated by possible future applications in spintronics and quantum information processing technologies. Understanding the dynamical phenomena in such systems is crucial for precise control and manipulation of spin and charge degrees of freedom, and broadens the general knowledge about quantum transport through magnetic nanostructures. Motivated by these challenges, in this communication we theoretically study the quench dynamics in quantum impurity systems coupled to spin-polarized reservoirs. In particular, we examine the behavior of a quantum dot coupled to external ferromagnetic lead and a large-spin molecule interacting with spin-polarized conduction band via the Heisenberg exchange interaction. The real-time evolution is calculated by means of the time-dependent density-matrix numerical renormalization group method. For the quantum dot system, we examine the system's response to quench in the spin-dependent coupling strength to ferromagnetic lead as well as in the position of the dot's orbital level. The dynamics is analyzed by studying the time-dependent expectation values of the dot's occupation and magnetization. We predict a non-monotonic buildup of the ferromagnetic-contact-induced exchange field in the system. For large-spin molecule, we perform quench in the exchange interaction and analyze the time evolution of local magnetization as well as the development of local quadrupolar exchange field. The relevant time scales describing the dynamics are identified.

Elias Ferreiro-Vila

Wed 3.1.2
elias.ferreiro.vila@gmail.com
Spain

Ciqus-University of Santiago de Compostela (USC)

AFM Electric Field-Induced Local Topotactic Transformation between Perovskite and Brownmillerite $SrFeO_{3-\delta}$.

E. Ferreiro-Vila,[a] S. Blanco-Canosa,[b] I. Lucas del Pozo,[c] Hari Babu Vasili,[d] C. Magén,[c] J. Rubio-Zuazo,[e] R. G. Castro,[e] L. Morellón,[c] F. Rivadulla.[a,*]

[a] Centro de Investigación en Química Biolóxica e Materiais Moleculares (CIQUS), Universidade de Santiago de Compostela (USC), 15782 Santiago de Compostela, Spain.
[b]Donostia International Physics Center (DIPC), 20018, San Sebastián, Spain.
[c] Instituto de Nanociencia de Aragón (INA), Departamento Física de la Materia Condensada, Universidad de Zaragoza, 50018 Zaragoza, Spain.
[d]ALBA Synchrotron Light Source, Cerdanyola del Valles, 08290 Barcelona, Catalonia, Spain
[e] BM25-SpLine Spanish CRG Beamline at the ESRF, 71 Av. Des Martyrs, Grenoble, 38043, France.

Reversible crystallographic transformation between perovskite (PV) $ABO_{3-\delta}$ and brownmillerite (BM) $ABO_{2.5}$ (A=Ca^{2+}, Sr^{2+}; B=$Fe^{4+/3+}$, $Co^{4+/3+}$) oxides can be induced by topotactic oxygen exchange at moderate-high temperatures on the presence of reducing/oxidizing agents, or using different electrochemical configurations [1,2]. This is possible by a combination of large oxide-ion conductivity in these structures, and a small free energy difference between (4+/3+) redox pairs of many 3*d* transition metal ions. Here we demonstrate the room temperature topotactic transformation between PV $SrFeO_{3-\delta}$ and BM $SrFeO_{2.5}$ induced by the electric field of an Atomic Force Microscopy (AFM) tip. Charged oxygen vacancies in the PV can be manipulated with micron size resolution, creating accumulation regions where they spontaneously rearrange to produce the BM phase. The stability provided by the change in the crystallographic transformation reduces the oxygen diffusion once the electric field is removed (high retention of on/off states). This allows the local control of the chemical, electrical and magnetic properties, with very high spatial resolution. Our results open the door to the fabrication of stable ionic-based devices which imply local crystallographic transformations [4].

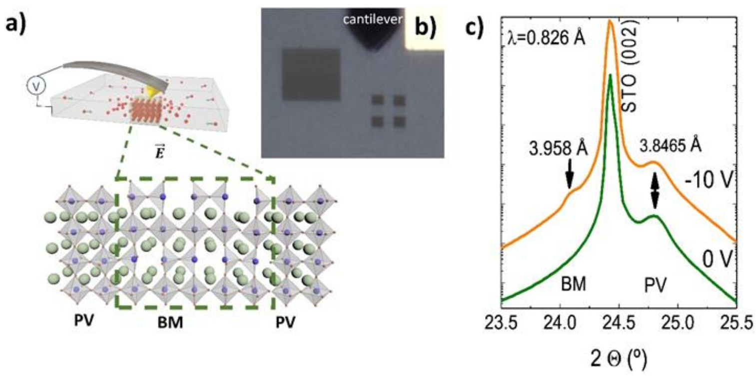


Figure: **AFM electric field-induced local topotactic transformation**. a) Applying an electrical voltage between the AFM tip and the PV film in contact mode produces a large electric field in a localized region in the area underneath the tip. The negative voltage at the AFM tip drags the oxygen vacancies of the conducting PV towards the area closer to the tip. b) Optical image (reflected light) of the electric field polarized region observed with the AFM camera. The regions scanned with the electric field applied with the AFM tip (a 50×50 μm^2 square and four smaller 10×10 μm^2 squares) appear as black areas, consistent with a decrease in conductivity with respect to the surrounding conducting PV. The triangular shadow on the top of the image corresponds to the AFM cantilever. c) Detail of X-ray θ-2θ scans (synchrotron radiation, λ=0.826 Å) of a pristine area of the film, showing only the peak of the PV. Focusing the beam on the region polarized at -10 V, reveals a weak peak corresponding to the BM phase. The contribution from the PV phase is still observable, due to the large area probed by the beam.

Irene Lucas Del Pozo

Universidad de Zaragoza-INA

Wed 3.1.3
ilucas@unizar.es
Spain

Influence of Co^{2+} redistribution on the apparent auxetic to non-auxetic crossover in $CoFe_2O_4$ thin films.

Elías Ferreiro-Vila [a], Lucía Iglesias [a], Irene Lucas [b], Noa Varela-Domínguez [a], Cong Tinh Bui [a], Beatriz Rivas-Murias [a], J. M. Vila-Fungueiriño [c], Pilar Jiménez-Cavero [b], Cesar Magén [d], Luis Morellón [b], Víctor Pardo [g, h], and Francisco Rivadulla [a]

a) *Centro de Investigación en Química Biolóxica e Materiais Moleculares (CIQUS), and Departamento de Química-Física,*

b) *Instituto de Nanociencia de Aragón (INA), Departamento Física de laMateria, Pedro Cerbuna 12, Condensada Universidad de Zaragoza, 50018 Zaragoza, Spain*

c) *Institut d´Électronique et des Systèmes (IES) UMR 5214, CNRS Université de Montpellier, 860 rue Saint Priest, 34095 Montpellier, France*

d) Instituto de Ciencia de Materiales de Aragón (ICMA), Universidad de Zaragoza- CSIC, 50009 Zaragoza, Spain

f) *Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain*

g)Departamento de Física Aplicada, Facultade de Física, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain.

h) Instituto de Investigacins Tecnolóxicas, Universidade de Santiago de Compostela, E-15782, Santiago de Compostela, Spain

In oxide spinels of general formula AB_2O_4 ($A=Mg^{2+}$, Fe^{2+}; $B=Al^{3+}$, Cr^{3+}, etc.) cations distribute among octahedral and tetrahedral sites [1] according to their size and the crystal-field stabilization energy [2]. The cationic arrangement determines the mechanical, magnetic, and transport properties of the spinel, and can be influenced by external parameters like temperature, pressure, or epitaxial stress in the case of thin films [3].

In this work we demonstrate that $CoFe_2O_4$ (CFO) accommodates the epitaxial stress by a continuous migration of Co^{2+} from the Octahedral (Oh) to Tetrahedral (Th) sites due to the combination of both, temperature and induced epitaxial stress. As a result dramatic changes in the magnetic anisotropy, and an apparent transition from molecular auxetic to non-auxetic behavior is observed. To accomplish this study we compare films synthesized by two complementary methods, a chemical solution method (polymer assisted deposition, PAD) and pulsed laser deposition (PLD), which allowed us to explore an unusually large range of epitaxial stress. We report a progressive change in the sign of the Poisson ratio, ν, in thin films of CFO, defining a smooth crossover from auxetic ($\nu < 0$) to non-auxetic ($\nu > 0$) behavior in response to epitaxial stress and temperature. Microstructural and magnetization studies, as well as ab-initio calculations, demonstrate that such unusual elastic response is actually due to a progressive redistribution of Co^{2+} among the Oh and Th sites of the spinel structure. The results presented in this work clarify a long standing controversy about the magnetic and elastic properties of Co-ferrites, and are of general applicability for understanding the stress-relaxation mechanism in complex crystalline structures [4].

[1] West, A. R. Solid State Chemistry and its Applications (John Wiley and Sons, 2014).
[2] Goodenough, J. B. & Loeb, A. L. Physical Review 98, 391–408 (1955).
[3] Fritsch, D. & Ederer, C. Applied Physics Letters 99, 2011–2014 (2011). 1106.5887.
[4] E. Ferreiro-Vila, L. Iglesias, I. Lucas et.al., sent for publication

Lior Klein

Bar-Ilan University

Wed 3.2.1

kleinl@biu.ac.il

Israel

A route towards magnetic memory with 6 bits per cell

Lior Klein, Shubhankar Das, Ariel Zaig, and Moty Schultz

Department of Physics, Nano-magnetism Research Center, Institute of Nanotechnology and Advanced Materials, Bar-Ilan University, Ramat-Gan 52900, Israel

One of the promising ways to address the rapidly rising demand for denser memory is to store more states in a single memory cell. We fabricate magnetic structures consisting of 3 (or 4) crossing ellipses which exhibit in the overlap area effective 3 (or 4) easy axes and demonstrate their switching with spin orbit torques between 8 (or 16) discrete remanent magnetic states. We show that if the two types of structures are to be used as the two ferromagnetic layers in a magnetic tunnel junction, up to 64 resistance states would be measured, paving the way for magnetic random access memory with 6 bits per cell.

Fernando Sols

Universidad Complutense de Madrid

Wed 3.2.2
f.sols@fis.ucm.es
Spain

Protected cat states in a superfluid boson gas

Gregor Pieplow, Charles E. Creffield, Fernando Sols

Departamento de Física de Materiales

Universidad Complutense de Madrid

We investigate the behavior of a one-dimensional Bose-Hubbard gas in both a ring and a hard-wall box, whose kinetic energy is made to oscillate with zero time-average, which suppresses first-order particle hopping [1]. For intermediate and large driving amplitudes the system in the ring has similarities to the Richardson model, but with a peculiar type of pairing and an attractive interaction in momentum space. This analogy permits an understanding of some key features of the interacting boson problem. The ground state is a macroscopic quantum superposition, or cat state, of two superfluid states which collectively occupy opposite momentum eigenstates. Interactions give rise to a reduction (or modified depletion) cloud that is common to both macroscopically distinct states. Symmetry arguments permit a precise identification of the two orthonormal macroscopic many-body branches which combine to yield the ground state. In the ring, the system is susceptible to variations of the effective flux which however preserve the macroscopic superposition. The shared nature of the reduction cloud provides some protection against collapse of the cat state due to particle losses. For the hard-wall case, the macroscopic quantum superposition is protected because the system cannot collapse into a nonzero current state [2].

[1] G. Pieplow, F. Sols, C. E. Creffield, New J. Phys. 20, 073045 (2018).

[2] G. Pieplow, C. E. Creffield, F. Sols, in preparation.

Jose Maria De Teresa

CSIC-UNIVERSITY OF ZARAGOZA

Wed 3.2.3
deteresa@unizar.es
Spain

Magnetotransport properties of superconducting W-C nanowires grown by Ga^+- and He^+- Focused Ion Beam Induced Deposition (FIBID)

R. Córdoba[a,b*], P. Orús[a,b,#], A. Ibarra[c], D. Mailly[d,$], G. Hlawacek[e], I. Guillamón[f], H. Suderow[f], J. M. De Teresa[a,b,c,+]

[a] Departamento de Física de la Materia Condensada, Universidad de Zaragoza, Spain
[b] Instituto de Ciencia de Materiales de Aragón (ICMA), CSIC - Universidad de Zaragoza, Spain
[c] Laboratorio de Microscopías Avanzadas (LMA), Instituto de Nanociencia de Aragón (INA), Universidad de Zaragoza, Spain
[d] Centre de Nanosciences et de Nanotechnologies, CNRS-Univ. Paris Saclay, France
[e] Institute of Ion Beam Physics and Materials Research, HZDR, Dresden, Germany
[f] Departamento de Física de la Materia Condensada, Instituto de Ciencia de Materiales Nicolás Cabrera, Condensed Matter Physics Center (IFIMAC), Universidad Autónoma de Madrid, Spain

Focused Ion Beam Induced Deposition (FIBID) using a Ga^+ FIB source and $W(CO)_6$ precursor permits the growth of W-C superconducting nanostructures with T_C around 5 K [1]. When the lateral dimension of the W-C nanowires is 50 nm, a re-entrance of superconductivity as a function of field is observed, arising from vortex confinement [2]. As will be shown in the present contribution, in such narrow nanowires, long-distance (10 μm) non-local vortex transportation is found [3], with potential for applications based on individual vortex manipulation. On the other hand, when a He^+ FIB source is used in combination with $W(CO)_6$ precursor, superconducting in-plane and out-of-plane nanostructures with higher resolution can be grown. Thus, superconducting out-of-plane nanotubes (with tunable inner and outer diameters) as well as more complex 3D structures, with T_C up to 7 K, can be grown [4]. Moreover, high-resolution (from 100 nm to 10 nm in width) in-plane nanowires grown by He^+-FIBID show T_C around 3.5 K and harness non-local vortex transportation (work in progress).

[

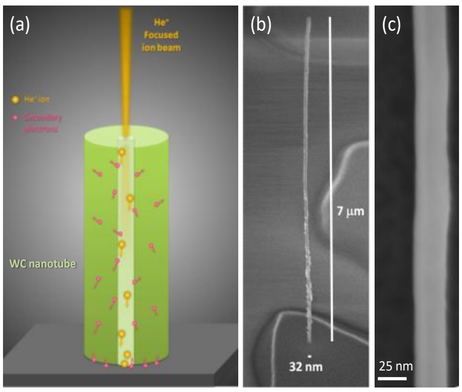


Figure 1. (a) Vertical growth of WC hollow nanowires using a He^+ FIB focused to ~1 nm. (b) SEM image of a vertical WC hollow nanowire (52° tilted stage). (c) High magnification SEM image of the WC nanowire. Image from reference [4].

Aleksandra Petkovic

Laboratoire de Physique Théorique, Université de Toulouse

Wed 3.2.4
alpetkovic@gmail.com
France

Phonon-mediated induced interaction between impurities in a Bose liquid

Benjamin Reichert, Zoran Ristivojevic, and Aleksandra Petkovic

Laboratoire de Physique Théorique, Université de Toulouse, CNRS, UPS, 31062 Toulouse, France

Particles interacting locally with a surrounding medium can get correlated and can experience an induced interaction. Such mechanism is at the hearth of conventional superconductivity, where the electrons of opposite spin become Cooper paired thanks to the attraction mediated by phonons. In this talk we will consider neutral particles (impurities) that interact locally with a one-dimensional Bose liquid. When treated classically, impurities experience a short-range induced interaction for separation shorter than the superfluid healing length. Due to the effect of quantum fluctuations, the impurities actually interact at distances much greater than the healing length by a long-range interaction that acquires a universal form. We develop a theory based on the Gross-Pitaevskii equation that accounts for the effect of quantum fluctuations and obtain an analytical expression for the induced interaction that is valid at arbitrary distances [1, 2].

[1] Benjamin Reichert, Zoran Ristivojevic, and Aleksandra Petkovic, New J. Phys. **21,** 053024 (2019); https://doi.org/10.1088/1367-2630/ab1b8e

[2] Benjamin Reichert, Aleksandra Petkovic, and Zoran Ristivojevic, Phys. Rev. B **99,** 205414 (2019).

Marcin Konczykowski

Laboratoire des Solides Irradies, Ecole Polytechnique

Wed 3.3.1

marcin.konczykowski@polytechnique.edu

France

Superconductivity vs. spin or charge order: competing or intertwined orders

Marcin Konczykowski

LSI, CEA/DRF/IRAMIS, Ecole Polytechnique, CNRS, Institut Polytechnique de Paris, F-91128 Palaiseau, France

Superconductivity of many systems arises from the background of magnetic or charge order. Representative example is iron-based superconducting pnictides (IBS) where substitution induced depression of antiferromagnetism (AF) of parent compound lets emerge superconducting order. In wide underdoped region of composition – temperature phase diagram superconductivity arises from AF state. Similarly, in canonical transition metal dichalcogenide $NbSe_2$, superconductivity stem from charge density wave (CDW) state. The key issue is in what extend the charge/spin order exclude superconductivity or contribute to pairing.

In order to elucidate this question we investigated effect of disorder induced in controlled way by energetic particle irradiation on stability of ordered phases. In both types of systems, depression of charge or spin order by disorder leads to enhancement of superconducting state. In my presentation I will discuss evolution of composition - temperature phase diagram with point-like disorder induced by low temperature irradiation of 122 family of IBS and in $NbSe_2$ [1]. In the later compound strong depression of CDW by disorder is associated with changes of phonon spectra monitored by Raman spectroscopy and X ray diffraction.

[1] Kuyil Cho, et al. NATURE COMM. 9, 2796, (2018)

Work done in collaboration with: Kyuil Cho, S. Teknowijoyo, M.A. Tanatar, J. Guss, P.B. Gartin, J.M. Wilde, A. Kreyssig, R.J. McQueeney, A.I. Goldman, V. Mishra, P.J. Hirschfeld, R. Prozorov, K. Kolincio and R. Grasset

Victor Moshchalkov

KU Leuven

Wed 3.3.2

victor.moshchalkov@fys.kuleuven.be

Belgium

Exotic vortex matter in superconductors

Victor V. MOSHCHALKOV[1], Jun-Yi GE,[1,3] Vladimir N. GLADILIN,[1,2] Jacques TEMPERE,[2] Jozef T. DEVREESE,[2] Joris Van de VONDEL[1]

[1] *KU Leuven, Belgium*
[2]*Universiteit Antwerpen, Belgium*
[3]*Materials Genome Institute, Shanghai University, China*

A brief overview is given of recently discovered new forms of exotic vortex matter in superconductors: *Karman vortex streets, giant vortices, vortex chains and vortex clusters and chains in type-1.5 superconductors, symmetry-induced antivortices*. Direct experimental observation of magnetic dipoles generated by the Meissner current at topological defects (antidots) in superconducting film will be also discussed. Each magnetic dipole can be considered as a pair of fluxoids with opposite polarities. Remarkably, the magnetic flux of each pole and antipole is not necessarily quantized and can carry all non-integer momenta between integer values. However, the total magnetic flux of each dipole remains zero, which fully complies with the quantum character of superconductivity. The magnetic dipoles also provide an efficient way to measure the local intensity and direction of flowing supercurrent, which is rather difficult to realize in any other way. (*Nature Com. 6, Article No: 6573, 2015; NANO LETTERS Volume: 17 Issue: 8 Pages: 5003-5007, 2017; Nature Communications Volume: 7 Article Number: 13880, 2016)*

Luis Brey

ICMM-CSIC

Wed 3.4.1
brey@icmm.csic.es
Spain

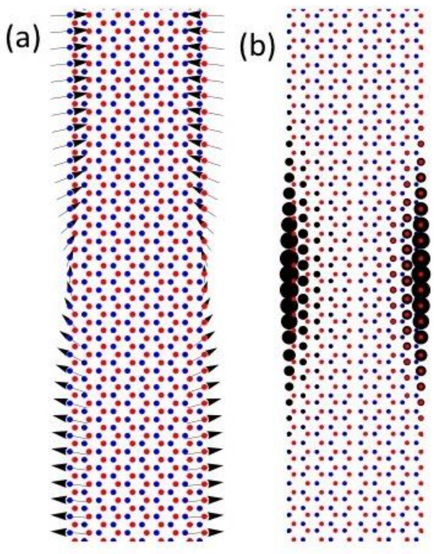
Charged topological solitons in zigzag graphene nanoribbons

M.P.López-Sancho and Luis Brey

Material Science Institute of Madrid, CSIC, Cantoblanco, Madrid, 28049, Spain

Graphene nanoribbons with zigzag-terminated edges have a magnetic ground state characterized by edge ferromagnetism with antiferromagnetic coupling between opposite edges. This ground state appears because of a broken symmetry in the spin sector. Therefore, by inverting the spin polarization of the full system there is another energy degenerate ground state. The band structures of the degenerate ground states are inverted as shown in Figure 1. When connecting two domains with opposite mass *i.e.* spin orientation, a symmetry protected zero energy topological state appears at the interface between the degenerate ground states. These topological states are soliton-like excitations that carry charge ±*e* with half electron localized at each edge of the nanoribbon, Figure 2.

The connection between topological defects and electric charge suggests that solitons can be the relevant charge excitation in zigzag graphene nanoribbons. Then whenever adding (subtracting) charge to the system an array of solitons can be formed, creating a solitonic phase. By performing numerical calculations, we find that at low doping, charge added to the system creates magnetic domains and becomes localized at the domain walls separating opposite degenerate ground states [1]. Interestingly our results show that the topological properties of the zigzag graphene nanoribbons are generated by electron-electron interactions rather than by spin orbit coupling, orbital or bond ordering. [1] M. P. López-Sancho and Luis Brey, *2D Mater.* 5, 015026 (2018)



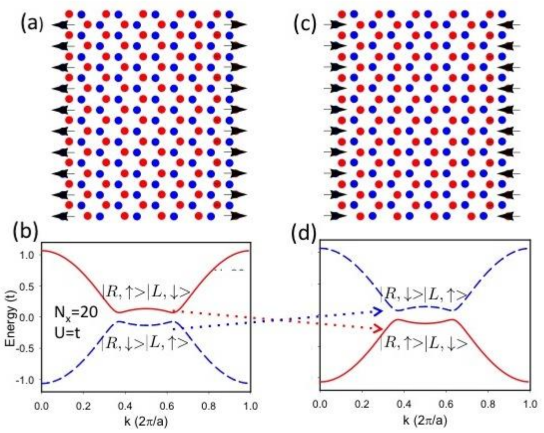


Fig. 1.

(a)(c) Schematic picture of the spin

polarization of an undoped zigzag nanoribbon. b)(d) Band structure for the degenerate ground states (a) and (c) respectively. Fig.2 (a) Local spin polarization and (b) excess excess of charge near a domain wall separating two degenerate ground states.

Valerii Vinokur

Argonne National Laboratory

Wed 3.4.2
vinokour@anl.gov
USA

Bose metal as a bosonic topological insulator

Valerii Vinokur[a], Cristina Diamantini[b], Carlo Trugenberger[c], Yakov Kopelevich[d], Svetlana Postolova[e,f], Aleksey Mironov[e,f]

[a]*Argonne National Laboratory, Materials Science Division, 9700 S Cass Ave, Argonne, IL 60439, USA*

[b]*NiPS Laboratory, INFN and Dipartimento di Fisica e Geologia, University of Perugia, via A. Pascoli, I-06100 Perugia, Italy*

[c]*SwissScientific Technologies SA, rue du Rhone 59, CH-1204 Geneva, Switzerland*

[d]*Universidade Estadual de Campinas-UNICAMP, Instituto de Fısica "Gleb Wataghin"/DFA Rua Sergio Buarque de Holanda, 777, Brasil*

[5]*A. V. Rzhanov Institute of Semiconductor Physics SB RAS, 13 Lavrentjev Avenue, Novosibirsk, 630090 Russia*

[6]*Novosibirsk State University, Pirogova str. 2, Novosibirsk630090, Russia*

Transport measurements of the superconductor-insulator transition (SIT) in disordered two-dimensional films and Josephson junction arrays showed the existence of an anomalous metallic phase that persists to low temperatures. The nature of this mysterious phase, often referred to as "Bose metal," remains unclear. We develop a gauge theory of the Bose metal as the phase in which Cooper pairs and vortices are out of the Bose condensate due to strong quantum fluctuations and form an incompressible liquid of intertwined Aharonov-Bohm-Casher loops. As a result, the Bose metal emerges as an integer (Z) bosonic topological insulator in which bulk transport is suppressed by topological mutual statistics interactions, the Hall resistance vanishes, and longitudinal charge transport is mediated by U(1)-symmetry-protected gapless edge modes. The transport measurements in NbTiN films across the disorder- and magnetic field-driven SIT and observe a disorder and magnetic field–tuned transition from a true superconductor to a metallic phase with saturated longitudinal resistivity.

References

[1] A. Kapitulnik, S. A. Kivelson, B. Spivak, arXiv:1712.07215v1 [cond-mat.supr-con] (2017).
[2] M. C. Diamantini, C. A. Trugenberger & V. M.Vinokur, Communications Physics, 1, 77 (2018).

Alexander Gerber
Tel Aviv University

Israel

Interpretation of experimental evidence of the topological Hall effect and the domain wall resistance.

Alexander Gerber

Tel Aviv University

The subject of this talk is whether we interpret correctly the experimental evidence of two topics of great interest: the topological Hall effect and the domain wall resistance. The topological Hall effect in magnetic materials is considered the ultimate trademark of the skyrmion phase. Experimentally the phenomenon is identified by distinct non-monotonic features in the Hall effect signal presumed to be the evidence of the topological origin. It will be shown that similar features, unrelated to the skyrmion physics, arise in heterogeneous ferromagnets when components of the material exhibit the extraordinary Hall effect with opposite polarities. The relevance of this mechanism to a number of cases will be discussed. The second subject is the domain wall resistance which is revealed by an unusual non-monotonic magnetoresistance behaviour. We show that a similar property can develop due to the tilted magnetization, like in films with tilted off-plane magnetic anisotropy. This and the unusual extraordinary Hall effect in the presence of an in-plane magnetic field are natural results of the standard Hall effect and anisotropic magnetoresistance mechanisms when the tilted anisotropy is properly accounted for.

Albert Fert

Thu 4.1.1-2
Albert.FERT@cnrs-thales.fr
France

Recent advances on skyrmions in multilayers

A. Fert[1], F. Ajejas Bazan[1], K. Bouzehouane[1], D. Céspede-Berrocal[4], M. Chshiev[2], S.Collin[1],V. Cros[1], K. Garcia[1], W. Legrand[1], J. Liang[3], D. Maccariello[1], S. Petit-Watelot[4], N. Reyren[1], J-C. Rojas-Sanchez[4], H. Yang[3]

[1] Unité Mixte de Physique CNRS-Thales, Université Paris-Sud, Université Paris-Saclay, 91767,

1 Av. Fresnel, Palaiseau, France

[2] Univ. Grenoble Alpes, CEA, CNRS, Grenoble INP, IRIG-Spintec, 38000, Grenoble, France

[3]Ningbo Institute of Materials Technology and Engineering, CAS, Ningbo 315201, China

[4]Institut Jean Lamour, University of Nancy, France

*albert.fert@cnrs-thales.fr

After a general introduction on magnetic skyrmions, I will focus on recent advances in our research on skyrmions induced by interfacial chiral spin interactions in magnetic multilayers based on classical ferromagnetic transition metals (samples fabricated by sputtering, measurements at room temperature):

- Electrical creation and detection of skyrmions
- Current-induced motion of skyrmions, pinning by defects.
- Shaping skyrmions in 3D, skyrmions in the 10 nm diameter range
- Antiferromagnetic skyrmions in multilayers with antiferromagnetic interlayer couplings
- Skyrmions in 2D magnetic layers (transition metal dichalcogenides)
- Skyrmions in rare-earth alloys layers

Dmitry Garanin

Thu 4.1.3

einschlag@gmail.com

USA

Lehman College of the CUNY

Skyrmion glass in systems with static randomness

D. A. Garanin and E. M. Chudnovsky

The City University of New York

A 2D Heisenberg ferromagnet with exchange J and random magnetic anisotropy of strength $D_R \ll J$ has been studied. Analytical theory for the dependence of the average size of a pinned skyrmion on the magnetic field H, and for stability of such skyrmions on a lattice, has been developed. It has been complemented by numerical studies of 2D lattices containing up to 40 million spins. At low fields, the average size of the skyrmion, λ, is determined by the average size of Imry-Ma domains. On increasing the field, the skyrmions first shrink, with $\lambda \propto D_R/H$, and then collapse at fields distributed around $H_c \propto D_R^{4/3}$. Concentration of the skyrmions goes down with the field as $\exp[-(H/H_c)^{3/2}]$ [1].

We study a 2D exchange model with a weak static random field on lattices containing over one hundred million spins. Ferromagnetic correlations persist on the Imry-Ma scale inversely proportional to the random-field strength and decay exponentially at greater distances. We find that the average energy of the correlated area is close to the ground-state energy of a skyrmion, while the topological charge of the area is close to ±1. Correlation function of the topological charge density exhibits oscillations with a period determined by the ferromagnetic correlation length, while its Fourier transform exhibits a maximum. These findings suggest that static randomness transforms a 2D ferromagnetic state into a skyrmion-antiskyrmion glass. [2]

In addition, we show recent results on thermal excitation of skyrmions in systems with DMI and on biskyrmions supported by the dipole-dipole interaction.

[1] E. M. Chudnovsky and D. A. Garanin, Skyrmion glass in a 2D Heisenberg ferromagnet with quenched disorder, New J. Phys. **20**, 033006-(9) (2018).

[2] E. M. Chudnovsky and D. A. Garanin, Topological Order Generated by a Random Field in a 2D Exchange Model, Phys. Rev. Lett. **121**, 017201-(5) (2018).

Oleg Tretiakov
UNSW

Thu 4.2.1
o.tretiakov@unsw.edu.au
Australia

Spintronics with (Anti)Skyrmions and Bimerons

Oleg A. Tretiakov,[a]

[a]*School of Physics, University of New South Wales, Sydney, NSW 2052 Australia*

Skyrmions are topologically protected spin textures, which may be used in spintronic devices for information storage and processing. However, skyrmions in ferromagnets have some intrinsic difficulties, which must be overcome to use them for spintronic applications, such as the inability to move along electric current due to skyrmion Hall effect [1]. I will discuss how to work around this problem by using instead of skyrmions different anisotropic topological objects – antiskyrmions, recently observed in systems with anisotropic Dzyaloshinskii-Moriya interaction [2]. I will explain their current-driven dynamics in both ferromagnets and antiferromagnets based on the transformation between skyrmion and antiskyrmion. Yet as another solution to eliminate the skyrmion Hall effect, I will also talk about skyrmions in antiferromagnetic materials [3]. We demonstrate how they can be stabilized [4] and manipulated at finite temperatures [3]. An antiferromagnetic skyrmion is a composite topological object with a similar but of opposite sign spin texture on each sublattice, which results in a complete cancellation of the Magnus force and as a result absence of skyrmion Hall effect. However, the topological spin Hall effect of antiferromagnetic skyrmion texture is nonzero and enhances the spin transfer torques acting on skyrmions [5]. Finally, I will describe the existence in antiferromagnets of bimerons, a pair of two merons that can be understood as the in-plane magnetized version of a skyrmion [6].

[1] K. Litzius, I. Lemesh, B. Kruger, P. Bassirian, L. Caretta, K. Richter, F. Buttner, K. Sato, O. A. Tretiakov, J. Forster, R. M. Reeve, M. Weigand, I. Bykova, H. Stoll, G. Schutz, G. S. D. Beach, and M. Klaui, Nature Physics 13, 170 (2017).

[2] A. K. Nayak, V. Kumar, T. Ma, P. Werner, E. Pippel, R. Sahoo, F. Damay, U. K. Rößler, C. Felser, and S. S. P. Parkin, Nature 548, 561 (2017).

[3] J. Barker and O. A. Tretiakov, Phys. Rev. Lett. 116, 147203 (2016).

[4] P. F. Bessarab, D. Yudin, D. R. Gulevich, P. Wadley, M. Titov, and O. A. Tretiakov, Phys. Rev. B 99, 140411(R) (2019).

[5] C. A. Akosa, O. A. Tretiakov, G. Tatara, and A. Manchon, Phys. Rev. Lett. 121, 097204 (2018).
[6] B. Göbel, A. Mook, J. Henk, I. Mertig, and O. A. Tretiakov, Phys. Rev. B 99, 060407(R) (2019).

Gervasi Herranz

Institut de Ciencia de Materials de Barcelona ICMAB-CSIC

Thu 4.2.2
gherranz@icmab.cat
Spain

Electric-field tunable magnetoplasmonic gratings

Rafael Cichelero[a], Mikko Kataja[a], Gervasi Herranz[a]

[a] *Institut de Ciència de Materials de Barcelona (ICMAB-CSIC), Campus de la UAB, Bellaterra, Catalonia, Spain*

Photonic or hybrid electronic/photonic circuits are considered to be a promising perspective for the next-generation of integrated devices [1]. This brings up the need for integrated photonic nonreciprocal devices that could find use for optical isolation at small scales, enabling propagation along one direction and blocking the reverse one. Optical nonreciprocity is usually achieved by magneto-optic materials. However, as the relevant device length is reduced to very small scales in integrated devices, the magneto-optic activity –which is proportional to the amount of material–, is drastically reduced. It is therefore necessary to compensate the large reduction in size and magneto-optic activity with a large enhancement of the intrinsic response. Facing this challenge, a substantial research has been devoted to boost the intrinsic magneto-optical magnetoplasmonic devices [2]. Along these lines, metallic diffraction gratings have been studied in the context of magnetoplasmonic crystals where control on surface plasmon polaritons (SPPs) is exerted by external magnetic fields.

Here we studied the optical properties of magnetoplasmonic gratings using Fourier optics microscopy [3], which provides access to the band structure of photonic crystals. We used this approach to study selectively surface plasmon polaritons propagating along backward or forward directions, enabling us to easily assess their non-reciprocal magnetic modulation. In this context, we studied the interplay between diffraction and plasmons in magnetoplasmonic gratings. Interestingly, large magneto-optic signals – two orders of magnitude larger than intrinsic responses– are found. Such large signals are caused by frequency shifts in energy and angular spectra of plasmon resonances induced by broken time-reversal symmetry. Interestingly, we show that after incorporation of ferroelectrics plasmon propagation can be also modulated by electric fields, to the extent of reversing the sign of magneto-optic signals. The combined action of magnetic and electric fields opens up interesting avenues for active integrated nanophotonic devices. We anticipate that our results can be generalized to complex diffractive elements, such as plasmonic metasurfaces, where they could find use in designing nonreciprocal isolating devices.

[1] M. Hochberg, T. Baehr-Jones, Towards fabless silicon photonics, Nat. Photonics 4: 492 – 494, 2010.

[2] G. Armelles et al. Magnetoplasmonics: Combining Magnetic and Plasmonic Functionalities. Adv. Opt. Mater. 1: 10–35, 2013.

[3] R. Cichelero et al. Non-reciprocal diffraction in magnetoplasmonic gratings. Opt. Exp. 26: 34842-34852, 2018.

Josep Fontcuberta

Thu 4.2.3

fontcuberta@icmab.cat

Spain

Institut de Ciència de Materials de Barcelona (ICMAB-CSIC)

In-operando adjustable orbital polarization in nickelate perovskites

H. B. Vasili,[1] D. Pesquera,[2,3] M. Valvidares,[1] P. Gargiani,[1] E. Pellegrin,[1] F. Bondino,[4] E. Magnano,[4] A. Barla,[5] and J. Fontcuberta[2]

[1] *ALBA Synchrotron Light Source, E-08290 Cerdanyola del Vallès, Barcelona, Catalonia, Spain*

[2] *Institut de Ciència de Materials de Barcelona (ICMAB-CSIC), Campus UAB, 08193, Bellaterra, Catalonia, Spain*

[3] *Department of Materials Science, University of Cambridge, Cambridge CB3 0FS,* United Kingdom

[4] Istituto Officina dei Materiali (IOM), Consiglio Nazionale delle Ricerche (CNR), I-34149 Trieste, Italy

[5] *Istituto di Struttura della Materia (ISM), Consiglio Nazionale delle Ricerche (CNR), I-34149 Trieste, Italy*

The different occupation of electronic orbitals, the so-called orbital polarization, is a key parameter determining electric and magnetic properties of materials. Here we report on the achievement and demonstration of in-operando voltage-controlled tuning of the orbital occupation in $LaNiO_3$ epitaxial thin films grown on piezoelectric substrates. The different static contributions to the orbital occupation are disentangled, namely the epitaxial strain and the surface symmetry breaking, and the superimposed piezo-electric related orbital polarization is determined by exploiting x-ray linear dichroism at the Ni-$L_{2,3}$ edges. Remarkably, it is found that the voltage-controlled orbital polarization largely amplifies the effects of epitaxial strain.

Milorad Milosevic

Thu 4.2.4

milorad.milosevic@uantwerpen.be

University of Antwerp

Belgium

Hydrogen-induced high-temperature superconductivity in two-dimensional materials: The case of hydrogenated monolayer MgB_2

Jonas Bekaert[1], Mikhail Petrov[1], Alex Aperis[2], Peter M. Oppeneer[2], Milorad V. Milošević[1]

[1]*University of Antwerp, Department of Physics, Groenenborgerlaan 171, Antwerp, Belgium*

[2]*Uppsala University, Department of Physics and Astronomy, Lägerhyddsvägen 1, Uppsala, Sweden*

In his seminal work of 1968 Ashcroft showed that dense metallic hydrogen, if ever produced, could be a high-temperature superconductor, owing to its very high Debye temperature, as a result of its minimal mass, enabling very strong phonon-mediated superconducting pairing according to the Bardeen-Cooper-Schrieffer (BCS) theory [1]. Currently, it has been well established that hydrogen-based compounds under ultra-high pressure, such as the polyhydrides H_3S [2] and LaH_{10} [3,4], superconduct through the conventional electron-phonon coupling mechanism to attain the record critical temperatures (T_c) known to date.

We here demonstrate that the intrinsic advantages of hydrogen for phonon-mediated superconductivity can be exploited in a completely different system, namely two-dimensional (2D) materials [5]. Namely, we found that hydrogen adatoms can strongly enhance superconductivity in 2D materials. Firstly, Van Hove singularities in the electronic structure, originating from atomic-like hydrogen orbitals, lead to a strong increase of the electronic density of states, thus enhancing the electron-phonon coupling. Furthermore, the emergence of high-frequency hydrogen-related phonon modes in this system boosts the electron-phonon coupling further.

As a concrete example, we will focus on the effect of hydrogen adatoms on the superconducting properties of monolayer MgB_2 [6,7], which we investigated by solving the fully anisotropic Eliashberg equations, in conjunction with a first-principles description of the electronic and vibrational states, and the coupling between them. We will show that hydrogenation leads to a high T_c of 67 K, which can be boosted to over 100 K by biaxial tensile strain. This proves that hydrogenation of a 2D material can indeed induce strong electron-phonon coupling and high-T_c superconductivity, as exploited in the bulk hydride compounds with record T_c's to date [3,4], yet without the need to apply excessively high pressures that hamper practical applications.

[1] N. W. Ashcroft, Phys. Rev. Lett. **21**, 1748 (1968).
[2] A. P. Drozdov, M. I. Eremets, I. A. Troyan, V. Ksenofontov, and S. I. Shylin, Nature **525**, 73 (2015).
[3] M. Somayazulu, M. Ahart, A. K. Mishra, Z. M. Geballe, M. Baldini, Y. Meng, V. V. Struzhkin, and R. J. Hemley, Phys. Rev. Lett. **122**, 027001 (2019).
[4] A. P. Drozdov, P. P. Kong, V. S. Minkov, S. P. Besedin, M. A. Kuzovnikov, S. Mozaffari, L. Balicas, F. Balakirev, D. Graf, V. B. Prakapenka, E. Greenberg, D. A. Knyazev, M. Tkacz, and M. I. Eremets, arXiv:1812.01561 (2018).
[5] J. Bekaert, M. Petrov, A. Aperis, P. M. Oppeneer, and M. V. Milošević, arXiv:1902.03818 (2019).
[6] J. Bekaert, L. Bignardi, A. Aperis, P. van Abswoude, C. Mattevi, S. Gorovikov, L. Petaccia, A. Goldoni, B. Partoens, P. M. Oppeneer, F. M. Peeters, M. V. Milošević, P. Rudolf, and C. Cepek, Sci. Rep. **7**, 14458 (2017).
[7] J. Bekaert, A. Aperis, B. Partoens, P. M. Oppeneer, and M. V. Milošević, Phys. Rev. B **96**, 094510 (2017).

Boris Spivak

University of Washington

Thu 4.3.1
spivak@uw.edu
USA

Magneto-enhancement of superconductivity in composite D-wave superconductors

B.Z.Spivak

University of Washington,

We study composite D-wave superconductors consisting of randomly oriented and randomly distributed superconducting droplets embedded into a matrix. In a certain range of parameters the application of a small magnetic field enhances the superconductivity in these materials while larger fields suppress superconductivity as usual in conventional superconductors. We investigate the magnetic field dependence of the superfluid density and the critical temperature of such superconductors

Uwe C. Tauber

Thu 4.3.2
tauber@vt.edu
USA

Department of Physics, Virginia Tech

Non-equilibrium relaxation and critical aging of flux lines following current quenches

Harshwardhan Chaturvedi,[a] Hiba Assi,[b] Ulrich Dobramysl,[c] Barton L. Brown,[a] Michel Pleimling,[a,d] and Uwe C. Täuber [a]

[a] *Department of Physics and Center for Soft Matter and Biological Physics, Virginia Tech, Blacksburg, VA, USA*

[b] *Roanoke College, Salem, VA, USA*

[c] *Wellcome Trust / CRUK Gurdon Institute, University of Cambridge, Cambridge, U.K.*

[d] *Academy of Integrated Science, Virginia Tech, Blacksburg, VA, USA*

We investigate the non-equilibrium relaxation dynamics of magnetic vortex lines in type-II superconductors following rapid changes of the external driving current by means of an elastic line model simulated with Langevin molecular dynamics. The vortices are subject to randomly distributed attractive point-like pinning centers, and are initialized in the moving steady state at sufficiently large drives. Subsequently, the current is instantaneously lowered to a value that pertains to either the moving, disorder-dominated glassy, or critical depinning regime. The ensuing relaxation of the flux lines is studied via one-time observables such as their mean velocity and radius of gyration, and by the two-time transverse displacement autocorrelation function. We analyze dynamical scaling and aging behavior in the system, which in particular emerge after quenches into the glassy pinned state [1], with non-universal scaling exponents; and for low temperatures near the critical current with universal power law behavior [2]. We are currently extending these studies to the dynamics of skyrmion topological defects in magnetic films [3].

This research is supported by the U.S. Department of Energy, Office of Basic Energy Sciences, Division of Materials Sciences and Engineering under Award DE-FG02-09ER46613.

[1] H. Chaturvedi, H. Assi, U. Dobramysl, M. Pleimling, U.C. Täuber, J. Stat. Mech. 083301 (2016).

[2] H. Chaturvedi, U. Dobramysl, M. Pleimling, U.C. Täuber, manuscript in preparation (2019).

[3] B.L. Brown, U.C. Täuber, M. Pleimling, Phys. Rev. B 97, 020405(R) (2018).

Valeriy Ryazanov

Institute of Solid State Physics, Russian Academy of Sciences

Thu 4.4.1
valery.ryazanov@gmail.com
Russia

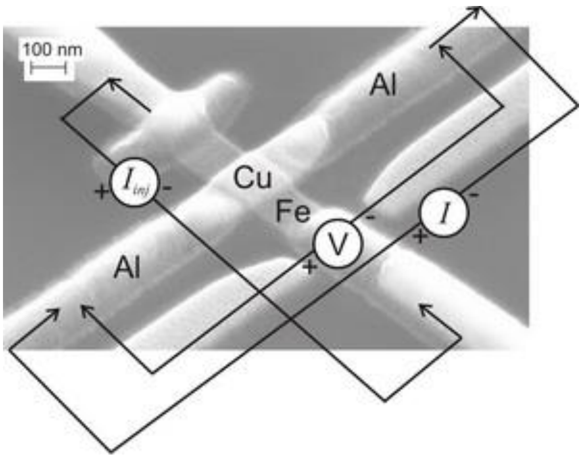
0-π-transition controlled by spin-polarized injection

V.V. Ryazanov, T.E. Golikova, G.A. Penzyakov, I.E. Batov

Institute of Solid State Physics, Russian Academy of Sciences

Chernogolovka, Moscow district, 142432 Russia

We have repeated well-known experiment by J.J.A. Baselmans et al [1] using the spin-polarized injection to Josephson barrier of SNS junction (see Fig.1). We have observed two clearly distinct transitions: both from conventional (0-) to π-state (with inversion of superconducting phase difference) and back π-0 transition. We suppose that the "Baselmans effect" mechanism related to energy electron redistribution is significantly complemented by influence of "induced magnetism" due to spin-injection, i.e. the SNS junction with spin-injection is similar to SFS junction [2]. Along with a discussion of this new experiment, we are going to review other our recent experiments related to the injection of nonequilibrium quasiparticles into the barrier and the banks of planar Josephson nanostructures.



[1] J.J.A. Baselmans, A. F. Morpurgo, B.J. van Wees, T.M. Klapwijk, Nature **43**, 397 (1999).

[2] V.A. Oboznov, V.V. Bol'ginov, A.K. Feofanov, V.V. Ryazanov, A.I. Buzdin, Phys. Rev. Lett. **96**, 197003 (2006).

Pawel Skupinski

Institute of Physics, Polish Academy of Sciences

Fri 5.1.1
Pawel.Skupinski@ifpan.edu.pl
Poland

Electrical and magnetic properties of magnetic topological materials of the $(Bi,Sb)_2(Te,Se)_3$ family

P. Skupiński,[a] **K. Grasza,**[a] ***A. Reszka,***[a] ***A. Avdonin,***[a] ***M. Arciszewska,***[a]

B. J. Kowalski,[a] ***A. Wołoś,***[b]

[a]*Institute of Physics, Polish Academy of Sciences, al. Lotników 32/46, 02-668 Warsaw, Poland*

[b]*Faculty of Physics, University of Warsaw, ul. Pasteura 5, 02-093 Warsaw, Poland*

Topological insulators are at the center of interest of the condensed matter physics due to their fundamental properties and possible application in modern electronics. The topological gapless surface states are protected by the time-reversal symmetry and can be manipulated (the gap at the Dirac point can be opened and tuned, spin texture can be manipulated) by introducing a time-reversal-breaking perturbation (e.g., through doping with elements comprising magnetic moments).

In this work, we present our experience in the control of electrical and magnetic properties of materials from the $(Bi,Sb)_2(Te,Se)_3$ family, doped with Mn. In pure Bi_2Te_3 the type of electrical conductivity can be controlled by adjusting the composition of elements during the growth process [1]. The stoichiometric and bismuth rich melts crystallize into p-type Bi_2Te_3 whereas tellurium rich melts give the n-type Bi_2Te_3. This relation is no longer valid when manganese is added to the system. While the presence of Mn in the stoichiometric Bi_2Te_3 results in the p-type conductivity with concentration of holes up to 10^{20} cm^{-3}, the excess of Te in the melt does not result in the n-type material. The obtained crystals are p-type with concentration of 10^{19}-10^{20} cm^{-3}. Moreover, the n-type conductivity with electron concentration of 10^{20} cm^{-3} is observed in crystals obtained from Bi-rich melt.

The presence of Mn in materials of the $(Bi,Sb)_2(Te,Se)_3$ family affects their magnetic properties. We have observed three ferromagnetic phases with phase transition temperatures around 5 K, 10-12 K, and 24 K, respectively. The ferromagnetic phase with the phase transition temperature of 24 K was observed in binary Bi_2Te_3 as well as in $Bi_{2-x}Sb_xTe_{3-y}Se_y$, both doped with Mn. Anomalous Hall effect was observed below 15 K. At 4 K two overlapping hysteresis were found.

We would like to acknowledge National Science Center, Poland, grant No. 2016/21/B/ST3/02565.

[1] K. A. Kokh, S. V. Makarenko, V. A. Golyashov, O. A. Shegai, O. E. Tereshchenko, Cryst. Eng. Comm. **16**, 581 (2014).

Michael Baker

The University of Manchester

Fri 5.1.2
michael.baker@manchester.ac.uk
United Kingdom

The Dynamics of Exchange Coupled Toroic Moments within a Nanomagnet

Michael L. Baker[a]

[a]*The School of Chemistry, The University of Manchester, M13 9PL Manchester, United Kingdom & The University of Manchester at Harwell, Didcot, OX11 0FA, United Kingdom.*

The continued desire for increased transistor density makes molecular scale electronics an inevitability. Molecules with toroidal quantum states represent an interesting solution to high density molecular information storage, since their quantum states are insensitive to stray magnetic fields, but interact strongly with charge and spin currents. The enhancement of toroic motifs through coupling toroidal moments is a new an interesting development with relevance to both fundamental investigations and potential nanoscale computation applications. Following an introduction to single molecule toroics (SMTs) a recent investigation of a Dy_8 molecule will be presented. Dy_8 is of particular interest given it's snub square based arrangement consisting of four interlaced Dy triangles, see Figure. This arrangement of weakly exchange coupled Dy ions leads to an antiferrotoroic molecular ground state with slow magnetic relaxation. To date the experimental measurement of Dy^{III} ion magnetic anisotropy axes and their exchange interactions within SMTs represents a considerable challenge due to the non-magnetic nature of the toroidal motif. To overcome this and obtain access to the low energy states of Dy_8 a multi orientation single crystal micro Hall sensor magnetometry approach has been adopted. Using an effective Hamiltonian model the microscopic spin structure of Dy_8 is identified confirming a canted antiferrotoroidic tetramer molecular ground state and its low energy excited states. These findings are supported with electrostatic calculations that independently confirm the experimentally determined magnetic anisotropy axes for each Dy^{III} ion within the molecule.

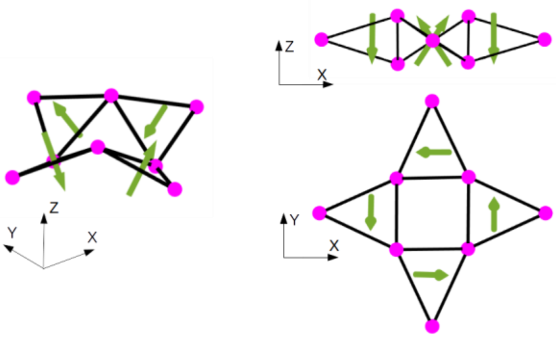


Figure. Schematic views of the central core of Dy ions within the Dy_8 molecule (purple spheres). Green arrows show the canted nature of the four toroic moments within the molecular ground state.

[1] Q. Zhang, M. L. Baker, S. Li, M. P. Sarachik, J. J. Baldoví, A. Gaita-Ariño, E. Coronado, D. I. Alexandropoulos and T. Stamatatos. Submitted (2019).

Ali Gencer

Ankara University

Fri 5.1.3

Ali.Gencer@science.ankara.edu.tr

Turkey

Conduction Cooled Superconducting Magnet for 1.5 T MRI Applications; Design, Fabrication with Materials Processing and Performance Tests

A. Gencer[a,b,d], E. Coskun[b,d] , E.Ertekin[d], S.Safran[a,d], S.Gecer[d], E.S. Kilicarslan[d], M.Ekin[d], Y.Oznal[d], C.Baris[b], M.H.Gencer[b], S.Oncul[b] and Y. Kamioka[c,d]

[a]Ankara University, Science Faculty, Phys. Dept., 06100-Tandogan- Ankara, Turkey

[b] SuperMag R&D Engineering Inc., Bahcelievler Mah. 71. Cad. 17, 06830-Golbasi, Ankara, Turkey

[c]ColdTech Associates, 6-5, Takanodai, Kodaira,187-0024 Tokyo, Japan

[d]Ankara University, Center of Excellence for SUperconductivity Research, (CESUR), 06830-Golbasi-Ankara, Turkey

One of the most versatile applications of Superconductivity is by no means Magnetic Resonance Imaging (MRI), which has become one of the most established and important usable equipment for medical diagnosis of some life threatening diseases for the last 40 years. Technology has become more advanced with many sophisticated functionalities over the recent times. However, the need to use liquid helium (LHe) to cool down the superconducting magnet to the required low temperatures has become one of the most obstacles as the liquid helium prices have risen recently to a highly unaffordable price range in addition to the other cumbersome issues like availability to be mentioned in the presentation. Conduction cooling and portable use of some specialty MRI systems have become more popular with flexible use of advantages to meet the demands of patients in need of sophisticated diagnosis and treatment. In this paper, a conduction-cooled superconducting magnet system with an operating current of 164.1 A was designed to obtain a sustainable field of 1.5 T with the required homogeneity supply for more than 1 hour 20 minutes with much sufficient time than the needed scan time. The magnet was designed, manufactured and tested for some possible potential MRI applications. The superconducting magnet consists of 3 coils wound by using NbTi superconducting multi-filamentary wires on with co-axial Oxygen free Copper (OFC) former with the dimensions of 422 mm long and 102 mm ID with a room temperature bore of 60 mm. The coils were installed with a high thermal shield in a very high-vacuumed cryostat. A two stage G-M Crycooler with a cooling power of 1 W at 4 K in the second stage and 65 W in the first stage at 50 K to cool the whole system to the temperatures around 4 K from the room temperature. In this paper, design details, manufacturing, materials and thermal analysis in addition to the performance tests of the whole system are to be presented.

Ferran Macià
Universitat de Barcelona

Fri 5.2.1
ferran.macia@gmail.com
Spain

Acoustic Spin Waves

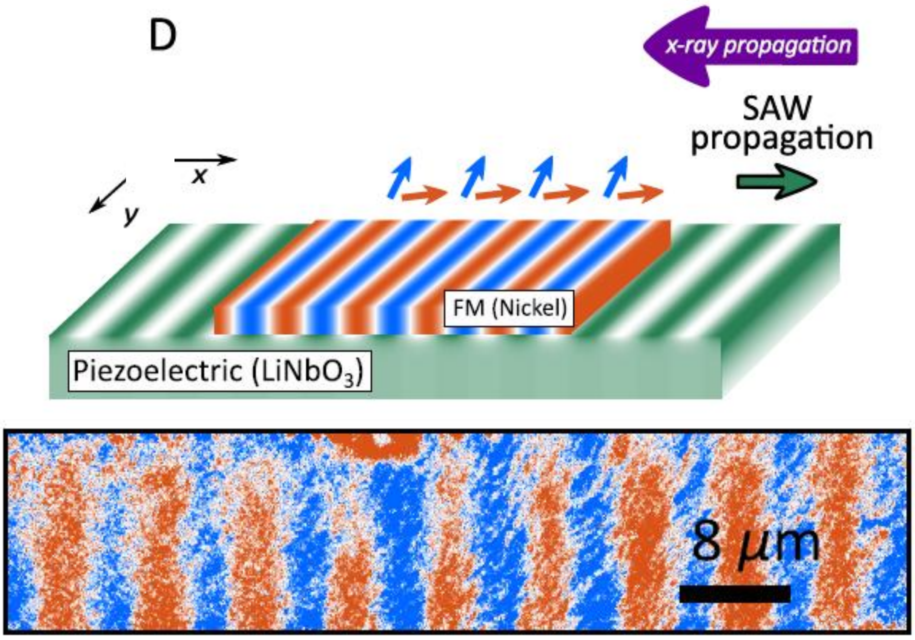
Ferran Macià[1], Nahuel Statuto[1], Michael Foerster[2], Alberto Hernandez-Mínguez[3], Lucia Aballe[2], Joan Manel Hernàndez[1],

[1]*Dept. of Condensed Matter Physics, University of Barcelona, 08028 Barcelona, Spain*

[2]*ALBA Synchrotron Light Source, 08290 Cerdanyola del Valles, Spain*

[3]*Paul-Drude-Institut fur Festk□orperelektronik, Hausvogteiplatz 5-7, 10117 Berlin, Germany*

Spin waves in ferromagnets are coherent dispersive waves, typically in the low GHz frequency regime and with wavelengths of hundreds of nanometers. Recent interest for spin waves is motivated by the possibility of its integration into nano-scale devices for high-speed and low-power signal processing. However, generation of spin waves with high amplitudes—and their detection—is challenging due to the mismatch of wavelengths with electromagnetic waves in free space, which is of the order of several centimeters. Using hybrid systems composed of piezoelectric plus magnetic materials it is possible to create large amplitude spin waves with up to 25 degrees variation in the magnetization orientation. I will show direct images that quantify the "strain spin waves"—both standing and propagating—with different wavelengths, propagating



Upper panel: Drawing showing both the piezoelectric (LiNbO3) and the Ferromagnetic (Ni) materials in presence of a SAW—stripes indicate the presence of SAW in the piezoelectric surface and the induced magnetic wave on Ni.

Lower panel: XMCD Image with a field of view of 75 × 15 μm² showing the Ferromagnetic (Ni) and the piezoelectric (LiNbO3) materials in presence of a SAW—stripes indicate the presence of a magnetic wave. XMCD images of strain spin waves of frequencies 500, 375, 10 250, and 125 MHz having wavelengths of 8, 12, 16, and 32 micrometers.

over large distances up to several millimeters, orders of magnitude longer than previously achieved.

Libor Smejkal

JGU Mainz

Fri 5.2.2

lsmejkal@uni-mainz.de

Germany

Topological Antiferromagnetic Spintronics

Libor Šmejkal

INSPIRE group, Johaness Gutenberg Universitat, Mainz, Germany

Departments of Spintronics and Nanoelectronics, Institute of Physics, Czech Academy of Sciences, Prague, Czech Rep.

We will start the talk with a brief introduction of the main experimental and theoretical discoveries shaping the field of topological antiferromagnetic spintronics [1,2]. We will show that the antiferromagnets allow combining topological electronic structures with long-range magnetic order and spintronics functionalities. As a central topic, we will discuss crystal symmetries and electronic structure of antiferromagnets with topological electronic bands.

We will focus on Dirac-quasiparticle antiferromagnets [3,4] and crystal Hall effect antiferromagnets [5]. Dirac-quasiparticle antiferromagnets such as CuMnAs [4], can simultaneously host Dirac quasiparticles and Neel spin-orbit torques allowing for the THz control of antiferromagnetic order and enhanced anisotropic magnetoresistance [3,4].

The crystal Hall effect antiferromagnets host previously unrecognized spontaneous Hall effect generated by the local or global crystal chirality in combination with a trivial magnetic order. We will show that notorious collinear antiferromagnets - commonly anticipated to be prevented from any spontaneous Hall effects- can host a large magnitude of this crystal Hall effect [3] and we will list material candidates.

[1] LŠ and T. Jungwirth, Symmetry and topology in antiferromagnetic spintronics, Topology in Magnetism, Eds. J. Zang, V. Cros, A. Hoffmann, *Springer International Publishing* (2018)
[2] LŠ, Yuriy Mokrousov, Binghai Yan, Allan H. MacDonald, Topological antiferromagnetic spintronics, *Nature Physics* 14, 242–251 (2018)
[3] S. Yu. Bodnar, LŠ, I. Turek, T. Jungwirth, O. Gomonay, J. Sinova, A.A. Sapozhnik, H.-J. Elmers, M. Kläui, M. Jourdan, Writing and Reading antiferromagnetic Mn2Au: Néel spin-orbit torques and large anisotropic magnetoresistance, *Nature Communications* 9, 348(2018)
[4] LŠ, J. Železný, J. Sinova, T. Jungwirth, Electric control of Dirac quasiparticles by spin-orbit torque in an Antiferromagnet, Phys. Rev. Lett. 118 (2017) 106402-106402.
[5] LŠ, Rafael Gonzalez-Hernandez, Tomas Jungwirth, Jairo Sinova, arXiv:1901.00445 (2019)

Rosa López

Fri 5.2.3

rosa.lopez-gonzalo@uib.es

Institute for Complex and Interdisciplinary Physics IFISC

The Kondo effect in Thermoelectrics

Rosa Lopez [a], Miguel A. Sierra [a], David Sanchez [a]

[a]*Institut de Física Interdisciplinària i de Sistemes Complexos*

IFISC (CSIC-UIB), E-07122 Palma de Mallorca

We present a work to deal with (i) a single quantum dot strongly connected to two leads that are thermally biased by $\theta = T_L - T_R$ (T_L, T_R are the reservoir temperatures for Left and Right contacts, respectively) [1] and (ii) an artificial molecule formed by two serially coupled quantum dots [2]. First of all our aim is to study the behavior of the Kondo effect in the simplest system of a unique quantum dot using three different approaches, namely, a perturbation formalism based on the Kondo Hamiltonian, a slave-boson mean-field theory for the Anderson model at large charging energies and a truncated equation-of-motion approach beyond the Hartree-Fock approximation. The two former formalisms yield a suppression of the Kondo peak for thermal gradients above the Kondo temperature, showing a remarkably good agreement despite their different ranges of validity. The third technique allows us to analyze the full density of states within a wide range of energies. Additionally, we have investigated the quantum transport properties (electric current and thermocurrent) beyond linear response. In the voltage-driven case, we reproduce the split differential conductance due to the presence of different electrochemical potentials. In the temperature-driven case, we observe a strongly nonlinear thermocurrent as a function of the applied thermal gradient. Depending on the parameters, we can find nontrivial zeros in the electric current for finite values of the temperature bias. Importantly, these thermocurrent zeros yield direct access to the system's characteristic energy scales (Kondo temperature and charging energy). For the double quantum dot case we employ the slave-boson formulation to obtain the nonlinear thermal and thermoelectrical responses. When the Kondo correlations prevail over the antiferromagnetic coupling J between dot spins we demonstrate that the setup shows negative differential thermal conductance regions behaving as a thermal diode. Besides, we report a sign reversal of the thermoelectric current $I(\theta)$ controlled by t/Γ (t and Γ denote the interdot tunnel and reservoir-dot tunnel couplings, respectively) and θ. All these features are attributed to the fact that at large θ, both $Q(\theta)$ (heat current) and $I(\theta)$ are suppressed regardless the value of t/Γ because the double dot decouples at high thermal biases. Eventually, and for a finite J, we investigate how the Kondo-to-antiferromagnetic crossover is altered by θ the. All these features are attributed to the fact that at large θ, both $Q(\theta)$ (heat current) and $I(\theta)$ are suppressed regardless the value of t/Γ because the double dot decouples at high thermal biases. Eventually, and for a finite J, we investigate how the Kondo-to-antiferromagnetic crossover is altered by θ

[1] M. A Sierra , R. Lopez, D. Sanchez, Phys. Rev. B 96, 085416 (2017).

[2] M. A Sierra , R. Lopez, J-S Lim Phys. Rev. Lett. 121, 096801 (2018).

Rodolfo Miranda
IMDEA Nanociencia UAM

Fri 5.2.4
rodolfo.miranda@imdea.org
Spain

Mapping the spin distribution of molecules adsorbed on graphene

Rodolfo Miranda [a b]

[a] *IMDEA Nanociencia, Cantoblanco, 28049 Madrid, Spain*

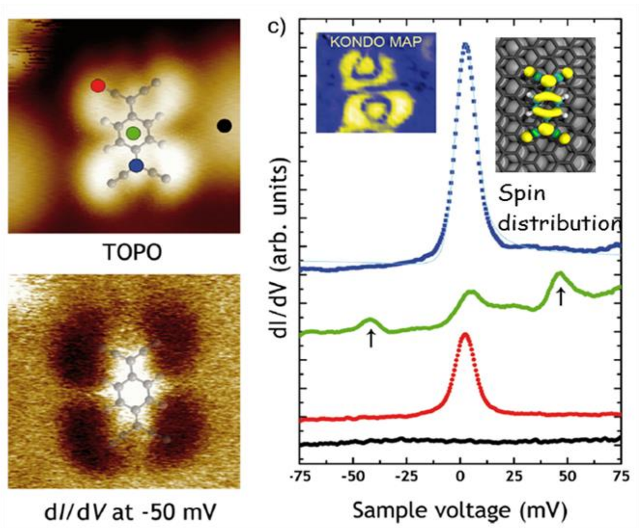
[b] *Departamento de Física de la Materia Condensada, Universidad Autónoma Madrid, Cantoblanco, 28049 Madrid, Spain*

Creating an ordered 2D array of objects with protected magnetic moments deposited at surfaces, individually addressable and with potentially controlled interactions between their spins would be highly desirable for different quantum technologies. Being able to visualize the distribution in space of the spins is crucial to advance our knowledge and control of these systems. Below a certain temperature, a magnetic moment located at the surface can be screened by the electron sea of the substrate giving rise to a many body Kondo resonance.

We present some selected examples to illustrate how by recording the spatial distribution of the sharp Kondo resonance at the Fermi level with Scanning Tunneling Spectroscopy at low temperatures one can visualize experimentally the spin distribution:

i) Spin distributed in a molecular orbital: isolated molecules of TCNQ /graphene/Ru(0001) [1]
ii) Spin localized in a bond: isolated molecules of F4-TCNQ/graphene/Ru(00101) [2]
iii) The turning on (and off) of localized magnetic moments by controlled, reversible reaction of an acceptor molecule (i.e. TCNQ) and a radical covalently bonded to graphene epitaxially grown on Ru(0001) [3-5]

The controllable production of a superconducting tip for the STM allows to explore the ultimate limit of resolution and the new physics revealed by the Zero Bias Conductance peaks in TCNQ molecules adsorbed on Pb-intercalated graphene grown on Ir(111), a substrate with a giant spin-orbit coupling [6]



Eshkulov Abdugani

Poster
abdugani4@rambler.ru
Uzbekistan

Tashkent State Technical University

The research of spin-orbital interaction in intermetallic compounds of system GD-IN on paramagnetic area

O.K. Kuvandikov[1]*, A.A. Eshkulov[2], R.M. Rajabov[1]
[1]*Samarkand State University. Samarkand. Uzbekistan*
[2]*Tashkent State Technical University. Tashkent. Uzbekistan*

qodir1992

Then the effective spin-orbital interaction parameter λ_{SO} is

$$\lambda_{SO} = \frac{R_S \mu_0 \mu_B \hbar g}{2e^2 \rho^2}.$$

An analysis of the experimental data demonstrates a correlation between the Hall coefficient R_H and the magnetic susceptibility χ for the intermetallic Gd_3In, Gd_3In_5 and $GdIn_3$ compounds shown in Fig. 1. As can be seen from the figure, the dependence of R_H on χ is linear for the samples. Extrapolating R_H to zero (*OY* axis), the normal, R_0, and anomalous, R_S, components of the Hall coefficients can be determined.

The normal, R_0, and anomalous, R_S, components of the Hall coefficient were determined from experimental investigations of temperature dependences of the Hall coefficient, magnetic susceptibility, and specific electrical resistance of the intermetallic Gd_3In, Gd_3In_5 and $GdIn_3$ compounds.

However, the coefficient of the anomalous Hall effect decreases with increasing indium concentration, whereas the effective spin-orbital interaction parameter λ_{SO} increases. This can be explained for the Kondo model [1]. It is assumed that magnetic electrons are localized, their magnetizing action on the conduction electrons can be neglected, and that exactly non-magnetized conduction electrons are carriers of the anomalous Hall effect. Therefore, the Kondo model is applicable to REM, since 4*f*-electrons do not participate in the formation of current.

The effective spin-orbital interaction parameters λ_{SO} of the examined intermetallic compounds were calculated from the anomalous components R_S of the Hall coefficient and the specific electrical resistance.

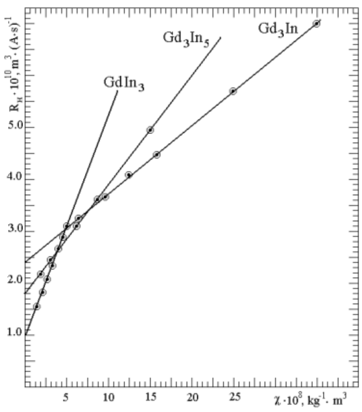


Fig. 1. Dependence of R_H on χ for the intermetallic Gd–In compounds.

Leonid Burlachkov (Feigel)

Bar-Ilan University

Poster
leonid@biu.ac.il
Israel

"Bulk" and "surface" regimes in AC magnetic response in type-II superconductors

Leonid Burlachkov and Nikita Fuzailov

Department of Physics, Bar-Ilan University

Ramat-Gan 52900, Israel

Solving analytically and numerically the flux diffusion equation [1,2] in current-carrying type-II superconductors embedded into AC magnetic field, we prove that there exist two different regimes of vortex kinetics and energy dissipation. The "usual" mechanism is determined by the dynamics of Abrikosov vortices in the bulk of the sample, whereas the "novel" one is related to giant retardation of flux motion at the surface when the "annihilation line" $B = 0$ enters or exits the sample. The effect is mostly pronounced if the frequency ω of the external field is relatively high, such that 1/ω is of the same order of lower than the characteristic relaxation time of vortices in the sample. This condition can be easily fulfilled in clean samples or at high temperatures where the vortices are slightly pinned or unpinned at all (flux flow). In this limit the Bean model can no longer be used, and one has to solve numerically the equation of flux diffusion. Similar effect has been considered already with respect to the dramatic effect of Bean-Livingston barrier in high-temperature superconductors [3], but here the vortex-antivortex interaction at the surface affects the flux dynamics in the whole sample. We prove that the surface regime appears only if the magnetic field B changes sign in the sample, i.e. when both vortices and antivortices are present.

We construct a phase diagram that discriminates between the bulk and the surface regimes as function of the amplitude of the external magnetic field H, its frequency ω and transport current I and prove that thi is actually a "two-dimensional" diagram that depends on two parameters: "reduced" current and frequency: $\tilde{I} - \widetilde{\omega}$. These two different dissipation regimes were observed experimentally in Ref. [4] as "in-phase" regime where the maxima of the induced voltage and, in turn, of the energy dissipation measured as function of time coincide with the corresponding maxima of the absolute value of the external magnetic field $H(t)$, and "out of phase" regime. The agreement between the experimental data and our theoretical analysis is encouraging.

It has been proved in our analysis that the frequency of the external magnetic filed ω is the main parameter that discriminates between these two dynamic regimes though I also has certain effect. This study, especially construction of the complete phase diagram, is quite challenging for application of the high-temperature superconductors in any kind of AC current-carrying wires.

[1] M.R.Beasley, R.Labusch and W.W.Webb, Phys. Rev. **181** (1969) 682.
[2] L.Burlachkov, D.Giller and R.Prozorov, Phys. Rev. B **58** (1998) 15067
[3] L.Burlachkov, Phys. Rev B **47** (1993) 8056.
[4] G. Lukovsky et al, IEEE Trans. on Appl. Supercond. 17, 3137 (2007).

Daniel Capic

CUNY Graduate Cent

Poster
dcapic@gradcenter.cuny.edu
United States of America

Writing Skyrmions with a Magnetic Dipole

Dmitry A. Garanin,[a] Daniel Capic,[a] Senfu Zhang,[b] Xixiang Zhang,[b] and Eugene M. Chudnovsky[a]

[a] Physics Department, Herbert H. Lehman College and Graduate School, The City University of New York, 250 Bedford Park Boulevard West, Bronx, New York, 10468-1589, USA

[b] Physical Science and Engineering Division (PSE), King Abdullah University of Science and Technology (KAUST), Thuwal 23955-6900, Saudi Arabia

We demonstrate numerically on large spin lattices that one can write skyrmions in a thin magnetic film with a magnetic dipole of a few tens of nanometer in size. Nucleation of non-chiral skyrmions as well as chiral skyrmions formed by the Dzyaloshinskii-Moriya interaction has been investigated. Analytical model is developed that agrees with numerical results. It is shown that skyrmions can be written though a number of scenarios that depend on the experimental technique and parameters of the system. In one scenario, that branches into subscenarios of different topology, the magnetic dipole on approaching the film creates a skyrmion-antiskyrmion pair. As the dipole moves closer to the film it induces collapse of the antiskyrmion and creation of a non-zero topological charge due to the remaining skyrmion. In a different scenario the dipole moving parallel to the film nucleates a skyrmion at the boundary and then drags it inside the film. Possible implementations of these methods for writing topologically protected information in a magnetic film are discussed. [1]

[1] D.A.Garanin, D.Capic, S.Zhang, X.X.Zhang, and E.M. Chudnovsky, Writing skyrmions with a magnetic dipole, Journal of Applied Physics 124, 113901-(8) (2018)

Jaume Calvo de la Rosa

Poster
jaumecalvo@ub.edu
Spain

Universitat de Barcelona

Soft Magnetic Composites: structure, magnetic properties and new formulations

Jaume Calvo-de la Rosa,[a] *Chao Chen-Ye,[b] Arturo Lousa,[c]* Javier Tejada,[b]

[a] Department of Materials Science and Physical Chemistry, Chemistry Faculty, Universitat de Barcelona, Martí i Franquès 1, 08028 Barcelona, Spain

[b] Department of Condensed Matter Physics, Physics Faculty, Universitat de Barcelona, Barcelona, Martí i Franquès 1, 08028 Barcelona, Spain

[c] Department of Applied Physics and Optics, Physics Faculty, Universitat de Barcelona, Barcelona, Martí i Franquès 1, 08028 Barcelona, Spain

Soft Magnetic Materials (SMMs) are of great technological interest due to their elevated magnetic permeability and low hysteresis losses. These materials are usually metals or metallic alloys. Nevertheless, pure metals allow the generation of induced electrical currents between particles, which are known as eddy currents, and become a second energy loss source. In order to keep the elevated permeability, small hysteresis and also to reduce the eddy current losses, new composites materials are gaining attention. These Soft Magnetic Composites (SMCs) are usually made up of a high permeability core surrounded by an insulating layer, which has the role of avoiding the eddy currents between particles.

In this work the structural and magnetic properties of common SMM and SMC samples are analyzed [1]. The particle size distribution and the presence of the insulating shell in the SMC sample is chemically detected and observed by electron microscopy. Then, the effect that these physical differences have on the final magnetic properties (static and frequency – dependent) are analyzed. The hysteresis cycle is measured with an SQUID magnetometer, meanwhile the permeability between 1 kHz and 13 MHz is measured by impedance spectroscopy.

Additionally, some new laboratory-made SMC formulations are studied and compared with the commercial ones, reaching better magnetic properties in green form. Finally, the change in properties that bulk toroids have due to the annealing process (which is a necessary step for technological applications) are discussed for all the materials.

[1] J. Calvo-de la Rosa, J. Tejada, and A. Lousa, "Structural and impedance spectroscopy characterization of Soft Magnetic Materials," *J. Magn. Magn. Mater.*, vol. 475, 2019.

Alexander Chizhik

Universidad del País Vasco

Poster
oleksandr.chyzhyk@ehu.es
Spain

Spiral and elliptical structure in magnetic cylinders

A. Chizhik

Universidad del País Vasco, San Sebastian, Spain

Identification and characterisation of novel and unusual magnetization states remains a topic of research in modern magnetism. Recently, control of the magnetization state between the surface and volume in cylindrical microwires with the giant magneto-impedance effect has been demonstrated. Herein, the phenomenon of spatial migration of spiral magnetic domains inside a microwire is demonstrated using the magneto-optical Kerr effect [1]. The main properties of the inclined spiral structure were determined, where the surface domain structure possessed a length limited only by actual sample length. Transformation of the structure from a spiral to an elliptical structure could be controlled by external torsion stress. Hysteresis and magnetic images were simulated based on a model assuming a spatial distribution of the internal stress inside the microwire, whose results were consistent with the experimental results. A consistent interpretation of the results in terms of the formation and transformation of the spiral magnetic domain structure is proposed.

[1] Chizhik, A. & Gonzalez, J., “Magnetic Microwires. A Magneto-Optical Study”, Pan Stanford Publishing, Singapore (2014).

Alina Crisan

National Institute for Materials Physics

Poster

ocrisan@infim.ro

Romania

L10 based nanocomposite magnets for integration in spintronic devices

A.D. Crisan,[a] **O. Crisan,**[a]

[a]*National Institute for Materials Physics, PO Box MG-7, 077125 Magurele, ROMANIA*

Among the rare-earth-free systems that are currently investigated in search for novel permanent magnet solutions for various applications, with special emphasis on the magnets required to operate in extreme conditions, the FePt binary system, where the tetragonal hard magnetic L10 phase can be formed by suitable microstructure processing via annealing, has been extensively studied. A variation of this system, the ternary FeMnPt system, has been also recently shown to exhibit good permanent magnet behavior due to the suitable formation of the L10 phase. In addition to be likely to form the L10 phase as its parent binary system, the ternary FeMnPt benefits from the reduced costs due to the reduced amount of Pt and may exhibit particular magnetic structure due to the influence of the antiferromagnetic Mn. In the present work, we have employed a mixed sputtering technique, based on the use of both elemental and compound target for developing L10 FeMnPt thin films with specific structural features, that triggers better magnetic performances in terms of coercivity and maximum energy products. The as-obtained films have been thermally annealed and characterized by means of transmission electron microscopy, X-ray diffraction, Mossbauer spectroscopy, magneto-optic Kerr effect (MOKE) and SQUID magnetometry. The aim is to correlate the Mn induced microstructural and lattice changes with the magnetic properties and to optimize the microstructure for an early formation of the ordered L10 phase and increased coercivity compared to the as-prepared, structurally disordered, face centred cubic initial state of the films. Acknowledgements:

Financial support from Romanian Ministry of Research and Innovation from project PN-III-P4-ID-PCE-2016-0833 is gratefully acknowledged.

Marc De Paz

Universitat de Barcelona

Poster

marcdepazstadorotea@gmail.com

Spain

Quantum and classical superparamagnetism in Stern-Gerlach simulation

Authors: Marc de Paz Monfort, Aleix Bou Comas, Javier Tejada Palacios

University of Barcelona

Abstract: Many of the superparamagnetic classical and quantum phenomena can be observed with a Stern-Gerlach device, so the purpose of this poster is to explore the behaviour of single domain particles in that device under certain conditions of temperature and magnetic field. A simulation is been performed in order to reproduce non analytical results. Some applications of the so mentioned experiment are also discussed.

Amel Derras-Chouk

CUNY Graduate Center and Herbert H. Lehman College

Poster
amel.derras@gmail.com
USA

Thermal Collapse of a Skyrmion

Amel Derras-Chouk[a], Eugene M. Chudnovsky[a], and Dmitry A. Garanin[a]

[a]*Physics Department, Herbert H. Lehman College and Graduate School, The City University of New York 250 Bedford Park Boulevard West, Bronx, New York 10468-1589, USA*

Thermal collapse of an isolated skyrmion on a two-dimensional spin lattice has been investigated. The method is based upon solution of the system of stochastic Landau-Lifshitz-Gilbert equations for up 10^4 spins. Recently developed pulse-noise algorithm has been used for the stochastic component of the equations. The collapse rate follows the Arrhenius law. Analytical formulas derived within a continuous spin-field model support numerically-obtained values of the energy barrier and the pre-exponential factor, and their dependence on the magnetic field. Our findings agree with experiments, as well as with recent numerical results obtained by other methods.

Jesús González

Universidad del Magdalena

Poster
jgonzaleza@unimagdalena.edu.co
Colombia

Magnetic frustration in superconducting multilayers

V. Vermeiren,[a] J. D. González,[b] and M. V. Milošević [a]

[a] *Theory of Functional Materials, Department of Physics,*

University of Antwerp, Groenenborgerlaan 171, B-2020 Antwerpen, Belgium

[b] *Facultad de Ingeniería, Universidad del Magdalena, Santa Marta, Colombia*

The magnetic frustration of a periodically stacked superconducting type I-type II multilayer, is studied by use of Ginzburg Landau theory taking into account the spatially varying material parameters of the system. We first examine the scope of the proximity effect between the layers in an infinitely thick type I-type II multilayer under the influence of the layer widths and characteristics of the two used superconductors on the order parameter behavior in both components is analized. An equilibrium field-temperature (H-T) phase diagram, for the vortex configurations in the multilayer at different temperatures, is thereby constructed. In this phase diagram, a characterization of four different phases, unattainable in single component superconductors, is performed. Separate simulations on bulk type I and type II superconductors, with the characteristic length scales of the two components in the reference sample give more insight in the nature of the phase transition that occurs in which one vortex jumps from the type II layer at low temperature to the type I layer at high temperature. The vortex configurations of the different situations, offer more insight into the nature of the interlayer vortex interaction between the vortices in the two components, but also unusual hybrid magnetic behavior of the studied multilayer.To date, this interaction has never been studied.

Tatiana Krinitsina

Institute of Metal Physics

Poster

krinitsina@imp.uran.ru

Russia

Magnetotransport features in Dy based nanostructures caused by helical magnetic ordering of Dy layers

L.I. Naumova, M.A. Milyaev, R.S. Zavornitsyn, T.P. Krinitsina, T.A. Chernyshova, V.V. Proglyado, V.V. Ustinov

Institute of Metal Physics UB RAS, Ekaterinburg, Russia

GMR nanostructures with rare earth metal layers possess a combination of 3d and 4f magnetism and therefore they are of interest for scientific and practice applications. In the work presented, the pseudo- and exchange biased spin valves with Dy nanolayer have been fabricated by magnetron sputtering. We study the microstructure and magnetic properties of Dy nanolayer, which is surrounded with Ta and/or CoFe layers. The formation of the Dy-Co-Fe alloy in Dy/CoFe interfaces was also taken into account. The variation of magnetoresistive properties of the spin valves caused by magnetic changes in dysprosium and Dy/CoFe interfaces were investigated. It has been shown that the transition to helical magnetic ordering occurs in dysprosium layer if the layer thickness is not less than 20 nm. For Ta/Dy/Ta and CoFe/Dy/CoFe layered structures the transition was accompanied with the changes of resistance, which are typical for bulk dysprosium (fig.1). We observed magnetoresistance variations, which accompanied the transition for pseudo- and exchange biased spin valves of CoFe/Cu/CoFe/Dy and CoFe/Cu/CoFe/Dy/CoFe/FeMn composition. Formation of exchange coupling in Dy/CoFe interface and the appearance of relevant magnetic unidirectional anisotropy has been revealed for the spin valve with Dy nanolayer in the pinned layer. We suppose that the appearance of the unidirectional anisotropy emphasizes the forming of antiferromagnetic helical magnetic ordering in Dy layer. Earlier it was shown that in a single crystal dysprosium the magnetic moment direction in adjacent atomic layers (0001) is rotated by a specific angle, and the angle is dependent on the temperature of the sample. In our experiments the direction of relevant unidirectional anisotropy changes with variation of temperature. Therefore, we used the magnetoresistive properties of spin valve as measuring instrument and revealed the existence of helical magnetic ordering in Dy polycrystalline nanolayer at the temperature of 43 – 133 K [1].

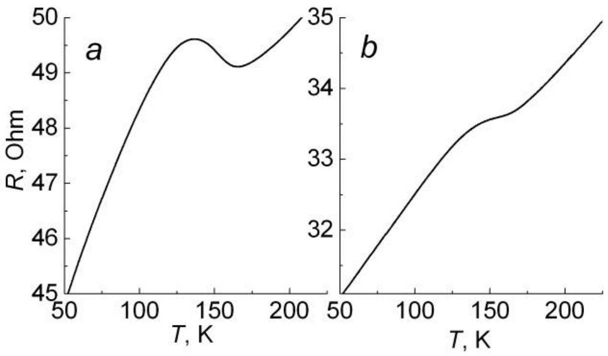


Fig. 1. Resistance-temperature dependence measured for

a) Ta(5nm)/Dy(40nm)/Ta(5nm) and *b*) CoFe(5nm)/Dy(40nm)/CoFe(5nm)

Antonio Lopez-Martin

Institute of Smart Cities, Public University of Navarre

Poster

antonio.lopez@unavarra.es

Spain

Magnetic sensors for contactless angle detection in the automotive sector

A. Lopez-Martin and A. Carlosena

Institute of Smart Cities, Public University of Navarre

Campus Arrosadia 31006 Pamplona, Spain

Contactless angle detection is widely used in automotive applications. For instance, it is applied in electronic brakes and "drive by wire" automotive systems. As opposed to conventional potentiometers, contactless potentiometers are free of wear, enlarging the lifetime of the device. Currently, magnetic sensors are commonly employed for this task since they work under hostile and dirty environmental conditions [1]. Hall sensor arrays and magnetoresistors have been widely used for this task, but lately giant magnetoresistance (GMR) sensors are becoming popular since they are less sensitive to air gap deviations, simplifying the mechanical design of the contactless potentiometer [2]. In this work we discuss the applicability of magnetic sensors in contactless angle detection for automotive systems, and we compare various industrial alternatives that we have implemented. It is experimentally demonstrated that using a GMR sensor bridge with ferromagnetic layers antiferromagnetically coupled via interlayers and a properly calibrated ASIC interface, measured absolute errors lower than 1º can be achieved in a 170º angular range and a temperature range from -40 ºC to 120 ºC.

Supported by Grant TEC2016-80396-C2-1-R (AEI/FEDER-EU).

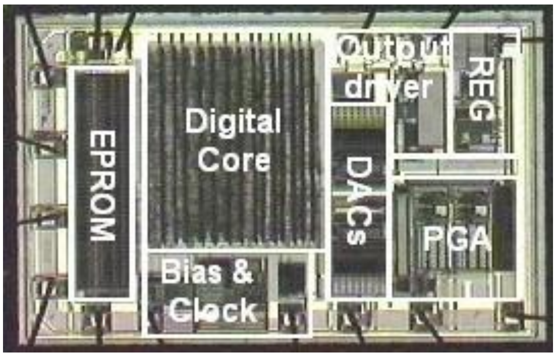


Figure 1. Fabricated ASIC readout interface for GMR sensor

[1] G. Rieger, K. Ludwig, J. Hauch, W. Clemens. Sensors & Actuators A: Physical, 91, 7 (2001).
[2] A. Lopez-Martin, A. Carlosena, IEEE Sensors J., 9, 191 (2009).

Maria Magnitskaya

Vereshchagin Institute for High Pressure Physics, Russian Academy of Sciences

Poster
magnma@gmail.com
Russia

Pressure-tuned Fermi-surface topology and transport anomalies in noncentrosymmetric transition-metal monogermanides

M.V. Magnitskaya,[a,b] **N.M. Chtchelkatchev**[a,c]

[a]*Vereshchagin Institute for High Pressure Physics, Russian Academy of Sciences, Troitsk, Moscow, 108840, Russia*

[b]*Lebedev Physical Institute, Russian Academy of Sciences, Moscow, 119991, Russia*
[c]*Moscow Institute of Physics and Technology, Dolgoprudny, Moscow Region, 141700, Russia*

This talk is devoted to *ab initio* density-functional study of noncentrosymmetric (B20) transition-metal monogermanides including new high-pressure-synthesized materials not found in nature. Such high-pressure phases remain metastable at normal conditions, therewith they preserve their noncentrosymmetric B20-type structure. The calculation procedure, as well as experimental technique of high-pressure synthesis and characterization of these compounds is described in our recent paper [1]. A part of calculation results for B20-RhGe at normal and higher pressure have been briefly published previously [2]. For new high-pressure B20-RhGe, we study the pressure evolution of electronic, optical, dynamical, transport, and thermoelectric properties using the density functional calculations and Boltzmann transport equations. We show appreciable transformation of the phonon spectrum under high pressure, including a vanishing anisotropy of the transverse acoustic phonon modes. An analysis of the band structure shows that the presence of parallel and nearly flat bands in fairly large regions of **k**-space gives rise to prominent peaks of the interband optical absorption. The symmetry-conditioned Dirac-like crossing points in the electronic spectrum are essential for the pressure evolution of the Fermi surface topology. Based on the calculations at ambient and higher pressures, we consider pressure-induced successive Lifshitz transitions which manifest themselves in anomalies of thermopower and conductivity. B20-RhGe is shown to be a poor metal with a moderate carrier density. The asymmetric electronic spectrum near the Fermi level results in a rather large Seebeck coefficient. The application of high pressure tunes the conductivity and thermopower of B20-RhGe in the same way as a low-level hole-doping does. This suggests a way to improve the thermoelectric efficiency. This work was supported by Russian Science Foundation (Grant RSF 18-12-00438).

[1] V.A. Sidorov, A.E. Petrova, N.M. Chtchelkatchev, M.V. Magnitskaya, L.N. Fomicheva, D.A. Salamatin, A.V. Nikolaev, I.P. Zibrov, F. Wilhelm, A. Rogalev, A.V. Tsvyashchenko, Phys. Rev. B, 98, 125121 (2018).
[2] M. Magnitskaya, N. Chtchelkatchev, A. Tsvyashchenko, D. Salamatin, S. Lepeshkin, L. Fomicheva, M. Budzyński, J. Magn. Magn. Mater., 470, 127 (2019).

Riya Nandi

Virginia Tech

Poster
riya11@vt.edu
India

Non-universal Critical Aging Scaling in Three-dimensional Heisenberg Antiferromagnets

Riya Nandi , **Uwe C. Täuber,**[a]

[a] Department of Physics (MC 0435) and Center for Soft Matter and Biological Physics, Virginia Tech, Robeson Hall, 850 West Campus Drive, Blacksburg, Virginia 24061, USA

We numerically investigate the stationary and non-equilibrium critical dynamics in three-dimensional isotropic Heisenberg antiferromagnets. Since the non-conserved staggered magnetization couples dynamically to the conserved magnetization density, we employ a hybrid simulation algorithm that combines reversible spin precession with relaxational Kawasaki spin exchange processes. We measure the dynamic critical exponent and identify a suitable intermediate time window to obtain the aging scaling exponents. Our results support an earlier renormalization group prediction: While the critical aging collapse exponent assumes a universal value, the associated temporal decay exponent in the two-time spin autocorrelation function depends on the initial distribution of the conserved fields; here, specifically on the width of the initial spin orientation distribution.

Alexey Ognev

Far Eastern Federal University

Poster
ognevav@gmail.com
Russia

Magnetic skyrmion nanolithography realized by magnetic force microscopy

A.V. Ognev[a,g], A.S. Samardak[a], A.G. Kolesnikov[a], A.V. Sadovnikov[b,c], S.A. Nikitov[b,c], I.V. Soldatov[d], A. Talapatra[e], J.R. Mohanty[e], Y.J. Kim[f], I.H. Cha[f], Y.K. Kim[f]

[a] School of Natural Sciences, Far Eastern Federal University, Vladivostok, Russia
[b]Laboratory "Metamaterials", Saratov State University, Saratov, Russia
[c]Kotel'nikov Institute of Radioengineering and Electronics, Russian Academy of Sciences, Moscow, Russia
[d]Leibniz Institute for Solid State and Material Research (IFW-Dresden), Dresden, Germany
[e]Indian Institute of Technology, Hyderabad, India
[f]Department of Materials Science and Engineering, Korea University, Seoul, Korea
[g]National Technology Initiative Center of Neurotechnology, Virtual and Augmented Reality Technologies, FEFU, Vladivostok, Russia.

Magnetic skyrmions are stable spin textures with a quasi-particle behavior attracting a lot of interest as objects for fundamental and applied physics. The stability, mobility, and small size of skyrmions make them promise for application in spin current devices and Sk memory. Nowadays developing the methods for the nucleation of Sk with control of their localization is very actual task for the practical implementation of new types of magnetic memory and magnonics devices.

In this paper the [Pt (1 nm)/CoFeSiB (1.5 nm)/W (1 nm)]$_n$ multilayers (MLs) with the n = 1...20 repetition were investigated. In this system the magnetic structure is driven by a competition between direct exchange interaction, inter-layer dipolar coupling, perpendicular magnetic anisotropy and the interfacial Dzyaloshinkii-Moriya interaction (iDMI). The combination of the heavy metals can enhance the effective value of iDMI up to -1.0 mJ/m^2 and stable Sk can be nucleated.

We have revealed that the stray field induced by standard magnetic moment MFM tips during a multi-pass scanning results in a well-ordered Sk lattice with periodicity of about 150 nm. We have optimized the scanning parameters for creation of the Sk arrays with arbitrary shape (see Fig 1). The developed technique of a Sk nanolithography allows one to create local groups of ordered skyrmions, for example, in multilayered nanostructures or films with PMA and IDMI. This approach opens possibilities for creating environments for studying the topological Hall effect.

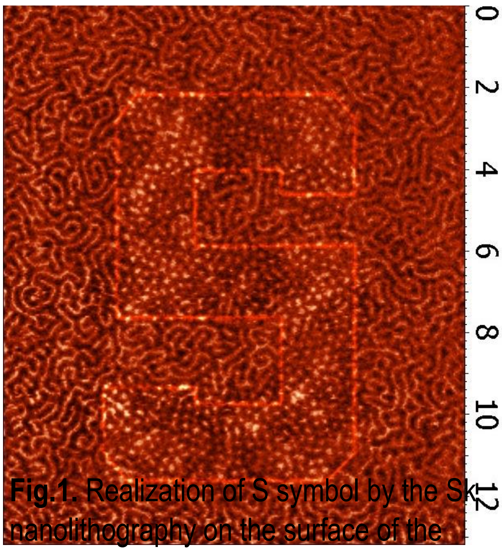


Fig.1. Realization of S symbol by the Sk nanolithography on the surface of the (Pt/CoFeSiB/W)$_{10}$ film. The MFM image size is 11×13 μm^2.

This work is supported by the RFBR (19-02-00530 and 17-52-45135), the Russian Ministry of Education and Science under the state task (3.5178.2017 and 3.4956.2017), the NTI Center of Neurotechnology, Virtual and Augmented Reality Technologies of the FUFU (Grant No. 1/1251/2018 16.10.2018).

Antolii Rinkevich

Institute of Metal Physics

Poster

rin@imp.uran.ru

Russia

Great variations of electromagnetic waves amplitude reflected from composite media containing permalloy flakes

A.Rinkevich, D.Perov, E.Kuznetsov

Institute of Metal Physics, Ekaterinburg, Russia

Magnetic antiresonance condition can stimulate great increase of the amplitude of electromagnetic wave reflected from composite media containing ferromagnetic particles [1]. Transmission of electromagnetic waves through a plate of composite media based on permalloy flakes and reflection from the plate is investigated here. The media under study is prepared of permalloy flakes sized from 2 to 50μ placed into polymer epoxy-amine matrix. Two series of metamaterial samples are under study with the volume portion of permalloy particles 15% and 30%. In both cases there are no direct electrical contact between permalloy particles. Microwave measurements have been carried out at frequencies of 12 to 38 GHz in magnetic fields to 12 kOe. Sharp decrease of transmitted wave is observed under ferromagnetic resonance (FMR) condition caused by absorption. Under magnetic antiresonance (FMAR) condition, in opposite, maximum of reflection coefficient is observed at frequencies exceeding 30 GHz. For example, for sample with the volume portion of permalloy of 30%, the variation of reflection coefficient in magnetic field reaches 300%, see Fig.1. These high variations are of interest to develop magnetic field driven microwave devices. Magnetic field variations of refractive index are also estimated.

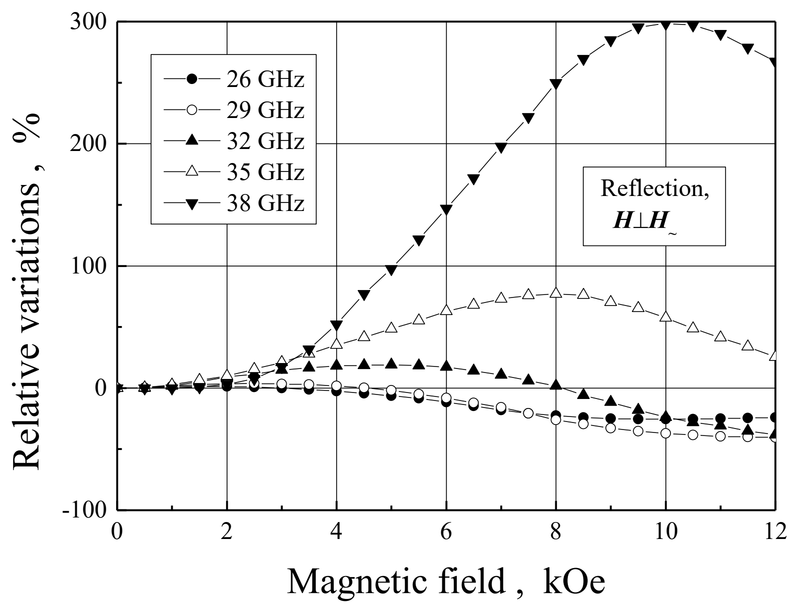


Figure 1. Magnetic field dependence of the amplitude of the waves of millimeter waveband reflected from the composite media containing 30% permalloy flakes

Joann Sitnicka

Faculty of Physics, University of Warsaw

Poster
Joanna.Sitnicka@fuw.edu.pl
Poland

Structural, magnetic and electronic investigations of 3D topological insulator Bi_2Te_3 doped with Mn

Joanna Sitnicka,[a] Anna Reszka,[b] Kamil Sobczak,[c] Jolanta Borysiuk,[a] Marcin Konczykowski,[d] Paweł Skupiński,[b] Krzysztof Grasza,[b] Bogdan Kowalski,[b] Irina Fedorchenko,[d] Andrei Avdonin,[b] Mateusz Tokarczyk,[a]

Natalia Olszowska,[e] Jacek Kołodziej,[e] Lia Krusin-Elbaum,[f] Agnieszka Wołoś[a]

[a]Faculty of Physics, University of Warsaw, ul. Pasteura 5, 02-093 Warsaw, Poland
[b]Institute of Physics Polish Academy of Sciences, al. Lotników 32/46, 02-668 Warsaw, Poland
[c]Faculty of Chemistry, Biological and Chemical Research Centre, University of Warsaw, Żwirki i Wigury 101, 02-089 Warsaw, Poland
[d]Laboratoire des Solides Irradies, Ecole Polytechnique, 91 128 Palaiseau, France
[d]Kurnakov Institute of General and Inorganic Chemistry, 119991 Moscow, Russia
[e]Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University, ul. prof. Stanisława Łojasiewicza 11, 30-348 Krakow, Poland
[f]Department of Physics, The City College of New York, CUNY, New York, NY 10031, USA

3D topological insulators (TI) represent a category of matter with insulating bulk and metallic (gapless) surface. The electronic surface states are immune to localization as long as time reversal symmetry (TRS) is preserved. Incorporating magnetic ions into the host TI material will break TRS, which will result in the surface gap opening.

We studied electronic, magnetic and structural properties of a 3D topological insulator Bi_2Te_3 doped with manganese atoms. Complementing theoretical predictions which ensure that Mn will mostly take substitional positions onto Bi sites [1], our TEM (transmission electron microscopy) imaging and EDX (energy-dispersive X-ray spectroscopy) microanalysis show that studied system with high Mn content (about 2 at. %) forms self-organized quintuple/septuple layer (QL/SL) heterostructures in which Mn incorporates both substituting Bi site and in the centre of SL of $MnBi_2Te_4$ compound. $MnBi_2Te_4$ has been predicted to be antiferromagnetic TI in which ferromagnetic (FM) ordering is expected within each SL [2]. FM alignment of local magnetic moments in SL facilitate FM coupling of the randomly distributed subsitional Mn as our ferromagnetic spin resonance (FMR) measurements revealed higher Curie temperature compared to samples in which SL were not observed. FMR measurements were performed versus temperature and versus orientation of the external magnetic field with respect to the Bi_2Te_3 c-axis. At higher temperatures single resonance line is present showing slight anisotropy of the resonance field. Obtained g-factor agrees with that determined earlier for paramagnetic Mn^{2+} substituting Bi site in Bi_2Te_3 [3]. Below 17 K for samples containing SL layers and below about 7 K for samples without SL layers the spectrum develops strong anisotropy indicating paramagnetic-ferromagnetic phase transition. To view the surface electronic structure, we performed angle resolved photoemission spectroscopy (ARPES) experiments. ARPES measurements revealed that SL influence surface states, moving the Dirac cone up to the bulk band gap.

We would like to acknowledge National Science Center, Poland, grant no 2016/21/B/ST3/02565.

[1] J. Henk, M. Flieger, I. V. Maznichenko, I. Mertig, A. Ernst, S. V. Eremeev, E. V. Chulkov, Phys. Rev. Lett. 109, 076801 (2012).
[2] J. Li, Yang Li, Shiqiao Du, Zun Wang, Bing-Lin Gu, Shou-Cheng Zhang, Ke He,Wenhui Duan, Yong Xu,arXiv:1808.08608 (2018).
[3] S. Zimmermann, F. Steckel, C. Hess, H. W. Ji, Y. S. Hor, R. J. Cava, B. Buchner, and V. Kataev, Phys. Rev. B 94, 125205 (2016).

Joan Josep Suñol

University of Girona

Poster
joanjosep.sunyol@udg.edu
Spain

Magnetism and structural analysis of Fe-Zr and Fe-Nb based nanostructured alloys prepared by mechanical alloying

Albert Carrillo,[a] Lluisa Escoda, [a] Joan Saurina, [a] Joan Josep Suñol, [a]

[a] *Dep. de Fisica, Universitat de Girona, Campus Montilivi, Girona, Spain*

It is known that size dependent phenomena (due to magnetic nanostructures as clusters) and crystallographic defects (at the nanoscale) determine the magnetic response of nanostructured Fe-based alloys [1]. In this work, nanostructured alloys of the Fe-Nb and Fe-Zr rich based systems were prepared by high energy mechanical alloying in two milling devices (shaker, planetary). Upon continued milling, inter-layer spacing decreased and the number of layers in particles increased, which resulted in true alloying at the atomic level. This phenomenon was confirmed by coercivity trend, which was decreased due to introduction of minor elements into the bcc Fe lattice [2]. Interatomic distance, crystallographic defects and elemental atomic distribution affects the magnetic response.

Nanocrystalline size ranged between 6 and 15 nm. Lower crystalline size was found in samples with a second minor phase. Milling on shaker mill favors the formation of a unique phase in Fe-Nb based alloys, and the formation of a minoritary Zr rich solid solution in Fe-Zr based alloys. Results indicates that shaker mill is more energetic.

All samples are soft magnetic at room temperature. Lower coercivity values (14.3 and 14.6 Oe) were found in the samples with only one crystalline phase. We can conclude that in soft ferromagnetic alloys produced by mechanical alloying, final product microstructure and the material properties depends of milling device.

Keywords: Fe based alloys; nanostructure; Magnetic properties.

[1] A. Carrillo, L. Escoda, J. Saurina, J.J. Suñol, AIP Advances, 8, 047704 (2018)

[2] H.A. Baghbaderani, S. Sharafi, M.D. Chermahini, Powder Technology 230, p. 240-246 (2012).

Vladimir Ustinov

Institute of Metal Physics

Poster
ustinov@imp.uran.ru
Russia

Spin and electric currents in inhomogeneously magnetized metals

Vladimir Ustinov, Ivan Yasyulevich

Institute of Metal Physics UB RAS, Ekaterinburg, Russia

A large number of works devoted to the study of spin transport in a system of conduction electrons of metals and semiconductors, is based on the use of the equations of motion for electron magnetization of the Bloch equation type, which allows taking into account all possible causes of changes in the electron magnetization with time: the magnetization precession in an external magnetic field $\mathbf{B}(\boldsymbol{r},t)$, its relaxation to equilibrium value, as well as the diffusion of the magnetization non-uniformly distributed in space. The corresponding term in the Bloch equation describing the diffusion of magnetization is written as the divergence of the electron magnetization flux, which is proportional to the flow of the spin moment.

In this paper, the equations of motion for the electron density $N(\mathbf{r},t)$, the spin moment density vector $\mathbf{S}(\mathbf{r},t)$, the electron current density vector $\mathbf{V}(\mathbf{r},t)$, and the spin current density tensor $\overleftrightarrow{\mathbf{J}}(\mathbf{r},t)$ are derived from the quantum kinetic equation for the density matrix by passing to the semiclassical limit when describing the orbital motion of electrons. At the same time, a consistent quantum-mechanical approach is preserved to describe the spin transport. Here we present only finite equations for $N(\mathbf{r},t)$, $\mathbf{V}(\mathbf{r},t)$, $\mathbf{S}(\mathbf{r},t)$ and $\overleftrightarrow{\mathbf{J}}(\mathbf{r},t)$:

$$\frac{\partial}{\partial t}N + \frac{\partial}{\partial \mathbf{r}}\cdot\mathbf{V} = 0\,, \tag{1}$$

$$\frac{\partial}{\partial t}\mathbf{S} + \frac{\partial}{\partial \mathbf{r}}\cdot\overleftrightarrow{\mathbf{J}} + [\mathbf{S}\times\mathbf{\Omega}_{\mathrm{L}}] + \frac{1}{T_S}\delta\mathbf{S} = 0\,, \tag{2}$$

$$\frac{\partial}{\partial t}\mathbf{V} + \frac{D}{\tau}\frac{\partial}{\partial \mathbf{r}}\delta N - \frac{e}{m}N\mathbf{E} - \mathbf{\Omega}_{\mathrm{C}}\times\mathbf{V} + \frac{\mu}{m}\delta S_i\frac{\partial}{\partial \mathbf{r}}B_i + \frac{1}{\tau}\mathbf{V} = 0\,, \tag{3}$$

$$\frac{\partial}{\partial t}\overleftrightarrow{\mathbf{J}} + \frac{D}{\tau}\frac{\partial}{\partial \mathbf{r}}\otimes\delta\mathbf{S} - \frac{e}{m}\mathbf{E}\otimes\mathbf{S} - \mathbf{\Omega}_{\mathrm{C}}\times\overleftrightarrow{\mathbf{J}} + \overleftrightarrow{\mathbf{J}}\times\mathbf{\Omega}_{\mathrm{L}} + \frac{1}{\tau}\overleftrightarrow{\mathbf{J}} = 0\,. \tag{4}$$

Here δN and $\delta\mathbf{S}$ are the deviations of densities $N(\mathbf{r},t)$ and $\mathbf{S}(\mathbf{r},t)$from their instantaneous locally equilibrium values, τ is the pulse relaxation time, T_S is the spin-lattice relaxation time of electrons, μ, e, m are the magnetic moment, charge and effective electron mass, and D is the diffusion coefficient, $\mathbf{\Omega}_{\mathrm{C}} = \frac{|e|}{\boldsymbol{mc}}\mathbf{B}$, $\mathbf{\Omega}_{\mathrm{L}} = \frac{2\mu}{\hbar}\mathbf{B}$. In equations (1) - (4), the symbols of multiplication in form of a point, an oblique cross and an oblique cross in a circle are used to denote the operations of scalar, vector, and direct product of vectors and tensors, respectively. When writing the relaxation terms of equations (2) - (4), the terms describing asymmetric scattering of electrons due to their spin-orbit interaction with scatterers are omitted. The second term in the left side of equation (4) for spin current describes the effects of spin diffusion, the third term corresponds to the effects of electron spin drift under the action of an electric field, the fourth one describes the movement of charge and spin carriers under the action of Lorentz's force in circular orbits with cyclotron frequency Ω_{C}, the fifth term - the effects of precession of moving spins with a Larmor frequency Ω_{L}, and the sixth one - attenuation of spin currents. If the external fields do not depend on coordinates and time, then the stationary solution of equation (4) for the spin current density tensor $\overleftrightarrow{\mathbf{J}}$ is simply written in terms of the electron flux density $\mathbf{V}$ and spin density $\mathbf{S}$ as $\overleftrightarrow{\mathbf{J}} = \mathbf{V}\otimes\mathbf{S}/\,N$, where $\mathbf{V}$ is stationary solution of the equation (3).

This work was supported by the Russian Foundation for Basic Research (Grant 19-02-00057a) and Russian Academy of Sciences (project 32-1.1.3.5).

Arkady Zhukov

Dept. Phys. Mater., UPV/EHU

Poster
arkadi.joukov@ehu.es
Spain

Tuning of magnetic properties of Heusler-type glass-coated microwires

V. Zhukova,[a,b] , M.Ipatov,[a,b], P. Corte-Leon,[a,b] J.Gonzalez,[b] abd A. Zhukov[a,b,c]

[a]*Dpto. Fisica de Materiales, Fac. Quimicas, UPV/EHU, 20009 San Sebastian, Spain*

[b]*Dpto. de Física Aplicada, EIG, UPV/EHU, 20018, San Sebastian, Spain*

[c]*IKERBASQUE, Basque Foundation for Science, 48011 Bilbao, Spain*

Studies of Heusler alloy have attracted considerable interest owing to a number of interesting features such as large magnetic field-induced strain, the ferromagnetic shape-memory effect, magnetic field induced martensitic transition, a substantial magnetocaloric effect (MCE) and the half-metallic behaviour [1].The conventional method for preparation of Heusler alloys is arc-melting followed by long high temperature annealing [1,2].

High MCE observed in Heusler-type alloys is fairly attractive for magnetic refrigeration [1,2]. For increasing of the heat exchange rate the use of either thin wires or thin films is beneficial [1,2]. Hence, recently we performed attempt to prepare Heusler-type microwires using Taylor-Ulitovsky method [1].

Generally, as-prepared Ni-Mn-Ga microwires at room temperature exhibit a very weak magnetization, M. As-prepared samples additionally present magnetoresistance, MR, effect and considerable dependence of M(H) dependences (particularly M-values) on magnetic field values attributed to the magnetic and atomic disorder.

Annealing conditions strongly affect the temperature dependence of magnetization, resistance, R, and Curie temperature of prepared microwires. Annealing of the samples resulted in a drastic change of magnetic properties: a ferromagnetic ordering with Curie temperature near room temperature. We observed the hysteresis in R(T) and M(T) dependences in as-prepared and annealed samples. After annealing allowing internal stresses relaxation and disorder reduction we observed features that can be interpreted as the first order phase transformation. Consequently properly processed Heusler-type glass-coated Ni2MnGa microwires can exhibit first order phase transition.

[1] Novel Functional Magnetic Materials, Fundamentals and Applications (ed. A. Zhukov), Springer Series in Materials Science, vol 231, Springer International Publishing, 2016, ISSN 0933-033X.
[2]. D.C. Dunand, P. Müllner, Adv. Mater. 2011, 23, 216-232 (2011)

List of participants (1/2)

Name	Contribution	e-mail
Abdugani, Eshkulov	Poster	abdugani4@rambler.ru
Baker, Michael	Fri 5.1.2	michael.baker@manchester.ac.uk
Brey, Luis	Wed 3.4.1	brey@icmm.csic.es
Burlachkov (Feigel), Leonid	Poster	leonid@biu.ac.il
Buzdin, Alexander	Mon 1.3.1	alexandre.bouzdine@u-bordeaux.fr
C. Tauber, Uwe	Thu 4.3.2	tauber@vt.edu
Calvo de la Rosa, Jaume	Poster	jaumecalvo@ub.edu
Capic, Daniel	Poster	dcapic@gradcenter.cuny.edu
Ceccarelli, Lorenzo	Mon 1.4.2	lorenzo.ceccarelli@unibas.ch
Chizhik, Alexander	Poster	oleksandr.chyzhyk@ehu.es
Chtchelkatchev, Nikolay	Tue 2.1.2	n.chtchelkatchev@gmail.com
Chudnovsky, Eugene		EUGENE.CHUDNOVSKY@lehman.cuny.edu
Crisan, Adrian	Tue 2.4.1	acrisan652@gmail.com
Crisan, Alina	Poster	ocrisan@infim.ro
De Teresa, Jose Maria	Wed 3.2.3	deteresa@unizar.es
De Paz, Marc	Poster	marcdepazstadorotea@gmail.com
Derras-Chouk, Amel	Poster	amel.derras@gmail.com
Di Bernardo, Angelo	Mon 1.4.1	ad659@cam.ac.uk
Drchal, Václav	Mon 1.2.2	drchal@fzu.cz
Ferreiro-Vila, Elias	Wed 3.1.2	elias.ferreiro.vila@gmail.com
Fert, Albert	Thu 4.1.1-2	Albert.FERT@cnrs-thales.fr
Fontcuberta, Josep	Thu 4.2.3	fontcuberta@icmab.cat
Garanin, Dmitry	Thu 4.1.3	einschlag@gmail.com
Gencer, Ali	Fri 5.1.3	Ali.Gencer@science.ankara.edu.tr
Gerber, Alexander	Wed 3.4.3	
Golubov, Alexander	Tue 2.3.2	a.golubov@utwente.nl
Gómez León, Álvaro	Mon 1.2.3	a.gomez.leon@csic.es
González, Jesús	Poster	jgonzaleza@unimagdalena.edu.co
Herranz, Gervasi	Thu 4.2.2	gherranz@icmab.cat
Klein, Lior	Wed 3.2.1	kleinl@biu.ac.il
Koelle, Dieter	Tue 2.3.1	koelle@uni-tuebingen.de
Konczykowski, Marcin	Wed 3.3.1	marcin.konczykowski@polytechnique.edu
Krinitsina, Tatiana	Poster	krinitsina@imp.uran.ru
López, Rosa	Fri 5.2.3	rosa.lopez-gonzalo@uib.es
Lopez-Martin, Antonio	Poster	antonio.lopez@unavarra.es
Lucas Del Pozo, Irene	Wed 3.1.3	ilucas@unizar.es
Macià, Ferran	Fri 5.2.1	ferran.macia@gmail.com
Magén, César	Mon 1.1.2	cmagend@unizar.es
Magnitskaya, Maria	Poster	magnma@gmail.com
Marin Palacios, Pilar	Mon 1.2.4	mpmarin@fis.ucm.es
Martín, José Manuel	Tue 2.2.3	jmmartin@ceit.es
Mazalski, Piotr	Tue 2.1.3	ncmazals@kinga.cyf-kr.edu.pl

List of participants (2/2)

Name	Contribution	e-mail
Milosevic, Milorad	Thu 4.2.4	milorad.milosevic@uantwerpen.be
Miranda, Rodolfo	Fri 5.2.4	rodolfo.miranda@imdea.org
Miu, Lucica	Mon 1.3.2	lucicamiu50@gmail.com
Moshchalkov, Victor	Wed 3.3.2	victor.moshchalkov@fys.kuleuven.be
Moskvin, Alexander	Tue 2.2.1	alexander.moskvin@urfu.ru
Nandi, Riya	Poster	riya11@vt.edu
Ognev, Alexey	Poster	ognevav@gmail.com
Petkovic, Aleksandra	Wed 3.2.4	alpetkovic@gmail.com
Prischepa, Serghej	Mon 1.1.1	prischepa@bsuir.by
Rinkevich, Antolii	Poster	rin@imp.uran.ru
Ryazanov, Valeriy	Thu 4.4.1	valery.ryazanov@gmail.com
Sharony, Amos	Tue 2.2.4	Amos.Sharoni@biu.ac.il
Sitnicka, Joann	Poster	Joanna.Sitnicka@fuw.edu.pl
Skupinski, Pawel	Fri 5.1.1	Pawel.Skupinski@ifpan.edu.pl
Smejkal, Libor	Fri 5.2.2	lsmejkal@uni-mainz.de
Sols, Fernando	Wed 3.2.2	f.sols@fis.ucm.es
Spivak, Boris	Thu 4.3.1	spivak@uw.edu
Suñol, Joan Josep	Poster	joanjosep.sunyol@udg.edu
Suñol, Joan Josep	Mon 1.1.3	joanjosep.sunyol@udg.edu
Tejada , Javier		Javier.tejada@fmc.ub.edu
Tretiakov, Oleg	Thu 4.2.1	o.tretiakov@unsw.edu.au
Ustinov, Vladimir	Poster	ustinov@imp.uran.ru
Vázquez, Manuel	Tue 2.2.2	mvazquez@icmm.csic.es
Vinokur, Valerii	Wed 3.4.2	vinokour@anl.gov
Wołoś, Agnieszka	Poster	agnieszka.wolos@fuw.edu.pl
Wrześniewski, Kacper	Wed 3.1.1	wrzesniewski@amu.edu.pl
Yamashita, Masahiro	Mon 1.2.1	yamasita.m@gmail.com
Zhukov, Arkady	Tue 2.1.1	arkadi.joukov@ehu.eus
Zhukov, Arkady	Poster	arkadi.joukov@ehu.es

-NOTES-

-NOTES-

-NOTES-

-NOTES-

-NOTES-

-NOTES-

-NOTES-

-NOTES-