

T10 TEAMS SURVEY

Summary of the information collected in December 2019 about the teams of CSIC working in

TEMÁTICA 10: DIGITALIZACIÓN (M+s+v) ***PROCESSING DIGITAL AND COMPLEX INFORMATION***

Coordinator: Roberta Zambrini (IFISC)

Associate: Gemma Rius (IMB-CNM)

Initial structure:

DESAFIO 10A: ELECTRÓNICA INTELIGENTE Y SOSTENIBLE

DESAFIO 10B: INTEGRACIÓN DE AVANCES EN FOTÓNICA

DESAFIO 10C: APLICACIÓN DE LAS NUEVAS TECNOLOGÍAS CUÁNTICAS

DESAFIO 10D: PLATAFORMAS ABIERTAS PARA OPEN SCIENCE

DESAFIO 10E: DESARROLLOS PARA INTERNET OF THINGS

DESAFIO 10F: HUMANIDADES DIGITALES

DESAFIO 10H: PARTICIPACION CIUDADANA

DESAFIO 10A: ELECTRONICA INTELIGENTE Y SOSTENIBLE

IMSE-CNM, Instituto de Microelectrónica de Sevilla

- High-Performance Sigma-Delta Converters (Jose M. de la Rosa)
- Unit Of Micro/Nanometric Circuits And Systems (Francisco V. Fernandez)

IMB-CNM, Institut de Microelectrònica de Barcelona

- Advanced Thin Dielectric Films (Francesca Campabadal)
- NEMS and nanofabrication (Joan Bausells)
- Microenergy sources and system integration (Luis Fonseca)

ICMA, Instituto de Ciencia de Materiales de Aragón

- NANOMIDAS (José Maria De Teresa Noguera)

ICMM, Instituto de Ciencia de Materiales de Madrid

- Heterostructures for optics and optoelectronics (Alicia de Andres)

ITEFI, Instituto de Tecnologías Físicas y de la Información

- Advanced Ultrasound Electronics and Sensors (Jorge Camacho)

Also interested in the challenge 10A:

IFCA, Instituto de Física de Cantabria

- Computación Avanzada y e-Ciencia (Jesus Marco, see 10D)

IMB-CNM Institut de Microelectrònica de Barcelona

- PDS - Nanomaterials and micro/nanofabrication for QTech and Space applications (Gemma Rius, see 10C)

IMSE-CNM , Instituto de Microelectrónica de Sevilla

High-Performance Sigma-Delta Converters

Jose M. de la Rosa, Virginia Zúñiga

Team description:

This research line deals with the design of sigma-delta ADCs integrated in nanometer CMOS. These ADCs are the state-of-the-art solution to efficiently digitize signals in a wide range of digital-driven applications – from ultra-low-power biomedical devices to communications.

Keywords:

Analog-to-Digital Converters, Sigma-Delta Modulators, Digitizers, nanometer CMOS

Projects:

- FENIX-SDR: Flexible Nanometer CMOS Analog Integrated Circuits for the Next Generation of SDR Mobile Terminals, TEC2010-14825/MIC, **2011-2014**. (236.676€). PI: Jose M. de la Rosa.
- ARAMIS: Adaptive RF and Mixed-signal Integrated Systems for 4G Wireless Telecom, TEC2007-67247-C02-00/MIC, **2007-2010**. (450.483€). PI: Jose M. de la Rosa.
- TAMES-2: Testability of Analogue Macrocells Embedded in System-on-Chip, ESPRIT-IST-2001-34283, **2002-2004**. (311.789€). PI: Belén Pérez-Verdú, Jose M. de la Rosa (technical responsible).

Publications:

- J. M. de la Rosa: Sigma-Delta Converters – Practical Design Guide. Wiley-IEEE Press, 1st ed., 2013 (ISBN 978-1-119-97925-8, 1st edition), 2nd. ed. 2018 (87 citations).
- J.M. de la Rosa: “Sigma-Delta Modulators: Tutorial Overview, Design Guide and State-of-the-Art Survey.” IEEE Trans. on Circuits and Systems – I: Regular Papers, vol. 58, no.1, pp. 1-21, 2011 DOI: 10.1109/TCSI.2010.2097652 (245 citations) .
- J. Ruiz-Amaya, J.M. de la Rosa et al.: “High-Level Synthesis of Switched-Capacitor, Switched-Current and Continuous- Time Sigma-Delta Modulators Using SIMULINK-based Time-Domain Behavioral Models”. IEEE Transactions on Circuits and Systems, vol. 52, no. 9, pp. 1795-1810, 2005 DOI: 10.1109/TCSI.2005.852479, (142 citations).

Challenge:

Cognitive digitisers. The idea is to design smart digitisers managed by embedded artificial intelligence. Their hardware components combine adaptive signal processing techniques with a neuromorphic processor that optimize their performance metrics, by means of machine learning.

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

The main motivation is to contribute to define research strategies and targets towards the design of more efficient digitizers in a digital-driven world. Analog-to-Digital Converters (ADCs) are key enabler components in order to implement the digital transformation in which our society is currently immersed. In this general scenario, it is essential to explore novel data-conversion paradigms such as low-cost RF/GHz-range digitization,

mostly-digital & scaling-friendly, time-to-digital conversion and ultra-low-power amplifier-less circuit solutions. Special emphasis should be put on the development of ADCs with a high degree of programmability and autonomy to handle different signal types, effects of environmental interference, battery conditions of increasingly interconnected electronic devices. The use of these digital-assisted, AI-managed circuits and systems techniques should be explored for the realization of efficient digitizers in order to benefit from technology evolution towards the nanoscale.

IMSE-CNM , Instituto de Microelectrónica de Sevilla

UNIT of MICRO/NANOMETRIC CIRCUITS AND SYSTEMS - Modeling, Design and Synthesis Techniques of Analog, Mixed-Signal, RF and Heterogeneous Circuits and Systems

Francisco V. Fernández, Rafael Castro López, Elisenda Roca

Team description:

Our objective is to develop new modeling, design and synthesis strategies for analog, mixed-signal and RF integrated circuits and systems, aiming at better performances and smaller power consumption, while dealing with (i.e., mitigate and exploit) increasing variability in modern technologies.

Keywords:

Systematic design methodologies, Circuit optimization, Reconfigurable design, Variability-aware design, Hardware-base security applications

Projects:

- MARAGDA: Multilevel approach to the reliability-aware design of analog and digital integrated circuits (TEC2013-45638-C3-3-R) PI: Francisco V. Fernández Fernández **(2014-2016)**

- TOGETHER: Towards Trusted Low-Power Things: Devices, Circuits and Architectures (TEC2016-75151-C3-3-R), PI: Francisco V. Fernández Fernández / Rafael Castro López **(2016- 2021)**

- FLEXICS: Técnicas de diseño de circuitos y sistemas micro-nanoelectrónicos flexibles y reconfigurables de bajo consumo y bajo coste aplicados a comunicaciones inalámbricas. (Proyecto P12-TIC-1481), PI: F. V. Fernández **(2014- 2019)**.

Publications:

- F. Passos, E. Roca, J. Sieiro, R. Fiorelli, R. Castro-López, J.M. López-Villegas, F.V.Fernández, "A multilevel bottom-up optimization methodology for the automated synthesis of RF systems," IEEE Trans. on Computer Aided Design of Integrated Circuits and Systems, 2019.

- J.Díaz-Fortuny, J.Martin-Martinez, R.Rodríguez, R.Castro-Lopez, E.Roca, X.Aragones, E.Baraja, D.Mateo, F.V.Fernandez, M.Nafria, "A Versatile CMOS Transistor Array IC for the Statistical Characterization of Time-Zero Variability, RTN, BTI and HCI", IEEE J.Solid State Circuits, Vol. 54(2), pp. 476-488, 2019.

- A.Toro-Frías, P.Martín-Lloret, J.Martín-Martínez, R.Castro-López, E.Roca, R.Rodríguez, M.Nafria, F.V.Fernández, "Reliability simulation for analog ICs: Goals, Solutions and Challenges", Integration – The VLSI Journal, Vol. 55, pp341-348, 2016.

- J. Díaz-Fortuny, P. Saraza-Canflanca, R. Castro-Lopez, E. Roca, J. Martin-Martinez, R.

Rodriguez, F.V. Fernandez, M. Nafria, "Flexible Setup for the Measurement of CMOS Time-Dependent Variability With Array-Based Integrated Circuits," in IEEE Transactions on Instrumentation and Measurement, 2019. DOI: 10.1109/TIM.2019.2906415.

Challenge:

The aspects of "hardware security" are not only essential for the development of IoT, but also in many other contexts related to Digitalization, so we believe that it would have enough entity to constitute a specific and independent challenge in which our research line would be better integrated.

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

One of our main objectives is to develop modeling, design and synthesis strategies for integrated circuits aiming at better performance, smaller area and fabrication costs, and smaller power consumption. Variability, including aging, is also another important objective in our group. The increased variability (both at time zero and time-dependent) in modern technologies is degrading circuit performances and our approach here is two-fold: first, to mitigate these negative effects, and, second, to exploit them for hardware-based security applications. In relation to the challenges, we are working in the following activities:

DESAFIO 10A:

Circuit optimization techniques and design methodologies developed around them to improve electronics sustainability by helping to obtain circuits with a reduced area and/or smaller power consumption.

Reconfigurable circuits to provide solutions with a unique and smart adaptive implementation thus reducing the total hardware required.

Aging-aware methods and tools to evaluate the impact of aging in modern technologies, where extending the circuit lifetime (otherwise shortened by aging) is key for electronics sustainability.

DESAFIO 10E:

Circuit optimization techniques that help optimizing power consumption, one of the most important challenges of IoT applications.

Variability-aware design, which takes into account variability during circuit design, to extend the circuit lifetime and enhance the circuit robustness, two must-have features for IoT. Making this a reality involves a wide range of challenges, from device-level characterization and modeling, to simulation and optimization techniques.

Automated RF methodologies to efficiently optimize power and area of the RF circuits that IoT sensors/applications need to communicate with.

Hardware-based cryptographic primitives that use the intrinsic variability of fabrication processes to improve security in IoT applications.

IMB-CNM, Institut de Microelectrònica de Barcelona

Advanced Thin Dielectric Films

Francesca Campabadal, Mireia Bargalló González, Marcos Maestro Izquierdo, Samuel Poblador Cester

Team description:

Current activities are devoted to the development of fabrication technologies and electrical characterization of memristor devices for their use as non-volatile memories and as electronic synapses in neuromorphic systems.

Keywords:

memristor, resistive switching, electronic synapse

Projects:

-Fabricación, caracterización, simulación, modelado y aplicaciones de dispositivos de conmutación resistiva. PI : F. Campabadal, MCIU – TEC2017-84321-C4-1-R, **2018-2020**.

-Fabricación, caracterización y simulación de dispositivos de conmutación resistiva basados en dieléctricos de alta permitividad. PI: F. Campabadal, MINECO - TEC2014-52152-C3-1-R, **2015-2018**.

-Advanced characterization and modeling of switching variability and reliability in emerging resistive random access memory devices. IP: Mireia Bargalló González, MINECO - TEC2014-54906-JIN, **2015-2018**

Publications:

-Unipolar resistive switching behavior in Al₂O₃/HfO₂ multilayer dielectric stacks: fabrication, characterization and simulation. M. Maestro-Izquierdo et al. Nanotechnology, accepted 2019.

-Mimicking the spike-timing dependent plasticity in HfO₂-based memristors at multiple time scales. M. Maestro-Izquierdo et al. Microelectronic Engineering, 215, 111014, 2019.

-Investigation of Filamentary Current Fluctuations Features in the High-Resistance State of Ni/HfO₂-Based RRAM. Mireia Bargallo Gonzalez, et al. IEEE Transactions on Electron Devices, 63, 3116-3121, 2016.

Contribution:

Artificial Intelligence electronic systems will be able to replicate brain functions, such as learning from experience, reasoning or decision-making. Consequently, these systems, composed of artificial neurons and electronic synapses, promise to revolutionize today's society in the future. In particular, electronics applied to Artificial Intelligence will allow everyday objects such as vehicles, medical equipment or industrial machinery to be able to analyze their environment and make decisions for themselves, resulting in highly efficient solutions. Today's industry is making electronic circuits that replicate the behavior of neurons in biological systems. However, the electronic implementation of synapses, which are the elements that modulate the connection between neurons based on their activity, is still a challenge for the scientific community. Resistive switching-based nanodevices are probably the best placed to replicate neuronal synapses. This is due to two reasons, the first is the capability of these devices of modulating their electrical resistance thus emulating connectivity between neurons. And the second is their small size, few nanometers, which allows many devices to be integrated in a very small area, allowing the number of connections between neurons to be comparable to that of a biological system. Our group can contribute to this challenge by fabricating resistive switching devices and by implementing biological learning rules to the manufactured devices through electrical measurement programming algorithms that replicate neuronal activity.

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NEMS and nanofabrication

Joan Bausells, Francesc Pérez-Murano, Esteve Amat, Marta Fernández-Regúlez, Albert Alcacer, Alberto Del Moral, Christian Pinto, Olga Muntada

Team description:

Investigation of electronic and electromechanical properties of nanostructures to provide new or improved features to nanodevices and nanosystems, as well as R&D on advanced methods for nanofabrication, preferably those that can be applied in the area of the micro/nano electronics and related fields

Keywords:

Nanofabrication, nanoelectronic devices, single electron devices, directed self-assembly , NEMS.

Projects:

- Ion-irradiation-induced Si Nanodot Self-Assembly for Hybrid SET-CMOS Technology (IONS4SET), PI: F. Pérez-Murano, Funding agency: EC (Horizon 2020), Period: **2016-2020**, Funding: 612.825 €.
- Scalable strategies for the fabrication of Single-Electron Devices (STARSED), PI1: J. Bausells, PI2: Francesc Pérez-Murano, Funding agency: Agencia Estatal de Investigación, Period: **2019-2021**, Funding: 110.110 €.
- PLASIPM (Horizon 2020 EUROPEAID 777222), Funding agency: EC (Horizon 2020), Period: **2019-2020**. Funding: 40,000€.

Publications:

- E. Amat, F. Klüpfel, J. Bausells, F. Pérez-Murano, Influence of quantum dot characteristics on the performance of hybrid SET-FET circuits, IEEE Transactions on Electron Devices 66 (2019) 4461.
- S. Gottlieb, D. Kazazis, I. Mochi, L. Evangelio, M. Fernández-Regúlez, Y. Ekinci, and F. Perez-Murano, Nano-confinement of block copolymers in high accuracy topographical guiding patterns: modelling the emergence of defectivity due to incommensurability, Soft Matter 14 (2018) 6799.
- J. Llobet, G. Rius, A. Chuquitarqui, X. Borrísé, R. Koops, M. Van Veghel, and F. Perez-Murano, Arrays of suspended silicon nanowires defined by ion beam implantation: mechanical coupling and combination with CMOS technology. Nanotechnology 29 (2018) 155303.

Collaborations:

Gemma Rius/Philippe Godignon. Power Devices and Systems Group. IMB-CNM. Collaboration with other CSIC groups in the areas of nanofabrication, characterization and electronic design are envisioned.

Also involved/interested in:

TEMÁTICA 4. RETOS EN BIOMEDICINA Y SALUD

Contribution:

In the framework of smart electronics and the internet of things, the goal of the group is to

continue the research and development activity in nanoelectronic devices with low energy consumption. Currently this is being done in the IONS4SET European H2020 project, in which the group is involved in the development of room-temperature single-electron transistors (SET).

The nanofabrication activity of the group can also be applied to the challenge 10C of quantum technologies. The group has a large experience in nanofabrication for micro/nanoelectronics. This includes the more standard top-down techniques and the advanced bottom-up techniques such as the directed self-assembly (DSA) of block copolymers. Real applications of quantum computing will require the use of a large number of qubits. From the technological point of view, superconducting qubits cannot be integrated in large numbers, and it is anticipated that this will require the use of semiconductor qubits. Therefore, nanofabrication compatible with microelectronics is expected to be a key enabling technology for achieving a very large scale of integration of qubits. This would be a long term objective, and one of the goals of the group is to contribute to this development of nanofabrication techniques towards semiconductor-based quantum computers.

IMB-CNM Instituto de Microelectrónica de Barcelona

Microenergy sources and sensor integration

Luis Fonseca, Carles Cané, Isabel Gràcia, Eduard Figueras, Joaquín Santander, Marc Salleras, Stella Vallejos, Milena Tomic, Neus Sabaté, Juan Pablo Esquivel, Irene Merino, Sunil K Sailapu, Marina Navarro, Laura Ortega, Marc Dolcet, Denise Estrada, Robert Soriano

Team description:

Use of Micro-nanotechnologies for the development of microsensors (gas and liquids) and microenergy sources devices. We usually deal with materials typical of silicon technology, lately complemented with alternative materials such as polymer/paper and their associated low-cost technologies

Keywords:

metal oxide gas sensors, silicon technologies, paper devices, thermoelectricity, self-powered devices

Projects:

ERC-Supercell, Neus Sabate, – EU (Jul 15- Jun 20) 1920 k€, FET-PROACT Harvestore, Luis Fonseca, –EU (Dec 18-Nov 23) 850 k€, JIN-mixsense, Stella Vallejos, – MEIC (Ene 17 – Ene 20) 166 k€

Publications:

"'Plug-and-Power' Point-of-Care diagnostics: A novel approach for self-powered electronic reader-based portable analytical devices" *Biosensors & Bioelectronics* 118, 88-96 2018

"Highly hydrogen sensitive micromachined sensors based on aerosol-assisted chemical vapor deposited ZnO rods" *Sensors and Actuators B* 268, 15-21 2018

"Self-powered smart patch for sweat conductivity monitoring" *J of Microsystems & nanoengineering* 5, art nº 3 (10pp) 2019

"SiGe nanowire arrays based thermoelectric microgenerator" *Nano Energy* 57, 492-499,

2019

M^a Carmen Horrillo, Grupo de I+D en Sensores, ITEFI

Challenge:

We propose a "DIGITAL INTERACTION WITH THE PHYSICAL WORLD" challenge. It could be that, depending on the scopes of the pre-established challenges, our contribution may already fit, partially or totally, in 10E (DESARROLLOS PARA INTERNET OF THINGS) or 10A (ELECTRONICA INTELIGENTE Y SOSTENIBLE)

Also involved/interested in:

TEMÁTICA 4. RETOS EN BIOMEDICINA Y SALUD;
TEMÁTICA 6. PRODUCCION PRIMARIA RESPONSABLE;
TEMÁTICA 8. ENERGIA LIMPIA, SEGURA Y EFICIENTE

Contribution:

In the field of gas sensing we will contribute to explore routes for synthesize more performant nanostructured metal oxides (e.g. ZnO, WO₃, Fe₂O₃) via scalable vapour chemical routes (e.g. aerosol assisted chemical vapor deposition) for direct integration with rigid (e.g. silicon) or flexible (e.g. polymers) selective low-power consumption gas sensing microsystems. They will be useful for a variety of applications, such as environmental (air quality) control and preventive medicine (sensing of gaseous biomarkers from exhaled breath)

In the field of microenergy, different energy autonomy scenarios will continue to be explored: short-term (even single use), mid-term and long-term. For the short and mid-term, microgeneration and microstorage devices printable, and built on paper-based substrates, will be explored and developed further, such as biodegradable batteries and also fuel cells (and batteries) used as self-powered sensors. For the long-term scenarios, energy harvesting will be considered, particularly resorting to thermoelectricity. In this case, all-silicon planar thermoelectric microgenerators based on Si-related nanowires will be further researched towards an increase of device density and the successful integration of miniaturized heat exchangers, so that a useful energy/power can be extracted from a 1 cm² device in Industrial IoT applications. Such MEMS structures will be also readapted to exploit other thermoelectric scalable and abundant materials in thin film form, as well as for the combination of harvesting and storage features in single microenergy devices (e.g. thermogalvanic batteries, ion-gated thermoelectric generators...)

ICMA, Instituto de Ciencia de Materiales de Aragón

NANOMIDAS

Jose Maria De Teresa Nogueras, Myriam Aguirre, Pablo Orús, David Serrate, Rubén Gracia, César Magén, Javier Pablo-Navarro, Marten Piantek, Soraya Sangiao.

Team description:

Nanolithography by means of focused electron and ion beams of functional materials and investigation of its electrical properties. Characterization by means of transmission

electron microscopy. Atomic scale Engineering by means of scanning Tunneling Microscopy and non-contact force microscopy.

Keywords:

Nanofabrication. Electron Microscopy. Scanning Tunneling Microscopy. Electrical properties.

Projects:

- Materials for Neuromorphic Circuits (MANIC, code 861153), H2020- European Training Network, H2020-MSCA-ITN-2019. Presupuesto: 250.904 €. IP: C. Magén. **(2019-2022)**
- Nanoestructuras espintrónicas para tecnologías de la información con eficiencia energética, MINECO (MAT2017-82970-C2-2-R) **(2018-2020)**, 181.500 € para CSIC IP: C. Magén
- Electronica Molecular: aproximacion multidisciplinar para una tecnologia más barata y sostenible (TEBAS), Gobierno de Aragón, código LMP33-18, convocatoria proyectos multidisciplinarios RIS3, BOA 06/07/2018 **(2018-2020)**, 85.500 €, IP: P. Cea

Publications:

- R. Córdoba, D. Mailly, R. O. Rezaev, E. I. Smirnova, O. G. Schmidt, V. M. Fomin, U. Zeitler, I. Guillamón, H. Suderow, J. M. De Teresa, "Three-dimensional superconducting nanohelices grown by He⁺ focused-ion-beam direct writing", Nano Letters, 19, 8597 (2019)
- R. Córdoba, P. Orús, S. Strohauser, T. Torres, J. M. De Teresa, "Ultra-fast direct growth of metallic micro- and nano-structures by focused ion beam irradiation", Scientific Reports 9, 14076 (2019)
- J. Martínez-Castro, M. Piantek, S. Schubert, M. Persson, D. Serrate, and C. F. Hirjibehedin, "Electric polarization switching in an atomically thin binary rock salt structure", Nat. Nanotechnol., 13, 19 (2018)
- M. J. Martínez-Pérez, J. Pablo-Navarro, B. Müller, R. Kleiner, C. Magén, D. Koelle, J. M. de Teresa and J. Sesé, "NanoSQUID magnetometry on individual as-grown and annealed Co nanowires at variable temperature", Nano Letters, 18, 7674 (2018)

Contribution:

Our group NANOMIDAS develops its activities within the framework of the Laboratory of Advanced Microscopies, a Spanish ICTS located in Zaragoza. We use state-of-the-art electron and ion microscopes to fabricate, characterize and measure advanced nanoelectronic devices. We develop new fabrication processes to create unique nanostructures with enhanced functionalities. Our characterization tools allow fabrication as well as characterization down to the smallest nanoscale size. Our expertise can be synergetically used with the expertise of other CSIC groups to develop new nanoelectronic devices with low energy consumption, high integration and enhanced functionalities. We aim to focus our contributions on electronic devices based on nanoscale magnetic or superconducting materials and to provide new tools useful for semiconductor industry.

ICMM, Instituto de Ciencia de Materiales de Madrid

Heterostructures for optics and optoelectronics

Alicia de Andrés, Jose Luis Martínez Peña, Rafael Jiménez, Riobóo, Carlos Prieto, Sandra Cortijo

Team description:

Synthesis of 2D materials with CVD for the fabrication of heterostructures for the single photon generation and detection, as well as for spintronic-superconducting devices by combining appropriate materials and 2D topologies.

Keywords:

2D doping, 2D heterostructures, magnetism, optical materials, quantum materials

Projects:

-MATERIALES HIBRIDOS Y 2D PARA SENSORES Y APLICACIONES EN ENERGIA (2019- 2021). RTI2018-096918-B-C41. Ministerio de Ciencia Innovación y Universidades. I.P.: A. de Andrés y C. Prieto

"Materiales para conversión de energía: óxidos, calcogenuros, pnicturos y haluros" (2018-2021). MAT 2017-84496-R. Ministerio de Ciencia Innovación y Universidades. I.P.: J.L. Martinez y J.A. Alonso

Publications:

-Efficient heterostructures for combined interference and plasmon resonance Raman amplification, ACS Appl. Mat. & Interfaces 9, 4119–4125 (2017)

- New concepts for production of scalable single layer graphene oxidized regions by local anodic oxidation of graphene, Small, 1902817, (2019)

-Photoluminescence enhancement of monolayer MoS₂ using plasmonic gallium nanoparticles, Nanoscale Advances 1, 884 (2019)

Also involved/interested in:

TEMÁTICA 4. RETOS EN BIOMEDICINA Y SALUD; TEMÁTICA 8. ENERGIA LIMPIA, SEGURA Y EFICIENTE

Contribution:

1-One goal is the fabrication of new materials with applications in quantum communications based on the creation of isolated defects in 2D dichalcogenides (vacancies and controlled doping) in order to obtain on one hand single photon emitters and detectors and on the other bidimensional diluted magnetic semiconductors for spintronics. Van der Waals heterostructures based on these 2M materials are envisaged for the development of energy efficient and ultrarapid combined electronic and photonic circuits integrated in the devices.

2-The other goal is developing a new generation of spintronic-superconducting nano-devices using a hybridization of ferromagnetic insulating materials, superconducting metals and 2D topology (insulators, superconductors) giving rise to heterostructures with a fundamental role, both from the fundamental and technological point of view in high density storage. Moreover, recently, experiments on magnetically doped topological insulators have indicated the possibility of lossless signal transmission related to a self-organization phenomenon. This may pave the way to develop materials that display this phenomenon at room temperature and can be used as processing units in a quantum computer.

ITEFI, Instituto de Tecnologías Físicas y de la Información

Advanced Ultrasound Electronics and Sensors

Jorge Camacho, Luis Elvira, Oscar Martínez, Antonio Ramos, Enrique Riera, Alberto Ibañez, Montserrat Parrilla, Margarita González

Team description:

The research line “Advanced Ultrasound Electronics and Sensors” looks for developing a new generation of ultrasound systems for medical & industrial applications. We have a consistent track record of scientific publications & technologic results on the frontier of the international state-of-the-art

Keywords:

Ultrasound electronics, smart devices, medical echography, non-destructive evaluation, ultrasound sensors

Projects:

- TOPUS: Tomografía por emisión de positrones y ultrasonidos, J. Camacho, Comunidad de Madrid, **2014-2018**, 666.770 €.
- NUTHIC : Non-Contact ultrasound inspection technology for highly integrated composite parts, C. Fritsch/J. Camacho, H2020, **2014-2017**, 1.646.232 €.
- Medical device to reduce the number of lumbar punctures in infants with fever without source and good general appearance that are at low risk of having Bacterial Meningitis, L. Elvira, Massachussets Institute of Technology, **2013-2014**, 119.000 €.

Publications:

- J. Camacho, M. Parrilla and C. Fritsch. “Phase Coherence Imaging”. IEEE-TUFFC, 56-5, pp. 958-974, Q1, 249 cites, “Outstanding paper award 2009 IEEE-UFFC”.
- J. Camacho; O. Martínez; M. Parrilla; R. Mateos; C. Fritsch. “A strict-time distributed architecture for digital beamforming of ultrasound signals”. IEEE Trans. on Instrumentation & Measurement. 59 - 10, pp. 2716 – 2723, Q1, 11 cites.
- L. Elvira Carmen Durán, Ricardo T. Higuti, Marcelo M. Tiago, Alberto Ibañez, M. Parrilla, Eva Valverde, Javier Jiménez y Quique Bassat, “Development and characterization of medical phantoms for ultrasound imaging based on customizable and mouldable polyvinyl alcohol cryogel-based materials and 3-D printing: Application to high frequency cranial ultrasonography in infants.”, Ultrasound in Medicine and Biology, Vol 45, No 8, pp 2226-2241.
- J.F. Cruza; J. Camacho; J. M. Moreno; C. Fritsch. “Ultrafast hardware-based focal law calculator for automatic focusing”. NDT & E International. 74, pp. 1 – 7, 2016, Q1.
- J. Camacho and C. Fritsch, “A wideband overvoltage protection circuit”, patent nº 20480/0210508-US0, EEUU, 2008.
- Francisco Camarena, Ultrasound Medical and Industrial Laboratory, I3M.

Also involved/interested in:

TEMÁTICA 4. RETOS EN BIOMEDICINA Y SALUD

Contribution:

Ultrasound electronics is transversal to many application fields like medical diagnostic,

industry quality control, safe transport, process manipulation, mobile technology, communications, heritage conservation, haptics and virtual reality.

Research in ultrasound technology includes several hot topics in electronics research like: high performance analog front-ends, HF power amplifiers, massive channel systems, distributed digital architectures, harmonic spectral processing, waveform design, data acquisition strategies, high bandwidth communications and parallel computing.

Our contribution to the challenge “smart and sustainable electronics” aims to answer these questions: What are the requirements of the next generation of ultrasonic systems? How to increase the computation capacity while minimizing power consumption & complexity and ensuing portability? How to integrate electronics and sensors for smart ultrasonic devices? What new applications can be addressed by improving current electronic and sensors?

Our approach is to generate the knowledge to answer these questions and to develop a next generation of ultrasound electronics. Technology transfer is a main goal of our groups, to return to society its effort by creating highly specialized jobs and improving the life quality through technology.

Within this challenge, we propose to address these specific topics:

-Smart electronics and ultrasonic sensors for non-destructive evaluation: Concepts like auto-focus, compressive sensing, ultra-fast imaging, massive sensor networks, air-coupled ultrasound and power ultrasound, currently addressed by our groups, are within the main future challenges.

-Medical ultrasound technology: In this field, we propose to advance in the early diagnosis of diseases with high social impact. Nowadays we are working on electronics for detection of breast, liver and pancreas cancer, cardiovascular accidents and meningitis screening in infants.

DESAFIO 10B: INTEGRACIÓN DE AVANCES EN FOTONICA

IMN-CNM Instituto de Micro y Nanotecnología

- Dispositivos Nanofotónicos, NANOPOD (*Pablo Aitor Postigo*)
- Theory of Metallic Nanostructures and Magnetoplasmonics (*Antonio Garcia Martin*)

IMB-CNM Instituto de Microelectrónica de Barcelona

- (Bio)Chemical Transducers Group (GTQ): Photonics Integration (*Carlos Domínguez Horna*)

IFCA Instituto de Física de Cantabria

- Nonlinear Dynamics/Photonics (*Angel Valle*)

CFM Centro de Física de Materiales

- Theory of Nanophotonics Group (*Javier Aizpurua*)

ICMM Instituto de Ciencia de Materiales de Madrid

- Heterostructures for optics and optoelectronics (*Asunción (Alicia) de Andres*)
- Photonic Crystals Group (*Cefe López Fernández*)

IEM Instituto de Estructura de la Materia

- Nanophotonics (*Giannini Vincenzo*)

IFISC Institute for Cross-Disciplinary Physics and Complex Systems

- Nonlinear Photonics (*Ingo Fischer*)

IO-CSIC Instituto de Óptica "Daza de Valdés"

- Nonlinear Dynamics and Fiber Optics Group (NDFO) (*Juan Diego Ania Castañón*)

ICMA Instituto de Ciencia de Materiales de Aragón

- Quantum Materials and Devices (*Luis Martín Moreno*)
-

Also interested in the challenge 10B:

IFISC Institute for Cross-Disciplinary Physics and Complex Systems

- Complex and Open Quantum Systems (*Roberta Zambrini*)

IMB-CNM Instituto de Microelectrónica de Barcelona

- PDS - Nanomaterials and micro/nanofabrication for QTech and Space applications (*Gemma Rius*)

IMN-CNM Instituto de Micro y Nanotecnología

Dispositivos Nanofotónicos (NANOPOD)

Pablo Aitor Postigo, Joaquín Guimbao Gaspar, Alejandro Vidal García, Lukas Max Weituschat

Team description:

Nano and microdevices for information and communications technologies: quantum photonic devices, integrated single photon emitters. Integration of quantum light emitters with photonics and electronics on chips.

Keywords:

quantum photonics, nanophotonics, single photon emitter, 2D materials

Projects:

- "Scalable Two-dimensional Quantum Photonics" (S2QUIP), P.A. Postigo, UE Quantum Technologies Flagship (QuTe) **2018-2020**, 350k€
- "Photonic and Quantum Thermometry" (PhotoQuant), P.A. Postigo, UE EMPIR, **2018-2020**, 150k€
- MP1403 "Nanoscale Quantum Optics", M. Agio, UE COST Actions, **2016-2019**, 150k€

Publications:

- "Indistinguishability and collection efficiency of transition metal dichalcogenides single photon emitters embedded in silicon nitride photonic integrated circuits"
J Guimbao, LM Weituschat, JM Llorens, PA Postigo
arXiv preprint arXiv:1911.08290
- "Controlling the properties of single photon emitters via the Purcell effect" M Maragkou, Anna Kamila Nowak, E Gallardo, HP Van der Meulen, I Prieto, LJ Martínez, Pablo Aitor Postigo, JM Calleja
Physical Review B 86 (8), 085316
- "Optical coupling of two distant InAs/GaAs quantum dots by a photonic-crystal microcavity" EE Gallardo, LJ Martínez, AK Nowak, D Sarkar, HP Van Der Meulen, JM Calleja, C Tejedor, I Prieto, D Granados, AG Taboada, JM García, PA Postigo,
Physical Review B 81 (19), 193301
- "Emission polarization control in semiconductor quantum dots coupled to a photonic crystal microcavity" E Gallardo, LJ Martínez, AK Nowak, HP Van der Meulen, JM Calleja, C Tejedor, I Prieto, Daniel Granados, Alfonso G Taboada, JM García, Pablo Aitor Postigo,
Optics Express 18 (12), 13301-13308
- "Optical coupling of double L7 photonic crystal microcavities for applications in quantum photonics" PA Postigo, I Prieto, LE Muñoz-Camúñez, JM Llorens
2017 19th International Conference on Transparent Optical Networks (ICTON)1-5

Also involved/interested in:

TEMÁTICA 1. NUEVAS BASES PARA UNA SOCIEDAD GLOBALIZADA SOSTENIBLE

Contribution:

The objective of the Nanophotonic Devices Group (NANOPOD) is to use the emerging field of Nanophotonics (photonics in the nanoscale) to develop new applications, materials and devices that can address current technological problems in the field of quantum optical telecommunications.

The group has extensive experience in design, fabrication and characterization of photonic crystal lasers, single photon emitters and optoelectronic high-speed photodetectors. It has participated in numerous national and international projects and contracts with companies. It has several patents and the support of national and international funds. The specific objectives of the group are:

- Experiments/fabrication: Design, manufacture and characterization of quantum photonic devices that make use of photonic nanostructures (such as photonic crystals and 2D materials) to improve their performance or to be used in new applications.
 - Theory: Development of nanophotonic simulation techniques, application of simulation tools using 3D finite differences in the time domain (FDTD).
 - Industrialization: Development and use of nanofabrication techniques and characterization of nanophotonic devices (top-down and bottom-up).
-

IMN-CNM, Instituto de Micro y Nanotecnología**Theory of Metallic Nanostructures and Magnetoplasmonics**

Antonio Garcia Martin

Team description:

The research is framed in the area of nanophotonics, in particular in the optical properties of complex nanostructures possessing simultaneously magneto-optical and/or chiral activity and resonant excitations (magneto-plasmonic systems).

Keywords:

plasmonics, magnetoplasmonics, optical forces, radiative heat transfer

Projects:

- NANOstructured active MAGneto-plasmonic MAterials- NANOMAGMA, Antonio Garcia Martin (coordinator), UE-FP7, **2008-2011**
- Magneto-optically active plasmonic systems, Antonio Garcia Martin (coordinator), MINECO, **2012-2014**,
- Active Metastructures (AMES), Gaspar Armelles, MINECO, **2015-2017**

Publications:

- G. Armelles, A. Cebollada, A. García-Martín, and M.U. González, Magnetoplasmonics: Combining Magnetic and Plasmonic Functionalities, *Advanced Optical Materials* 1, 10-35 (2013),
- B. Caballero, A. García-Martín, and J.C. Cuevas. Hybrid magnetoplasmonic crystals boost the performance of nanohole arrays as plasmonic sensors. *ACS Photonics* 3, 203 (2016),
- L. Aigouy, M.-U. González, H.-J. Lin, M. Schoenauer-Sebag, L. Billot, P. Gredin, M. Mortier, Z. Chen and A. García-Martín, Mapping plasmon-enhanced upconversion

fluorescence of Er/Yb-doped nanocrystals near gold nanodisk, *Nanoscale* 11, 10365-10371 (2019)

Collaborations:

Jose A. Sánchez Gil, Plasmonics, Metamaterials & HRI Dielectric Photonics Instituto de Estructura de la Materia.

Cefe López, Photonic Crystals Group, Instituto de Ciencia de Materiales de Madrid

Also involved/interested in:

TEMÁTICA 4. RETOS EN BIOMEDICINA Y SALUD; TEMÁTICA 8. ENERGIA LIMPIA, SEGURA Y EFICIENTE

Contribution:

The research would focus on the novel phenomena and applications arising from symmetry breaking in light matter interactions. In particular we would continue with the exploration of magneto-optical effects, paying special attention to low absorption systems or materials. Additionally, chirality relies in the breaking of spatial symmetries endorsing novel characteristics to the systems. Both, magneto-optical and chiral activities are well adapted to control light propagation in small volumes to develop efficient, low dissipation optical modulators and isolators. As an add-on, well appreciated sensing capabilities as transducers for gas and bio sensing. We plan on extend our research to complex metasurfaces or metamaterials also in the THz regime, analyze the thermal radiation and radiative heat transfer and optical forces, all within the framework of magneto-optically active and/or chiral systems.

IMB-CNM, Instituto de Microelectrónica de Barcelona

(Bio)Chemical Transducers Group (GTQ): Photonics Integration

*Carlos Domínguez Horna, César Fernández Sánchez, Francesc Xavier Muñoz Berbel.
Process Engineers of the Clean Room.*

Team description:

The research line started in 1992 to develop optical sensors fabricated with a CMOS compatible photonic integrated technology. The established technology has evolved into a mature platform able to be used for the design and fabrication of basic building blocks of Photonic Integrated Circuits (PICs).

Keywords:

Silicon nitride, photonic circuits, wide spectrum, low loss, optical sensors

Projects:

- MEMPICs: Red de investigación en circuitos fotónicos integrados de membrana (RED2018-102768-T). C. DOMINGUEZ. Agencia Estatal de Investigación. **2019-2021**. 20000 €.

- PROTECT: Pre-commercial lines for production of surface nanostructured antimicrobial and anti-biofilm textiles, medical devices and water treatment membranes. F.X. MUÑOZ. H2020-NMBP-PILOTS-2016 ref. 720851-2. **2016-2019**. 265104 €.

- ND4ID: New Diagnostics for Infectious Diseases. F.X. MUÑOZ. H2020-MSCA-ITN-2015 ref. 675412. **2016-2020**.

Publications:

- P. Muñoz, P. W. L. van Dijk, D. Geuzebroek, M. Geiselmann, C. Domínguez, A. Stassen, J. D. Doménech, M. Zervas, A. Leinse, C. G. H. Roeloffzen, B. Gargallo, R Baños, J. Fernández, G. Micó Cabanes, L. A. Bru, D. Pastor. "Foundry developments towards silicon nitride photonics from visible to the mid-infrared," IEEE J. Sel. Top. Quantum Electron., Vol 25 (5) (2019) 8200513 (13 pp). DOI: 10.1109/JSTQE.2019.2902903.

- A. Rahim, J. Goyvaerts, B. Szelag, J-M Fedeli, P. Absil, T. Aalto, M. Harjanne, C. G. Littlejohns, G. T. Reed, G. Winzer, S. Lischke, Z. Lars, D. Knoll, D. Geuzebroek, A. Leinse, M. Geiselmann, M. Zervas, H. Jans, A. Stassen, C. Domínguez, P. Muñoz, D. Domenech, A. L. Giesecke, M. C. Lemme, R. Baets. "Open-access silicon photonics platforms in europe," IEEE J. Sel. Top. Quantum Electron., Vol. 25 (5) (2019) Art: 8200818 (18 pp). DOI: 10.1109/JSTQE.2019.2915949.

- P. Muñoz, G. Micó, L. A. Bru, D. Pastor, D. Pérez, J. D. Doménech, J. Fernández, R. Baños, B. Gargallo, R. Alemany, A. M. Sánchez, J. M. Cirera, R. Mas, and C. Domínguez, "Silicon nitride photonic integration platforms for visible, near-infrared and mid-infrared applications," Sensors 17(9), 2088 (2017). DOI: 10.3390/s17092088.

Collaborations:

Pablo Aitor Postigo Resa, INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT). INSTITUTO DE MICRO Y NANOTECNOLOGÍA.

Also involved/interested in:

TEMÁTICA 4. RETOS EN BIOMEDICINA Y SALUD; TEMÁTICA 7. IMPACTO DEL CAMBIO GLOBAL

Contribution:

The IMB-CNM holds a moderate confinement Silicon Nitride photonics integration platform aiming at covering a wavelengths range from the VIS to the long NIR (400-3700 nm wavelength range) for photonic integrated applications such as biophotonics, tele/datacom and sensing (TRL \geq 7). A Process Design Kit (PDK) is available for the Synopsis/PhoeniX Software platform, containing all the technology related information automatized for the design, simulation and layout of the user components, facilitating the submission of PIC contributions to the platform.

New process modules are under development to enable expansion of the platform, increasing the functionality of the photonic integrated circuit to cover the biosensing and molecular spectra applications. The modules are based on the experience gained by fabricating interferometric biosensors and PIC for nanoscopy purposes, working in the visible range. And, try to incorporate advance nanometric fabrication techniques, like Deep UV (DUV) Lithography to reduce the final size of the components to cover applications in the field of photonic circuits for quantum applications.

Moreover, the Silicon Nitride platform runs under MPW shared-access cost-effective scheme, i. e. facilitating the access to small industries who has the need for small series testing, and to the academic groups due to the low cost it represents for prototyping.

With respect to long-term vision according to market need, there is on-ongoing research to design and demonstrate silicon nitride membranes for waveguide technology reaching broadband operation (wavelengths range 0.4-6.7 μ m). First technologies modules are rested and prototype designs are fabricated for testing the first building blocks.

IFCA Instituto de Física de Cantabria

Nonlinear Dynamics/Photonics

Angel Valle, Ana Quirce, Luis Pesquera

Team description:

Our research focuses on the nonlinear behavior of semiconductor lasers, in particular when they are subject to optical injection, feedback and gain-switching. Several applications of these systems, such as all-optical signal processing and generation of optical frequency combs, are envisaged.

Keywords:

Semiconductor lasers, Gain switching, Optical injection, Optical Frequency Combs, Lidar

Projects:

-Advanced LIDAR systems based on Optical Frequency Combs, Coherent Technologies and Chaotic Signals, PI: Angel Valle, Ministerio de Ciencia, Innovación y Universidades, FEDER, AEI: RTI2018-094118-B-C22, Period: **2019-2021**, Funding: 66.550 euros
-Frequency combs generated by semiconductor lasers, PI: Angel Valle, Ministerio de Economía y Competitividad. TEC2015-65212-C3-1-P, Period: **2016-2018**, Funding: 54.800 euros

Publications:

- A. Rosado, A. Pérez-Serrano, J. M. G. Tijero, Á. Valle, L. Pesquera, I. Esquivias, "Enhanced optical frequency comb generation by pulsed gain-switching of optically injected semiconductor lasers", *Optics Express* 27, 9155-9163 (2019)
- A. Quirce, C. de Dios, A. Valle, L. Pesquera, P. Acedo, "Polarization Dynamics in VCSEL-Based Gain Switching Optical Frequency Combs," *Journal of Lightwave Technology* 36, 1798-1806 (2018)
- F. Denis-le Coarer; A. Quirce; P. Perez; A. Valle; L. Pesquera; M. Sciamanna; H. Thienpont; K. Panajotov, "Injection locking and polarization switching bistability in a 1550nm-VCSEL subject to parallel optical injection," *IEEE Journal of Selected Topics in Quantum Electronics*, vol.23, no.6, pp.1800910-1800910 (2017)

Collaborations:

Salvador Balle, IMEDEA (UIB-CSIC)
Ingo Fischer, Nonlinear Photonics, IFISC (UIB-CSIC)

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

The main contribution is the development of innovative approaches for lidar systems based on laser diode sources for several applications, such as ranging, anemometry, velocimetry, and remote gas sensing. Our proposal addresses several challenges: Climate change (atmospheric remote sensing, measurement of the concentration of greenhouse gases); Smart and integrated transport (sensors for distances and velocities); Secure, clean and efficient energy (turbine-mounted wind lidar); Defense and security (lidar

scanning from aircraft). The foreseen approaches will be the use of Optical Frequency Combs (OFCs) and pulsed chaotic signals as lidar sources and the use of coherent and self-mixing techniques. OFCs will be generated from single mode semiconductor lasers (edge-emitting and Vertical-Cavity Surface-Emitting Lasers, VCSELs) by gain switching and optical injection. Pulsed chaotic emission will be obtained by applying optical feedback to a laser diode operated under pulsed gain-switching. Several coherent approaches including In-Phase Quadrature (I-Q) modulation and/or I-Q detection will be explored. Self-mixing will be implemented in a VCSEL in external cavity configuration in order to obtain polarization self-modulation. Each approach will be implemented in a lidar system. A lidar test platform will be set up in order to perform the proof of concept of each approach at laboratory level. Each lidar system will be evaluated for one or more of the targeted applications depending on the adequacy of the approach. Routes for integration in Photonic Integrated Circuits (PICs) will be explored and a PIC for ranging applications based on OFCs will be designed and fabricated. We will design an integrated on-chip tunable laser with I-Q modulators. The OFCs will be generated with electro-optic phase modulators. We will evaluate experimentally the quality of the OFCs obtained from the PICs in terms of the flatness, span and line spacing required for lidar applications.

CFM Centro de Física de Materiales

Theory of Nanophotonics Group

Javier Aizpurua, Nerea Zabala, Rubén Esteban

Team description:

The group addresses the optical response of nanoscale systems. By implementing different theoretical methods, the interaction between light and matter is unveiled in different optical and infrared spectroscopy and microscopy configurations at the nanoscale.

Keywords:

Nanophotonics; Plasmonics; Light-matter interaction; TDDFT; cavity-QED

Projects:

- TeraHertz detection enabled by mOleculaR optomechanics (THOR), PI: Javier Aizpurua, European Commission (FET-Open), 1-03-2019 to 28-02-2022, 327.353 €.
- NanoPhOtonic devices applying SElf-assembled colloIDs for novel ON-chip light sources; POSEIDON, PI: Javier Alzpurua, European Commission (FET-Open), 1-01-2020 to 31-12-2023, 282.833 €.
- Nanofotónica cuántica para la caracterización de nuevos procesos y aplicaciones en espectroscopías moleculares, microscopía de campo cercano y tecnologías cuánticas con fotones (Q-NANOFOT), Gobierno Vasco (Grupos de alto rendimiento), 1-01-2019 to 31-12-2021, 245.700 €

Publications:

- "Extreme nanophotonics from ultrathin metallic gaps", J. J. Baumberg, J. Aizpurua, M. H. Mikkelsen, D. R. Smith *Nature Materials*, 18, 668–678 (2019).
- "Boron nitride nanoresonators for phonon-enhanced molecular vibrational spectroscopy at the strong coupling limit", M. Autore, P. Li, I. Dolado, F. J. Alfaro-Mozaz, R. Esteban, A.

Atxabal, F. Casanova, L. E. Hueso, P. Alonso-González, J. Aizpurua, A. Y. Nikitin, S. Vélez, and R. Hillenbrand, *Light: Science & Applications*, 7, 17172 (2018) .

- "Single-molecule optomechanics in 'pico-cavities'", F. Benz, M. K. Schmidt, A. Dreismann, R. Chikkaraddy, Y. Zhang, A. Demetriadou, C. Carnegie, H. Ohadi, B. de Nijs, R. Esteban, J. Aizpurua, and J J. Baumberg. *Science* 354, 726-729 (2016) .

Collaborations:

Alejandro González Tudela, Información cuántica y fundamentos de Teoría cuántica, IFF.
Luis Martín Moreno, ICMA.

Also involved/interested in:

TEMÁTICA 4. RETOS EN BIOMEDICINA Y SALUD; TEMÁTICA 8. ENERGÍA LIMPIA, SEGURA Y EFICIENTE

Contribution:

The contribution of the Theory of Nanophotonics group to the challenge of Integration of Photonic Advances will rely on the development of theoretical tools and calculations able to address the complexity of light-matter interaction at the nanoscale, including quantum effects, non-linearities, and statistics of light emission, among others. Our research activity targets the design, characterization, understanding, and prediction of novel optoelectronic properties in nanoscale systems. To that end a variety of different theoretical methods, such as classical electrodynamical calculations, time-dependent density functional theory, quantum chemistry simulations, or cavity-quantum electrodynamics, are developed and implemented, in order to explore the use and integration of material configurations which range from organic molecules to metallic nanoantennas, through quantum dots or two-dimensional heterostructures. The goal is to exploit nanoscale photonics in integrating solutions for quantum communications, enhanced-sensing and detection, and more effective optical energy managing.

ICMM - Instituto de Ciencia de Materiales de Madrid

Heterostructures for optics and optoelectronics

Asunción (Alicia) de ANDRES, José Luis Martínez, Carlos Prieto, Rafael Jiménez

Team description:

The current interest focuses on the synthesis of 2D materials with CVD for the fabrication of heterostructures for the single photon generation and detection, as well as for spintronics-superconducting by combining appropriate materials and 2D topology.
PREPARATION AND CHARACTERIZATION

Keywords:

2D materials, sputtering-CVD, transport, magnetic and optic properties

Projects:

- "New solar collector concept for high temperature operation in CSP applications" (HITECO), SP1-Cooperation Collaborative project FP7-ENERGY-2010-1 (European Commission, Grant Agreem. N. 256830)
- "Materiales híbridos avanzados para aplicaciones fotónicas 2.0" (PHAMA_2.0).

Programa de I+D entre grupos de investigación de la Comunidad de Madrid.

S2013/MIT-2740

- "Materiales híbridos basados en grafeno para aplicaciones en energía y detección óptica" (MINECO, MAT2015-65356-C3-1-R)

Publications:

- Sandra Cortijo, Leo Álvarez-Fraga, Gil Gonçalves, Mercedes Vila, Patricia Alvarez, Rosa Menéndez, Alicia de Andrés and Carlos Prieto, "In-situ carboxylation of graphene by CVD growth for biosensing" Carbon 141, 719-727 (2019), [DOI: 10.1016/j.carbon.2018.10.033]

- L. Alvarez-Fraga, E. Climent-Pascual, M. X. Aguilar-Pujol, F. Jiménez-Villacorta, R. Ramirez-Jiménez, C. Prieto, A. de Andres, "Efficient heterostructures for combined interference and plasmon resonance Raman amplification" ACS Appl. Mater. Interfaces 9, 4119–4125 (2017) [DOI: 10.1021/acsami.6b12490]

- C. Prieto, J.L. Martínez, "CÉLULA FOTO-TERMOELÉCTRICA PRIMARIA" O.E.P.M. (P201831136, 23 noviembre 2018).

Also involved/interested in:

TEMÁTICA 8. ENERGIA LIMPIA, SEGURA Y EFICIENTE

Contribution:

1-Materials with applications in quantum communications based on the creation of isolated defects in 2D dichalcogenides (vacancies or controlled doping) in order to obtain single photon emitters. The extraordinary properties of van der Waals heterostructures with unique potential for photonic circuits will be explored.

2-New generation of nano-devices for spintronic-superconducting using a hybridization of ferromagnetic insulating materials, superconducting metals and 2D topology (insulators, superconductors) giving rise to heterostructures with a fundamental role, both from the fundamental and technological point of view in high density storage.

ICMM - Instituto de Ciencia de Materiales de Madrid

Photonic Crystals Group

Cefe López Fernández and A Blanco

Team description:

Fabrication and optical studies of photonic crystals and photonic glasses by self-assembly. The group has accumulated over twenty years' experience in the field and has laboratory facilities for a whole range of optical techniques and materials preparation techniques.

Some of these techniques have permitted to deepen in the study of porous materials with and without order.

Keywords:

Nanophotonics, photonic crystals, random lasers, reservoir computing

Projects:

-Maxillofacial bone Regeneration by 3D-printed laser-activated Graphene Oxide scaffolds; FLAG-ERA JTC 2019 - Graphene - Applied Research and Innovation; Spanish IP: C.

Lopez; 450 k€, Period: **2020-2022**

- “Sistemas fotónicos para eficiencia energética” SIFE2, MINECO MAT2015-68075-R; IP: A Blanco + C López, amount 229 k€; Period **2016-2018**

“Structured Materials for photonic, Optomechanical and Thermal applications” SMOOTH; MCIU: RTI2018-093921-B-C41; IP: C López; amount: 194k€ Period: **2019-2021**

Publications:

- C Avci, I Imaz, A Carné-Sánchez, JA Pariente, N Tasios, J Pérez-Carvajal, MI Alonso, A Blanco, M Dijkstra, C Lopez, and D MasPOCH, “Self-assembly of polyhedral metal-organic framework particles into three-dimensional ordered superstructures”, Nature Chemistry, 10, 78-84 (2017)

- E Jiménez-Villar, IF. da Silva, V Mestre, NU. Wetter, C Lopez, PC. de Oliveira, WM. Faustino, and GF. de Sá; “Random Lasing at Localization Transition in a Colloidal Suspension (TiO₂@Silica)”. ACS Omega 2, 2415–2421 (2017)

- C López, “The true value of disorder” Adv. Opt. Mater. 1800439 (2018) (AOM Hall of fame)

- J Jaramillo-Fernández, G L Whitworth, J A Pariente, A Blanco, P D García, C. López, and C M Sotomayor-Torres, “A self-assembled two-dimensional thermo-functional material for radiative cooling” Small, 1905290 (2019) (Frontispiece)

Contribution:

Along the last decade, the group has acquired state-of-the-art expertise in light transport and emission from photonic nano-structures for unconventional laser sources like photonic crystal lasers and random lasers. In this area, the group has developed a new kind of exceptionally low cost devices that permit to create random lasers neural networks and hold promise as reservoir computing substrates where control on single entities can be exerted all-optically.

IEM Instituto de Estructura de la Materia

Nanophotonics

Giannini Vincenzo, José Antonio Sanchez Gil

Team description:

We study light matter interactions in nanostructured systems

Keywords:

Nanophotonics, Plasmonics, Condensed Matter Theory, Metamaterials

Projects:

- NANOTOPO, FIS**2017**-91413-EXP, Ministerio de Economía y Competitividad

- MELODIA (Nos. PGC**2018**-095777-B-C21 and MCIU/AEI/FEDER, UE), Ministerio de Economía y Competitividad

Publications:

- Plasmonic nanoantennas: fundamentals and their use in controlling the radiative

properties of nanoemitters. V. Giannini, AI Fernández-Domínguez, SC Heck, SA Maier. Chemical reviews 111 (6), 3888-3912 (2011).

- Strong enhancement of the radiative decay rate of emitters by single plasmonic nanoantennas. OL Muskens, V Giannini, JA Sánchez-Gil, J Gomez Rivas. Nano letters 7 (9), 2871-2875 (2007).

- Extraordinarily transparent compact metallic metamaterials. Samuel J Palmer, Xiaofei Xiao, Nicolas Pazos-Perez, Luca Guerrini, Miguel A Correa-Duarte, Stefan A Maier, Richard V Craster, Ramon A Alvarez-Puebla, Vincenzo Giannini. Nature communications 10 (1), 2118, (2019).

Collaborations:

Jan Siegel (Instituto de Optica, Madrid), Antonio García-Martín (Instituto de Micro y Nanotecnología, Madrid), Ania Castañón (Instituto de Optica, Madrid), Juan Diego, Soto Crespo, José M^a (Instituto de Optica, Madrid)

Challenge:

Materials for electronics and photonics with near-zero power consumption.

The aim of this search is the design of devices where transport may take place with no energy dissipation, relying on the topological or the superconducting properties of the material

Contribution:

We are particularly interested in thematics related to nanophotonics. An important goal of the next 50 years in physics (and for our society) is the realization of photonic circuits, where light takes the place of electrons. This will allow extremely fast devices with low energy-consuming. Besides, such devices make use of un nanostructured material and are in their nature extremely small (micron-scale), making them extremely appealing. We can contribute to designing such nanostructure and exploring the potential of photonics circuits. As well as, we can suggest new material and approaches for the realization of such devices.

More in detail, we have been developing different numerical and theoretical models that allow fast calculation and simulation of light-matter interaction. Both, in the classical limit (Maxwell equation) and in the quantum case. In particular, we can apply our experience in metamaterials to the realization of nanostructured material where thanks to the plasmonics effect, we can shrink light in a few hundred nanometers and use it as information carriers. Another important aspect of our research is related to topological insulators and topological photonics. In such cases, we aim to build photonic devices that can transport light without losses. In other words, we could transmit light without scattering, making our devices remarkably robust to perturbation. This represents a shift in the technology that we have at the moment, that could have an impact even bigger than what silicon and electronics had in the past.

Finally, we want to remark that we have an interdisciplinary nature that crosses the boundary of photonics, electronics and condensed matter. This makes possible that there are other possible "desafios" where we could provide an important contribution, these are the ELECTRONICA INTELIGENTE Y SOSTENIBLE and APLICACIÓN DE LAS NUEVAS TECNOLOGÍAS CUÁNTICAS challenges.

IFISC Institute for Cross-Disciplinary Physics and Complex Systems

Nonlinear Photonics

Ingo Fischer, Claudio Mirasso, Apostolos Argyris, Miguel C. Soriano, Damià Gomila, Pere Colet, André Röhm, Irene Estébanez

Team description:

We explore complex phenomena in photonics, bridging Modern Photonic Sources and Functional Complex Systems. We concentrate on complex and spatio-temporal phenomena, explore novel photonic solutions from communication to information processing.

Keywords:

complex photonic networks, spatio-temporal laser dynamics, photonic reservoir computing, chaos synchronization and its applications, neuro-inspired information processing

Projects:

- Unidad de excelencia María de Maeztu. PI: Claudio R. Mirasso, Ingo Fischer, MDM-2017-0711, **2018-2022**

Total amount: 2.000.000 €

- IDEA: Improving data DEcoding in optical communication networks All-optically using neuro-inspired photonic systems, PI: Claudio R. Mirasso; Miguel C. Soriano; Ingo Fischer TEC2016-80063-C3 **2016-2019**

Total amount: 101.585 €

- POST-DIGITAL, PI: Ingo Fischer

Innovative Training Networks (ITN): H2020-MSCA-ITN-2019, **2020-2024**

Total amount: 500.000 €

Publications:

- Brunner, D.; Soriano, M.C.; Mirasso, C.R.; Fischer, I. Parallel photonic information processing at gigabyte per second data rates using transient states. *Nature Communications*. 4, pp. 1364. 2013.

- Soriano, M.C.; Garcia-Ojalvo, J.; Mirasso, C.R.; Fischer, I. Complex photonics: Dynamics and applications of delay-coupled semiconductor lasers. *Reviews of Modern Physics*. 85, 421, 2013.

- Bueno, J.; Brunner, D.; Soriano, M.C.; Fischer, I. Conditions for reservoir computing performance using semiconductor lasers with delayed optical feedback. *Optics Express*. 25 - 3, pp. 2401 - 2412. 2017.

- A. Argyris; J. Bueno; I. Fischer, Photonic machine learning implementation for signal recovery in optical communications, *Scientific Reports* 8, pp. 8487, 2018.

- J. Bueno, S. Maktoobi, L. Froehly, I. Fischer, M. Jacquot, L. Larger, D. Brunner, Reinforcement learning in a large-scale photonic recurrent neural network, *Optica* 5, 756-760. 2018.

Collaborations:

Angel Valle y Luis Pesquera, Nonlinear Dynamics, IFCA

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

Novel technologies related to optical communications, sensing, the Internet of Things (IoT) and artificial intelligence have been generating unique opportunities and potential to enhance our quality-of-life, and to provide new services for our society and economy. However, the perspective to manage and process the dramatically increasing amount of data relies on our ability to handle these data with high-speed, suitable hardware and much improved energy efficiency.

In our group, we are developing novel neuro-inspired photonic devices that are able to fulfill the before mentioned requirements. Excellently performing neuro-inspired concepts and algorithms, in particular related to machine learning, have been developed, but their energy requirements and lack of speed hinder their implementation in a significant number of current and future applications. Hence, we follow a different approach, building upon our experience of designing and realizing neuro-inspired information processing systems, mainly in photonic hardware. In contrast to traditional machine learning, we replace the modelled Artificial Neural Networks by real-world dynamical systems consisting of multiple connected optical nodes or even simple delay-dynamical system.

We aim at extending previous photonic information processing concepts by taking advantage of multilevel systems and applying novel learning concepts adapted to the particular data and processing requirements. Our guiding principle is the realization and implementation of photonic systems that combine conceptual and hardware simplicity, high-speed, flexibility, energy efficiency and high performance. Altogether, our research may represent an important step towards ultra-fast, energy-efficient information processing systems, complementary to standard approaches. Ultimately, it may serve a digital society, in which photonic systems improve data handling and processing and allow realizing new services.

IO-CSIC Instituto de Óptica "Daza de Valdés"***Nonlinear Dynamics and Fiber Optics Group (NDFO)***

Juan Diego Ania Castañón, José María Soto Crespo, Pedro Corredera Guillén, José Luis de Miguel Antón, Aitor Villafranca Velasco, Juan Galindo Santos, Hugo Fidalgo Martins

Team description:

Study of nonlinear effects in optical fiber waveguides, with particular emphasis on telecommunications and sensing applications, fiber lasers and the implementation of novel fiber-based photonic systems based on nonlinear interactions. Optical fiber metrology and instrumentation.

Keywords:

Nonlinear dynamics, fiber optics, lasers, sensors, photonic devices

Projects:

- TECNICAS AVANZADAS DE GENERACION, AMPLIFICACION Y MEDIDA DE SEÑALES OPTICAS COMPLEJAS EN FIBRA OPTICA (RTI2018-097957-B-C33) - IP: Juan Diego Ania Castañón, MICINN (2019-2021), 213 807 €

- MSCA COFUND MULTIPLY (EU 713694) - IP (responsable CSIC): Juan Diego Ania Castañón EU (2017-2020), 193 119 €

- SENSors and Intelligence in Built Environment (EU 734331, H2020-MSCA-RISE-2016) -

IP (responsable CSIC): Aitor Villafranca Velasco, EU (2017-2020), 63 000 €

Publications:

-Williams E.F., Fernández-Ruiz M.R., Magalhaes R., Vanthillo,R., Zhan, Z., González-Herráez M. & Martins H. F. et al. Distributed sensing of microseisms and teleseisms with submarine dark fibers. Nat Commun 10, 5778 (2019)
doi:10.1038/s41467-019-13262-7

"On-chip Fourier-transform spectrometers and machine learning: a new route to smart photonic sensors"

A Herrero-Bermello, J Li, M Khazaei, Y Grinberg, AV Velasco, M Vachon,Pavel Cheben, Lina Stankovic, Vladimir Stankovic, Dan-Xia Xu, Jens H Schmid, Carlos Alonso-Ramos Optics letters 44 (23), 5840-5843 (2019)

"Open-Cavity Spun Fiber Raman Lasers with Dual Polarization Output", Nuño, J.; Rizzelli, G., Gallazzi, F.; Pulido, C.; Corredera, P.; Wabnitz, S.; Ania-Castanon, J.D.; Scientific Reports, 7: 13681 (2017); doi:10.1038/s41598-017-13193-7

"Peregrine solitons beyond the threefold limit and their two-soliton interactions", S Chen, Y Ye, JM Soto-Crespo, P Grelu, F Baronio, Physical review letters 121 (10), 104101 (2017)

- 7 patents and 2 spin-off companies over the past 10 years on different areas related to sensors, lasers and photonic devices.

Collaborations:

Rafael Molina Fernández, Group of Strongly Correlated and Mesoscopic Systems, IEM-CSIC; Vincenzo Giannini, Nanophotonics Group, IEM-CSIC

Challenge:

Challenge: Sustainable scaling of global communications.

At the estimated growth rate of global ICT, of up to a 9%/year, the energy consumption of global communications could rise up to 20% of world production by 2030. Together with the Capacity Crunch, this represents a huge challenge for society.

Also involved/interested in:

TEMÁTICA 1. NUEVAS BASES PARA UNA SOCIEDAD GLOBALIZADA SOSTENIBLE;TEMÁTICA 4. RETOS EN BIOMEDICINA Y SALUD;TEMÁTICA 8. ENERGIA LIMPIA, SEGURA Y EFICIENTE

Contribution:

- Theoretical and experimental exploration of nonlinear effect applications in optical media, with a focus in optical fiber and an emphasis on applications related to sensing, telecommunications, amplification and lasing.

- Design and development of novel fiber optic devices based on the nonlinear interaction between optical signals.

- Theoretical study of all kinds of dissipative solitons in nonlinear systems of diverse dimensionality, including their characterization and the results of their interactions as a function of the medium properties. Design of pulsed lasers based on such studies.

- Design and development of high-performance photonic devices based on silicon waveguides enhanced through subwavelength structures, with applications in communications, sensing and microspectrometry.

- Optical fiber metrology: generation of a qualitative improvement in the study of optical fiber standards, including novel fibers.

- Consolidation and transfer of results and intellectual property to industry and society and the integration of photonic devices and technologies in novel products and tools.

ICMA, Instituto de Ciencia de Materiales de Aragón

Quantum Materials and Devices

Luis Martín Moreno, Fernando Luis Vitalla, Agustín Camón Lasheras, Javier Sesé Monclús, David Zueco Lainez, María José Martínez Pérez, Fernando de León Pérez, Sergio Gutiérrez Rodrigo, Carlos Pobes Aranda, Pavel Strichovanec, Tetiana Slipchenko, Charles Downing, Ignacio Gimeno Alonso, Rosa Jaudenes Calleja, Sergi Terradas Briansó, Marcos Rubín Osanz, Jorge Calvo Ibor, Luis Cort.

Team description:

Estudiamos futuras tecnologías basadas en la manipulación y detección de estados cuánticos en materiales, en interacción con radiación electromagnética. El grupo aúna fabricación, experimentación y teoría, dentro de tres áreas: circuitos cuánticos, nanofotónica y sensores.

Keywords:

Hybrid quantum materials, nanophotonics, sensors, optoelectronics, device fabrication

Projects:

- Nuevos fenómenos en nanofotónica con Materiales avanzados (MAT2017-88358-C3-1-R), programa RETOS, **2018-2020**

Investigador principal: L. Martín Moreno y David Zueco

- Graphene flagship, Programa FLAGSHIP, **2018-2020**

Investigador principal: Y. Kinaret. Investigador principal en el ICMA: L. Martín-Moreno.

Participantes (grupo DGA): Luis Martín-Moreno, T. Slipchenko.

- Nanoestructuras para el control y la generación no lineal de luz (MAT2017-88358-C3-2-R), Proyecto: Nacional, programa RETOS, **2018-2020**

Investigador principal: Sergio Gutiérrez Rodrigo y Fernando de León Pérez

Publications:

-Polaritons in layered two-dimensional materials. Low T, Chaves A, Caldwell JD, Kumar A, Fang N, Avouris P, Heinz TF, Guinea F, Martin-Moreno L, Koppens F. *Nature Materials* 16 (2):182-194 (2017)

- Magnetoplasmonic enhancement of Faraday rotation in patterned graphene metasurfaces. Tamagnone M., Slipchenko T.M., Moldovan C., Liu P.Q., Centeno A., Hasani H., Zurutuza A., Ionescu A.M., Martin-Moreno L., Faist J., Mosig J.R., Kuzmenko A.B., Poumirol J.-M. *Physical Review B*, 97, 241410 (2018)

- Spoof Surface Plasmon Metamaterials. PA Huidobro, AI Fernández-Domínguez, JB Pendry, L Martín-Moreno, F. J. Garcia-Vidal. Cambridge University Press (2018)

- Strong Coupling of a Single Photon to a Magnetic Vortex. Martínez-Pérez M.J., Zueco D. *ACS Photonics*, 6, 360 (2019).

Collaborations:

Javier Aizpurua, CFM

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

Nuestro grupo tiene amplia experiencia en plasmónica (para guiar y concentrar luz en la nanoescala), metamateriales (extendiendo el rango de aplicación de propiedades en el óptico a frecuencias más bajas, como el rango infrarrojo, de Terahercios y/o ondas milimétricas), y materiales de anchura atómica (tanto conductores como el grafeno, semiconductores como el MoS₂, y materiales hiperbólicos como el BN).

Trabajamos también en el diseño de dispositivos ópticos, sobre todo en sensores y fotodetectores basados en la combinación de antenas metálicas y grafeno, así como en el diseño de dispositivos excitónicos para la absorción y propagación de luz, tanto en materiales bidimensionales como en capas moleculares.

DESAFIO 10C: APLICACIÓN DE LAS NUEVAS TECNOLOGÍAS CUÁNTICAS

ICMA Aragón Materials Science Institute

- M4, Multifunctional Molecular Magnetic Materials (*Javier Campo*)
- Quantum Materials and Devices (*Luis Martín Moreno, Fernando Luis*)

ICMM Instituto de Ciencia de Materiales de Madrid

- Theory of Quantum Materials and Solid State Quantum Technologies (*Ramon Aguado*)
- Novel Platforms and Nano-devices for Quantum Simulation and Computation (*Gloria Platero*)

IFISC Instituto de Física Interdisciplinar y Sistemas Complejos

- FISNANO - Física de Nanosistemas (*Llorenç Serra*)
- Complex and Open Quantum Systems (*Roberta Zambrini*)

IFF Instituto de Física Fundamental

- QUINFOG - Quantum Information and Foundations Group (*Juanjo García Ripoll*)
- MolClu - Molecular Clusters in gas and liquid phases (*Pablo Villarreal Herrán*)

ITEFI Institute of Physical and Información Technologies

- Quantum Cryptography (*Verónica Fernández Mármol*)

IEM Instituto de Estructura de la Materia

- Condensed Matter Theory (*Rafael Molina*)

IMB-CNM Instituto de Microelectrónica de Barcelona

- PDS - Nanomaterials and micro/nanofabrication for QTech and Space applications (*Gemma Rius*)

Also interested in the challenge 10C:

IMB-CNM, Instituto de Microelectrónica de Barcelona

- NEMS and nanofabrication (*Joan Bausells, see*)

ICMA Aragón Materials Science Institute

M4, Multifunctional Molecular Magnetic Materials

Javier Campo, Victor Laliena, Javier Luzon, J.A. Rodriguez Velamazán, Miguel Pardo, Cristina Piquer, Oscar Fabelo

Team description:

The M4 group is consolidated around the preparation and study of multifunctional magnetic materials of molecular nature. It is a broad objective and open to many possibilities. It includes more than 15 permanent staff and several research lines.

Keywords:

magnetic skyrmions, magnonic, molecular multiferroics, organic magnets, quantum magnetism, chiral magnetism

Projects:

- Quiralidad Magnética en Materiales Moleculares Magnéticos y Multifuncionales (ChiMag). Main Researcher: Javier Campo, PGC2018-099024-B-I00 MICIU, **2019 - 2021** Funding: 151.250 €

-Preparación y estudio de Materiales Magnéticos Multifuncionales de carácter Molecular (M4). Main Researcher: Javier Campo, Gobierno de Aragón – E11_R17 **2017-2019** Funds: 42.850 €

Publications:

- J. Alberto Rodríguez-Velamazán, Oscar Fabelo, Javier Campo, Juan odríguez-Carvajal, Navid Qureshi and Laurent C. Chapon, Switching of the Chiral Magnetic Domains in the Hybrid Multiferroic (ND4)2[FeCl5(D2O)], *Sci. Rep.* 8:10665 | (2018)

DOI:10.1038/s41598-018-28883-z

- Victor Laliena and Javier Campo, Stability of skyrmion textures and the role of thermal fluctuations in cubic helimagnets: a new intermediate phase at low temperature, *Phys Rev B*, 96, 134420 (2017)

- Victor Laliena, Germán Albalade, Javier Campo, Stability of the skyrmion lattice near the critical temperature in cubic helimagnets, *Phys Rev B*, 98, 224407 (2018)

- Beldjoudi, Yassine; Arauzo, Ana; Campo, Javier; Gavey, Emma; Pilkington, Melanie; Rawson, Jeremy, Structural, Magnetic and Optical Studies of the Polymorphic 9#-Anthracenyl Dithiadiazolyl Radical, *J. Am. Chem. Soc.*, 141 17 6875-6889 (2019)

DOI:10.1021/jacs.8b11528

Challenge:

MAGNONIC, see text before

Contribution:

The main objective is the transport and processing of information using spin waves. This has remarkable advantages over electronic: it dissipates less energy (no Joule losses) and the magnons can spread over macroscopic distances (several cm in some materials). The small wavelength of the magnons in relation to the photons of the same frequency in the free space (five orders of magnitude) makes the magnetic advantageous with respect to the photonic. Chiral magnets have specific properties that make them enormously interesting, such as non-reciprocal propagation. Periodic networks appear spontaneously

in homogeneous materials and therefore lack the imperfections of the rough interfaces of the heterogeneous materials, which cause the dispersion of the magnons. However, spin wave propagation has been studied extensively only in linear structures (helical and conical). Studies in solitonic structures are reduced to the propagation of magnons in thin films in the presence of isolated skyrmions, and in skyrmion networks only in bulk materials, incompletely. The study of the magnetic chiral solitons has only been carried out in weak field conditions.

It is therefore proposed to study the propagation of magnons in networks of chiral solitons and skyrmions formed in different geometries of thin films and macroscopic materials. Especially interesting is the network of chiral solitons, since their periodicity depends strongly on the applied magnetic field. We propose to analyze the effect of the crossover between the network of chiral solitons and the conical state by tilting the field with respect to the chiral axis. We propose to investigate the nonlinear effects in a perturbative (interaction of magnons) and non-perturbative (numerical solutions of the Landau-Lifschitz-Gilbert equation), and the role of temperature using stochastic terms.

ICMA Instituto de Ciencia de Materiales de Aragón

Quantum Materials and Devices

Luis Martín Moreno, Fernando Luis Vitalla, Agustín Camón Lasheras, Javier Sesé Monclús, David Zueco Lainez, María José Martínez Pérez, Fernando de León Pérez, Sergio Gutiérrez Rodrigo, Carlos Pobes Aranda, Pavel Strichovanec, Tetiana Slipchenko, Charles Downing, Ignacio Gimeno Alonso, Rosa Jaudenes Calleja, Sergi Terradas Briansó, Marcos Rubín Osanz, Jorge Calvo Ibor, Luis Cort.

Team description:

Estudiamos futuras tecnologías basadas en la manipulación y detección de estados cuánticos en materiales, en interacción con radiación electromagnética. El grupo aúna fabricación, experimentación y teoría, dentro de tres áreas: circuitos cuánticos, nanofotónica y sensores.

Keywords:

Hybrid quantum materials, nanophotonics, sensors, optoelectronics, device fabrication

Projects:

- Scaling Up quantum computation with Molecular spins (SUMO) Programa QUANTERA H2020, UE. Fase Nacional: Programación conjunta internacional PCI2018-093116. Único proyecto, de entre los financiados, coordinado por un equipo español **2018- 2021**

Investigador principal: Fernando Luis (Coordinador)

Participantes (grupo DGA): Fernando Luis, David Zueco, Luis Martín-Moreno, Ignacio Gimeno, Marcos Rubín.

- Fault Tolerant Molecular Spin processor (FATMOLS)

Ámbito del proyecto: Internacional. Programa FET-OPEN de H2020

Entidad financiadora: H2020-FETOPEN-2018-2019-2020-01 call, H2020 Framework Programme **2020-2022**

Investigador principal: Fernando Luis (Coordinador)

Participantes (grupo DGA): Fernando Luis, David Zueco, Luis Martín-Moreno, María José Martínez-Pérez, Javier Sesé, Ignacio Gimeno, Marcos Rubín

Publications:

- F. Luis, A. Repollés, M. J. Martínez-Pérez, D. Aguilà, O. Roubeau, D. Zueco, P. J. Alonso, M. Evangelisti, A. Camón, J. Sesé, L. A. Barrios, and G. Aromí, *Molecular Prototypes for Spin-Based CNOT and SWAP Quantum Gates*, *Phys. Rev. Lett.* 107, 117203 (2011).
- M. D. Jenkins, D. Zueco, O. Roubeau, G. Aromí, J. Majer, and F. Luis, *A scalable architecture for quantum computation with molecular nanomagnets*, *Dalton Transactions* 45, 16682-16693 (2016). Invited paper and inside front cover.
- A. Gaita-Ariño, F. Luis, S. Hill and E. Coronado, *Molecular spins for quantum computation*, *Nature Chemistry* 11, 301–309 (2019).
- M. J. Martínez-Pérez, J. Pablo-Navarro, B. Müller, R. Kleiner, C. Magén, D. Koelle, J. M. de Teresa and J. Sesé. *NanoSQUID Magnetometry on Individual Co Nanowires at Variable Temperature*. *Nano Lett.* 18, 7674–7682 (2018).

Collaborations:

Juan José Garcia Ripoll, QUINFOG, Instituto de Física Fundamental.

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

The activity of QMAD focuses on developing hybrid devices that can find applications in quantum simulation, computation and sensing.

We are developing a quantum processor based on molecular spin qubits “wired-up” by microwave superconducting circuits. This includes magnetic molecules able to implement simple quantum error correction codes and superconducting devices able to coherently couple the spins of individual molecules. In the long term, it will define an alternative roadmap to reach the next level of computational power (100-1000 qubits).

These hybrid devices allow the generation of spin squeezed states, which form the basis for quantum magnetic sensing. We also work on the fabrication of superconducting sensors (nanoSQUIDs) able to detect single spins and topological magnetic states, with potential applications in high-density information storage . We are also developing radiation detectors base on superconductors (TES) that can be used in quantum communication.

ICMM Instituto de Ciencia de Materiales de Madrid***Theory of Quantum Materials and Solid State Quantum Technologies***

Ramón Aguado, Elena Bascones, Luis Brey, M^a José Calderón, Leonor Chico, Pablo San José

Team description:

Among the various proposals for solid state quantum computing, we give theoretical support to: (1) topological quantum computing based on Majorana states and (2) silicon based quantum computing where spin or charge qubits are defined by states confined by selected impurities or quantum dots.

Keywords:

Theory, quantum materials, solid state quantum computing, Silicon qubits, Topological qubits.

Projects:

Topology and correlations in Quantum Materials and Solid State Quantum Technologies (QuMaTe), M^a José Calderón/Ramón Aguado, AEI, **2019-2021**

Publications:

- Prada et al, arXiv preprint arXiv:1911.04512;
- Avila et al, Nature Comm. Physics, 2 133, 2019;
- JC Abadillo-Uriel et al, Physical Review B 98 (16), 165438, 2018

Contribution:

Quantum materials can be broadly defined as physical systems where the interplay between different degrees of freedom leads to emergent novel ordered phases where quantum mechanics play a pivotal role. Two of the most relevant aspects of quantum materials research nowadays are the topological nature of quantum wave functions and the non-local entanglement of quantum states. Both are relevant for applications in quantum computing. Of the many different approaches to the practical implementation of a quantum computer, our activities focus on solid state quantum computing, which holds promise for scalability, long coherence times and compatibility with current technologies. In particular, we focus on silicon qubits and Majorana-based topological qubits. Our work is performed in close collaboration with international groups leading state-of-the-art experimental research in this field. This includes collaborations with Hitachi Cambridge Lab, University of New South Wales, University of California Los Angeles, University of Wisconsin-Madison, Microsoft Quantum Delft & Copenhagen, Pittsburgh Quantum Institute, IST Austria, Chalmers University and Tsinghua University

ICMM Instituto de Ciencia de Materiales de Madrid***Novel Platforms and Nano-devices for Quantum Simulation and Computation***

Gloria Platero, Sigmund Köhler, Tobias Stauber, Álvaro Gómez León, Miguel Bello, Beatriz Pérez, Jordi Picó

Team description:

Spin and charge qubits in semiconductor quantum dots for quantum computation; decoherence and relaxation; quantum state transfer and transport in quantum dot arrays. Quantum simulation of low dimensional systems: Floquet systems, topological properties, quantum dynamics, effect of interactions.

Keywords:

spin qubits, quantum dots, Floquet systems, topology in 1D and 2D atomic arrays

Projects:

Bits Cuánticos De Espin De Electrones Y Huecos En Redes De Puntos Cuánticos: Efecto De Campos Ac, Disipación Y Topología, MAT2017 (MAT2017-86717-P) , PI1: G. Platero,

PI2: S. Kohler, **2018- 2020**.

Publications:

- Simulation of chiral topological phases in driven quantum dot arrays, B. Pérez-González, M. Bello, G. Platero, A. Gómez-León, Phys. Rev. Lett., 123,126401 (2019);
- Spin entangled state transfer in quantum dot arrays: Coherent adiabatic and speed-up protocols, Y. Ban, X. Chen, S. Kohler and G. Platero, Advanced Quantum Technologies, 2019, DOI: 10.1002/qute.201900048 (2019).;
- Unconventional quantum optics in topological waveguide QED, M. Bello, G.Platero,I.Cirac and A. González-Tudela, Science Advances, vol 5, numero 7, eaaw0297 26 July 2019

Collaborations:

A. González Tudela, IFF (Instituto de Física Fundamental) ; R. López Gonzalo, IFISC (CSIC)

Contribution:

We analyze protocols to transfer entangled electrons between distant sites in semiconductor quantum dot arrays. We consider adiabatic and also short cuts to adiabaticity protocols. We investigate both electron and hole spin qubits as well as valley qubits and the effect of decoherence and relaxation produced by the interaction with dissipative baths as hyperfine interaction with nuclei, electric contacts or phonon baths. Our research focuss also on charge and spin qubits in quantum dots coupled to a quantum cavity.

We also investigate protocols to entangle distant nuclear spins where their interaction is mediated by spin electrons which propagate by surface acoustic waves. We consider a large density of nuclear spins both homogeneously and inhomogeneously coupled to the electron spins and analyze the entanglement between them.

We investigate Floquet topological insulators in low dimensional lattices. We propose ac driving protocols to simulate the extended SSH hamiltonian with long range hoppings. We analyze new topological phases induced by the driving and the role of edge states in the dynamics of interacting electrons in a dimer chain. We investigate the effect of disorder and the coupling of a quantum cavity with a dimer chain (SSH hamiltonian).

We also investigate topology, quantum interferences and interactions in quasi-1D topological insulators as the photonic Creutz and Creutz-Hubbard Ladders lattices. The inclusion of a repulsive Hubbard-type interaction term, which can give rise to repulsively bound pairs termed doublons, is considered.

IFISC Instituto de Física Interdisciplinar y Sistemas Complejos

FISNANO (Física de Nanosistemas)

Llorenç Serra, Rosa López, David Sánchez, Sungguen Ryu, Nassima Benchtaber

Team description:

We are devoted to questions related to quantum transport for charge (nanoelectronics), spin (spintronics), energy (thermoelectrics) and information (quantum correlations), with a particular focus on nanostructures.

Keywords:

nanophysics; quantum transport; quantum thermodynamics; spintronics; superconductivity

Projects:

MAT2017-82639: Transport in Quantum Materials at the Nanoscale. PIs: David Sánchez y Rosa López. **2018-2021.**

Publications:

- Javier Osca; Llorenç Serra, "Magnetic orbital motion and $0.5e^2/h$ conductance of quantum-anomalous-Hall hybrid strips", "Applied Physics Letters", Volumen 114, Número 133105, Páginas 133105-1-133105-5, 2019.
- Sánchez, D.; Sánchez, R.; López, R.; Sothmann, B., "Nonlinear chiral refrigerators", "Physical Review B", Volumen 99, Páginas 245304-1-245304-9, 2019.
- Sierra, M. A.; Sánchez, D.; Jauho, A.-P.; Kaasbjerg, K., "Fluctuation-driven Coulomb drag in interacting quantum dot systems", "Physical Review B", Volumen 100, Páginas 081404-1-081404-5, 2019.

Collaborations:

G. Platero (ICMM), R. Aguado (ICMM), M. Martín-González (IMN)

Also involved/interested in:

TEMÁTICA 8. ENERGIA LIMPIA, SEGURA Y EFICIENTE

Contribution:

We propose theoretical models to understand new phenomena in nanoelectronic devices and quantum materials. In particular, regarding challenge 10C "Applications of new quantum technologies" we intend to investigate applications of i) nano devices for thermoelectric applications allowing more efficient refrigerators that minimize energy losses; ii) qubit realizations based on Majorana modes in nanodevices of topological materials allowing quantum gates with a more robust information processing against decoherence. Our theoretical approach combines quantum transport with thermodynamics, topological materials and strong correlations, using both analytical and numerical methods.

IFISC Institute for Cross-Disciplinary Physics and Complex Systems

Complex and Open Quantum Systems

Roberta Zambrini, Gian Luca Giorgi, Johannes Nokkala, Albert Cobot, Marco Cattaneo, Rodrigo Martinez, Miguel C. Soriano

Team description:

Theoretical research and in particular on Complex and Open Quantum Systems in topics such as Quantum Synchronization, Quantum Networks, Quantum Optics and Information, and Quantum Machine Learning.

Keywords:

Quantum Synchronization, Quantum Networks, Quantum Information, Quantum Machine

Learning

Projects:

- QuProCS Quantum Probes for Complex Systems
H2020-FETPROACT on Quantum simulation <http://www.quprocs.eu/>
PI: R. Zambrini, Ref: 641277 (2015-2018)
- NOMAQ Non-Markovian quantum evolutions in structured environments.
PI: R. Zambrini, Ref: FIS2014-60343P (2014-17)
- EpheQuCS Emergent phenomena and decoherence in quantum complex systems
PI: R. Zambrini, Ref: FIS2016-78010-P (2017-2019)

Publications:

- Cabot, A., Galve, F., Eguíluz, V. M., Klemm, K., Maniscalco, S., & Zambrini, R. Unveiling noiseless clusters in complex quantum networks. *npj Quantum Information*, 4(1), 57 (2018).
- Garau Estarellas, G., Giorgi, G. L., Soriano, M. C., & Zambrini, R. Machine Learning Applied to Quantum Synchronization-Assisted Probing. *Advanced Quantum Technologies*, 1800085 (2019).
- Manzano, G., Plastina, F., & Zambrini, R. Optimal work extraction and thermodynamics of quantum measurements and correlations. *Physical Review Letters*, 121, 120602 (2018).

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

The Complex Quantum Systems team contributes to different aspects of T10 and T11.

- Quantum machine learning: In the last year the team has started a new research line in this broad interdisciplinary research line between artificial intelligence and quantum physics, where quantumness can reside either in the processed data, in the information processing device or in both. The specific goal of the team at IFISC is the implementation of quantum machine learning in the context of non-conventional computation and mainly in reservoir computing. We are studying implementations both with quantum networks qubits and continuous variables allowing to exploit the high dimension of Hilbert space even for few atoms, superconducting qubits, light modes... The goal is to establish the possibility of a quantum advantage in the context of noisy intermediate-scale quantum computing (NISQ). This is a promising direction in quantum technologies and quantum computation (challenge 10C), and in AI and big data, being quantum machine learning and neuromorphic computing also deeply related to T11.
- Quantum networks: Quantum technologies are moving from high control of single quantum units to extended composed systems, with increasing degree of complexity. Different kinds of quantum networks studied recently range from quantum systems whose connections are represented by non-classical states and correlations to networks wherein physical interactions link quantum nodes and with main applications, respectively, in secure quantum communication and in quantum transport in biological and artificial complex systems. Our main results are in the context of decoherence and quantum synchronization of complex networks, and also in the reconfigurable implementation of quantum networks in photonic platforms, being this a topic also related to the challenge 10B: INTEGRACIÓN DE AVANCES EN FOTÓNICA. Dynamics implementations of quantum networks in superconducting circuits are also an interesting avenue.

IFF Instituto de Física Fundamental

QUINFOG (Quantum Information and Foundations Group)

Juan José García Ripoll, Diego Porras, Alejandro González-Tudela, Carlos Sabín, Tomás Ramos, Erik Torrontegui, Manuel Pino, Alejandro A. Valido

Team description:

Theoretical research on quantum technologies. Design of quantum computers and simulators, generation of non-classical states of light and quantum sensors. Development of quantum software with applications in optimization problems (e.g. in finance and logistics) and quantum simulation.

Keywords:

Theoretical quantum technologies; Quantum computing; Quantum software; Quantum simulation; Quantum optics

Projects:

- QUITEMAD-Comunidad de Madrid, Programa de Investigación Tecnologías **2018** Ref: P2018/TCS-4342, Financiación total 1M€, financiación CSIC aprox. 120M€.

PI: Juan José García-Ripoll

- Frontiers in Quantum Simulation, Proyecto de Generación del Conocimiento, MCIU, **2019-21**. Reference PGC2018-094792-B-100 Financiación: 180 kEuros

PI: Diego Porras and Alejandro González Tudela

- Cobosam - Correlated Boson-Sampling Metrology. Asian Office of Aerospace R&D AFOSR, Ref: 18IOA019 (**2018-2020**), Financiación: \$50k.

PI: Juan José García Ripoll

Publications:

- "Analogue quantum chemistry simulation"

Javier Argüello-Luengo, Alejandro González-Tudela, Tao Shi, Peter Zoller & J. Ignacio Cirac, *Nature* 574, 215–218 (2019)

- "Unitary quantum perceptron as efficient universal approximator"

Erik Torrontegui, Juan José García-Ripoll

EPL (Europhysics Letters) 125, 30004 (2019)

- "Simulating a quantum magnet with trapped ions"

A. Friedenauer, H. Schmitz, J. T. Glueckert, D. Porras & T. Schaetz
Nature Physics 4, 757–761(2008)

- "Photodetection and Photocounting of single microwave photons"

G. Romero, J. J. García-Ripoll, and E. Solano,

Spanish Patent Application No. 200802933 and international patents in USA, Canada, Europe, and Japan: . (2011)

Collaborations:

ICMA (David Zueco) on quantum optics and quantum plasmonics

ICMM (Gloria Platero) on topological quantum optics

Contribution:

In the last years we have witnessed an impressive advance in the fields of quantum computation and simulation. Companies like IBM, Google, D-Wave and Rigetti Computing are close to show computational capabilities exceeding those of conventional computers. Many of those quantum computers can already or will be soon accessed remotely on the cloud. Theory researchers can now focus on quantum software development, which can then be used in practical applications on hardware maintained by international companies or consortia. At the same time, advances in quantum hardware is opening up new opportunities for the development of new technologies with photonic systems and trapped atoms.

One of the biggest challenges being faced is how to exploit the computational power offered by commercial quantum computers. There exist several approaches including the development of quantum algorithms to solve real-life optimization problems in real life, such as problems in logistic, finance and digital economy. We also know efficient algorithms that can simulate molecules and complex chemical compounds.

This is a multidisciplinary challenge, since it requires a joint effort by experts in quantum technology, computation and in those disciplines in which quantum computing and simulation can be applied. CSIC is thus in a privileged position to coordinate a response to this challenge.

In QUINFOG (IFF), we work on quantum software development in collaboration with financial institutions and companies like IBM. We also collaborate with international experimental groups in the development of new applications for quantum hardware, such as quantum simulation of complex materials. Introducing quantum computing and simulation as a scientific challenge would allow us to participate in a coordinated effort with other groups and participate in multidisciplinary initiatives.

IFF Institute of Fundamental Physics

MolClu - Molecular Clusters in gas and liquid phases

Pablo Villarreal Herrán, Salvador Miret-Artés, Tomás González-Lezana, Aristeo Prosimiti

Team description:

Development of theoretical approaches, far beyond simplified models, and the design of specific computational tools to address efficiently real problems of physicochemical interest. The main goal is the detailed understanding of a variety of molecular processes through quantum dynamics simulations

Keywords:

computer simulations, molecular processes, ab initio/first-principles interactions, clusters/nanostructures/nanodroplets

Projects:

- FIS2017-83157-P, T. González-Lezana/A. Prosimiti, D.G.I.G.-MINECO, **2018 - 2020**, 85 keuros
- IND2017/AMB-7696, A. Prosimiti, CAM, **2018 - 2020**, 150 keuros

Publications:

DOI: 10.1021/acs.jpcclett.7b03047,
DOI: 10.1039/C8CP04522D ,
DOI: 10.1002/chem.201800497

Collaborations:

InterMol group, AstroMol group, IEM

Also involved/interested in:

TEMÁTICA 9. ENTENDIENDO LOS COMPONENTES BASICOS EL UNIVERSO, SU ESTRUCTURA Y EVOLUCIÓN

Contribution:

10C.1: Molecular Simulators

This topic aligns with principal objectives in the field of molecular sciences. The main objectives are summarized to: (i) built up predictive, accurate and transferable models from first-principles approaches for a molecular-level description of relevant molecular processes, (ii) design and development of new computational tools, allowing the full cycle of molecular modelling, employing state-of-the-art programming, software-engineering standards, and cutting-edge scientific knowledge, (iii) address efficiently real problems of relevance.

ITEFI Institute of Physical and Información Technologies**Quantum Cryptography**

Verónica Fernández Mármol, Natalia Denisenko

Team description:

High-speed polarization encoding free-space quantum communications with automated beam tracking for reducing atmospheric turbulence effects. Continuous variables quantum key distribution. Polarization frame reference compensation for mobile quantum communications.

Keywords:

free space quantum key distribution

Projects:

- TEC2015-70406-R, Comunicaciones cuánticas con variables continuas Ministerio de Economía y Competitividad. IP: Vicente Martín Ayuso. (C.S.I.C y University Politécnica de Madrid,). **2016-2019**. 126.500 €.
- S2013/ICE-2801, Quantum Information Technologies Madrid + Comunidad de Madrid. IP: Miguel Martín-Delgado Alcántara. (C.S.I.C. Universidad Politécnica de Madrid, University Complutense de Madrid; University Carlos III de Madrid). **2014-2018**. 580.060 €.
- TEC2012-35673, Redes Cuánticas Híbridas Ministerio de Economía y Competitividad. IP: Vicente Martín Ayuso. (C.S.I.C. University Politécnica de Madrid). **2012-2015**. 58.000 €

Publications:

-A. Ocampos-Guillen, J. Gomez-Garcia, N. Denisenko, Veronica Fernandez, "Double-Loop

Wavefront Tilt Correction for Free-Space Quantum Key Distribution”, IEEE Access, 7, pp.114033-114041. ISSN 2169-3536. (2019) DOI:

<https://doi.org/10.1109/ACCESS.2019.2933694> (scientific paper)

- P. Arteaga-Diaz, A. Ocampos Guillén, Veronica Fernandez, “Enabling QKD under Strong Turbulence for Wireless Networks with Tilt Wavefront Correction”, 2019 21st International Conference on Transparent Optical Networks (ICTON) (2019-07) | DOI:

<https://doi.org/10.1109/icton.2019.8840410> ISBN: 9781728127798 (conference paper)

- Veronica Fernandez; J. Gómez-García; A. Ocampos-Guillén; A. Carrasco-Casado, “Correction of Wavefront Tilt Caused by Atmospheric Turbulence Using Quadrant Detectors for Enabling Fast Free-Space Quantum Communications in Daylight”, IEEE Access, 6 - 1, pp. 3336 - 3345. 2018. ISSN 2169-3536, (2018) DOI:

[10.1109/access.2018.2791099](https://doi.org/10.1109/access.2018.2791099) (scientific paper)

Collaborations:

Pablo Aitor Postigo from NANOPOD, Institute of Micro and Nano Technology

Contribution:

Digital communications in electronic commerce (online purchases, online banking, secure email, operation in government or public e-platforms, etc.) carry our sensitive information through the Internet and must therefore be adequately secured to avoid access to undesired recipients. New advances in computing power and/or the advent of a Quantum Computer can expose information encrypted with current cryptographic algorithms. We can however achieve unconditional security with the One Time Pad encryption, but this needs random and previously shared keys at the ends of the communication link. This can be achieved using Quantum Key Distribution, (QKD), which allows the distribution of random keys with verifiable security using the principles of Quantum Mechanics.

In 2009, our group started from scratch the only research line in Spain in free space quantum key distribution and in 2013, we achieved the highest reported QKD key rate at that time in a free space city link, which crossed the CSIC campus in Madrid. We have also worked in compensating atmospheric effects through automatic beam tracking and pointing systems, capable of an order of magnitude increase in the secret key rate of QKD systems. From 2015, we started a new research line based on continuous variable QKD systems, more compatible with telecom networks. Finally, we are also working to develop technologies for mobile QKD applications, such as drone or satellite-based applications. In the context of the Quantum Communication Infrastructure, an initiative that aims to connect several European cities through QKD links, it is necessary to increase the robustness of current systems to make them resilient in realistic conditions of operation. Our goal is to provide various QKD technologies and knowledge to this initiative through robust, high-speed QKD systems; using different –including novel- protocols, for wireless efficient QKD applications.

IEM Instituto de Estructura de la Materia

Condensed Matter Theory

Jorge Dukelsky, Rafael Molina, José González

Team description:

Our investigation explores new phenomena in novel quantum materials that may lead to

topological and chiral flow of electrons. We also study the physical limitations imposed on the quantum processing of information by non-equilibrium thermodynamics.

Keywords:

topological materials, quantum thermodynamics, many-body systems, quantum transport

Projects:

- Dinamica, Topologia E Integrabilidad En Sistemas Cuanticos De Muchos Cuerpos (PGC2018-094180-B-I00), Rafael Molina, Agencia Estatal Investigación, **2019-2022**, 42.834,00 €

- Nuevos Modelos Para Materiales Quirales (FIS2017-82260-P), Tobias Stauber y José González, MINISTERIO DE ECONOMIA Y COMPETITIVIDAD, **2018-2020**, 36.300,00 €

- Mas Alla De Campo Medio Y Soluciones Exactas En Sistemas Cuanticos De Muchos Cuerpos (FIS2015-63770-P), Jorge Dukelsky y Rafael Molina, MINISTERIO DE ECONOMIA Y COMPETITIVIDAD, **2016-2019**, 65.219,00 €

Publications:

- J. Mur-Petit, A. Relaño, R.A. Molina and D. Jaksch, Revealing missing charges with generalised quantum fluctuation relations, *Nature Communications* 9, 2006 (2018)

- R. A. Molina and J. González, Surface and 3D Quantum Hall Effects from Engineering of Exceptional Points in Nodal-Line Semimetals, *Physical Review Letters* 120, 146601 (2018)

- J. González and T. Stauber, Kohn-Luttinger Superconductivity in Twisted Bilayer Graphene, *Physical Review Letters* 122, 026801 (2019)

Challenge:

Materials for electronics and photonics with near-zero power consumption

Contribution:

We are working on the proposal of new materials synthesized from low-dimensional constituents, where the electronic and photonic properties can be tailored from their structure at the nanoscale. This is part of a revolution started with the discovery of graphene in 2004, but it has evolved into an almost endless list of new compounds covering 2D or 3D

heterostructures including topological materials. The aim of this search is the design of devices where transport may take place with no energy dissipation, relying on the topological or the superconducting properties of the material. The new frontier to be reached during the next decades is the development of novel electronic and photonic devices operating at unprecedented high speed and minimum consumption of energy.

In particular, we are exploring at present new phenomena in novel quantum materials that may lead to topological and chiral flow of electrons, including materials such as graphene, the chalcogenide family and Weyl semimetals like TaAs. We are developing exactly solvable models and advanced numerical methods for the description and understanding of exotic and topologically protected phases of matter in many-body quantum systems.

The group also studies the physical limitations and constraints imposed on the quantum processing of information by the fluctuation relations of quantum non-equilibrium thermodynamics, both in a general theoretical framework and in particular platforms like trapped ions or semiconductor-based qubits.

We believe that our contribution towards these goals would fit better within a new challenge as proposed below.

IMB-CNM Instituto de Microelectrónica de Barcelona

PDS - Nanomaterials and micro/nanofabrication for QTech and Space applications

Gemma Rius, Philippe Godignon, Sofia Aslanidou

Team description:

We develop novel/custom processing technologies for enabling elements/ devices for Q Computing & Harsh Environment operation, e.g in Space. The approach is centred in Quantum & Nanomaterials, superconductors & 2D materials, and combined with surface micro/nano structuring of semiconductor substrates

Keywords:

Micro/nanofabrication, graphene, superconductors, 2D materials, quantum computing

Projects:

GRACE. Retos Colaboración
QuantumCAT RIS3 and QTEP PTI
WHISKIES. ESA-CORA-MAP

Publications:

- Arrays of suspended silicon nanowires defined by ion beam implantation: mechanical coupling and combination with CMOS technology
J Llobet et al. Nanotechnology, 29, 15 (2018)
- Optical nano-imaging of gate-tunable graphene plasmons
Jianing Chen et al. Nature 487, 77–81 (2012)
- Anisotropic growth of long isolated graphene ribbons on the C face of graphite-capped 6H-SiC
Nicolas Camara et al. Phys. Rev. B 80, 125410 (2009)

Collaborations:

Lourdes Fábrega (ICMAB)

Also involved/interested in:

TEMÁTICA 4. RETOS EN BIOMEDICINA Y SALUD; TEMÁTICA 12. ¿NUESTRO FUTURO? EXPLORACION Y COLONIZACION DEL ESPACIO

Contribution:

10C. Aplicación de las nuevas tecnologías cuánticas

Our experience and technical capabilities allow us to provide the base of the stack for quantum computation for specific implementations. Our quantum hardware can be built on conventional substrates such as silicon, advanced technical substrates such as SiC, and incorporate normal metals for superconducting operation, such as Al or Nb, following demonstrated qubit implementations such as superconducting circuits and resonators. Enabling alternative or improved superconducting materials/thin films is part of our current interest.

Additionally, we are able to integrate in these platforms broad range of nanoelectronic devices (nanostructured silicon) and nanomaterials, especially, graphene and other 2D materials. We would define and implement the fabrication/processing technology based on

co-design of architectures and layouts according to proposed/original quantum gates and algorithms in collaboration, and including neural networks implementations and strategies. Our vision is to become providers of versatile and flexible hardware during the next 5-10 years for NISQ devices, made of one or few qubits, to solve real applications for end users targeting at simulation, optimization, machine learning and artificial intelligence-based problems and demands. Preliminary developments are already being co-developed in close collaboration with Dr. Pol Forn-Díaz (IFAE).

Additionally, while these technology platforms may find spin-off application in other Quantum Technologies such as e.g. Quantum Sensing and Imaging, we aim to contribute with this approach or adapted elements/materials to the T10 Desafíos: 10A. Electrónica inteligente y sostenible, and 10B. Integración de avances en fotónica.

DESAFIO 10D: PLATAFORMAS ABIERTAS PARA OPEN SCIENCE

ICM Instituto de Ciencias del Mar

- Continental Margin Group-GMC

IATA Instituto de Agroquímica y Tecnología de Alimentos

- Open science

IFCA (Instituto de Física de Cantabria)

- Climate and data science
- Computación Avanzada y e-Ciencia

ICTJA Inst. Earth Sciences Jaume Almera

- Structure & Dynamics of the Earth

IFIC (Instituto de Física Corpuscular)

- Grid & e-Science

RJB - Real Jardín Botánico / IPE-Instituto Pirenaico de Ecología

- PTI-ECOBIODIV (a CSIC Interdisciplinary Thematic Platform)

IFISC - Institute for Cross-Disciplinary Physics and Complex Systems

- Dynamics and Collective Phenomena in Social and Socio-technical Systems

IAA Instituto de Astrofísica de Andalucía

- AMIGA

Also interested in Challenge 10D:

ILLA Instituto de Lengua, Literatura y Antropología

- Social Anthropology (Francisco Ferrándiz)

ICM Instituto de Ciencias del Mar

Continental Margin Group-GMC

Gemma Ercilla Zarraga, Belén Alonso, David Casas, Ferran Estrada, Carmen Juan

Team description:

The research focuses on the basic and applied geology (geological hazards) of continental margins and deep-marine environments in different geological contexts in different latitudes. The research involves geomorphology, stratigraphy, sedimentology, geotechnics, tectonics and bottom currents.

Keywords:

Marine Geology, Continental margins, Geological hazards, stratigraphy and sedimentology, geotechnics

Projects:

EMODNET Ingestion and Safe-keeping of Marine Data; IP: Dick Schaap; European Commission (General for Maritime Affairs and Fisheries -DG MARE), **2016-2021**

Publications:

- Gemma Ercilla, Carmen Juan, F. Javier Hernández-Molina, Miguel Bruno, Ferran Estrada, Belén Alonso, David Casas, Marcel.li Farran, Estefanía Llave, Marga García, J. Tomás Vázquez, Elia D'Acremont, Chistian Gorini, Desiré Palomino, Javier Valencia, Bouchta El Moumni and Abdellah Ammar. Significance of bottom currents in deep-sea morphodynamics: An example from the Alboran Sea. *Marine Geology*.378, 157-170, 2016. doi:10.1016/j.margeo.2015.09.007 I.F.: 2.710
- Belén Alonso, Gemma Ercilla, David Casas, Dorrik A.V. Stow, Francisco J. Rodríguez-Tovar, Javier Dorador, Francisco-Javier Hernández-Molina. Contourite vs gravity-flow deposits of the Faro Drift (Gulf of Cadiz) during the Pleistocene: Sedimentological and mineralogical approaches. *Marine Geology*, 377, 77-94, 2016. I.F.: 2.710
- J. Galindo-Zaldivar, G. Ercilla, F. Estrada, M. Catalan, E. Acremont, O. Azzouz, D. Casas, M. Chourak, J. Vázquez, A. Chalouan, C. Sanz, M. Benmakhlouf, C. Gorini, B. Alonso, D. Palomino, J. Rengel, A. Gil. Imaging the growth of very recent faults: the case of 2016-17 seismic crisis sea bottom deformation in the Alboran Sea (Western Mediterranean). *Tectonics*. 37: 2513-2530.2018: IF: 3,78.
- Gemma Ercilla, Carmen Juan, Raul Periáñez, Belén Alonso, ... Javier Valencia TITULO: Influence of alongslope processes on modern turbidite systems and canyons in the Alboran Sea (southwestern Mediterranean). *Deep Sea Research Part I: Oceanographic Research*, vol. 144, 1-16. 2019. FI: 2.384.

Challenge:

It will be first step towards the defragmentation of Spanish marine geoscience community, through an innovative infrastructure service that will engage a community of academic and industry researchers working on marine geohazard features.

Contribution:

To build an infrastructure service to map Marine Geohazards along the Spanish continental margins which successfully brought together all major marine geoscience institutes to create a network that provided a service of interest to both science and society. To engage researchers from different backgrounds (academia, industry) and

career stages (early, senior) in interactions with each other and with the wider community of coastal and maritime stakeholders, in order to build an expert network of marine geoscientists with the competencies necessary to undertake activities of scientific and social impact. To develop a common methodology and standard for the identification, interpretation and cartographic representation of seabed features constituting potential marine geohazards, in order to establish a standard approach and shared language that will facilitate joint research activities across the Mediterranean region as well as, in future, other offshore settings and/or other mapping theme

IATA Instituto de Agroquímica y Tecnología de Alimentos

Open science

Remedios Melero

Team description:

My research lines during last years have been focused on open science and particularly to those aspects related to open access to scholarly outputs, copyright, open access policies, open research data and institutional repositories.

Keywords:

open access, open data, open science, scholarly publications, open science policies

Projects:

- Ciencia abierta en España: una aproximación global para evaluar su grado de implementación MINISTERIO DE CIENCIA, INNOVACIÓN y UNIVERSIDADES. Ernest Abadal Falgueras (PI) . Partner: Remedios Melero (IATA-CSIC). **2019-2021**.
- *Remedios Melero*(IATA-CSIC). **2017-2019**.
- FOSTER (FACILITATE OPEN SCIENCE TRAINING FOR EUROPEAN RESEARCH) European Commission. 7FP. Eloy Rodrigues (Univ Minnho, coordinator). Partner (IP): Remedios Melero (IATA-CSIC). **2014-2016**.

Publications:

- Helene Brinken , Iryna Kuchma, Vasso Kalaitzi, Joy Davidson, Nancy Pontika, Matteo Cancellieri, et al. 2019. A Case Report: Building Communities with Training and Resources for Open Science Trainers. LIBER Quarterly, 29(1), pp.1–36. DOI: <http://doi.org/10.18352/lq.10303>
- R. Melero; D. Melero-Fuentes; J.M. Rodríguez-gairín. 2018. Monitoring Compliance with governmental and institutional open access policies across Spanish Universities El Profesional de la Información 27 (4), pp.858-878. Doi: 10.3145/epi.2018.jul.15
- Melero R.; Laakso M.; Navas-Fernández M.2017. Openness of Spanish scholarly journals as measured by access and rights. Learned Publishing 30, pp.143-155. doi:10.1002/leap.1095
- Serrano-Vicente, R.; Melero, R.; Abadal, E.2016. Open Access Awareness and Perceptions in an Institutional Landscape. Journal of Academic Librarianship. 42, pp.595-603. doi: 10.1016/j.acalib.2016.07.002

Collaborations:

Rafael Alexandre, INGENIO. Ismael Ràfols, INGENIO

Contribution:

I think that my experience in topics related to open science, both in terms of infrastructure and the governance of open science platforms, can contribute to approach and promote the meaning of open science among the researchers, who are critical stakeholders to contribute to the openness of science. Culture change and change in habits to make open access to scientific publications a common practice among researchers, including research data, are relevant issues to comply with new requirements of funders, and for sharing science mainly funded by public funds.

IFCA (Instituto de Física de Cantabria)

Climate and data science

José Manuel Gutiérrez, Antonio Cofiño, Jesús Fernández, María Dolores Frías, Jorge Baño, Mikel Legasa, Maialen Iturbide, Joaquín Bedia, Ana Casanueva, Rodrigo Manzanos

Team description:

Data science in climate applications including the development of open science frameworks.

Keywords:

climate, climate change, data science, reproducibility, open science

Projects:

- CORDEX4USERS - World-Wide CORDEX for Users through the C3S Climate Data Store", COPERNICUS, **2019-2021**. PI: JOSÉ MANUEL GUTIÉRREZ
- "Climate risk analysis and visualization platform for adaptation and disaster risk reduction in agriculture – climate component". FAO (FOOD AND AGRICULTURE ORGANIZATION). **2019-2020**. PI: JOSÉ MANUEL GUTIÉRREZ

Publications:

- Bedia, J., San-Martín, D., Iturbide, M., (...), Manzanos, R., Gutiérrez, J.M (2019) The METACLIP semantic provenance framework for climate products. Environmental Modelling and Software 119, pp. 445-457
- Iturbide, M., Bedia, J., Herrera, S., (...), Cofiño, A.S., Gutiérrez, J.M. (2019) The R-based climate4R open framework for reproducible climate data access and post-processing. Environmental Modelling and Software 111, pp. 42-54.

Collaborations:

PTI CLIMA

Also involved/interested in:

TEMÁTICA 7. IMPACTO DEL CAMBIO GLOBAL

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

Interest in participating in open science topics.

IFCA - Instituto de Física de Cantabria

Computación Avanzada y e-Ciencia

Jesús Marco de Lucas, Álvaro López. Fernando Aguilar. Lara Lloret. María Castrillo. Daniel García. David Rodríguez. Aida Palacio. Ignacio Heredia.

Team description:

We cover scientific and technical aspects. Scientific activities go from the integration of instrumentation in distributed infrastructures, to the definition of new distributed computing architectures. Technical activities involve the operation of a mid-size computing and storage infrastructure.

Keywords:

computacion, cloud, HPC, modelizacion, machine learning

Projects:

- DEEP-Hybrid-DataCloud, Álvaro López García, European Commission, **2017-2020**
- COS4CLOUD, Jaime Piera (CSIC), European Commission, **2019 - 2023**
- EOSC-Hub, Tiziana Ferrari (EGI.eu), European Commission, **2018 - 2020**

Publications:

- G. Nguyen, S. Dlugolinsky, M. Bobák, V. Tran, Á. López García, I. Heredia, P. Malík, and L. Hluchý. "Machine Learning and Deep Learning frameworks and libraries for large-scale data mining: a survey". In: Artificial Intelligence Review (Jan. 2019). ISSN: 1573-7462. DOI: 10.1007/s10462-018-09679-z.
- Á. López García, E. Fernández del Castillo, and I. Campos Plasencia. "An efficient cloud scheduler design supporting preemptible instances". In: Future Generation Computer Systems 95 (2019), pp. 68–78. ISSN: 0167-739X. DOI: 10.1016/j.future.2018.12.057.
- X. Chen, S. Dallmeier-Tiessen, R. Dasler, S. Feger, P. Fokianos, J. Benito Gonzalez, H. Hirvonsalo, D. Kousidis, A. Lavasa, S. Mele, D. Rodriguez Rodriguez, T. Šimko, T. Smith, A. Trisovic, A. Trzcinska, I. Tsanaktsidis, M. Zimmermann, K. Cranmer, L. Heinrich, G. Watts, M. Hildreth, L. Lloret Iglesias, K. Lassila-Perini, S. Neubert. "Open is not enough". In: Nature Physics 15 (2019), pp. 113–119. ISSN: 1745-2481. DOI: 10.1038/s41567-018-0342-2.

Collaborations:

Isabel Bernal, DIGITAL.CSIC.

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

Although we selected the T10D challenge we would like to contribute to several challenges from T10 area by providing our experience in distributed computing and storage systems. More specifically, due to our prior participation in related projects, we can contribute to T10A, T10D, T10E, T10H.

In what regards the specific T10D challenge, one of the areas that we would like to contribute is the development of tools and platforms that aim to provide software sustainability in the context of open science within CSIC. We would like to promote a software sustainability action in order to build an ecosystem for scientific software development, fostering software recognition as an intellectual and scientific asset (as another kind of publication). Moreover, we would like to provide tools to ensure that CSIC-developed scientific software is of enough quality, ensuring its sustainability over the time before it is archived and deposited on the repository. Therefore we would like to participate in the design and implementation of the challenge solutions, addressing and supporting the architecture definition and specification, requirement elicitation and the platform implementation. We do think that this has to be done on a holistic way, involving all relevant stakeholders within the council (management, scientists, research software engineers, repository). Our expectations of the T10D are high, as we think that open science require from a next generation of tools and platforms that will impact how research is done.

ICTJA Inst. Earth Sciences Jaume Almera

Structure & Dynamics of the Earth

Juaquina Alvarez Marron, C. Ayala-galan, D. Brown, J.Diaz-Cusi, M. Fernandez, D. Garcia-Castellanos, I. Jimenez-Munt, M. Schimmel, M. Torne-Escassany, J. Verges, R. Carbonell

Team description:

Multidisciplinary research: structure, dynamic processes of the Earth's interior. Basic, highly applied research: natural hazards, geologic risk, natural resources (mineral, hydrocarbons, geothermal), subsurface infrastructures, storage (energy, hazardous waste)

Keywords:

Natural resources and hazards, Geologic risk, Earth processes, Geodynamics, Geophysics

Projects:

-EPOS-SP "European Plate Observing system, sustainability phase" M. Cocco, (Spain. R. Carbonell) Eu-H2020, **2020-2023** (<https://www.epos-eu.org/>)

-SIT4ME: Seismic imaging technologies for mineral exploration. R. Carbonell EIT-Raw materials. (<http://sit4me.eitrawmaterials.eu/>)

Publications:

-Díaz, J., M. Ruiz, P. S. Sánchez-Pastor, and P. Romero (2017), Urban Seismology: on the origin of earth vibrations within a city, *Scientific Reports*, 7(1), 15296, doi: 10.1038/s41598-017-15499-y.

-Andrés, Marzán, Ayarza, Martí, Palomeras, Torné, Campbell, Carbonell. (2018). Curie Point Depth of the Iberian Peninsula and Surrounding Margins. A Thermal and Tectonic Perspective of its Evolution. *Journal of Geophysical Research.*, 123(3), 2049-2068, doi: 10.1002/2017JB014994

-Marti, D., I. Marzan, J. Sachsenhausen, J. Alvarez-Marrón, M. Ruiz, M. Torne, M. Mendes, and R. Carbonell (2019) 3-D seismic travel-time tomography validation of a detailed subsurface model: a case study of the Záncara river basin (Cuenca, Spain) *Solid*

Earth, 10, 177-192, <https://doi.org/10.5194/se-10-177-2019>, 2019

-Andrés, J., Marzán, I., Ayarza, P., Martí, D., Palomeras, I., Torné, M., et al. (2018). Curie point depth of the Iberian Peninsula and surrounding margins. A thermal and tectonic perspective of its evolution. *Journal of Geophysical Research: Solid Earth*, 123. doi: 10.1002/2017JB014994

-Andrés, J. Alcalde, P. Ayarza, E. Saura, I. Marzán, D. Martí, J.R. Martínez Catalán, R. Carbonell, A. Pérez-Estaún, J.L. García-Lobón and F.M. Rubio, Basement structure of the Hontomín CO2 Geological storage facility (Burgos, Spain): integration of microgravity & 3D seismic reflection data, *Geo-Temas*, 16 (1) ISSN 1576-5172, pp 523-526

-Díaz, J. Gallart, R. Carbonell, Moho topography beneath the Iberian-Western Mediterranean region mapped from controlled-source and natural seismicity surveys, *Tectonophysics*, Volume 692, Part A, 2016, Pages 74-85, ISSN 0040-1951, doi: 10.1016/j.tecto.2016.08.023.

Collaborations:

J. Fernandez-Torres (IDEO) Geodesia Espacial, Campos Potenciales (de gravedad y geomagnético) y Geomatemáticas

F. Tornos (ICEO) Procesos de Formación Mineral

Challenge:

Subsurface digital Models: Assessing geo-hazards, geo-resources challenges.

Why: Earth-Related themes are neglected in the current CSIC- aims

Also involved/interested in:

TEMÁTICA 7. IMPACTO DEL CAMBIO GLOBAL

Contribution:

Facilitate integrated use of data, data products, data services and facilities focused in Earth Sciences. These have been generated, acquired designed, supported etc. by and within the EU research institutions. Provide a strong bridge to open research possibilities which are not part of the CSIC's current thematic aims, for example the lack of Solid Earth oriented challenges which are key for the development of a carbon free society. Provide a link to ESFRI infrastructures such as EPOS, EMSO and other ESFRI. The promotion of EPOS and solid Earth related data-sets, data products and services should bring together Earth scientists, national research infrastructures, ICT (Information & Communication Technology) experts, decision makers, and public to develop new concepts and tools for accurate, durable, and sustainable answers to societal questions concerning geo-hazards, geo-resources and those geodynamic phenomena relevant to the environment and human welfare. It is the fully integrated framework to study a continuously changing planet. The vision is that the integration of the existing national and trans-national research infrastructures will increase access and use of the multidisciplinary data recorded by the solid Earth monitoring networks, acquired in laboratory experiments and/or produced by computational simulations

IFIC (Instituto de Física Corpuscular)

Grid & e-Science

Santiago González de la Hoz, Jose Francisco Salt Cairols, Francisco Javier Sanchez

Martinez, Jose Enrique Garcia Navarro

Team description:

GRID-CSIC infrastructure for Open Science

Keywords:

GRID; LHC; e-Science

Projects:

- Proyecto Hacia un genuino Tier-2 federado español de ATLAS para afrontar el reto de la gestión y procesado del Big Data del LHC. Código: FPA2016-75141-C2-1-R (2016-2019). Agencias Estatal de Investigación (AEI). Investigador Principal: Santiago González de la Hoz, con una dotación de 925000 euros.
- I-COOP + research cooperation agreement (COOPB20247). Launching to Platform of Grid computing in Morocco to meet the new challenges of Physics research. Responsible researcher: Dr. José Francisco Salt Cairols. Financing entity: CSIC. Period 2017-2018.

Publications:

- G. Aad et al. (ATLAS Collaboration). Search for the Production of a Long-Lived Neutral Particle Decaying within the ATLAS Hadronic Calorimeter in Association with a Z boson from pp Collisions at $\sqrt{s} = 13$ TeV pp collision. PHYSICAL REVIEW LETTERS 122, 151801 (2019).
- G. Aad et al. (ATLAS Collaboration). Search for heavy charged long-lived particles in the ATLAS detector in 36.1 fb⁻¹ of proton-proton collision at $\sqrt{s} = 13$ TeV. PHYSICAL REVIEW D 99, 092007 (2019).
- G. Aad et al. (ATLAS Collaboration). Search for long-lived particles produced in pp collisions at $\sqrt{s} = 13$ TeV that decay into displaced hadronic jets in the ATLAS muon spectrometer. PHYSICAL REVIEW D 99, 52005 (2019).

Also involved/interested in:

TEMÁTICA 9. ENTENDIENDO LOS COMPONENTES BASICOS EL UNIVERSO, SU ESTRUCTURA Y EVOLUCIÓN;
TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

Relacionado con ATLAS se pueden hacer plataformas abiertas para la divulgación de resultados del experimento, o para la divulgación por medio de Masterclasses del trabajo que realizan los físicos de ATLAS a partir de datasets de datos.

RJB- Real Jardín Botánico / IPE-Instituto Pirenaico de Ecología
PTI-ECOBIODIV (a CSIC Interdisciplinary Thematic Platform)

Francisco Pando / Begoña García, 63 people from CEAB, EBD, EEZ, IATS, ICM, IFCA, IMEDEA, IRNASE, IPE, MNCN, RJB, UIMB, IFCA

Team description:

ECOBIODIV is aiming to unify research and data on Biodiversity and Ecosystems. it intends to develop a Platform to allow researchers and managers to integrate or access all kinds of data to address biodiversity and environmental challenges and to provide modelling and analysis tools to address them

Keywords:

Biodiversity, Ecosystems, Data, Platform, ICT,

Projects:

- ELTER Plus; Jaana Bäck, EC, **2020-2025**, 10M€
- ELTER PPP; Michael Mirtl, EC, **2020-2025**, 4M€
- Sustainability for Mediterranean Hotspots in Andalusia integrating LifeWatch ERIC (SUMHAL), Margarita Paneque, Ministerio de Ciencia, Innovación y Universidades, 15M€ [submitted; pending]

Publications:

<https://datos.gbif.es/>

See answer for question 4 + PTI-CLIMA

Also involved/interested in:

TEMÁTICA 7. IMPACTO DEL CAMBIO GLOBAL

Contribution:

At the core of PTI ECOBIODIV is connecting data and tools under FAIR principles to provide them via an Open Science Platform and thus in full alignment with "DESAFIO 10D: PLATAFORMAS ABIERTAS PARA OPEN SCIENCE"

IFISC - Institute for Cross-Disciplinary Physics and Complex Systems
Dynamics and Collective Phenomena in Social and Socio-technical Systems

Jose Javier Ramasco, Pere Colet, Maxi San Miguel, Sandro Meloni, Victor Eguiluz

Team description:

En el grupo del IFISC hemos desarrollado análisis de sistemas sociales desde el punto de vista de los datos masivos (big data). En principio, los estudios afectan a diversos aspectos de los sistemas sociales, desde opinión y votos hasta movilidad y demografía.

Keywords:

big data, sistemas sociales, movilidad

Projects:

- PACCS: Physics approach to complexity in sociotechnical systems" con código RTI2018-093732-B-C22 del programa Retos de la AEI (**2019-2021**)
- BigData4ATM: Passenger-centric Big Data Sources for Socio-economic and Behavioral Research in ATM, proyecto H2020 sobre el uso de datos masivos para el desarrollo de herramientas de toma de decisiones en el transporte aéreo europeo (**2016-2018**).

- INSIGHT: Innovative Policy Modelling and Governance Tools for Sustainable Post-Crisis Urban Development, proyecto FP7 sobre el uso de datos en toma de decisiones sobre el uso del suelo en ciudades (2013-2016).
- TREE: Data-driven modelling of network-wide extension of the Tree of REactionary delays in ECAC area, proyecto sobre simulación basada en datos masivos para la reducción de retrasos en el transporte aéreo en Europa (2013-2016).
- EUNOIA: Evolutive User-centric Networks for Intraurban Accessibility, proyecto FP7 coordinado desde el IFISC sobre uso de datos masivos y simulaciones para mejorar la movilidad en ciudades (2012-2015).

Publications:

- M. Mazzoli, A. Molas, A. Bassolas, M. Lenormand, P. Colet and J.J. Ramasco Field theory for recurrent mobility, Nature Communications 10, 3895 (2019).
- A. Bassolas, J.J. Ramasco, R. Herranz and O.G. Cantu-Ros, Mobile phone records to feed activity-based travel demand models: MATSim for studying a cordon toll policy in Barcelona, Transportation Research A 121, 56-74 (2019).
- T. Louail, M. Lenormand, J. Murillo Arias and J.J. Ramasco, Crowdsourcing the Robin Hood effect in cities, Applied Network Science 2, 11 (2017).
- B. Campanelli, P. Fleurquin, A. Arranz, I. Etxebarria, C. Ciruelos, V.M. Eguiluz and J.J. Ramasco, Comparing the modeling of delay propagation in the US and European air traffic networks, Journal of Air Transport Management 56, 12 (2016).
- B. Campanelli, C. Ciruelos, A. Arranz, I. Etxebarria, S. Peces, P. Fleurquin, V.M. Eguiluz and J.J. Ramasco, Modelling delay propagation trees for scheduled flights, Proceedings of the 11th USA/Europe Air Traffic Management R&D Seminar, Lisbon, Portugal, 2015.

Collaborations:

Diego Ramiro, CCHS

Also involved/interested in:

TEMÁTICA 1. NUEVAS BASES PARA UNA SOCIEDAD GLOBALIZADA SOSTENIBLE;
TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

I will contribute to 10 D, H, F

IAA Instituto de Astrofísica de Andalucía

AMIGA

Lourdes Verdes-Montenegro, Lourdes Verdes-Montenegro, Susana Sánchez, Julián Garrido, Laura Darriba, Sebastián Luna, Javier Moldón, Mike G. Jones, Ancor Damas-Segovia, Javier Román, Mayte Castillo

Team description:

Coordination of the Spanish participation in the ESFRI SKA (Square Kilometre Array), and development of a SKA Regional Centre (SRC) prototype. Expertise in radioastronomy and in e-Science technology for supporting Open Science at the SRCs to enable scientific reproducibility in a Big Data context.

Keywords:

Open Science, Scientific Reproducibility, DCIs, Big Data reserach, e-Science

Projects:

- "ESCAPE: European Science Cluster of Astronomy & Particle physics ESFRI research infrastructures" (SEP-210506816, 31 organisations), PI: G. Lamanna (CNRS), IAA-PI: L. Verdes-Montenegro- European Commission call: H2020-INFRAEOSC-**2018-2020**. 01/02/2019-30/07/2022. 15.983.301,25€ (IAA: 108.375€)

- "WF4EVER Advanced Workflow Preservation Technologies Preservation for Enhanced Science" (FP7-270192), FP7 - EC, J. M. Gómez Pérez (iSOCO company – PI project), L. Verdes-Montenegro (Coordinator of Astronomy WP, IAA-PI). **2010-2013**, 2.940.000€ (IAA: 313.765€)

- "SKA-Link: combining knowledge to pioneer Big-Data solutions for SKA Data Centres" (CSIC call i-link 2016 - I-LINK1122). PI: L. Verdes-Montenegro. **2017 - 2018**. 27.100€

Publications:

- "Why Open science at the SRCs?". Lourdes Verdes-Montenegro, Susana Sánchez, Julián Garrido, Rachael Ainsworth. Invited talk at the SKA General Science Meeting and Key Science Workshop, April 2019, Manchester

- The "SKA Regional Centre Requirements" R. Bolton et al., including L. Verdes Montenegro. SKA technical document SKA-TEL-SKO-0000735. September 2017
Web services as building blocks for Science Gateways in Astrophysics. S. Sanchez, P. Martin, J.E. Ruiz, L. Verdes-Montenegro, J. Garrido, R. Sirvent, A. Ruiz-Falcó, R. Badia, D. Lezzi. 2016 Journal of Grid Computing, 1-13. DOI: 10.1007/s10723-016-9382-y

- The Spanish Square Kilometre Array White Book. Editors: Miguel A. Perez-Torres, L. Verdes-Montenegro, J. C. Guirado, A. Alberdi, J. Martin-Pintado, R. Bachiller, D. Herranz, J. M. Girart, J. Gorgas, C. Hernandez-Monteagudo, S. Migliari and J. M. Rodriguez Espinosa. 2015. Sociedad Española de Astronomía, 1-289. ISBN: 978-84-606-8955-3

- AstroTaverna - Building workflows with Virtual Observatory services. J.E. Ruiz, J. Garrido, J.D. Santander-Vela, S. Sánchez, L. Verdes-Montenegro. 2014 Astronomy and Computing 7-8, Special Issue on The Virtual Observatory: I, 3-11, doi:10.1016/j.ascom.2014.09.002

Collaborations:

Rafael Garrido, Stellar Seismology Team, IAA-CSIC; Spanish Network on Open e-Science centres: it includes several following CSIC centres

Challenge:

Reproducibility is a challenge increasing together with the data deluge. Open Science can facilitate scientific reproducibility, but is not synonymous. We would propose to add to "Plataformas abiertas para Open Science" + "y Reproducibilidad científica" to cover the full problematic.

Also involved/interested in:

TEMÁTICA 9. ENTENDIENDO LOS COMPONENTES BASICOS EL UNIVERSO, SU ESTRUCTURA Y EVOLUCIÓN

Contribution:

Reproducibility, a cornerstone of the scientific method, is still a challenge. In the era of computational research, reproducing an experiment can be impossible due to the lack of

access to input data, configuration parameters, software environment, analysis tools as well as to annotations and provenance information describing all those elements.

This challenge is currently being increased by the data deluge generated by megascience infrastructures. Solutions are starting to emerge, involving e-science technologies to enhance scientific collaboration and knowledge sharing, ensuring transparency, opening data and methods, or encouraging Open Science.

Since 2003, AMIGA group has complemented fundamental science with applied e-Science research, aiming to support astronomers to cope with the data and computational complexity while doing reproducible science. Now it is applying this expertise to the SKA ESFRI, an international project to build the world's largest radio telescope.

The SKA will have the potential to provide revolutionary science in Astrophysics, Physics and Astrobiology. Once complete, it will be the greatest data research public project, composed of thousands of antennas that will generate a copious data flux (~ 1TB/s). The SKA observatory will deliver ~ 600 PB/yr of data products to a worldwide distributed network of SKA Regional Centres (SRCs), which will provide the community with access to data and to the computing power and tools required for their analysis.

AMIGA is contributing to design the SRC network as a collaborative framework where researchers can address the challenge of handling SKA data to extract scientific knowledge in a reproducible way. We are also developing a SRC prototype at the IAA, fully engaged with Open Science. Our goal is that this prototype will be a transversal and open platform, which will provide tools to enable researchers to produce FAIR (i.e. Findable, Accessible, Interoperable and Reusable) data and methods.

DESAFIO 10E: DESARROLLOS PARA INTERNET OF THINGS

CAR - Centre for Robotics and Automation

- LOPSI - Localization and exPloration for Intelligent Systems (*Antonio R. Jiménez Ruiz*)
- GAMHE- Group of advanced Automation of Machines, Highly complex processes and Environments (*Rodolfo Haber*)

ITEFI, Instituto de Tecnologías Físicas y de la Información

- GCARMA- Materials Characterization by Non Destructive Evaluation (*José Javier Anaya Velayos*)

IMSE-CNM INSTITUTO DE MICROELECTRÓNICA DE SEVILLA

- Unit of Design of Digital and Mixed-Signal Integrated Circuits - Microelectronics for Security (*Santiago Sánchez Solano*)
-

Also interested in the challenge 10E:

IFCA, Instituto de Física de Cantabria

- Computación Avanzada y e-Ciencia (Jesus Marco, see 10D)

ICMAT, Institute of Mathematical Sciences

- SPOR Statistics, Probability and OR9, Data Science (*David Rios*, see 10H)

IMSE-CNM, Instituto de Microelectrónica de Sevilla

- UNIT of MICRO/NANOMETRIC CIRCUITS AND SYSTEMS (*Francisco V. Fernández*, see 10A)

IMB-CNM Instituto de Microelectrónica de Barcelona

- Microenergy sources and sensor integration (*Luis Fonseca*, see 10A)

CAR - Centre for Robotics and Automation

LOPSI - Localization and exPloration for Intelligent Systems

Antonio R. Jiménez Ruiz

Team description:

Local Positioning Systems (LPS) for indoor/GPS-denied spaces, Smart environments and ubiquitous computing, Transduction and digital processing of acoustics signals, Inertial sensing and RF processing for localization & navigation, Bayesian estimation.

Keywords:

Localization, navigation, sensor fusion

Projects:

- MICROCEBUS: Sistemas locales de localización: enfoque holístico desde el sensado a la analítica. Ministerio Ciencia Innovación y Universidades, "Proyectos de I+D Retos Investigación" RTI**2018**-095168-B-C55
- REPIN+: Red de posicionamiento y navegación de interiores. TEC**2017**-90808-REDT
- NEXTPERCEPTION - Next generation smart perception sensors and distributed intelligence for proactive human monitoring in health, wellbeing, and automotive systems, H2020-ECSEL-**2019**-2-RIA

Publications:

- AR Jimenez, F Seco, C Prieto, J Guevara, A comparison of pedestrian dead-reckoning algorithms using a low-cost MEMS IMU, Intelligent Signal Processing, 2009. WISP 2009. IEEE International Symposium, (2009) (524 cites in GScholar)
- AR Jiménez, F Seco, JC Prieto, J Guevara, Indoor pedestrian navigation using an INS/EKF framework for yaw drift reduction and a foot-mounted IMU, Positioning Navigation and Communication (WPNC), 7th Workshop on, 135-143, (2010) (cited 397 in GScholar)
- AR Jimenez, F. Seo et al., Accurate pedestrian indoor navigation by tightly coupling foot-mounted IMU and RFID measurements, IEEE Transactions on Instrumentation and Measurement 61 (1), 178-189, (2012) (cited 367 times in GScholar).
- A.R. Jiménez and F. Seco, Comparing Ubisense, Bespoon and Decawave UWB location systems: indoor performance analysis, IEEE Transactions on Instrumentation and Measurement, vol. 66, no. 8, pp. 2106-2117, August 2017.
- J. Torres-Sospedra, A.R. Jiménez, et al. "The Smartphone-Based Offline Indoor Location Competition at IPIN 2016: Analysis and Future Work", Sensors 2017, 17(3), 557; <http://dx.doi.org/10.3390/s17030557>

Also involved/interested in:

TEMÁTICA 5. ENVEJECIMIENTO Y MENTE;
TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

Contribution to challenge "10E- Desarrollo para internet of things" by proposing solutions that help to estimate the context/location of persons or objects, specially in GNSS-denied

environments, specially indoors (buidings, metro tunnels, etc).

Center for Automation and Robotics (CAR)

GAMHE- Group of advanced Automation of Machines, Highly complex processes and Environments

Rodolfo Haber, Fernando Castaño, Domingo Guinea, Maria Garcia Alegre, Alberto Villalonga, Gerardo Beruvides, Raul del Toro, among others.

Team description:

GAMHE is focused on designing and development of new methods for modelling, control and optimisation in the conjunction of Control Engineering, Computer Science and AI. Key hot topics are sensors and new sensorial systems, embedded systems, cyber-physical systems and Industry 4.0.

Keywords:

digital transformation, Industry 5.0, ciber-physical systems, modeling, control

Projects:

Power2Power: Providing next-generation silicon-based power solutions in transport and machinery for significant decarbonisation in the next decade , Rodolfo Haber, H2020, **2019-2021**.

IPAE: Industry 4.0 in Production and Aeronautical Engineering, Rodolfo Haber, H2020, **2019-2020**

PRYSTINE: Programmable Systems for Intelligence in Automobiles, Jorge Villagra, H2020, **2018-2020**

Publications:

- La Fe et al., Automatic Selection of Optimal Parameters Based on Simple Soft-Computing Methods: A Case Study of Micromilling Processes. IEEE Transactions on Industrial Informatics 2019, 15, (2), 800-811.
- Castaño, F.; Haber, R. E.; del Toro, R. M., Characterization of tool-workpiece contact during the micromachining of conductive materials. Mechanical Systems and Signal Processing 2017, 83, 489-505.
- Beruvides, G.; Quiza, R.; Haber, R. E., Multi-objective optimization based on an improved cross-entropy method. A case study of a micro-scale manufacturing process. Information Sciences 2016, 334-335, 161-173.
- Procedimiento de parametrización automática de controlador mediante gemelo digital de un sistema ciberfísico, Patente solicitada: P201930465, 28/05/2019
- Procedimiento y sistema ciberfísico de manipulación y mecanizado de un panel rígido. Patente solicitada P201930579, 24/06/2019

Collaborations:

Jorge Villagra, AUTOPIA, CAR;

Challenge:

All research funding agencies in Europe, the US and Japan have specific calls related to cyber-physical systems and digital transformation. The EC challenge “digitalisation and transformation of European industry and services” has a budget for calls in 2020 of 1800

M€. Possible challenges: Digital transformation and cyber-physical systems, or Digitalization and Industry 4.0.

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

I will contribute by identifying state-of-art in this field, the national and international context by feeding back the prospective studies and results of technical committees of ACM, IEEE, IFAC and ASME in the CSIC roadmap. The contribution will be also centred on defining the CSIC strategy and some key enabling measures related to R+D in digital transformation. The main goal is to set a multidisciplinary CSIC working group in the field of digital transformation, cyber-physical systems and Industry 5.0 (new department in DG CONNECT, European Commission).

Nowadays, there are working groups and Scientific and Technical Committees in the main scientific societies such as the International Federation of Automatic Control (IFAC), Association for Computing Machinery (ACM), IEEE and the American Society of Mechanical Engineering (ASME). For example, the TC on Industrial Cyber-Physical Systems of IEEE Industrial Electronic Society and the TC on Modelling, Identification and Intelligent Systems (MIIS) of ASME. Likewise, a large number of scientific journals such as the ACM Transactions on Cyber-Physical Systems or IEEE Transactions on Industrial Informatics, some of the most important for their scientific impact in their respective areas. Collaborations with institutions such as the University of Berkeley, EPFL, POLIMI, TUNI, ETHZ, ENAS just to name a few examples are very important.

There are several groups, researchers and centers of CSIC working in different related topics such as IRI, ITEFI and IIIA. One key challenge is to cluster and glue the disperse activity in the field of digital transformation and cyber-physical systems in topics such as security, modeling, control, computational architectures, machine learning, ethical issues, among others.

ITEFI Instituto de Tecnologías Físicas y de la Información "Leonardo Torres Quevedo"

GCARMA- Materials Characterization by Non Destructive Evaluation

José Javier Anaya Velayos, Margarita Gonzalez Hernández, Sofía Aparicio Secanellas, Dalmay LLuveras, Isabel Sicilia

Team description:

Characterization of material in both the manufacturing process and during its life when it put into service. The group conducts basic research and technological developments in the following areas: NDE Ultrasounds, WSN, SHM, Monitoring processes, Smart materials and embedded sensors, GPR, IRT, Vision...

Keywords:

NDE, WSN, GPR, ultrasound, IoT, materials

Projects:

- HERITAGE WITHIN, IP: M.Gonzalez Hernandez, EACEA, European Commission, **2020-2021**, CSIC funding: 109.238 €, Project funding: 406.844 €.
- Multifunctional materials designed for the reinforcement and monitoring of transport infrastructure. PI: J.J.Anaya. Ministerio de Economía y Competitividad (RTC-2015-3185-4) **2015-2018**. CSIC funding: 238000€, Project funding 1.415.245 €
- Quality control of precast concrete by remote and non-destructive production monitoring (CUREND). PI: J.J.Anaya **2010-2013**, Ministerio de Ciencia e Innovación IPT-020000-2010-26. CSIC funding: 177980€, Project funding 1.091.112€

Publications:

- J. Ranz, S. Aparicio, J. V. Fuente, J. J. Anaya, and M.G. Hernández. Monitoring of the curing process in precast concrete slabs: An experimental study. *Construction and Building Materials* 122 (2016) 406-416. (Q1).
- Sofía Aparicio, María I. Martínez-Garrido, Javier Ranz, Rafael Fort and Miguel Ángel G. Izquierdo. Routing Topologies of Wireless Sensor Networks for Health Monitoring of a Cultural Heritage Site. *Sensors* 16 (2016) 1732, 14 pages. (Q1)
- S. Aparicio, J. Ranz, R. Galán, E. Villanueva, M.G. Hernández, J.J. Anaya, M.A.G. Izquierdo, J.V. Fuentes, R. Fernández, V. Ciscar, V. Albert.
Título: Procedimiento y sistema inalámbrico de medida del grado de fraguado y endurecimiento de materiales cementicios para la predicción de resistencias mecánicas.
Nº de solicitud: P201131005, Fecha: 15/Junio/2011
Nº de solicitud internacional: PCT/ES2012/070439, Fecha: 14/Junio/2012

Also involved/interested in:

TEMÁTICA 1. NUEVAS BASES PARA UNA SOCIEDAD GLOBALIZADA SOSTENIBLE;
 TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA;
 TEMÁTICA 12. ¿NUESTRO FUTURO? EXPLORACION Y COLONIZACION DEL ESPACIO

Contribution:

WSNs consist of distributed, wirelessly enabled embedded devices capable of employing a variety of electronic sensors. The most attractive feature of wireless sensor networks is their autonomy avoiding the need of costly and ungainly wiring between nodes, instead relying on the flexibility of routing algorithms to transport information from node to node. This allows nodes to be deployed in almost any location and for any application. Over the last decade, there is a growing effort to protect and support the structural materials. The need to protect our heritage from the environmental degradation is widely recognized by, e.g. the European Commission. Research has focused on solutions to preserve movable and immovable heritage assets using WSNs. However, the technology used to design these networks is almost obsolete and it is necessary to redesign new monitoring systems that are based on Internet of Things (IoT) technology and protocols to allow their use in the coming years. In addition to these adaptations and new designs, the research team will address in this new project an important problem which is the large volume of information obtained from different inspection techniques and the monitoring of structures and buildings. It is necessary to provide tools to facilitate that this information can be organized, merged, visualized and interpreted both by specialists of the used techniques and, more generally, by other professionals in the field of restoration and conservation of built heritage and the materials manufacture.

IMSE-CNM INSTITUTO DE MICROELECTRÓNICA DE SEVILLA

Unit of Design of Digital and Mixed-Signal Integrated Circuits -- Microelectronics for Security

Santiago Sánchez Solano (contact), Antonio J. Acosta Jiménez, M. Rosario Arjona López, M. Carmen Baena Oliva, Iluminada Baturone Castillo, Piedad Brox Jiménez, Carlos Jesús Jiménez Fernández, José Miguel Mora Gutiérrez, M. Pilar Parra Fernández, Manuel Valencia Barrero

Team description:

The goals of this research line are to verify the identity of hardware devices and users as well as to store and communicate sensitive information using techniques from cryptography and biometrics. Security against hardware attacks (fault injection and side-channel attacks) is specially analyzed.

Keywords:

Hardware Security, Cryptosystems, Biometric Systems, Hardware Attacks, Countermeasures.

Projects:

- HW-IDENTIoT: Design of hardware solutions to manage people and things identities with trust, security, and privacy in IoT ecosystem.

TEC2017-83557-R, Ministerio de Ciencia, Innovación y Universidades.

Iluminada Baturone / Piedad Brox – **2018-2020**

- INTERVALO: Integration and validation in laboratory of countermeasures against side-channel attacks in microelectronic cryptocircuits.

TEC2016-80549-R, Ministerio de Economía, Industria y Competitividad.

Antonio J. Acosta / Carlos J. Jiménez – **2016-2019**

- ID-EO: Design of crypto-biometric hardware for video encryption and authentication

TEC2014-57971-R, Ministerio de Economía y Competitividad.

Iluminada Baturone / Piedad Brox – **2015-2018**

Publications:

- Logic minimization and wide fan-in issues in DPL-based cryptocircuits against power analysis attacks. E. Tena-Sánchez and A.J. Acosta, International Journal of Circuit Theory and Applications, vol. 47, no. 2, pp 238-253, 2019. DOI: <https://doi.org/10.1002/cta.2587>

- VLSI Design of Trusted Virtual Sensors. M.C. Martínez-Rodríguez, M.A. Prada-Delgado, P. Brox and I. Baturone, Sensors, vol. 18, no. 2, article 347, 2018.

DOI: <https://doi.org/10.3390/s18020347>

- A PUF-and biometric-based lightweight hardware solution to increase security at sensor nodes. R. Arjona, M.A. Prada-Delgado, J. Arcenegui and I. Baturone.

Sensors, vol. 18, no. 8, article 2429, 2018 DOI: <http://dx.doi.org/10.3390/s18082429>

- Multiradix Trivium Implementations for Low-Power IoT Hardware.

J.M. Mora-Gutiérrez, C.J. Jiménez-Fernández and M. Valencia-Barrero, IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 25, no. 12, pp 3401-3405, 2017. DOI: <https://doi.org/10.1109/TVLSI.2017.2736063>

- Side-channel analysis of the modular inversion step in the RSA key generation algorithm.

A. Cabrera Aldaya, R. Cuiman Márquez, A.J. Cabrera Sarmiento and S. Sánchez-Solano, International Journal of Circuit Theory and Applications, vol. 45, no. 2, pp 199-213, 2017. DOI: <https://doi.org/10.1002/cta.2283>

Collaborations:

ITEFI - Instituto de Tecnologías Físicas y de la Información Leonardo Torres Quevedo
Grupo de investigación en Criptografía y Seguridad de la Información (GICSI)

PI: Luis Hernández Encinas

Challenge:

The aspects of “hardware security” are not only essential for the development of IoT, but also in many other contexts related to Digitalization, so we believe that it would have enough entity to constitute a specific and independent challenge in which our research line would be better integrated.

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

Hardware security plays an essential role in the development of IoT devices. The research line developed by our group focuses on microelectronic solutions for security applications. The main objectives are to verify the identity of hardware devices and users as well as to store and communicate sensitive information, resorting to the use of crypto-biometric techniques. Security against hardware attacks is especially analyzed, particularly fault injection and side-channel attacks such as differential power analysis (DPA).

Microelectronic solutions are aimed at implementing components and algorithms providing security together with efficient features of size, power consumption and operation speed.

The activities within this research line are devoted to:

- Exploration of cryptographic algorithms from a secure hardware implementation point of view. Development of architectures for such algorithms with optimized features in terms of VLSI design and resistance against attacks.
- Analysis of side-channel and fault-injection attack sources. Development of robust hardware solutions as well as setups and benchmarks to measure the security of microelectronic realizations against attacks with the inclusion of countermeasures. Vulnerability metrics.
- Design of modules based on PUFs (within programmable devices and/or integrated circuits) to implement security primitives particularly related to key generation, identifiers, and random numbers.
- Hardware implementation of algorithms to process and recognize biometric features such as fingerprints, faces, gait, voice, etc. Design of microelectronic solutions for biometric, multi-biometric, and crypto-biometric systems.
- Application of the above solutions to IoT, wearable devices, tokens, tags, consumer electronic devices, control systems, etc.
- Improving of security of IoT devices: Establishment of chains of trust rooted in the silicon manufacturing process for embedded systems based on RISC-V Instruction Set Architectures.

DESAFIO 10F: HUMANIDADES DIGITALES

INCIPIT - INSTITUTE OF HERITAGE SCIENCE

- INCIPIT (*Juan Castro Felipe Criado*)

IFIC (Institut de Física Corpuscular)

- Particle Physics and High Energy Computing (*Santiago Gonzalez de la Hoz*)

ILC - Instituto de Lenguas y Culturas del Mediterráneo y Oriente Próximo

- Grupo de Lingüística Griega (GLG) (*José Antonio Berenguer Sánchez*)

IH - Instituto de Historia

- Estructura Social y Territorio. Arqueología del Paisaje (*Inés Sastre Prats*)
- Iberian Societies and Mediterranean Mountain Landscapes; Archaeology and Social Processes (*Susana González Reyero*)
- Redes de Poder en las Sociedades Medievales (*Therese Martin*)
- Prehistoria Social y Económica (GIPSE) (*Pedro Díaz del Río Español*)

IFISC - Instituto de Física Interdisciplinar y Sistemas Complejos

- Complex Systems and Linguistics (*David Sanchez*)
- Dynamics and Collective Phenomena in Social and Socio-technical Systems (*Sandro Meloni*)

Also interested in the challenge 10F:

IFS Institute of Philosophy

- *GI TcP* (Research Group THEORIA CUM PRAXI TcP, see 10H)

INCIPIIT - INSTITUTE OF HERITAGE SCIENCE

INCIPIIT

Juan Castro

Team description:

The research topic is the identification, conceptualization and modeling of the new scenarios, needs, dynamics and opportunities for the Digital Cultural Heritage through the use of ICT (blockchain, AI) its new applications and possibilities that it provides.

Keywords:

DIGITAL CULTURAL HERITAGE; DIGITAL HUMANITIES

Projects:

- 1.- Digital Cultural Heritage: Documental management in Editorials, Libraries & Archives through blockchain technology (DIGITALHERITAGE_BC). [Pending approval by the AEI]
- 2.- Observatorio del Patrimonio Cultural Digital y el impacto de las nuevas tecnologías [Pending approval by Xunta de Galicia]

Publications:

- 1.- MANUAL PARA LA ELABORACIÓN DEL PLAN DE EMPRESA. CSIC [2010].
- 2.- GUIA BÁSICA PARA LA CREACIÓN DE EMPRESAS DE BASE TECNOLÓGICA EN EL CSIC [2010]
- 3.- HIGH RESOLUTION ELECTRON MICROSCOPY AND X-RAY PHOTOELECTRON SPECTROSCOPY STUDIES OF HETEROEPITAXIAL $\text{Si}_x\text{Ge}_{1-x}$ ALLOYS PRODUCED THROUGH LASER INDUCED DEPOSITION. APPLIED PHYSICS LETTERS. VOL 72, Nº22 [1998]

Contribution:

The research work in Digital Cultural Heritage is focused on document management in publishers, libraries, and archives using blockchain technology - mainly blockchain. The needs of the Social and Human Sciences on a series of conceptual and technological issues that arise in the access and preservation of the digital assets generated as a result of the integration of the new ICT technologies into the field of Sciences are addressed as a challenge of Information and Documentation. So how do these new scenarios affect the functions of preservation and custody of digital documentary heritage? How to address the responsibility of facilitating access, generation and preservation of documents while maintaining traceability that provides transparency, security and allows assigning different degrees and types of responsibilities? What challenges for the Digital Documentary Heritage are the necessary creation and management of a digital identity for the different present and future assets?

Currently working with a research consortium in the creation and management of the DIGITALHERITAGE_BC project is comprised, among others, of representative actors in the creation and management of digital assets. In turn, private sector agents are also providers of specialized professional services and cutting-edge ICT solutions. As specific objectives:

[i]: The analysis, characterization and modeling of the new dynamics that arise in the

management of the assets that constitute or will constitute the Digital Cultural Heritage.
[ii]: The identification of new emerging and potential relationship scenarios in which different actors interact with digital assets.
[iii]: The statement of new services in the editorial field, as well as for archives, libraries; provided by new ICT companies in the cultural field, with a capacity for rapid internationalization that allow the promotion, exchange and valorization of European documentary heritage as a shared resource.

IFIC (Institut de Física Corpuscular)

Particle Physics and High Energy Computing

Santiago Gonzalez de la Hoz, Jose Francisco Salt Cairols, Francisco Javier Sanchez Martinez, Alvaro Fernandez Casani, Esteban Fullana Torregrosa, Jose Julio Lozano Bahilo, Carlos Garcia Montoro, Javier Alberto Aparici Pozo, Victoria Sanchez Sebastian

Team description:

Contribution to the evolution of the computing model for the ATLAS experiment working in ATLAS software contributing to the development of the software infrastructure needed for the physics analysis, participating very actively in the EventIndex project for the ATLAS experiment.

Keywords:

GRID; LHC; HIGGS, Computing

Projects:

Proyecto Hacia un genuino Tier-2 federado español de ATLAS para afrontar el reto de la gestión y procesado del Big Data del LHC. Código: FPA2016-75141-C2-1-R (2016-2019). Investigador Principal: Santiago González de la Hoz, con una dotación de 925000 euros.

Publications:

-G. Aad et al. (ATLAS Collaboration). Search for the Production of a Long-Lived Neutral Particle Decaying within the ATLAS Hadronic Calorimeter in Association with a Z boson from pp Collisions at square root $s = 13$ TeV pp collision. PHYSICAL REVIEW LETTERS 122, 151801 (2019).

-G. Aad et al. (ATLAS Collaboration). Search for heavy charged long-lived particles in the ATLAS detector in 36.1 fb⁻¹ of proton-proton collision at square root $s = 13$ TeV. PHYSICAL REVIEW D 99, 092007 (2019).

-G. Aad et al. (ATLAS Collaboration). Search for long-lived particles produced in pp collisions at square root $s = 13$ TeV that decay into displaced hadronic jets in the ATLAS muon spectrometer. PHYSICAL REVIEW D 99, 52005 (2019).

Also involved/interested in:

TEMÁTICA 9. ENTENDIENDO LOS COMPONENTES BASICOS EL UNIVERSO, SU ESTRUCTURA Y EVOLUCIÓN

Contribution:

working to build, maintain and operate a Tier-2 Grid computing infrastructure for experimental data analysis and Monte Carlo event generation for the ATLAS experiment.

Developing machine learning techniques and applying them to physics analysis. Running High energy reconstruction software using Grid infrastructure and HPC like Mare Nostrum at BSC in Barcelona

ILC - Instituto de Lenguas y Culturas del Mediterráneo y Oriente Próximo

Grupo de Lingüística Griega (GLG)

José Antonio Berenguer Sánchez, Daniel Riaño Rupilanchas, José Antonio Berenguer Sánchez

Team description:

Our group works in different fields of Ancient Greek linguistics: phonetics, morphology, syntax, etc. Methodologically our research is based on cognitive, functional, and typological linguistics and the application of Digital Humanities, essential for the work with the linguistic corpus.

Keywords:

Digital Humanities, Ancient Greek Linguistics, Corpus Linguistics

Projects:

- MODO Y MODALIDAD EN GRIEGO ANTIGUO EN LA CORRESPONDENCIA PRIVADA EN PAPIRO (SS. III A.C. - VIII D.C.), PI José Antonio Berenguer Sánchez, Ministerio de Economía y Competitividad FFI2017-89110-P, **2018 - 2020**, 18.150,00 €
- ESTUDIOS DE SINTAXIS Y ESTILÍSTICA EN GRIEGO ANTIGUO USANDO TREEBANKS DE ACCESO LIBRE, PI Daniel Riaño Rupilanchas, Ministerio de Ciencia, Innovación y Universidades, **2019 - 2020**, 31.460,00 €

Publications:

- J. A. Berenguer-Sánchez, "Análisis del hiato vocálico en la lingüística del griego antiguo y en la tipología lingüística", *Revista Española de Lingüística*, 47 (2017) 7-33.
- J. A. Berenguer-Sánchez, "Partícula conjuntiva y pronombre interrogativo-indefinido en las lenguas indoeuropeas", *Ratna*, Madrid (2017) 35-42.
- Riaño Rupilanchas, Daniel y Holger Hessler 2015. " 'Aristarchus X' and Philodemus: digital linguistic analysis of a Herculanean text corpus." en Tomasz Derda, Adam Lajtar y Jakub Urbanik (eds) *Proceedings of the 27th International Congress of Papyrologists (Journal of Juristic Papyrology Suppl. XXVIII)* 491-501.

Contribution:

We are interested in the development of adequate Digital Humanities infrastructures in the CSIC, which allow the exchange, collaboration, and support of humanities projects with computational methods. Unlike other countries, this type of infrastructure is deficient in Spain and, more specifically, in our organization. Spain is not yet part of consortia such as DARIAH or CLARIN. We do not even have a national network or any relationship or coordination between groups interested in Digital Humanities within the CSIC.

Instituto de Historia

Estructura Social y Territorio. Arqueología del Paisaje

Inés Sastre Prats, Inés Sastre Prats. F. Javier Sánchez-Palencia Ramos. Almudena Orejas Saco del Valle. Brais X. Currás Refojos. Juan Luis Pecharromán Fuente. Damián Romero Perona

Team description:

La investigación del Grupo EST-AP se articula en torno al estudio del paisaje como síntesis de las relaciones sociales y de las comunidades con su medio desde una perspectiva diacrónica.

Keywords:

Arqueología del Paisaje. Arqueominería. Paisajes rurales preindustriales. SIG. Teledetección

Projects:

-Zona Arqueológica de La Médulas, ORGANISMO FINANCIADOR: Junta de Castilla y León, INVESTIGADOR PRINCIPAL: Dr. F.- Javier Sánchez-Palencia Ramos

1989 /1997, FINANCIACIÓN: 47.907.486 pesetas

-Paisajes rurales antiguos del Noroeste peninsular: formas de dominación romana y explotación de recursos (CORUS) (HAR2015-64632-P) INVESTIGADOR PRINCIPAL: Inés Sastre Prats, **2016 - 2018** FINANCIACIÓN: 53.900 euros

- ACCIÓN COST A27, Understanding pre-industrial structures in rural and mining landscapes (LANDMARKS) INVESTIGADOR RESPONSABLE: Almudena Orejas Saco del Valle (Chair), Financiación COST desde junio de 2004 hasta diciembre de 2006: 214.883 €, Financiación total COST estimada (**2004-2008**): 420.000 €

Financiación al IH estimada: 12-15.000 €

Publications:

Orejas, A. (dir.), 2001-2002. Alas historique des zones minières d'Europe I y II. Luxemburgo (OPCE, Comisión Europea)

Orejas, A.; Reher, G., 2012. "Landscape Archaeology: Science, Heritage and Sustainability". In José M^a Fera (ed.), Territorial Heritage and Development. Leiden (CRC Press, Taylor & Francis): 35-54.

Currás, B.X.; Sastre, I. eds. (2020): Alternative Iron Ages. Social theory from archaeological analysis. Routledge Studies in Archaeology. Routledge, London and New York. 368 pp.

Collaborations:

Red de Patrimonio CSIC
CONSOLIDER TCP

Also involved/interested in:

TEMÁTICA 1. NUEVAS BASES PARA UNA SOCIEDAD GLOBALIZADA SOSTENIBLE; TEMÁTICA 7. IMPACTO DEL CAMBIO GLOBAL

Contribution:

-Aplicación de sistemas de información geográfica, de teledetección y de IDEs en

Arqueología

- Generación, conservación y difusión on-line de archivos gráficos
- Difusión de documentos de trabajo, datos, informes y memorias

Instituto de Historia, Centro de Ciencias Humanas y Sociales

Iberian Societies and Mediterranean Mountain Landscapes; Archaeology and Social Processes

Susana González Reyero, Miriam Alba Luzón

Team description:

The RG studies Iberian Iron Age societies of the western Mediterranean in the broader context of cultural contact, colonialism and state formation in the Mediterranean of the I millennium BC, a period of profound social transformations that took place, on an unprecedented scale until then.

Keywords:

Archaeology, Historical heritage, Ancient Mediterranean, I millenium BCE, Iberians

Projects:

- Iberos. Aplicaciones del elearning al patrimonio arqueológico. Proyecto de la Fundación Española de Ciencia y Tecnología (FCT-10-1216). **2010-2012**, 20.000€.
- Proyecto PETRI (Transferencia de los resultados de la investigación con la empresa privada) a través de un convenio del CSIC con la Empresa MICRONET, S.A. **1999**.

Publications:

- GONZÁLEZ REYERO, S., 2012: Un ebook sobre patrimonio arqueológico: del texto al hipertexto, Iberos. Sociedades y territorios del occidente mediterráneo, p. 5-14. CSIC-FECYT, -ISBN: 978-84-00-09474-4.
- GONZÁLEZ REYERO, S., 2012: Iberos en la web 2.0. Desafíos y oportunidades para una comunicación dialogada de la ciencia, Iberos. Sociedades y territorios del occidente mediterráneo, p. 212-223CSIC-FECYT, e-ISBN: 978-84-00-09474-4.
- GONZÁLEZ REYERO, S., 2015: "Arqueologías digitales. Una reflexión sobre el cambio en la relación entre la academia y el público" La Alfolabia: Revista de Humanidades y Cultura, nº 3; pp. 31-52, Instituto de Humanidades de la Universidad Rey Juan Carlos, Madrid. ISSN: 2386-2491

Collaborations:

F.J Sánchez-Palencia Ramos

Also involved/interested in:

TEMÁTICA 1. NUEVAS BASES PARA UNA SOCIEDAD GLOBALIZADA SOSTENIBLE

Contribution:

The generation of digital data and products in our RG has grown exponentially in recent years due to both ongoing projects and digitalization processes of old documentation. We produce digital primary data, such as photographs, scientific drawings, videos, aerial photography, georeferenced data in GIS, etc., which we use to perform the following:

1. Archaeological and heritage analysis, whose results are published in regular academic media.
2. Development of digital scientific dissemination products such as our e-book: "Iberians. Societies and territories of the western Mediterranean" (e-ISBN: 978-84-00-09474-4). Since it was made available online, it is the most visited content within its area of knowledge (Prehistory and Archeology) in CSIC Books.
3. Participation in collaborative platforms between communities of researchers, such as "GeoDig, Digital technologies applied to microstratigraphic archaeological record" (<http://geodig.info>), which allow us to perform comparative analysis between chronologies and diverse geographical areas.

Given our belief in the transformative capacity of digitalization, in the sense that a great increase in the amount and variety of available scientific data has the capacity of changing the nature of research, we would like to contribute to a digital transformation that, in our opinion, is pushing the frontiers of science. We underline, in particular, the initiatives aimed at the collaboration and exchange of data and good practices, that can not only provide new answers but, above all, change our own questions. Digitalization enables data sharing and avoids data silos. Therefore it contributes to generating more value out of the data. Therefore, we would like to move forward in the implementation of the challenges posed by guidelines such as the European Open Science Cloud (EOSC) creating a virtual environment with services and digital infrastructures for research data management and communication.

Instituto de Historia

Redes de Poder en las Sociedades Medievales

Dr. Therese Martin, Julio Escalona; Cristina Jular Pérez-Alfaro; Eduardo Manzano Moreno; Therese Martin; Ana Rodríguez López

Team description:

El grupo integra especialistas en reinos cristianos, arte medieval y al-Andalus que estudian las redes de poder en las sociedades cristianas e islámicas a través del registro escrito, material y artístico

Keywords:

Historia Medieval; Historia de Arte Medieval; Arqueología Medieval; Historia del Islam Medieval; Historia de la Cultura Escrita

Projects:

- Petrifying Wealth. The Southern European Shift to Masonry as Collective Investment in Identity, c.1050-1300; Ana Rodríguez López; (ERC-Advanced Grant), **2017-2021**; 2.490.000 €.

- Formas y Escalas de las Divisiones del Espacio en el Noroeste de la Península Ibérica (AD 700-1035); Julio Escalona; Programa Estatal de Investigación, Desarrollo e Innovación Orientada a los Retos de la Sociedad, ref. HAR2016-76094-C4-3-R; **2017-2020**; 44.000 €.

- Scripta manent II. Conservar para dominar: el archivo nobiliario de los Velasco; Cristina Jular Pérez-Alfaro; MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD. Ref.: HAR2016-77423-R; **2017-2019**; 40.000 €.

Publications:

- Escalona, Julio, Jular Pérez-Alfaro, Cristina y Bellettini, Anna: "Two graphical models for the analysis and comparison of cartularies", *Digital Medievalist*, 11, 2016.
- Capdevila, Enrique ; Rodríguez del Pozo, Laura; Rodríguez, Ana: "Petrifying Wealth. The Southern European Shift to Masonry as Collective Investment in Identity, c.1050-1300" Data Management Plan 2017 (digital.csic: <http://hdl.handle.net/10261/155640>)

Collaborations:

Esperanza Alfonso Carro; Historia Cultural del Mediterráneo; ILC-CSIC

Also involved/interested in:

TEMÁTICA 1. NUEVAS BASES PARA UNA SOCIEDAD GLOBALIZADA SOSTENIBLE; TEMÁTICA 7. IMPACTO DEL CAMBIO GLOBAL

Contribution:

Nuestro trabajo abarca varios aspectos del desarrollo de las humanidades digitales:

- Desarrollo de métodos computerizados para el análisis de códigos medievales
- Publicación de webs y blogs asociadas a proyectos de investigación
- Desarrollo de bases de datos online de contenidos históricos y arqueológicos
- Desarrollo de geodatabases y cartografía digital de contenidos históricos y arqueológicos

Nuestro planteamiento se incardina en el concepto emergente de Humanidades Digitales. En este contexto, tratamos de adoptar una perspectiva crítica respecto de la forma en que el desarrollo de Internet ha desplazado el foco de interés (y de financiación) hacia la presentación de contenidos on-line, a menudo orientados sólo a la divulgación y de escasa aplicación para la investigación, y con gran tendencia a repetir esfuerzos redundantes ("reinventar la rueda"). Esto no quiere decir que desdeñemos la aplicación de las tecnologías digitales a la divulgación de contenidos científicos, pero sí que tratamos de ir más allá de ese marco. El objetivo clave es superar el concepto de bases de datos meramente catalográficas, avanzando en el desarrollo de herramientas (fundamentadas en bases de datos) que tengan verdadera potencia analítica para la investigación, ya sea en local, ya en bases de datos distribuidas en red.

Instituto de Historia (IH)***Prehistoria Social y Económica (GIPSE)***

Pedro Díaz del Río Español, Pedro Díaz del Río Español, Isabel Martínez Navarrete, Juan Manuel Vicent García, Ignacio Montero Ruiz, Ignacio de la Torre Sainz

Team description:

GIPSE is devoted to substantive archaeological research involving the use of ICT's: 1. Remote sensing and GIS, related to Landscape Archaeology and Heritage Management; 2. Digital image processing applied to Prehistoric rock art; 3. Design and development of information systems and databases.

Keywords:

Prehistory, Archaeology, Cultural Heritage, Spatial Data Infrastructures, , Information and Communication Technologies

Projects:

-Proyecto de Investigación Arqueológica en el yacimiento de Casa Montero (Madrid). Producción y circulación de sílex en el neolítico de la Meseta. Funding agency: Autopistas Madrid Sur Concesionaria Española S.A. PI: Pedro Díaz del Río Español. Funding: 2.200.000 €.

-Dieta y movilidad humana en la Prehistoria de la Península Ibérica (3100-1500 ANE). Los casos de la cuenca media del Tajo y el Alto Guadalquivir (HAR2013-47776-R). Funding agency: Ministerio de Economía y Competitividad. PI: Pedro Díaz del Río Español. Funding: 72.600 €.

- Biogeographic and cultural adaptations of early humans during the first intercontinental dispersals (BICAHEFID). Funding agency: ERC Advanced Grant. PI: Ignacio de la Torre Sainz. Period: **2019 - 2024**. Funding: 2.499.996 €.

Publications:

- Fraguas Bravo, Alfonso; Menchero Fernández, Antonio; Uriarte González, Antonio; Vicent García, Juan M.; Consuegra Rodríguez, Susana; Díaz Del Río, Pedro; Castañeda, Nuria; Criado, Cristina; Capdevila, Enrique & Capote, Marta (2010): "Spatial Data Infrastructures and archaeological excavation data: SILEX, the SDI of the Neolithic flint mine of Casa Montero (Madrid, Spain)". En Melero, F.J.; Cano, P. & Revelles, J. (eds.) Fusion of Cultures. Abstracts of the XXXVIII Annual Conference on Computer Applications and Quantitative Methods in Archaeology, CAA 2010: 63-66. Granada.

- Fernández-freire, Carlos; Del-bosque-gonzález, Isabel; Vicent-garcía, Juan M.; Pérez-asensio, Esther; Fraguas-bravo, Alfonso; Uriarte-gonzález, Antonio; Fábrega-álvarez, Pastor; Parcero-oubiña, César (2013): "A Cultural Heritage Application Schema: Achieving Interoperability of Cultural Heritage Data in INSPIRE". International Journal of Spatial Data Infrastructures Research 8: 74-97.

- Uriarte González, Antonio; Fernández Freire, Carlos; Fraguas Bravo, Alfonso; Castañeda Clemente, Nuria; Capdevila Montes, Enrique; Salas Tovar, Ernesto; Gilman, Antonio; Del Bosque González, Isabel & Vicent García, Juan M. (2017): "IDEArq-C14: Una Infraestructura de Datos Espaciales para la cronología radiocarbónica de la Prehistoria Reciente ibérica". En Barceló, J.A.; Bogdanovic, I. & Morell, B. (eds.) IberCrono. Cronometrías Para la Historia de la Península Ibérica. Actas del Congreso de Cronometrías Para la Historia de la Península Ibérica (IberCrono 2017). Barcelona, Spain, September 17-19, 2016. CEUR-WS, Vol-2024 (urn:nbn:de:0074-2024-4): 209-225.

Collaborations:

Unidad de Sistemas de Información Geográfica (uSIG, CCHS-CSIC). Responsable: Isabel del Bosque González.

Also involved/interested in:

TEMÁTICA 2. ORIGEN Y EVOLUCIÓN DE LA VIDA Y BIOLOGIA SINTETICA

Contribution:

The technological character of GIPSE is not substantive, but instrumental in nature. The development of methodologies that use ICT is a requirement of the theoretical issues that form the core of the research. Our social approach to the archaeological praxis includes an effort to insert this practice in its contemporary context. This translates into an essential concern for Heritage management as the main way of transferring archaeological research results into society.

Among other projects, our GI has been actively involved in Digital Humanities through the promotion and creation of online Information Systems devoted to the organization and public distribution of archaeological research data. Firstly, with the Corpus de Pintura Rupestre Levantina (CPRL) (<http://www.prehistoria.ceh.csic.es/AAR/>), result of the digitization of the historical Gil Carles Archive, a photographic inventory on Levantine rock art. In subsequent years, with its involvement in the field of Spatial Data Infrastructures (SDI), by means of its participation in the Thematic Working Group on Cultural Heritage of the Spanish SDI (IDEE) and also the creation of two archaeological SDI: SILEX, a SDI devoted to the integral open access publication of the archaeological record of the Neolithic flint mine of Casa Montero (Madrid) (<http://www.casamontero.org/en/ide.html>) and IDEArq (<http://idearqueologia.org>), a SDI for the online publication of georeferenced archaeological datasets, such as the Radiocarbon Database of Iberian Late Prehistory, the Isotopes Database on Iberian diet and mobility and the aforementioned Corpus de Pintura Rupestre Levantina.

Our latest project, the ERC-Advanced Grant Biogeographic and cultural adaptations of early humans during the first intercontinental dispersals (BICAEHFID) does also involve the design and implementation of a complex information system for the management and online publication of the dataset.

IFISC (Instituto de Física Interdisciplinar y Sistemas Complejos)

Complex Systems and Linguistics

David Sánchez, Maxi San Miguel, José J. Ramasco, Tobias Galla, Thomas Louf

Team description:

Computational linguistics: language variation, language competition, bilingualism, digital corpus

Keywords:

language variation, language competition, bilingualism, digital corpus

Projects:

RTI2018-093732-B-C22: PHYSICS APPROACH TO COMPLEXITY IN SOCIOTECHNICAL SYSTEMS (PACSS)

Publications:

- Mapping the Americanization of English in space and time, B Gonçalves, L Loureiro-Porto, JJ Ramasco, D Sánchez, PloS one 13 (5), e0197741 (2018)
- Language choice in a multilingual society: A view from complexity science, Loureiro-Porto, M San Miguel, Complexity in language. Developmental and evolutionary perspectives, 187-217 (2017)
- Geospatial distributions reflect rates of evolution of features of language, H Kauhanen, D Gopal, T Galla, R Bermúdez-Otero, arXiv preprint arXiv:1801.09637 (2018)

Contribution:

Novel digital methodologies for linguistics

IFISC - Instituto de Física Interdisciplinar y Sistemas Complejos

Dynamics and Collective Phenomena in Social and Socio-technical Systems

Sandro Meloni , Jose Javier Ramasco

Team description:

The line aims at identifying the mechanisms behind collective phenomena in social systems. Relying on Computational Social Sciences, Statistical Physics, Networks and Big Data, we study phenomena such as cooperation, social learning along with data-driven research on mobility, epidemics and energy.

Keywords:

Computational Social Sciences; Big Data; Human Mobility; Social Networks;

Projects:

- PACSS - PHYSICS APPROACH TO COMPLEXITY IN SOCIOTECHNICAL SYSTEMS. PIs: Raul Toral, Jose Ramasco, Maxi San Miguel, Sandro Meloni Funding Agency: AEI. Period: **2018-2020**. Funding: 350k €
- TEAMS - Towards an Ecological Approach of inforMation Systems. PIs: Samir Suweis, Javier Borge Holthoefter, Sandro Meloni, Funding Agency: Fondazione Cariparo. Period **2018-2019**. Funding: 30k €

Publications:

- Kin of coauthorship in five decades of health science literature. M. Prosperi, I. Buchan, I. Fanti, S. Meloni, P. Palladino, V.I. Torvik. PNAS 113 (32), 8957-8962 (2016).
- Explore with caution: mapping the evolution of scientific interest in Physics. A. Aleta, S. Meloni, N. Perra, Y. Moreno. EPJ Data Science volume 8, Article number: 27 (2019).
- Topical alignment in online social systems. F.M. Cardodo, S. Meloni, A. Santanche, Y. Moreno. Frontiers in Physics 7, 58 (2019).

Also involved/interested in:

TEMÁTICA 4. RETOS EN BIOMEDICINA Y SALUD

Contribution:

I am planning to contribute to challenges 10F, 10D and 10H.

DESAFIO 10H: PARTICIPACION CIUDADANA

ILLA Instituto de Lengua, Literatura y Antropología

- Social Anthropology (*Francisco Ferrándiz*)

Instituto de Políticas y Bienes Públicos

- SPRI - Systems and Policy of Research and Innovation (*Luis Sanz Menendez*)

IFS Institut of Philosophy

- GI TcP *Roberto* (*R. Aramayo*)

ICMAT, Institute of Mathematical Sciences

- SPOR (*David Rios Insua*)

IH - INSTITUTO DE HISTORIA

- NOMOS (*María Ruiz del Árbol Moro*)

IIIA

- Collective Decision Making for Citizen Participation (*Juan A. Rodríguez-Aguilar*)
-

Also interested in the challenge 10H:

IFCA, Instituto de Física de Cantabria

- Computación Avanzada y e-Ciencia (*Jesus Marco, see 10D*)

IFISC - Institute for Cross-Disciplinary Physics and Complex Systems

- Dynamics and Collective Phenomena in Social and Socio-technical Systems (*Sandro Meloni, see 10F*)

ILLA Instituto de Lengua, Literatura y Antropología

Social Anthropology

Francisco Ferrándiz, Alberto Corsín Jiménez, Daniel Curto Millet, Luis Nicanor Díaz González-Viana, Fátima Diyamou Brini, Laura Langa Martínez, Candela Morado Castresana, Margarita del Olmo Pintado, Miriam Saqqa Carazo, Pedro Tomé Martín, Juan José Villarías Robles

Team description:

We have been working on the free culture movement (free software, open science, free urbanism, digital commons, copyleft licenses) for the past fifteen years. We are particularly interested in the interfaces between digital and material participation, as well as in activist OS infrastructures

Keywords:

open science, citizen participation, digital commons, open access

Projects:

- 'Ecologías en beta: una exploración antropológica de mundos urbanos de código abierto', €110110, Ministerio Economía y Ciencia, CSO2014-51970-R, **2015-18** Principal Investigator: Alberto Corsín Jiménez.
- 'Economía cultural de la innovación abierta en la ciudad de Madrid', €90000, Ministerio de Ciencia, CSO2010-17735, **2010-14** Principal Investigator: Alberto Corsín Jiménez.
- 'Beyond the Code: Sustainability in Open Source', EU Marie Skłodowska-Curie Actions, €170121, **2016-2021**. Principal Investigator: Daniel Curto Millet.

Publications:

CHALLENGE 10H

- 2019. Derechos Urbanos Digitales, El País, 23/10/2019
- 2018. Reclamar las Infraestructuras. Madrid: La Aventura de Aprender.
- 2017. Prototyping cultures: art, science and politics in beta. London and New York: Routledge.
- 2014. 'The right to infrastructure: a prototype for open source urbanism'. Environment and Planning D: Society and Space 32 (2): 342-362

CHALLENGE 10D

- 2018. A Data Governance Framework for Ethnography
- 2018. Let's Do This Together: A Cooperative Vision for Open Access, Anthrodendum

Contribution:

10D. Alberto Corsín Jiménez is a founder of Libreria, a collective of researchers based in the social sciences who, drawing on the expertise of librarians, publishers, and other stakeholders, have been working for the past five years to bring about a more open, diverse, community-controlled scholarly communication system. He is a leading activist for open access and open science in anthropology and related disciplines, having designed protocols and frameworks for data management in the qualitative social sciences. What counts as "data" in ethnography and qualitative social science is very different from its usual understanding in STEM disciplines. The technical requirements, licenses, and

permissions for storage, access, privacy, distribution of such data must be carefully attended to, as well as incorporated in the design of our future open science infrastructures.

10H. In collaboration with various free culture activist networks we have been working on the definition of a new set of "Urban Digital Rights", staging a complex conversation between urban participatory rights movements and digital rights movements in contexts of surveillance and platform capitalism. In urban studies, the definition of a "right to the city" has long vexed social scientists, inasmuch as it involves regions of rights that include political liberties, civic freedoms, or rights to distributive justice. Today, these rights have been inflected in novel ways by data infrastructures and surveillance systems, therefore demanding a new conceptualization of what a system of urban justice and rights we need for the 21st century.

Instituto de Políticas y Bienes Públicos

SPRI - Systems and Policy of Research and Innovation

Luis Sanz Menendez, Vincenzo Pavone, Luis Sáenz Menéndez, Laura Cruz Castro, Catalina Martínez García, Adelheid Holl, Sara Degli Esposti, Manuel Pereira Puga

Team description:

Public engagement with science (PES) and science, technology and society studies (STS). This research line studies a) the social, political and economic consequences of how digital and medical knowledge is produced, shared and used, and b) the public assessment of (digital) science and technology.

Keywords:

Public assessment of Science, Citizen participation in Science, Digital technologies, Participatory Technology Assessment

Projects:

Trustworthy, Reliable and Engaging Communication Approaches (TRESKA): reference 872855; Funding Body: European Commission, H2020 (SWAFS), Coordinator: Jason Pridmore (Erasmus University Rotterdam), Participating Entities in Spain: IPP-CSIC, CSIC PI Sara Degli Esposti, CSIC funding 201.000 euros, January 2020- April 2022.

Surveillance, Privacy and Security: a large scale participatory assessment of criteria and factors determining acceptability and acceptance of security technologies in Europe (SurPriSe). PI: Johann Cas (ITAS-AAS), PI CSIC: Vincenzo Pavone. Seventh Framework Programme (Ref: 285492). Total Funding: 3.500.000 euros. Feb. 2012-Jan. 2015

Privacy enhancing shaping of security research and policy – a participatory approach to develop acceptable and accepted principles for European security industries and policies (PRISE), European Commission under the PASR Program (Preparatory Action for Security Research), research Contract between CSIC and ITA, Austria. Main researcher for the Spanish case study: Vincenzo Pavone. CSIC budget: 16.000 euros. Jan 2006-Dec. 2008.

Publications:

- Pavone, Vincenzo, Kirstie Ball, Sara Degli Esposti, Sally Dibb, and Elvira Santiago-Gómez (2018), "Beyond the Security Paradox: Ten Criteria for a Socially Informed Security Policy". *Public Understanding of Science*, Volume: 27 issue: 6, page(s): 638-654
- Degli Esposti, S. (2014). When big data meets dataveillance: The hidden side of analytics. *Surveillance & Society*, 12(2), 209-225.
- Vincenzo Pavone, Sara Degli Esposti (2012), "Public assessment of new surveillance-oriented security technologies: Beyond the trade-off between privacy and security". *Public Understanding of Science* 07/2012; 21(5):556-572.

Collaborations:

Alberto Corsin, Social Anthropology Group, ILLA (PI Francisco José Ferrándiz Martín+Francisco José Ferrándiz Martín). Eulalia Perez Sedeño (PI of the Science, Technology and Society Group, IFS)

Also involved/interested in:

TEMÁTICA 1. NUEVAS BASES PARA UNA SOCIEDAD GLOBALIZADA SOSTENIBLE

Contribution:

Our research is based on a pioneer work in public assessment and public participation in science and technology. WE aims at eliciting and analyzing lay knowledge in the areas of digital and medical technologies in general, with a special focus on surveillance-oriented security technologies, IoTs and on genetic data. We use mixed-methods, combining citizen participation techniques and methods, like the citizen summits and meetings, with rigorous qualitative and quantitative methodologies of data analysis. We also elaborate innovative formats, based on theatre plays, videos and participatory dynamics, to involve lay citizens and civil society associations to co-construct research priorities, goals and methods, along with the scientific community members. We interpret citizen participation as an opportunity to think and enact science from alternative perspectives, which prioritize citizens' needs and interests and incorporate their experiential knowledge in the development trajectory of scientific innovation, technology implementation and regulatory frameworks. Our work has been developed and tested successfully in a number of EU funded projects from FP6, FP7 and H2020 and is based on a fully articulated network of collaboration involving both national and international research institutions, civil society organizations, end-user organizations, companies and regulatory bodies, in countries like UK, Canada, The Netherlands, Italy, Austria, Germany, Norway and Australia. The digital world is one of the two main focuses of our research efforts, the medical world being the other one. Yet, our research is now moving fast into a new framework where the divide between the digital and the medical worlds is increasingly blurred and where a crucial element of citizens participation in the digital science will directly involve the release, management and use of medical and genetic data.

IFS Institut of Philosophy**GI TcP**

Roberto R. Aramayo, Xandra Garzón, Alejandro Sánchez Berrocal, Concha Roldán, Astrid

Team description:

Ethics, history of political ideas and philosophy of history constitute some of the methodological tools that TcP apply to topics such as the relationship between crises and digital revolutions, the banality of evil and the voluntary bondage induced by the thoughtless misuse of the new technology

Keywords:

Ethics / Digital Society / Digital Turn / Banality of Evil / Voluntary Bondage /

Projects:

- PAIDESOC. El desván de la razón: Cultivo de las pasiones, identidades éticas y sociedades digitales (FFI2017-82535-P) / Proyecto I+D Excelencia; **2018-2020**.

IP: Concha Roldán: 35.000 euros

- Philosophy of History and Globalisation of Knowledge. Cultural Bridges Between Europe and Latin America: WORLDBRIDGES (F7-PEOPLE-2013-IRSES:

PIRSES-GA-2013-612644). FP7: 604.800 euros

Entidades participantes: CSIC-España; Univ. Postdam-Alemania; TU Dresden-Alemania; Univ. Istanbul/Turquía; CIF/Argentina; UNAM/México **2014-2017**

- PRISMAS. Prismas filosófico-morales de las crisis: Hacia una nueva pedagogía sociopolítica (FFI2013-42395-P) MICINN (25.000 euros). Centro de aplicación: Instituto de Filosofía del CSIC. Período: **2014-2017**.

Publications:

- The Chimera of the Philosopher King. Around the Kantian Distinction between Moral Politician and Political Moralism. The Dilemmas of Power, or the Frustrated Love Affair between Ethics and Politics (2019)

- (2019) Roberto R. Aramayo, "Diderot's Criticism of Colonialism: a Plea for Equality and Reciprocity among Peoples", *Filosofija. Sociologija* 30, 1 (2019) pp. 62-69 [ISSN: 2424-4546]

- (2018) Roberto R. ARAMAYO, *Kant. Entre la moral y la política*, Alianza Editorial, Madrid. [978-84-9181-309-5]

https://www.alianzaeditorial.es/libro.php?id=5223714&id_col=100508&id_subcol=100512

- (2018) Roberto R. ARAMAYO, *Schopenhauer: La lucidez del pesimismo*, Alianza Editorial, Madrid [978-84-9181-105-3]

https://www.alianzaeditorial.es/libro.php?id=5268979&id_col=100508&id_subcol=100512

- (2018) Roberto R. Aramayo, "Radical and Moderate Enlightenment? The Case of Diderot and Kant", in Concha Roldán, Daniel Brauer, Johannes Rohbeck (eds.), *Philosophy of Globalisation*, Walter de Gruyter, Berlin/Boston, pp. 315-326. [ISBN: 9783110544671] <http://doi.org/10.1515/9783110492415-023>

Contribution:

The Research Group THEORIA CUM PRAXI TcP includes, among its members, two hired research fellows whose investigations deal with topics related to 10F and 10H; for Xandra Garzón cogitates on gender identity within the gaming industry and Alejandro Sánchez addresses the impact of digital culture on public involvement and the shaping of new political identities. Roberto R Aramayo thinks these challenges to be closely linked to 11F and 11G (studied by Concha Roldán and Astrid Wagner) and also, to 5G and 5F. Among the many interests of the research is the conceptualization, diagnosis and transference of knowledge coming from human and social sciences within our digitalized

society. The unstoppable globalization of technologies of communication provoke the ceasing of the functionality of the national frameworks of the current democracies and new structures are needed to be reinvented. Likewise, new identities and moral agencies of citizenships need to be thought again.

The approach and methodology of this group of researchers concentrates on the study of the new articulations and the social feedback, the mutual recognition of the social agents citizens and virtual citizens- and the different forms of interaction and new citizenship. In addition to that, it also considers what kind of civic progress these new transformations offer us as problems.

ICMAT, Institute of Mathematical Sciences

SPOR Statistics, Probability and OR9, Data Science

David Rios Insua, Alberto Torres, Roi Naveiro, Alberto Redondo, Alex Kosgodagan, April Liu, Victor Gallego, David Gordo, Simon Rodriguez,...

Team description:

SPOR covers areas like data engineering, machine learning, and group decision making. Within the proposed topics, it works in citizen participation, focus on supporting group decisions through the Internet, and social robotics, focus on developing societies of affective agents for education.

Keywords:

e-participation, group decision making, data science, social robotics

Projects:

- TED: Internet based complex decision support. David Rios. European Science Foundation. . 320000 (2002-2006)
- Edemocracia: Apoyo a la toma de decisiones complejas basadas en Internet. David Rios. MEC TSI2004-06801-C04-01. 87500. (2004- 2007)
- Conceptos y sistemas de apoyo a la democracia electrónica. David Rios. Comunidad de Madrid 506000. (2006-2009)

Publications:

- D. Rios Insua, S. French eParticipation: A group decision and negotiation perspective, Springer (2010).
- J. Gomez, C. Alfaro, D. Rios Insua, JM Lavin On deciding how to decide: designing participatory budgets (2013) European J. Operational Research 229 (3), 743-750
- P. Esteban, S. Liu, D. Rios Insua, J. Ortega Cooperation and competition in a community of autonomous agents, Autonomous Robots (2019) DOI: 10.1007/s10514-019-09867-y

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

Our general focus is on decision support methods with emphasis on group decision making, adversarial risk analysis and Bayesian methods. We would support line 10H with the development of well founded methods for group decision support and their

implementation in appropriate architectures. We have also large experience in affective decision making and social robotics and this may be used to develop a concept of societies of affective agents to be embedded in citizen participation processes. This could be relevant also for the line 10E (to develop a concept of Internet of affective things).

IH - INSTITUTO DE HISTORIA

NOMOS. Arqueología del espacio humanizado y su transferencia a la educación y a la gestión del patrimonio

María Ruiz del Árbol Moro

Team description:

La actividad del GI se articula sobre tres ejes temáticos: a) el estudio de la explotación de los recursos salinos en la Antigüedad; b) la investigación sobre el papel de los paisajes como recursos duraderos; c) la investigación sobre el potencial formativo de la arqueología.

Keywords:

arqueología, patrimonio cultural, educación, alfabetización científica

Projects:

2016-2018. Scientific Literacy at the school: improving strategies and building new practices of science teaching in early years education (SciLit) (2016-1-ES01-KA201-025282) Financiado Erasmus + Action KA2 (Cooperation for Innovation and the Exchange of Good Practices - Strategic Partnership). Aprox. 270 mil eur.

2016-2018. Los conjuntos patrimoniales como activos turísticos de la Comunidad de Madrid. Problemas y oportunidades en perspectiva territorial (S2015/HUM-3317). Financiado por la Comunidad de Madrid y el Fondo Social Europeo. Aprox. 75 mil eur

2016-2019. Paisajes rurales antiguos del Noroeste Peninsular: formas de dominación romana y explotación de recursos" (CORUS) (HAR2015-64632-P). Financiado por Ministerio de Economía y Competitividad (MINECO/FEDER). Aprox. 60 mil eur

Publications:

M. Ruiz del Árbol Moro (coord.). Scientific literacy at the school. An inquiry about Archaeology in the classroom. Madrid, 2018. Publicación electrónica (<http://www.csicenlaescuela.csic.es/scilit/intellectual-outputs.html>) (ISBN: ISBN: 978-84-09-02598-5). Existe traducción al castellano (ISBN: 978-84-09-04173-2: Alfabetización científica en la escuela: una investigación sobre "Arqueología en el aula". Está traducido también al italiano, polaco, estonio y lituano lituano (versiones descargables en la página web indicada).

F.J. Sánchez-Palencia, I. Sastre, A. Orejas, M. Ruiz del Árbol, "Augusto y el control administrativo y territorial de las zonas mineras del Noroeste hispano", Gerión (ISSN: 0213-0181) (<http://dx.doi.org/10.5209/GERI.56177>). Volumen: 35, pp. 833-874, 2017.

L. Levêque, M. Ruiz del Árbol, L. Pop (dirs.). Patrimoine, Images, Mémoire des Paysages Européens (Heritage, Images, Memory of European Landscapes). 2010. París: L'Harmattan (ISBN 978-2-296-10887-5).

CSIC EN LA ESCUELA (José María López Sancho & María José Gómez Díaz, ORGC, Cultura Científica)

Also involved/interested in:

TEMÁTICA 1. NUEVAS BASES PARA UNA SOCIEDAD GLOBALIZADA SOSTENIBLE

Contribution:

Mi contribución se podría orientar hacia dos ámbitos sobre los que tengo larga experiencia:

- 1) Aspectos sobre la participación ciudadana en relación con el papel de los paisajes (entendidos como resultado de la interacción entre las personas y su medio a lo largo del tiempo) como recursos duraderos, partiendo de su potencial si se integran las investigaciones científicas sobre su historia en las políticas de planificación territorial. En este sentido se trataría de trabajar en propuestas para su valoración y explotación como patrimonio cultural.
 - 2) Los aspectos relativos al potencial formativo de la arqueología en general, y de la arqueología del paisaje y el patrimonio cultural en particular, y su empleo como recurso educativo de amplio alcance para despertar una conciencia científica en las primeras etapas de la educación.
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IIIA

Collective decision making for citizen participation

Juan A. Rodríguez-Aguilar, Juan A. Rodríguez-Aguilar, Maite López-Sánchez, Marc Serramià, Manel Rodríguez, Simon Parsons, Natalia Criado-Pacheco, Jordi Ganzer-Ripoll

Team description:

Our goals: (1) to design aggregation operators that combine citizens' opinions to yield a collective decision satisfying social choice properties; (2) to apply artificial intelligence techniques to support decision makers (e.g. participatory budgets) and to visually explain results to citizens.

Keywords:

collective decision making; social choice; argumentation theory; information fusion; e-participation software tools

Projects:

AI4EU, Juan A. Rodríguez-Aguilar, H2020, 1/1/2019-31/12/2021

Crowd4SDG, Jesús Cerquides Bueno, H2020, negotiations pending, expected from 2020-2023

Publications:

Jordi Ganzer-Ripoll, Natalia Criado, Maite López-Sánchez, Simon Parsons, Juan A. Rodríguez-Aguilar. Combining social choice theory and argumentation: Enabling collective decision making. *Group Decision and Negotiation* (2019) 28(1):127-173, February 2019.

José Luis Fernández-Martínez, Maite López-Sánchez, Juan A. Rodríguez-Aguilar; Dionisio Sánchez-Rubio; Berenice Zambrano Nemegyei. Co-Designing Participatory Tools for a New Age: A Proposal for Combining Collective and Artificial Intelligences. *International Journal of Public Administration in the Digital Age (IJPADA)*, Special issue *Imagining the Engaged Citizen and Public in the Age of Social Media*, 5(4):1-17, 2018.

M. López-Sánchez, Marc Serramià, J.A. Rodríguez-Aguilar, J. Morales, M. Wooldridge, C. Ansótegui. Exploiting moral values to choose the right norms. In *Proceedings of the 1st AAAI/ACM Conference on Artificial Intelligence, Ethics and Society (AIES 2018)*, pp. 264-270, New Orleans, USA, February 2-3, 2018.

Juan A. Rodriguez-Aguilar, Multiagent Systems, IIIA

Also involved/interested in:

TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

We are currently collaborating with the Decidim citizen platform through a second project funded by the Barcelona City Hall. We can contribute with Artificial Intelligence algorithms for citizen participation.

FURTHER PROPOSED CHALLENGES

(tbd)

→ NUEVAS SOLUCIONES PARA LAS CIUDADES

IETCC. Instituto de Ciencias de la Construcción Eduardo Torroja
Sustainable and advanced construction

José A. Tenorio, Guillermo Sotorrío

Team description:

Our research lines focuses on three main aspects: Industrialization, energy and sustainability. The digital transformation is present in all being key for the construction sector, especially in the first.

Keywords:

Industrialization, energy, sustainability

Projects:

- Hybrid INDustrial CONstruction through a 3D printing “all-in-one” machine for large-scale advanced manufacturing and building processes. HINDCON. José A. Tenorio, EUROPEAN COMMISSION. Horizon 2020 - Research and Innovation Framework Programme. H2020-FOF-2016. Grant Agreement No 723611, (2016-2019), 4,8 million €. - - Construye 2020+. A new boost for green jobs, growth and sustainability. José A. Tenorio. EUROPEAN COMMISSION. Horizon 2020 - Research and Innovation Framework Programme. H2020- H2020-EE-2017-CSA-PPI. Grant Agreement No 785019, (2018-2021), 797.000€.

Publications:

S. Álvarez, L. F. Cabeza, A. Ruiz-Pardo, A. Castell, and J. A. Tenorio, “Building integration of PCM for natural cooling of buildings,” Appl. Energy, vol. 109, 2013.

Contribution:

Research group specialized in construction. We work in BIM and sustainability data.

→ MATERIALS FOR ELECTRONICS AND PHOTONICS WITH
NEAR-ZERO POWER CONSUMPTION

Instituto de Ciencia de Materiales de Madrid (ICMM)

Novel Platforms and Nano-devices for Quantum Simulation and Computation

Gloria Platero, Sigmund Kohler, Tobias Stauber, Alvaro Gomez

Team description:

Theoretical modelling of the electronic and optical properties of two-dimensional materials and van der Waals heterostructures - in particular twisted bilayer graphene

Keywords:

graphene, plasmonics, superconductivity, chirality, topology

Projects:

- "Nuevos modelos para materiales quirales" (FIS2017-82260-P) **2018-2020**

PRINCIPAL INVESTIGATOR: T. Stauber and J. Gonzalez Camora

- "Propiedades Fundamentales y Aplicaciones del Grafeno y otros Materiales Bidimensionales" (MAD2D-CM, S2013/MIT-3007), FINANCIAL ENTITY: Comunidad de Madrid y Unión Europea **2016-2018**

PRINCIPAL INVESTIGATOR: M. P. López-Sancho (872.200,00 €)

Publications:

- S. S. Sunku, G. X. Ni, B. Y. Jiang, H. Yoo, A. Sternbach, A. S. McLeod, T. Stauber, L. Xiong, T. Taniguchi, K. Watanabe, P. Kim, M. M. Fogler, and D. N. Basov. Quantum Photonic Crystal for Nano-Light. *Science* 362, 1153 (2018)

- J. González and T. Stauber, Kohn-Luttinger superconductivity in twisted bilayer graphene. *Phys. Rev. Lett.* 122, 026801 (2019)

- T. Stauber, A. Nemilentsau, T. Low, and G. Gómez-Santos. Unidirectional edge-modes for arbitrary two-dimensional materials. *2D Mater.* 6, 045023 (2019)

Collaborations:

Jose González, IEM

Luis Brey, ICMM

Luis Martín Moreno, ICMA

Challenge:

The proposed challenges involve applications, but do not mention the materials they are made of. T8B explicitly includes the word "materials" and one challenge of T10 could also include this word to better describe the work of a large group of people.

Contribution:

We are witnessing, nowadays, a revolution that has been triggered by the discovery of new materials synthesized from low-dimensional constituents, where the electronic and photonic properties can be tailored from their structure at the nanoscale. This revolution started with the discovery of graphene in 2004, but it has evolved into an almost endless list of new compounds covering 2D or 3D heterostructures including topological materials. The aim of this search is the design of devices where transport may take place with no energy dissipation, relying on the topological or the superconducting properties of the material. The new frontier to be reached during the next decades is the development of novel electronic and photonic devices operating at unprecedented high speed and minimum consumption of energy.

This challenge requires the collaboration among groups with different backgrounds in condensed matter physics, chemistry and material science in order to tackle complex problems ranging from the computational simulation of transport properties to the

synthesis of new materials. The search for these novel materials is currently attracting great funding in foreign institutions, reflected in the dominant interest raised by this topic in the main scientific meetings covering physics and material science around the world.

→ **TRUST AND SECURITY IN THE DIGITAL SOCIETY**

ITEFI - Instituto de Tecnologías Físicas y de la Información

Grupo de investigación en Criptología y Seguridad de la Información GiCSI

Luis Hernández Encinas, IC, Amparo Fuster Sabater, Agustín Martín Muñoz, David Arroyo Guardado, Luis Hernández Encinas, Víctor Gayoso Martínez, Alfonso Blanco Blanco Jose Ignacio Sánchez García

Team description:

We work on the Design, analysis and implementation of cryptosystems; Protocols for cloud computing, digital signatures, e-voting, random bit generators, etc.; Number Theory for information security; Evaluation of security protocols and cryptographic privacy-enhancing technologies; Blockchain, etc.

Keywords:

Authentication, Cloud computing, Cryptology, Information security, Privacy by default (and GDPR compliance)

Projects:

- "Criptografía para Optimizar la Privacidad y la CiberSeguridad (COPCIS)". MINEICO, TIN2017-84844-C2-1-R. Entidades participantes: CSIC, Universidades de Alcalá, Autónoma de Madrid y Málaga. **2018-2020**. Subvención: 93.533 euros. Investigador responsable: L. Hernández Encinas.

- "Protocolos criptográficos para la ciberseguridad: identificación, autenticación y protección de la información (ProCriCiS)". MINEICO, TIN2014-55325-C2-1-R. Entidades participantes: CSIC, Universidades de Alcalá y Málaga. Duración: **2015-2017**. Cuantía de la subvención: 59.500 euros. Investigador responsable: L. Hernández Encinas.

- "Ciberseguridad: Datos, Información y Riesgos (CIBERDINE)". Consejería de Educación, Juventud y Deporte, Comunidad de Madrid, S2013/ICE-3095-CM. Entidades participantes: Universidad Carlos III de Madrid, Instituto de Tecnologías Físicas y de la Información (ITEFI) del CSIC y Universidad Autónoma de Madrid. **2014-2018**. Cuantía de la subvención: 151.742,50 euros. Investigador responsable: L. Hernández Encinas.

Publications:

1. S.D. Cardell, A. Fuster-Sabater. "Binomial representation of cryptographic binary sequences and its relation to cellular automata". Complexity 2019, Article ID 2108014, 13 pages, 2019. <https://doi.org/10.1155/2019/2108014>

2. M. Conde Pena, R. Durán Díaz, J.-C. Faugère, L. Hernández Encinas, and L. Perret, "Non-quantum Cryptanalysis of the Noisy Version of Aaronson-Christianó's Quantum Money Scheme", IET Information Security, 13, 4 (2019), 362–366, <https://doi.org/10.1049/iet-ifs.2018.5307>.

3. A. Fuentes Rodríguez, L. Hernández Encinas, A. Martín Muñoz, and B. Alarcos Alcázar, "A Modular and Optimized Toolbox for Side-Channel Analysis", IEEE Access 7 (2019), 21889–21903, <https://doi.org/10.1109/ACCESS.2019.2897938>

4. A.B. Orúe, L. Hernández-Encinas, A. Martín and F. Montoya, "A lightweight Pseudorandom Number Generator for securing the Internet of Things", IEEE Access 5, 27800–27806 (2017), <https://doi.org/10.1109/ACCESS.2017.2774105>
5. V. Gayoso Martínez, L. Hernández Encinas y A. Martín Muñoz, "Criptografía con Curvas Elípticas", CSIC, Biblioteca de Ciencias no 44, 2018, 261 pp., ISBN: 978-84-00-10432-0 (papel), 978-84-00-10433-7 (electrónico), <http://editorial.csic.es/publicaciones/libros/13133/0/criptografia-con-curvas-elipticas.html>.

Collaborations:

- Instituto de Microelectrónica de Sevilla (IMSE-CNM)
Unit of Design of Digital and Mixed-Signal Integrated Circuits -- Microelectronics for Security, IP: Santiago Sánchez Solano, IC CSIC
- Instituto de Microelectrónica de Barcelona (IMB-CNM)
Dispositivos y Sistemas de Potencia, IP: Salvador Hidalgo, CT CSIC
- Instituto de Ciencias Matemáticas (ICMAT)
Statistics, Probability and Operations Research (SPOR), IP: David Ríos, Cat URJC

Challenge:

The massive use of devices connected to the Cloud poses an obvious threat to the security of Digital Society. National and international strategies consider Digital Security as a critical challenge. Security is a main focus of H2020 and a key R&D orientation included in Pillar 2 of Horizon Europe.

Also involved/interested in:

TEMÁTICA 1. NUEVAS BASES PARA UNA SOCIEDAD GLOBALIZADA SOSTENIBLE;
TEMÁTICA 11. INTELIGENCIA ARTIFICIAL, CIENCIA DE DATOS Y ROBOTICA

Contribution:

The Estrategia Nacional de Seguridad, the Estrategia Nacional de Ciberseguridad, the European Security Strategy, the NIS (Network and Information Systems) Directive and the Cybersecurity Act consider that the Security is a priority objective for governments in order to guarantee their national security and to create a digital society based on trust. In addition, to maintain such stability it is necessary to preserve the defense of constitutional and democratic values and principles, and the fundamental rights of citizens, protecting their personal data, their privacy, their freedom of expression and access to truthful and quality information. Somehow, they also consider that the citizen is also responsible for national security. Therefore, it is necessary to work with a multidisciplinary approach that covers all aspects related to security, beyond of the purely technical aspects. GiCSI investigates to grant Security of the information transmitted or stored by electronic means and their principal applications as cloud computing, e-governance, IoT, etc.
(La web solo permite 1000 caracteres, no los 2000 que se indican más arriba)