"Doctoral Day" Programme–26 January 2024

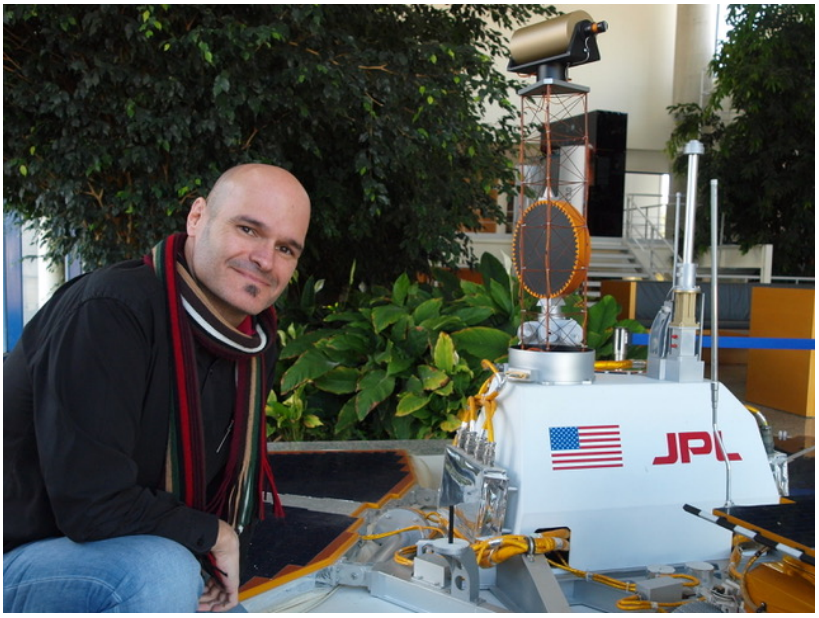
Date and time: Friday 26 January
Venue: Conference Room ("Salón de Grados"), Mathematics Building (2nd floor)

08:50-09:00.- Welcome
Joaquín Gómez Camacho, Programme Coordinator, Universidad de Sevilla,
Antonio Prados Montaño, Academic Commmittee Member, Universidad de Sevilla

09:00-10:00 Opening Talk

Latest advances in the study of the atmosphere of Mars: the Spanish contribution to NASA missions

Dr. José Antonio Rodríguez Manfredi,
Center for Astrobiology (CAB)–CSIC



Abstract: Spain's high scientific, technological and industrial level makes it possible for our country to participate very actively in the latest missions that have been sent by NASA to explore Mars, and even in those that are currently in preparation. During this talk, we will have the opportunity to discuss the Spanish contributions that have made it possible to study Martian atmospheric dynamics as never before, even constituting the first meteorological (mini-)network on another planet. Some of the most relevant scientific results obtained to date, and what the exciting future of Martian exploration holds, will also be discussed.

José Antonio Rodríguez Manfredi's short CV:

Dr. José Antonio Rodríguez Manfredi holds a PhD in Telecommunication Engineering, and is an OPI Scientific Researcher in the Advanced Instrumentation Department of the Center for Astrobiology (CAB), a joint center of the National Institute for Aerospace Technology (INTA) and the Spanish National Research Council (CSIC), of which he was Head of the Department from 2010 to 2015. Since 2012, he is the Principal Investigator (PI) of the Space Instrumentation Research Group of the CSIC/Centro de Astrobiología, a group that currently has 26 members.

JA is first author or co-author of more than 150 refereed scientific papers (135 Q1), and as many technical papers and reports for space agencies; H index = 44; 235 contributions to congresses (38 as first author, and with several invited talks); 4 PhD theses and 12 master/graduate final papers directed; scientific advisor of the Spanish delegation to the International Mars Exploration Working Group of NASA/ESA since 2019; president of the Commission for Communication Technologies of the Evaluation and Accreditation Directorate of the Andalusian Knowledge Agency since July 2020; member of the Technical Evaluation Committee of the Space area of the State Research Agency of the Ministry of Science and Innovation in 2019.

He is the PI of the Temperature and Winds for InSight (TWINS) space instrument aboard NASA's InSight mission (on Mars from 2018 to 2022), as well as of the Mars Environmental Dynamics Analyzer (MEDA) instrument, on NASA's Mars2020/Perseverance mission (on Mars since February 2021). He is also co-investigator and mission manager of the Rover Environmental Monitoring Station (REMS) instrument that is exploring the neighboring planet aboard NASA's Mars Science Laboratory/Curiosity since 2012.

JA has led as PI (13 projects), or contributed as researcher in 38 other projects: Research and Development projects funded by the European Commission, the State Research Agency (AEI, and previous equivalent agencies), as well as regional and local agencies and other institutions. JA is also a participating inventor in 2 patents licensed nationally, and at European (EU), Japanese and US level.

His interest is focused on the science and development of instrumentation for the characterization and modeling of subsurface atmospheric and geobiological conditions of other planets, especially Mars.

JA is very involved in the popularization of science, participating very actively in broadcasting programs, radio and television, talks in schools, universities, etc. (more than 300 participations), and has been recognized with 12 national and international awards and mentions (most of them granted by NASA, in addition to the Cross of Aeronautical Merit with white badge granted by the Ministry of Defense of Spain).

Morning Session

Date and time: Friday 26 January, 10:00-13:50
Venue: Conference Room ("Salón de Grados"), Mathematics Building (2nd floor)

Students' presentations

10:00-10:20.- Hossein Khosravi: "Possibility of In-Memory Computing by Using A Novel 10 T SRAM Bit-Cell for Binary Applications"

Abstract: In most computing systems, the Von Neumann architecture is being utilized so that the processing cores and memory units are decoupled. This conventional architecture has some limitations for running a data-intensive application such as a virtual machine in terms of throughput and energy efficiency. The limitation comes from the frequent and extensive transfer of data between memory storage and processing cores. Therefore, to fix the Von Neumann bottleneck, extensive research has been conducted to develop innovative computing approaches. Among these, one of the most feasible paradigms is In-Memory Computing (IMC). In-memory computing (IMC) is an alternative method, where specific computational tasks are conveyed to the memory itself, organized as a computational memory unit. Furthermore, memory units are one of the most important units in IMC, and recently several memory technologies have been investigated for the advancement of IMC including CMOS technologies and beyond CMOS nonvolatile technologies. Between these memories, SRAMs can provide the best access-speed performance and they are fully compatible with modern CMOS technologies. The purpose of this work is to design and simulate a novel 10T SRAM bit-cell with a high static noise margin and low power consumption for binary In-Memory Computing and investigate further action to check the performance of the cell in an extended array.

10:20-10:40.- Álvaro Sáiz Castillo: "Quantum Phase Transitions in periodically quenched systems"

Abstract: Quantum Phase Transitions (QPT) encompass a variety of phenomena that occur in quantum systems exhibiting several possible symmetries. Traditionally, these transitions are explored by continuously varying a control parameter that connects two different symmetry configurations. Here we propose an alternative approach where the control parameter undergoes abrupt and time-periodic jumps between only two values, and where the time acts as the order parameter of the QPT. This approach yields results surprisingly similar to those obtained by the traditional one and may prove experimentally useful in situations where accessing the control parameter is challenging.

10:40-11:00.- Amir Khan: "Design of Hardware-Efficient 4-in-1 Vision Sensor Architecture Enabling Object Recognition by Implementing the Signal-to-Information Conversion"

Abstract: Conventional image recognition and object detection algorithms heavily depend on manually crafted features and classifiers, streamlining computational processes by pinpointing specific attributes defined through expert heuristics. The efficacy of these systems encounters limitations when addressing intricate ensembles that fuse various low-

level image features with high-level semantics. Deep learning systems adeptly capture these semantic traits but come with substantial computational demands, necessitating a delicate balance between accuracy and computing resources through simplification and approximation. To address this challenge, we leverage the theory of compressive sensing (CS) to efficiently acquire signal information (features). Compressed samples obtained through CS can seamlessly feed into a linear support vector machine (SVM). This strategic use of CS offers advantages both at the signal acquisition stage, where manual feature crafting is avoided, and at the processor level, where a straightforward linear classifier suffices. In this study, we introduce a versatile CMOS vision sensor that harnesses the power of compressive sensing (CS) to extract compressed samples, enabling efficient feature acquisition. The proposed architecture demonstrates flexibility by accommodating three distinct CS schemes and traditional image readout.

11:00-11:20.- Gabriel Galeote Checa: "Unveiling Epilepsy: Advanced Signal Processing for Seizure Prediction and control in Brain Implantable Devices"

This presentation focuses on addressing epilepsy, a widespread condition affecting 3% of the population, where conventional treatments like antiepileptic drugs often fall short for many patients. Seizures are severe alterations of normal bodily functions, significantly diminish the quality of life for those with epilepsy. The utilization of algorithmic and signal processing techniques proves effective real-time identification, monitoring, and potential control of seizures. The talk present two strategies employing local field potentials for seizure control and predictive analytics. It highlights the integration of Digital Signal Processing within Microelectrode Array Recordings, providing valuable insights into addressing this neurological challenge. These algorithms are practical implementations, they can be implemented in microcontrollers or dedicated integrated circuits for edge computing, crucial for their application in brain implantable devices.

11:20-11:40.- Unai Abascal Ruiz: "Transport and accumulation of artificial radionuclides in a marine core from the Celtic Sea"

The Celtic Sea is affected by the Sellafield nuclear reprocessing plants derived radionuclides. Sellafield nuclear fuel reprocessing plant (NFRP) worked from 1952 to 2021 realising liquids and purge waters from fuel storage ponds containing a large range of radionuclides (e.g. I, Cs, U, Np, Pu) which could be used as oceanic tracers. In this work two sediment cores from the Celtic Sea collected in 2015 March, Core-A (51° 13' 59" N; 6° 7' 59"W) and Core-I (50° 36' 0"N; 7° 5' 59"W), located 250 km away from the Sellafield NFRP. 129I, 137Cs, 236U, 237Np, Pu isotopes and 241Am deep profiles are presented in order to analyze the influence of the Sellafield. 129I and 236U concentrations and inventories, 2.03·1015 at·m-2 and 4.09·1012 at·m-2 respectively for Core-A and 5.20·1014 at·m-2 and 5.96·1011 at·m-2 for Core-I, are measured showing more than one order of magnitude higher values than Northern Hemisphere solely influenced sediments by global fallout (1.30·1013 at·m-2 for 129I and 1.50·1011 at·m-2 for 236U). The influence of sediments in the radionuclides oceanic signal is studied concluding that they act a secondary source of 236U.

11:40-12:10.- COFFEE BREAK

12:10-12:30.- Lucas Garrido Gómez: "Development of instrumentation for nuclear reaction measurements and their applications to astrophysics"

Abstract: This talk focuses on the development of MARS (Modular Apparatus for nuclear Reaction Spectrometry), which has taken place in the ALOHA (Applied Laboratory On Heavy-ion Analysis) laboratory at University of Seville. The first stage of this development has been completed and includes: MARS assembly, characterization and proof of concept. As a second stage, we applied MARS to experimental measurements of 6Li + 12C, at energies around the Coulomb barrier (Vc = 4.5 MeV), in the 3MV particle accelerator of Sevilla (CNA). In addition, experimental measurements of 12,13C + 119,120Sn @ 47 MeV were performed at LAFN (Laboratório Aberto de Física Nuclear) of University of São Paulo, Brazil. These reactions are part of a wider systematic study, which main objective is to determine the reaction rates of stable weakly bound and exotic He, Li, Be, B, and C isotopes, used as projectiles, colliding on different targets. This work is developed in the context of two international networks: the IberoAmerican Network for Nuclear Astrophysics (IANNA) and the International Research Network for nuclear Astrophysics (IReNA). We present results from each development stage, as well as on-going and future work.

Abstract: 12:30-12:50.- Andrés Santana Andreo: "ATIUM: A Novel Chip for Aging Characterization of Digital Cells"

Abstract: ATIUM is a chip designed using UMC 65-nm CMOS technology for the characterization of aging effects on digital cells, specifically logic gates. The chip has been designed by mixing analog and digital design techniques, with the goal of using accelerated aging techniques to measure the degradation caused by aging in individual logic gates. Aging phenomena cause degradation in different transistor parameters (e.g., an increase in threshold voltage), generally reducing the current of the transistors inside logic gates and making them switch state slower. It is critical to measure aging in individual instances, as aging phenomena are stochastic in nature. However, this stochasticity can be obscured when aging in multiple cells is measured simultaneously, as is done in the state of the art. Through a novel design, a signal, whose frequency is sensitive to the gate delay of an individual logic cell, is carefully measured both before and after stress, obtaining on-chip measurements of circuit degradation. The final goal is to employ this information to develop design techniques which enhance the overall lifetime of circuits, aligning with the broader objective of promoting sustainability in electronics.

12:50-13:10.- Yassine Lamouaraa Sedlackova: "Asynchronous Pixel Operation for Single-Shot Concurrent Auto-Exposure and HDR Imaging"

Abstract: This presentation will introduce an image sensing technique that realizes automatic adaptation to the illumination conditions during image capture. This adaptation takes place asynchronously, requiring neither external control nor iterations on the exposure setting. The equations modeling the operation principle of the technique show exposure-time independence and dependence on the ratio of pixel and ambient illuminations, which means that, theoretically, any illumination scenario can be encoded. An extensive set of simulations confirms these characteristics; in particular, we simulated the capture of a 118-dB scene on a 160x120-px array over five orders of magnitude of ambient illumination. Corner and mismatch simulations reveal strong robustness of the proposed circuitry against process variations. Strategies to minimize the impact on the pixel pitch are also examined.

13:10-13:30.- Daniel López Aires: "Behaviour of natural clays exposed to nu-

clear waste corrosion products in the near-field of a geologic repository for nuclear waste disposal"

Abstract: Deep Geological Disposal stands out as the most promising and globally accepted solution to dispose the High-Level Radioactive Waste, the most problematic nuclear waste generated by nuclear energy. Bentonite, a type of swelling clay, is proposed as the last engineered barrier of the disposal due to its ability to limit water inflow to the waste container, to self-seal and to filter radionuclides, among others. Radionuclides retention plays a big role for to the long term safety and hence for the validation of this disposal strategy. However, up to our knowledge, there is a lack of information on this topic, which motivated this project, that aims to study the radionuclides retention properties of bentonites.

Batch adsorption and kinetics experiments are being carried out to test the radionuclide retention properties of three selected bentonites under a leachant emulating groundwater in a granitic environment. Currently leachates with natural Uranium and non-radioactive analogues of spent nuclear fuel are being used for the experiments. Kinetic experiments showed that the equilibrium is reached after 10 days, independently on the structural characteristics of the bentonite. Adsorption experiments are currently being performed.

13:30-13:50.- Carmen Torres Muñoz.: "Characterization of non-metalized SiC detectors using the IBIC technique"

Abstract: In this work, 4H-SiC detectors fabricated at the Institute of Microelectronics of Barcelona (IMB) have been analyzed without the metal layer, as a step prior to graphene deposition.

Using ion beam induced charge (IBIC) and time-resolved IBIC (TRIBIC) techniques, carried out at the National Accelerator Center (CNA) microbeam line, the spectral and transport response of virgin and irradiated detectors with neutron fluence has been characterized.

Using a 3 MeV proton focused beam, it has been observed that the spectroscopic response of the detectors is homogeneous over the whole surface, while the shape of the wave signals has a radial dependence. Indeed, the induced charge signals are faster when the beam is incident near the edge of the detector, where the electrode is located, and slower as the ion beam approaches the center of the detector. The size of the depletion zone in each of the detectors was also studied, finding good agreement with the thickness obtained by IBIC and CV measurements in the virgin detector. However, in the neutron irradiated sensors, the electrical characterization indicates a loss of diode-like behavior and the IBIC measurements show that the depletion zone decreases considerably with the irradiated fluence.

Flash Talks

13:50-13:55.- Kiera McKay: "Molecular contributions to impurity charge exchange spectra in the plasma edge region"

Abstract: In the plasma edge region, molecular behavior has the potential to impact measurements. This talk will explore how molecular emissions affect measurements taken using Charge Exchange Recombination Spectroscopy (CXRS), a diagnostic used to determine ion temperature, rotation, and density by injecting neutrals into the plasma and

analyzing the emission spectra produced during charge exchange reactions. The molecular contamination present in different plasma confinement regimes and a simulation method to address this contamination will be discussed.

13:55-14:00.- Francisco Javier Rubio Barbero: "Aging beyond humans, a step further into reliability-aware IC design"

Abstract: As humans, we age, and similarly, integrated circuits (ICs) also age, which impacts their performance and reliability. In cybersecurity applications, this is crucial to consider. The significance of IC aging in physical unclonable functions (PUFs), a type of lightweight security primitive, will be discussed, along with a recently designed novel PUF that takes advantage of the underlying stochasticity on the MOSFETs, to create a robust, lightweight security primitive.

14:00-14:05.- Apurba Karmakar: "HW/SW implementation of RSA digital signature on a RISC-V-based System-on-Chip"

Abstract: A digital signature is used to generate the signature of a message and verify the signature of that message. This signature scheme can ensure the validation of the authenticity, integrity, and non-repudiation of a message. This work describes the software and hardware hybrid implementation of the RSA digital signature on a System-on-Chip that uses a RISC-V processor as processing core. The most time-consuming operation behind the RSA algorithm, the modular exponentiation, is implemented in hardware.

14:05-14:10.- Gregorio García Valladares: "Optimal resetting strategies for search processes in heterogeneous environments"

Abstract: In many physical situations, there appears the problem of reaching a single target that is spatially distributed. We analyse how stochastic resetting, also spatially distributed, can be used to improve the search process when the target location is quenched. We consider a model with minimal but sufficient ingredients that allows us to derive analytical results for the relevant physical quantities and optimise them, which proves to be non-trivial.

14:10-14:15.- Jesús Salas Suárez-Bárcena: "Radiative power and SXR diagnostics in SMART"

Abstract: Electromagnetic radiation serves as a valuable tool for obtaining essential information regarding the density, temperature, and impurity concentrations within magnetized plasmas. In this study, a synthetic model has been formulated to characterize radiative power and Soft X-ray (SXR) emissions. The developed code has been effectively employed in simulating anticipated scenarios for the SMART (SMall Aspect Ratio Tokamak) configuration. Additionally, a dedicated SXR diagnostic has been designed to facilitate the acquisition of precise measurements in alignment with the study's objectives.

Attendees (without talk):

- Samira Baid
- Joaquín Ceballos Cáceres
- Miguel Ángel Chamorro Burgos
- Ignacio María Delgado Lozano
- Iván Díez de los Ríos Luis
- Hamidreza Erfanijazi
- Farnaz Faramarzi
- José Luis García León
- José Manuel Gata Romero
- Beatriz González González
- Jesús González Rosa
- Javad Gorji
- Valentín Gutiérrez Gil
- Marina Jiménez Cómez
- Daniel Jiménez Flores
- Victoria Lérida Toro
- Ramón López Cansino
- Antonio Jesús López Fuentes
- Alessio Mancini
- Servando Marín Meana
- Manuel Martínez Rojas
- Roberto José Méndez Romero
- María Laura Olivera Atencio
- Antonio Ordoñez Aguilera
- Pablo Oyola Domínguez
- Sergio Palomeque Mangut
- Antonio Patrón Castro
- Juan de Dios del Pino Corredera

- Pedro Punta de la Herrán
- Carlos Ríos Monje
- Eusebio Jesús Rodríguez Fernández
- José Rueda Rueda
- Natalia Ruiz Pino
- Darío Sánchez Jiménez
- Daniel Téllez Calle

TIMETABLE

Venue: Conference Room ("Salón de Grados")
Mathematics Building (2nd floor)

	Morning Session
08:50-09:00	**Welcome**
09:00-10:00	**Opening talk** **Dr. Rodríguez Manfredi**
	Students' presentations
10:00-10:20	Khosravi
10:20-10:40	Sáiz
10:40-11:00	Khan
11:00-11:20	Galeote
11:20-11:40	Abascal
11:40-12:10	COFFEE BREAK
12:10-12:30	Garrido
12:30-12:50	Santana
12:50-13:10	Lamouaraa
13:10-13:30	López
13:30-13:50	Torres
13:50-14:15	Flash Talks