Summer Doctoral Day Program – 4th July 2024
Morning Session

Date and time: 8:50. Thursday 4th July.
Venue: Conference Room ("Salón de Grados"), ETSI Edificación (Ground floor).
Av. Reina Mercedes 4A

08:50-09:00 - Welcome
Antonio Prados Montaño, Academic Program Coordinator, Universidad de Sevilla
María Villa Alfageme, Committee Member, Universidad de Sevilla

09:00-10:00 Opening Talk. Prof. Joaquín Gómez Camacho

10:00-14.30. – Students talks

Nuclear physics in everyday life

Prof. Joaquín Gómez Camacho,
Department of Atomic, Molecular and Nuclear Physics. Universidad de Sevilla

Abstract:

Nuclear Physics is a branch of science which can be considered as difficult, academic, and distant from the person in the street. This is not the case. There are simple questions which anyone can ask, that have the answer in nuclear physics. Where does heat come from? (not only from the sun). Where does the mass come from? (not mainly from the Higgs mechanism). Where do elements come from? (not only from stars). Besides, there are many applications (not only energy) of nuclear physics, which are linked with the Sustainable Development Goals of the UN. This talk, which is based on a recent NuPECC report http://www.nupecc.org/?display=pub/publications will be presented in this talk.

Joaquín Gómez Camacho short CV:

Prof. Joaquin Gómez Camacho is Professor of Atomic, Molecular and Nuclear Physics at the Universidad de Sevilla. He has been teaching particle, nuclear and particle physics for the last 30 years. His research field of research Nuclear Physics, convering theoretical, experimental and applied topics.

He was director of the National Accelerator Center, Centro Nacional de Aceleradores (CNA), Universidad de Sevilla - CSIC -Junta de Andalucía. for 10 years, from 2008 to 2018.

More details can be found in: *ORCID 0000-0003-0925-503*

Morning session

Venue: Conference Room ("Salón de Grados"), ETSI Edificación (Ground floor)

8:50 – 9:00	Welcome
9:00 – 10:00	Opening talk Prof. Joaquín Gómez Camacho

STUDENTS PRESENTATION

10:00 – 10:20	Eusebio Jesús Rodríguez Fernández
10:20 – 10:40	Maria Laura Olivera Atencio
10:40 – 11:00	Servando Marin Meana
11:00 – 11:20	Gabriel Galeote Checa
11:20 – 11:40	Apurba Karmakar
11:40 – 12:10	*COFFEE BREAK*
12:10 – 12:30	Roberto Roman Hajderek
12:30 – 12:50	Rafael de la Rosa Vidal
12:50 – 13:10	Pedro Barba Lozano
13:10 – 13:30	Ignacio Maria Delgado Lozano
13:30 – 13:50	Ramón López Cansino
13:50 – 14:10	Kiera Anne McKay
14:10 – 14:30	*FLASH TALKS*

Abstracts Students' presentations
LONG TALKS

10:00-10:20.- Eusebio Jesús Rodríguez Fernández:

"Mercator-like mapping of non-Euclidean spintronic circuits"

Curvature can be a powerful control tool used in interferometry to change the response of spin carriers to the field textures developed in spintronic circuits. In this work we make a review of the effects the curvature inflicts in the conductance and phases in one dimensional interferometric circuits. Moreover, we show the effects curved space can have in the circuits by developing a 2-dimensional map to the Euclidean plane of a triangular interferometer on a sphere, using Rashba

and Dresselhaus 110 spin-orbit interaction to emulate the effects of the curvature and holonomy of the sphere. Finally, we show how the map can be extended to a circuit covering a hemisphere or the full sphere

10:20-10:40.- Maria Laura Olivera Atencio:

"Quantum reinforcement learning in the presence of thermal dissipation."

Quantum machine learning (QML) promises to revolutionize data processing and problem-solving. Despite its potential, QML faces challenges from dissipation and noise due to environmental interactions, which affect quantum device coherence and performance. In this presentation, we examine the impact of thermal dissipation on quantum reinforcement learning. We adapt a quantum reinforcement learning protocol to account for thermal dissipation and perform both analytical calculations and numerical simulations. Our findings suggest that at sufficiently low temperatures, dissipation does not significantly hinder the protocol's performance and may even offer some benefits. These results indicate that quantum reinforcement learning can be effective under realistic thermal conditions, paving the way for the development of quantum agents capable of adapting to changing environments. This adaptability has significant implications for applications in quantum technologies and machine learning.

10:40-11:00.- Servando Marin Meana:

"Atmospheric Pressure Gliding-Arc Plasma for Hydrogen Production"

Gliding arc (GA) plasma technologies are a promising approach for hydrogen production due to its efficiency and low environmental impact. Herein, we analyze the H_2 production in a novel GA reactor from NH₃, using nitrogen and argon as carrier gases. GA plasma, characterized by its non-thermal nature and high electron density, effectively dissociates NH_3 into its constituents. The reactive environment of the plasma leads to break the stable NH_3 bonds facilitating the formation of hydrogen along with nitrogen as by-products. The choice of the carrier gas, N_2 or Ar, influences the reaction dynamics and energy efficiency. N_2, being the main component of air, offers a cost-effective and readily available medium while Ar, an inert gas, minimizes unwanted side reactions, which potentially improves H_2 yield and purity. Experimental investigations have demonstrated that GA plasma can achieve significant conversion rates by varying operational parameters such as gas flow rate, power, and electrode configuration. This method holds considerable potential for sustainable hydrogen production, offering a pathway to utilize NH_3, a widely available hydrogen carrier, in energy applications. The research contributes to the development of efficient, scalable, and environmentally friendly hydrogen production technologies, aligning with global efforts to transition to a hydrogen-based economy.

11:00-11:20.- Gabriel Galeote Checa:

"Advances in On-Edge Seizure Detection with Time Series Segmentation for Neural Implants"

Brain implantable devices are entering a new era, driven by advances in wireless power transmission, device miniaturization, and innovative brain stimulation technologies. A recent trend towards increasing the number of electrodes in these devices enhances spatial resolution and reliability through redundancy, but it also poses significant challenges in managing more data while maintaining low power consumption and device miniaturization. This presentation focuses on epilepsy, introducing a novel approach using time series segmentation for the automatic recognition and classification of relevant electrographic events in neural implants. By recording local field potentials—aggregated neuron activity within neural tissue—we can identify these critical events. We will demonstrate this approach and its hardware implementation using an FPGA and a real-time assessment environment. Our algorithm has been verified across various environments through implementations in multiple programming languages.

11:20-11:40.- Apurba Karmakar:

"Security of embedded systems based on RISC-V processors"

RISC-V is an open standard instruction set architecture (ISA), capturing enormous attention of the chip industry and researcher community due to its open access and power efficiency, resulting in a swift growth of RISC-V based embedded systems. Data security and authenticity are indispensable for any RISC-V based embedded systems. This work illustrates the data security of RISC-V based embedded systems by implementing hardware Root-of-Trust combining with some software implementations. The RSA (Rivest–Shamir–Adleman) and AES (Advanced Encryption Standard) have been chosen as hardware Root-of-Trust components that offer digital signature/verification, data encryption/decryption and message authentication. The proposed RoT modules have been packaged as IP with AXI-4 Lite interface and built a System-on-Chip with Rocket RISC-V processor. The System-on-Chip has been implemented on Xilinx Kintex-7 FPGA on the Genesys-2 FPGA board for performance analysis and functional verification. The acceleration factor has been calculated by comparing the software and hardware implementations. The IPs have been tested on Rocket RISC-V running Debian Linux OS as well a standalone platform. All the proposed implementations of RoT modules are verified using the National Institute of Standards and Technology (NIST) test vectors.

11:40-12:10.- COFEE BREAK

12:10-12:30.- Roberto Roman Hajderek:

"A lightweight remote attestation using PUFs and hash-based signatures for low-end IoT devices"

Remote attestation is a powerful mechanism that allows a verifier to know if the hardware of an IoT device (acting as a prover) has been counterfeited or tampered with and if its firmware has been altered. Remote attestation is based on collecting and reporting measurements in a trusted way. This work proposes to include a low-cost Root of Trust for Measuring and Reporting (RoTMR) in the prover, based on the combination of a Physically Unclonable Function (PUF) and an Attestation Read-Only Memory (A-ROM), and to use hash-based digital signatures in the attestation protocol. The proposed RoTMR is addressed to IoT devices based on a microcontroller that executes some application code (the measurable object) located in an external non-volatile memory accessible by an attacker. The A-ROM contains the attestation instructions and ensures that its contents cannot be altered and that its instructions are executed sequentially without modification. The use of hash-based digital signatures makes the solution quantum-resistant. The proposal was validated experimentally with the ESP32 microcontroller by using its SRAM as PUF and implementing WOTS+, which is a type of Winternitz One-Time Signature scheme (WOTS), the One-Time Signature of Smart Digital Signatures scheme (SDS-OTS), and the MTS schemes constructed with them.

12:30-12:50.- Rafael de la Rosa Vidal:

"An introduction to the Spatial Contrast computation on focal plane using asynchronous vision sensors"

Spatial Contrast is a crucial measurement in vision tasks, serving as the foundation for edge detection and playing a significant role in the study of the Human Vision System (HVS). Due to its importance, many researchers focus on enhancing computation methods by developing innovative techniques. One of the possible strategies involves shifting part of the processing to the focal plane, i.e. on-pixel. This presentation introduces the computation of Spatial Contrast using a particular type of vision sensor: asynchronous vision sensors. Their advantages over synchronous vision sensors, such as reduced latency and improved energy efficiency, will be explained, illustrating why they represent a promising alternative for these applications. Furthermore, experimental results from an Integrated Circuit (IC) designed to demonstrate the efficacy of this method will be presented. These results highlight the potential for significant advancements in vision tasking and its applications in various fields.

12:50-13:10.- Pedro Barba Lozano:

"Theoretical study of hierarchical sampling schemes for high-speed analog-to-digital converters"

Data communication links are limited in operation speed due to channel losses, and multilevel amplitude modulation schemes are employed to overcome this limitation. These require an Analog-to-Digital Converter (ADC) with enough resolution to differentiate between the different levels with the mentioned channel losses. As ADC conversion speed is limited by technology, high-speed implementations rely on the Time Interleaving technique, where several ADC channels operate in parallel to create a combined output at a higher rate. This technique carries additional design challenges, as any mismatch between the different channels would heavily deteriorate the resolution. One of the most restrictive ones, the skew between channels, can be overcome by using a hierarchical sampling scheme, where all samples are taken at the same point and then transferred to each of the channels.

13:10-13:30.- Ignacio Maria Delgado Lozano:

"Equivalente Circuit for Resonant Aperture-Coupled Microstrip Antennas"

This work proposes a methodology to extract the equivalent circuit of a broadband microstrip antenna consisting of two stacked patches fed through a resonant rectangular aperture by an open-ended microstrip line. The equivalent circuit includes three LC parallel resonators, out of which two are inductively coupled and two are capacitively coupled. In order to extract the equivalent circuit of the antenna, its simulated input impedance is fitted as a rational function, and the coefficients of the polynomials involved in the rational function are obtained by the least squares method. Once the rational function is known, the equivalent circuit parameters are derived in terms of the polynomial coefficients and subsequently optimized. A broadband microstrip antenna with center frequency of 8.79 GHz and fractional bandwidth around 45% has been designed and its equivalent circuit has been obtained. Good agreement has been found between the frequency response of the optimized equivalent circuit and that of the antenna.

13:30-13:50.- Ramón López Cansino:

"First measurements of 2D ion temperature maps with Coherence Imaging Charge Exchange Recombination Spectroscopy (CICERS) at Wendelstein 7-X"

The rigorous study of the transport mechanisms of a fusion plasma requires the development of diagnostics that can routinely deliver reliable measurement of relevant plasma parameters, such as e.g. ion temperature (Ti), impurity flow velocities (vZ) or impurity densities (nZ). Typical diagnostic setups can derive 1D profiles and assume these parameters to be a function of the magnetic flux surfaces justified by the predominant transport of particles along these surfaces. In this work, the development of a new diagnostic, the Coherence Imaging Charge Exchange Recombination Spectroscopy (CICERS) and its implementation in the Wendelstein 7-X stellarator is presented. This technique exploits the Coherence Imaging Spectroscopy technique to derive 2D maps of Ti, nZ and vZ from charge exchange radiation generated upon neutral beam injection in the plasma under study. First measurements are presented and validated against standard Charge eXchange Recombination Spectroscopy measurements.

13:50-14:10.- Kiera Anne McKay:

"Refining edge plasma density measurements using molecular gas puff modelling"

Measurements taken at the edge region of a confined plasma are crucial for fusion reactors, both because they set boundary conditions for the core of the plasma, where fusion reactions occur, and because of the proximity to the machine's walls, which can potentially be damaged by large thermal heat loads. One method of measuring ion temperature, velocity, and density in this region is by using the gas puff Charge eXchange Recombination Spectroscopy (gp-CXRS) diagnostic system, which puffs thermal neutrals into the plasma through a gas valve and measures the spectra produced as the neutrals undergo charge exchange reactions with impurity ions in the plasma. This measurement is complicated by the use of molecular neutrals, as the molecules produce their own emissions which contaminate the spectra. A method of multi-Gaussian spectra fitting has previously been developed to subtract the emissions from the spectra, and in this work, the method of modeling gas puff neutral density, which previously only modelled atoms, has been updated to consider molecular neutrals and their dissociation into atoms. The neutral source density is a critical component to calculating the plasma ion denisty from gp-CXRS measurements, thus this update offers improved edge density measurement capability.

FLASH TALKS

14:10-14:15.- Manuel Mayo León:

"Dynamics of a confined and ultraconfined system"

This work studies the dynamics of a system of inelastic hard spheres or disks confined between two parallel vibrating walls. The system is quasi-two-dimensional, and an evolution equation for the one-particle distribution function is formulated. The kinetic equation is solved using a two-temperature Gaussian distribution. Good agreement with molecular dynamics simulations is found. The diffusion in the plane for elastic particles is also studied, revealing normal diffusion with explicit values for the diffusion coefficient.

14:15-14:20.- Samira Baid:

"Quantum Computing Implementation of the Extended Lipkin Model for Studying Phase Transitions"

This research investigates the Extended Lipkin Model (ELM) as a representation of the Interacting Boson Approximation (IBA) phase diagram within quantum computing. We employ the ADAPT-VQE algorithm to compute ground state energy, develop a framework for ELM implementation on quantum platforms, and utilize Machine Learning to detect phase transitions. Our findings demonstrate that nuclear models like the ELM can be effectively executed on quantum computers with manageable errors, facilitating in-depth experimental studies of quantum shape phase transitions and nuclear structure.

14:20-14:25.- Alfonso Rodríguez González:

"Commissioning of the Gas Puff Charge Exchange Recombination Spectroscopy (GP-CXRS) in the SMART Tokamak"

In nuclear fusion, impurities play an important role as they influence the performance of the plasma. The GP-CXRS diagnostic can provide the temperature, density and rotation velocity of the impurities located in the edge region of the plasma. To this end, a gas box puffs a neutral gas into the plasma that reacts with the impurities in the plasma, inducing an excited state. The light emitted after their de-excitation can be analysed using a high-resolution spectrometer to obtain the properties mentioned previously. This diagnostic is expected to be installed in the SMall Aspect Ratio Tokamak (SMART) at the University of Seville to provide measurements of plasmas in positive and negative triangularity. A poloidal array of six gas boxes will be installed to measure the properties of the impurities along a poloidal plane, making this the first tokamak in the world to have such diagnostic. This contribution aims to provide the current state on the commissioning of this diagnostic, showing the status of the gas injection system and its characterisation, the spectrometer and the optical head.

14:25-14:30.- Fernando Puentes del Pozo:

"Design and initial development of the magnetic diagnostic suite for the SMART tokamak"

In this work, the magnetic sensor suite for the initial phase of SMART has been developed. This diagnostic suite consists of Rogowski coils, for the measurement of plasma and induced eddy currents, and magnetic probes and flux loops that will be used for the real-time control of the plasma, the reconstruction of the magnetohydrodinamic equilibrium and the detection of plasma instabilities. The sensor design will be shown and validated with synthetic diagnostics and out-vessel calibrations.

Attendees (not presenting)

- Diez De Los Rios Luis, Ivan
- Dominguez Muñoz, Antonio Damian
- Galeote Checa, Gabriel
- Garrido Gomez, Lucas
- Gonzalez Gonzalez, Beatriz
- Gorji, Javad
- Jimenez Comez, Marina
- Jimenez Flores, Daniel
- Jimenez Traves, Manuel
- Karmakar, Apurba
- Marin Meana, Servando
- Martin Holgado, Pedro
- Martinez Rojas, Manuel
- Mendez Romero, Roberto Jose
- Niazi, Mohammad
- Ordoñez Aguilera, Antonio
- Perez Maroto, Pablo
- Reyner Viñolas, Alex
- Rios Monje, Carlos
- Ruiz Pino, Natalia
- Saiz Castillo, Alvaro
- Salas Suarez Barcena, Jesus
- Tellez Calle, Daniel
- Torres Muñoz, Carmen
- Vegas Diaz, Alejandro