"Doctoral Day" Programme–13 December 2021

Date and time: Monday 13 December, 8:50
Venue: Aula 3B, Physics Building

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

Levitodynamics: use of levitated nanoparticles in the study of stochastic thermodynamics, aerosols, and materials science

Prof. Raúl Rica, University of Granada, Spain

Micro and nanoparticles can be individually levitated by different trapping mechanisms, among which optical tweezers and Paul traps are the most extended approaches. Even if they do not diffuse away due to the presence of the trap, trapped particles are still subjected to Brownian motion due to collisions with gas molecules. The analysis of the dynamics of trapped particles provides very useful information about the properties of the particles and the environment, allowing one to perform a variety of experiments in which a particle is used as an ultrasensitive probe. In this talk, we will present recent works that demonstrate the versatility and applicability of the technique in a large variety of fields, going from non-equilibrium dynamics to materials science and aerosol physics.

- Ricci F., et al., *A chemical nano-reactor based on a levitated nanoparticle in vacuum*, preprint arXiv:2107.01084 (2021).
- Militaru A., Lasanta A., Frimmer M., Bonilla L. L., Novotny L., Rica R. A., *Kovacs memory effect with an optically levitated nanoparticle*, Physical Review Letters **127** (2021) 130603.
- Conangla G. P., Rica R. A., Quidant R., *Extending vacuum trapping to absorbing objects with hybrid Paul-optical traps*, Nano Letters **20** (2020) 6018–6023.
- Conangla G. P., Schell A. W., Rica R. A., Quidant R., *Motion control and optical interrogation of a levitating single nitrogen vacancy in vacuum*, Nano Letters, **18** (2018) 3956-3961.
- Ricci F., Rica R. A., Spasenović M., Gieseler J., Rondin L., Novotny L., Quidant R., *Optically levitated nanoparticle as a model system for stochastic bistable dynamics*, Nature Communications, **8** (2017) 1-7.

Raul Rica's Short CV:

I obtained my PhD degree in 2011 from the University of Granada working on electrokinetics of concentrated suspensions of nanoparticles. During my thesis work, I was visiting researcher at the University of Graz (Austria), the MIT (USA) and the University of Milan (Italy). After my obtaining my PhD, I was a postdoc at the Department of Medicine in the University of Milan-Bicocca (2011-2012), where I worked on the development of a novel technique to obtain renewable energy from salinity differences using porous electrodes. Then I moved to The Institute of Photonic Sciences (ICFO, Barcelona) to work in the Optical Tweezers group (with Prof. Dmitri Petrov) as a postdoc (2012-2014) and in the Plasmon Nanooptics group (with Prof. Romain Quidant) as a Research Fellow (2014-2016). During the time at ICFO, I worked in several projects, with topics ranging from Stochastic Thermodynamics, to plasmonic sensing and levitated optomechanics. At the end of 2016, I joined the Ion Trapping Lab (Department of Atomic, Molecular and Nuclear Physics, University of Granada) to work towards ultraprecise mass measurements of heavy ions using laser-cooled ions as probes. In 2017, I obtained a "Juan de la Cierva-Incorporación" grant in the Department of Applied Physics, which finally lead to my present permanent position. Since 2020 I am Associate Professor in the same department, where I founded the Nanoparticles Trapping Laboratory, where we use optical tweezers and Paul traps to manipulate and study nanoparticles dispersed in a liquid or levitated in air (aerosols).

Morning Session

Date and time: Monday 13 December, 10:00
Venue: Aula 3B, Physics Building

Students' presentations

10:00-10:20.- Jesús González Rosa, "Inelastic neutrino-nuclei scattering in the superscaling model"

Abstract: The superscaling SuSAv2 model, that was successfully used to explain electron scattering data in the quasielastic (QE) as well as in the high inelastic regions is here extended to charged-current neutrino scattering processes on nuclei. We provide a detailed description of the Delta nucleon resonance and compare our predictions based on the pure Relativistic Fermi Gas (RFG) and SuSAv2 scaling functions with previous results obtained using a Delta scaling function fitted to the analysis of (e,e') data. The model is extended to the complete neutrino inelastic spectrum, resonant, non-resonant and deep inelastic scattering (DIS), by considering different parametrizations of the weak inelastic single-nucleon structure functions and a Parton Distribution Function (PDF) model. Our predictions, including also two-particle two-hole contributions, are compared with data taken by the T2K collaboration.

10:20-10:40.- Antonio Patrón Castro, "Universal non-equilibrium effects in a fluid with non-linear drag"

Abstract: We study the dynamical evolution of a fluid with non-linear drag, for which binary collisions are elastic, described at the kinetic level by the Enskog-Fokker-Planck (EFP) equation. Despite having an equilibrium (Maxwellian) solution, the system displays a really complex, glassy behaviour, when quenched to low enough temperatures. This response is controlled by a long-lived non-equilibrium state (LLNES), which is independent of both the degree of non-linearity of the drag force and the collision rate. The non-equilibrium phenomenology, which includes non-exponential, algebraic, relaxation and strong memory effects (Kovacs and Mpemba), presents universal properties: the time evolution of the temperature—for both relaxation and memory effects—falls onto a master curve, regardless of the details of the experiment.

10:40-11:00.- Victoria Lérida Toro, "^{129}I in sediment cores from the Celtic Sea by AMS through a microwave digestion process"

Abstract: The impact of the radioactive contamination in aquatic systems is often recorded in sediments, they can give detailed information on the history of the discharges from the sources and the environmental processes related to the transportation of the radionuclides to the sediment. For long-lived radioisotopes as Iodine-129, only high sensitivity techniques as Accelerator Mass Spectrometry can measure its concentration at environmental levels. To determine Iodine-129 in environmental samples, radiochemical methods are needed. In this work, a conventional microwave digestion method was upgraded for an optimum iodine extraction from the organic fraction and measurement by AMS. Two sediment cores from the Celtic Sea with different characteristics have been analysed to determine the Iodine-129 concentration. Despite an apparent diffusion in the

deep layers, depth profiles accurately reproduce Sellafield discharges.

11:00-11:20.- COFFEE BREAK

11:20-11:40.- Pablo Oyola, "Edge current density measurements with advanced diagnostics in ASDEX Upgrade"

Abstract: The tokamak has been shown to be the most promising device to generate fusion energy in the future. The highest performance is achieved in the so-called H-mode (high confinement mode), that is featured with a strong reduction of the fluctuations on the plasma edge, the formation of an edge transport barrier (ETB) and the build-up of a strong pressure gradients and current density density at the edge. These act a free energy source for instabilities and, particularly, edge localized modes (ELMs). ELMs produce strong transport of energy and particles away from the confined regions towards the wall, representing unacceptable heat loads in future reactors, like ITER. In this work, we will use two of the most advanced diagnostics installed in the ASDEX Upgrade tokamak: the imaging Heavy-Ion Beam Probe (i-HIBP), recently installed; and the beam emission polarimetry (BEP). The commissioning of the i-HIBP has been done and first signals are now available, and the corresponding synthetic diagnostic has been developed and benchmarked. For the BEP, first experiments in the AUG campaign 2020/21 have been performed and techniques have been developed to obtain the time-evolution of the magnetic field angle during ELM crashes.

11:40-12:00.- Joel François Tsoplefack, 'Transmission, reflection, trapping and scattering of moving discrete solitons in nonlinear Schrödinger lattices"

Abstract: We study the interactions of moving discrete solitons with a localized defect in periodic systems described by the Discrete Non-Linear Schrödinger (DNLS) equation. The localized defect is modeled by the delta function. Numerical simulations of collisions between moving solitons and the defect show that the soliton can be transmitted, reflected, trapped or scattered by the defect during the interaction, depending on the velocity of the incoming soliton and the defect strength.

12:00-12:20.- José Antonio Pavón, "n_TOF at CERN: Commissioning of the Second Beam Line for Phase 4 operation"

Abstract: The n_TOF Collaboration operates the neutron time-of-flight facility at CERN, based on a 20 GeV/c pulsed proton beam impinging on a thick lead target as neutron source. The facility is characterized by a high-instantaneous neutron beam intensity, high energy resolution and a wide neutron energy spectrum, spanning from sub-thermal to GeV. It comprises 3 experimental areas, EAR1, located at 185 m in the forward direction from the spallation target, EAR2, located at 20 m above the target, perpendicular to the proton beam direction, and NEAR, located at 3 m to the left of the target. During CERN's second long shut-down (2019-2020), the facility went through a major upgrade, including the installation of a new spallation target designed to fully optimise the features of the n_TOF experimental areas. In this work we present the main characteristics of the n_TOF facility at CERN with special focus on EAR2 as well as an overview of the beam lines commissioning.

12:20-12:40.- COFFEE BREAK

Flash Talks

12:40-12:45.- Antonio Márquez Alcaide: Compositional Gradients at the Nanoscale in Sub- stoichiometric Thin Films Deposited by Magnetron Sputtering at Oblique Angles: a Case Study on SiO_x Thin Films.

Abstract: The growth of nanocolumnar Si O_x thin films by the magnetron sputtering deposition technique at oblique angles have been analyzed from a theoretical and experimental points of view. Experimental results indicate the existence of stoichiometric variations along the diameter of the nanocolumns from x ∼0.3 to x ∼1.3 when growing Si $O_{0.5}$ thin films. This phenomenon is explained by considering the different momentum vector distribution of reactive and sputtered species responsible for the preferential incorporation of the sputtered species.

12:45-12:50.- Pablo Pérez Maroto: A NeuTron multi-foIL sPEctometer (ANTILoPE), first irradiation and measurement.

Abstract: For the commissioning of the new nTOF experimental area at CERN, NEAR, a detector based on neutron moderation and gold activation has been developed. The main goal of this work is to obtain the neutron flux produced in NEAR and to test for the first time this kind of detector. The operational concept and the first irradiations at CERN will be presented, along with the expected work ahead.

12:50-12:55.- Darío Sánchez Jiménez: Accelerator mass spectrometry (AMS): A powerful tool for the characterization of nuclear waste

Abstract: The generation of radioactive waste is an inherent consequence in applications where radioactive isotopes are used. A good characterization of these wastes is essential for their management and storage. In this work, the AMS technique is presented as an alternative to conventional radiometric techniques in order to improve the classification of low and intermediate level wastes (LILW) composed of very long half-life isotopes at very low concentrations, such as ^{36}Cl and ^{41}Ca.

12:55-13:00.- Unai Abascal Ruiz AMS measurement for Oceanographic studies

Abstract: Accelerator mass spectroscopy (AMS) is a useful technique for the measurement of different radionuclides used at Centro Nacional de Aceleradores (CNA.) We use the obtained data for Oceanographic studies, mainly in the Arctic, due to this radionuclides sources and behavior. The water masses influenced by the nuclear reprocessing plants and Fukushima Daiichi nuclear plant can be tracked for the understanding of the Arctic and the influence of the changes in this ocean on the global climate.

13:00-13:05.- Javad Gorji: Cognitive-Radio Digitizers

Abstract: The so-called Cognitive Radio (CR) technology allows communication systems to make a more efficient use of the electromagnetic spectrum. One of the key building blocks of these systems is the analog-to-digital converter, since an early digitization make it easier to implement CR functionalities in software rather in hardware. This talk summarizes the design challenges which will be addressed in this thesis which deals with the design of Artificial-Intelligence (AI) managed Sigma-Delta Converters for CR application.

13:05-13:10.-Daniel Suárez García: Introduction to proton radiotherapy and microdosimetry

Abstract: Proton radiotherapy as a treatment for cancer is increasingly used worldwide. The physical properties of protons allow delivering energy forward the affected zone further accurately. The study of this treatment in the framework of microdosimetry will be the work area of my thesis. During the talk, a brief explanation of proton therapy and microdosimetry will be provided.

13:10-13:15.-Andrés Santana Andreo Circuit Variability: Mitigate for Reliability, Exploit for Security

Abstract: Variability in integrated circuits (ICs) manifests itself in two ways, variability after fabrication (Time-Zero Variability, TZV) or during the lifetime of the circuit (Time-Dependent Variability, TDV). This variability needs to be characterized to develop models and understand the underlying physical phenomena. From this understanding two applications emerge: mitigation through variability-aware design methodologies, key to the reliability of circuits, and exploitation for hardware security, transforming a weakness into a feature through Physical Unclonable Functions.

13:15-13:20.- Eros Camacho Ruiz Microelectronic design of a hardware Root of Trust (RoT) robust to aging

Abstract: A hardware Root of Trust (RoT) is the foundation on which all secure operations of a computing system depend. The unstoppable advance of technological developments makes it necessary to increase the security of connected devices. A new form of identity certification between devices is needed: hardware-based certification using Physical Unclonable Function (PUF). On the other hand, the imminent arrival of quantum computing makes a new form of cryptography necessary: post-quantum cryptography (PQC). In this RoT, hardware identification solutions (PUFs) are intended to be grouped together with PQC acceleration solutions.

Attendants (without talk):

- Cruz Zabala, Diego José
- Domínguez Muñoz, Antonio Damián
- Franco Patiño, Juan Manuel
- Galeote Checa, Gabriel
- Galván Moreno, José Antonio
- García León, José Luis
- García Osuna, Adrián
- García Valladares, Gregorio
- Jiménez Traves, Manuel
- López Aires, Daniel
- López Fuentes, Antonio Jesús
- Mancini, Alessio
- Medrán del Río, José Luis
- Navascués Garvin, Paula de
- Perrotta, Simone
- Pino Corredera, Juan de Dios del
- Rosa Vidal, Rafael de la
- Rueda Rueda, José
- Saiz Castillo, Alvaro

TIMETABLE

	Morning Session
08:50-09:00	**Welcome**
09:00-10:00	**Opening talk** **Prof. Raúl Rica**
	Students' presentations
10:00-10:20	González
10:20-10:40	Patrón
10:40-11:00	Lérida
11:00-11:20	COFFEE BREAK
11:20-11:40	Oyola
11:40-12:00	Tsoplefack
12:00-12:20	Pavón
12:20-12:40	COFFEE BREAK
12:40-13:20	Flash Talks