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Book of Abstracts

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Welcome speech

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Field:

Language:

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Présentation RJP/Réseau Jeunes

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Oral presentations session / 24

Stellar nucleosynthesis and superheavy nuclei in our Universe and in the lab!

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The heaviest element which has been found in nature is uranium with 92 protons. So far, the elements up to atomic number 118 (oganesson) have been discovered and synthesised in the laboratory and the last one was named after the physicist Y. Oganessian in 2016. All transuranium elements are radioactive and their production rates decrease with increasing number of protons. An Island of Stability, where the nuclei have relatively long half-lives, is predicted at the neutron number 182 and, depending on the theoretical model, at the proton number 114, 120 or 126. Current experimental techniques do not allow to go so far to the neutron-rich side close to the Island of Stability. The observation of gravitational waves as well as electromagnetic waves originating from a neutron star merger has been published on October 16, 2017 and is a first proof of the nucleosynthesis of heavy elements in the r-process. It still remains an open question if superheavy nuclei have been formed in our universe. To answer these questions, we need insight into the nuclear properties of the heaviest elements and how these properties evolve when one moves toward to the neutron-rich side on the nuclear chart. During my PhD thesis, I set out to discover new, neutron-rich heavy nuclei using multi-nucleon transfer reactions. These studies will provide insight into the evolution of nuclear shells in the heavy element region.

In 2019, I have proposed and performed a first preliminary experiment at Argonne National Laboratory (close to Chicago, USA) to investigate deep-inelastic reactions mechanisms in the heavy elements region. We accelerated a beam of ^{136}Xe on a ^{238}U target with energy about 705 MeV and velocities close to 10% of the speed of light in vacuum. the Gammasphere 4π germanium-array coupled to the AGFA (Argonne gas-filled analyzer) separator with the implantation-decay station (PPAC, DSSD and silicon tunnels) and germanium clover detectors XArray at the focal plane aim at identify our nuclei of interest (prompt and delayed γ-spectroscopy…). For the first time, we performed a deep-inelastic reaction at 0° using AGFA to produce heavy U-like nuclei. The separation

with the beam Xe-like nuclei was a great success and we saw the first nucleon exchanges in this process and shows that this is a new pathway towards the synthesis of new super heavy neutron-rich isotopes.

Language:

English

Field:

Fondamental physics ; Nuclear structure

Oral presentations session / **6**

Theoretical prototype of a Hodgkin-Huxley neuron with 2D nanofluidic memristors

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New energy-efficient computer architectures inspired by the mammalian brain have been growing as an alternative to traditional von Neumann computing. Yet, existing hardware implementations use electrons as charge carriers, while neurons rely on transport of ions for both computation and the building of memory. In my presentation, I will show how a two-dimensional electrolyte confined between atomically smooth surfaces – a recently demonstrated nanofluidic device – can exhibit neuromorphic behaviour. I will show that ions in the 2D monolayer form tightly bound Bjerrum pairs, that assemble into micelle-like clusters upon application of an electric field. The long-timescale dynamics of these ionic assemblies are at the source of memory effects in the system's conductivity – a behavior known as "memristor effect". Guided by analytical predictions, I will also present molecular simulations of nanofluidic circuitry incorporating memristor building blocks. The resulting system is capable of spontaneously emitting voltage spike trains, replicating the Hodgkin-Huxley neuron model (Nobel Prize 1962). Theses findings reveal a minimal, experimentally-accessible biomimetic neuron architecture based on nanofluidic channels, paving the way for the development of ion-based computing and prototype ionic machines.

Reference :
Paul Robin, Nikita Kavokine and Lydéric Bocquet, Hodgkin-Huxley iontronics with two-dimensional nanofluidic memristors, under review (2021).

Field:

Nanoscale physics, nanofluidics, interface with neuroscience.

Language:

English

Oral presentations session / **7**

How does antimatter fall?: focus on GBAR experiment (CERN)

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One of the main questions of fundamental physics is the action of gravity on antimatter. We present here the simulation of the last part of the experiment GBAR at CERN, i.e. the measurement of the free fall acceleration ⊠ of antihydrogen atoms in the gravitational field of Earth. It includes the Monte-Carlo generation of trajectories and the analysis leading to the estimation of ⊠. A precision of the measurement beyond the % level is confirmed by taking into account the experimental design.

Language:

English

Field:

Antimatter - gravity - quantum physics - statistics

Poster advertising session / 16

How quantum correlations help us improve the precision and efficiency of quantum metrology protocols?

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In the last decade, quantum signals and detectors carved out a place for themselves in mainstream technology. Characterization of those devices at the quantum level is thus a crucial ingredient for the development of quantum technologies. Quantum metrology, on the other hand, is the art of estimating the value of one or more parameters of interest. Recently, it has been shown that the quantum Fisher information via local observables and via local measurements (i.e., local quantum Fisher information (LQFI)) is a central concept in quantum estimation and quantum metrology and captures the quantumness of correlations in the multi-component quantum system. This new discord-like measure is very similar to the quantum correlations measure called local quantum uncertainty (LQU). In the present study, we have revealed that LQU is bounded by LQFI in the phase estimation protocol. Also, a comparative study between these two quantum correlations quantifiers is addressed for the quantum Heisenberg XY model. Two distinct situations are considered. The first one concerns the anisotropic XY model and the second situation concerns isotropic XY model submitted to an external magnetic field. Our results confirm that LQFI reveals more quantum correlations than LQU.

Ref: A. Slaoui,L. Bakmou,M. Daoud and R.A. Laamara, A comparative study of local quantum Fisher information and local quantum uncertainty in Heisenberg XY model. Physics Letters A, 383 (2019) 2241-2247.

Language:

French

Field:

Quantum Information Theory, Quantum Metrology, and Quantum Optics

Poster advertising session / 32

Innovative Multi-Energy Deterministic Method to treat core-reflector interfaces

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One of the current challenges of heavy-material-reflector reactors is the need to precisely model space and energy flux variations at the core-reflector interface. Incorrect representations of reflector effects can introduce significant errors in the resulting calculation (reactivity and reaction rates). This paper aims to describe a methodology that provides a deterministic solver with the capability of better describing local heterogeneities and strong transients without sacrificing calculation time. It investigates the use of domain decomposition methods with cross sections of different energy meshes within the IDT deterministic solver. In this novel method, subdomains have different energy discretizations and no overlap. Boundary fluxes are condensed or reconstructed to account for spectral differences between subdomains to make the boundary condition fully consistent across all subdomains. Multi-grid cases, where subdomains have different energy discretizations are compared to cases with the same energy discretizations over the entire configuration.
Varying boundary flux expressions have been examined. The gains in precision and computation time using this methodology have been estimated on a core configuration inspired by the well-known C5G7-benchmark. Preliminary results are promising both in terms of time and precision.

Language:

English

Field:

Neutronics

Poster advertising session / 11

Biocompatible photoacoustic nanoparticular contrast agents based on BODIPY-scaffold and polylactide polymers

Authors: Jean-Baptiste Bodin[1]; Justine Coïs[2]; Lefebvre Flora[3]; Magali Noiray[3]; Gilles Clavier[2]; Jérôme Gateau[4]; Nicolas Tsapis[5]; Rachel Méallet-Renault[6]

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Photoacoustic imaging is an emerging biomedical imaging modality combining optical and ultrasound waves to map optical-absorption contrast at centimetric depth with sub-millimeter resolution. The key is the photoacoustic (PA) effect: optically absorbing structures emit ultrasound waves when excited with a ns-laser pulse. To reach cm-depth, PA imaging operates in the near-infrared (NIR) window in biological tissue (650-1000nm). NIR optical absorbers can thus be mapped throughout the range of depths and resolution explorable with medical ultrasound. We have designed novel PA molecules based on the BODIPY scaffold. These PA-BODIPYs were used as initiators for the ring opening polymerization of lactide to yield BODIPY-polylactide, that were further formulated into nanoparticles (NP). We present here the full spectroscopic and photoacoustic characterizations of the PA-BODIPYs, the corresponding polymers and NPs. Results show BODIPY NPs are promising contrast agents for PA imaging.

Language:

English

Field:

Photophysic, Photoacoustic imaging, polymer, nanoparticles

Poster advertising session / 26

Hight Granularity Timing Detector (HGTD)

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The large increase of pile-up interactions is one of the main experimental challenge for HL-LHC physics program. Covering the pseudo-rapidity region between 2.4 and 4.0, the Hight Granularity Timing Detector (HGTD) is therefore proposed for the ATLAS Phase-II upgrade. Using the ability to distinguish between interactions within an event at different ⊠ positions or time by high-precision timing information, HGTD is powerful to mitigate the effect of pile-up. One crucial element for this mitigation is to know the t0 of each of the 3.6 million channels, where t0 is the time of particles created at ⊠ =0. This is important to achieve the expected time resolution which expected to be around 15 ps, coming mainly from electronic jitters and geometrical effects, e.g. time of flight. These effects must be moderated and calibrated to minimised their contributions to time resolution. A calibration framework for time calibration is developed. In this presentation, we discuss in details the time calibration methodology and its performances using dedicated studies.

Language:

English

Field:

Experimental Physics, ATLAS detector, HGTD, HL-LHC

Poster advertising session / 20

Ab-initio study of harmful defect passivation in Se alloyed CdTe

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Cadmium telluride (CdTe) solar cells are still at the front end of the few thin-film technologies exceeding 22% of efficiency. The latter record was made possible by Se alloying in the CdTe absorber.[1] This surge in efficiency has seen the manufacturing cost reducing to such levels that now CdTe photovoltaics electricity is cheaper than popular silicon photovoltaics. CdTe has a band-gap value of ~1.5 eV close to the optimum band-gap of 1.34 eV for maximum theoretical solar cell efficiency according to the Shockley–Queisser thermodynamic limit. It has been shown that Se alloying can improve the CdTe solar cell efficiency. The first effect comes from a band-gap grading from 1.46 to 1.36 eV leading to an increase of the wavelengths absorption range. However, unavoidable native defects in the core of the semiconductor are expected to act as a non-radiative recombination center killing the energy conversion effect by capturing the charge carriers. In addition to band-gap grading, Se diffusion inside the CdTe absorber has been recently probe as a key for the passivation of some critical defects thus explaining the higher luminescence efficiency in Se alloyed solar cell. [2] In this contribution, using density functional theory (DFT), we will provide a microscopic picture of the role of Se in the process. Our study is two folds. We first identify the mechanism responsible for the fast diffusion of Se in CdTe. Next, we analyze the role of the diffusion Se in the passivation of two harmful intrinsic defects.
References:-
[1] N. R. Paudel and Y. Yan, Applied PhysicsLetters105, 183510 (2014)
[2] T. A. M. Fiducia, B. G. Mendis, K. Li, C. R. M. Grovenor, A. H. Munshi,K. Barth, W. S. Sampath, L. D. Wright, A. Abbas, J. W. Bowers, and J. M.Walls, Nature Energy4,504–511 (2019)

Language:

English

Field:

Poster advertising session / 37

On-off intermittency due to parametric Lévy noise

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Instabilities arise in many physical systems at some parameter threshold. Typically the system is embedded in an uncontrolled noisy environment. The fluctuating properties of the environment affect the control parameters of the instability, which leads to multiplicative noise. The result of multiplicative noise close to an instability threshold is on-off intermittency, which is characterised by an aperiodic switching between a large-amplitude "on" state and a small-amplitude "off" state.

Here, present a new form of intermittency, \textit{Lévy on-off intermittency}, which arises from multiplicative α-stable white noise close to an instability threshold. We study this problem in the linear and nonlinear regimes, both theoretically and numerically, for the case of a pitchfork bifurcation with fluctuating growth rate. We compute the stationary distribution analytically and numerically from the associated fractional Fokker-Planck equation in the Stratonovich interpretation. We characterize the system in the parameter space α, β of the noise, with stability parameter $\alpha \in (0, 2)$ and skewness parameter $\beta \in [-1, 1]$. Five regimes are identified in this parameter space, in addition to the well-studied Gaussian case $\alpha = 2$. Three regimes are located at $1 < \alpha < 2$, where the noise has finite mean but infinite variance. They are differentiated by β and all display a critical transition at the deterministic instability threshold, with on-off intermittency close to onset. Critical exponents are computed from the stationary distribution. Each regime is characterized by a specific form of the density and specific critical exponents, which differ starkly from the Gaussian case. A finite or infinite number of integer-order moments may converge, depending on parameters. Two more regimes are found at $0 < \alpha \leq 1$. There, the mean of the noise diverges, and no critical transition occurs. In one case the origin is always unstable, independently of the distance μ from the deterministic threshold. In the other case, the origin is conversely always stable, independently of μ. We thus demonstrate that an instability subject to non-equilibrium, power-law-distributed fluctuations can display substantially different properties than for Gaussian thermal fluctuations, in terms of statistics and critical behavior.

Language:

English

Field:

Stochastic dynamical systems, Nonequilibrium systems,
Bifurcations, Fluctuations & noise, Levy flights, Phase transitions, Stochastic processes

Poster advertising session / 31

Physics of embryonic cavity formation by hydro-osmotic coarsening

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The blastocoel is a fluid-filled cavity characteristic of the blastula stage during embryonic development. Its formation is a keystone in the morphogenesis of the mammalian embryo, yet the physical mechanism for its emergence remains unclear.
We recently showed that the blastocoel results from micron-sized cavities, nucleating at the adhesive side of cells and coarsening in a process akin to Ostwald ripening [1].
We investigate theoretically and numerically the collective dynamics of a one-dimensional chain of micro-cavities as a minimal model for cavity formation, considering explicitly the osmotic effects. We include permeation of water and osmolytes through the cellular membrane that may screen exchanges between micro-cavities [2].
We show that the coarsening of the chain is reminiscent of dewetting films, with a dynamical scaling law for the number of micro-cavities [3]. This scaling law is controlled by a screening length associated with water permeation, while the influence of osmotic inhomogeneities remains limited.
Finally, we consider active osmolyte pumping, that can lead to a novel dynamical scaling law dominated by the coalescence of micro-cavities, and that may also direct the position of the final cavity and break the radial symmetry of the embryo.

References
[1] Dumortier et al., Science, 2019
[2] Le Verge–Serandour and Turlier, bioRxiv, 2021
[3] Gratton and Witelski, Physica D, 2009

Language:

English

Field:

Theoretical Biophysics, Modelling, Morphogenesis, Embryogenesis

Poster advertising session / 40

The performance of a critical review of heat transfer characteristic using nanofluid flow

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the Experimental and theoretical research related to improving the transfer of a number of authors have carried out heat using nanoparticles and their results showed that the heat transfer of nanofluids is very important in this context our work presents a critical model for improved heat transfer This work is done on the basis of a 2D numerical dimension of heat transport models, which can be used to develop a better coupled geometry for a better cooling system This work includes the results of a numerical simulation performed to study the nanofluid flow . Two types of nanofluids involving Al2O3 and CuO nano-particles dispersed separately in base fluids of water and ethylene glycol , those nanofluids were taken to evaluate their effect on the flow around different arrangement of cylinders. The continuity and the momentum equations have been numerically
solved by using a special technic. Besides the thermo-physical parameters of nanofluids have been evaluated using the theory of one fluid phase, thus, con-temporary correlations of thermal conductivity and viscosity of nanofluids have been used in this paper as well as our previous work. The correlations are functions of particle volumetric concentration as well as temperature. The results of heat transfer characteristics of nanofluid flow of this critical review rev-eled clear improvement comparing with the base fluids. This enhancement is very interesting in engineering of flows with different situation characteristics, while the gap ratios (G/D) of our review and incidence angle exert an enhancement efficiency influence on the heat transfer characteristics. In this study the results obtained can be a fruitful source for developing and validating of new codes both in scientific and commercial manner.
Key words: Nanofluid, Fluid flow, Heat transfer, 2D simulation, critical review

Field:

Language:

English

Poster advertising session / 39

Scalar field dark matter scenarios

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In the paradigm of the Standard Cosmological Model, 83% of the mass density in the Universe cannot be explained with ordinary baryonic matter and requires an additional non-baryonic component. The preferred scenario since the 1980s is weakly interacting massive particles scenario (> 1 GeV) (WIMPS). However, despite many experiments, these particles have still not been detected. This has revived interest in alternative scenarios, including the possibility that dark matter is associated with a scalar field filling all the space. One of the most attractive features of this model is that scalar fields can form stable equilibrium configurations called solitons and then are able to form structure. This project aims the development of new numerical studies to analyze the formation of large-scale structures in this scenario. At this first stage, we develop numerical calculations in simple situations such us the relaxation of the scalar cloud in a galactic halo or the collision of two solitons.

Field:

Cosmology, dark matter.

Language:

English

Poster advertising session / 35

Experimental characterization of intergranular fracture of irradiated austenitic stainless steels

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Austenitic stainless steels are used in the nuclear industry to make the internals parts of Pressurized Water Reactors (PWR) such as baffle and former plates. Numerous Baffle-to-Former Bolts (BFB) intergranular failures have been reported as a result of Irradiation Assisted Stress Corrosion Cracking (IASCC) phenomenon. In order to predict the cracking of the grain boundary through a micromechanical approach, it is necessary to determine the intragranular mechanical behavior of the steel and the grain boundary strength.

Micro-compression tests of non-irradiated and proton irradiated 304L micro-pillars will be performed to collect experimental data on the mechanical behavior at the single crystal scale. Based on these experiments and data available in the literature, numerical simulations will be set up to calibrate the parameters of crystal plasticity constitutive equations as a function of irradiation dose and temperature.

To obtain the cracking resistance of the grain boundary, experimental bending tests on micro-cantilevers containing a grain boundary will be carried out on non-irradiated and proton irradiated pre-oxidized 304L steel. Numerical simulations of these experiments will be performed to evaluate failure stresses of the grain boundary as a function of oxidation time, irradiation and grain boundary type.

Field:

Material Sciences

Language:

English

Poster advertising session / 10

Energy Gap Closure of Crystalline Molecular Hydrogen with Pressure

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We study the gap closure with pressure in Phases III and IV of molecular crystalline hydrogen by Quantum Monte Carlo methods [1]. Nuclear quantum and thermal effects are considered from first principles with Coupled Electron Ion Monte Carlo. The fundamental electronic gaps are obtained from grand-canonical Quantum Monte Carlo methods [2] properly extended to quantum crystals. Nuclear zero point effects cause a large reduction in the gap (~2eV). As a consequence the fundamental gap closes at 530GPa for ideal crystals while at 360GPa for quantum crystals. Since the direct gap remains open until ~450GPa, the emerging scenario is that upon increasing pressure in phase III (C2/c-24 crystal symmetry) the fundamental (indirect) gap closes and the system enters into a bad metal phase where the density of states at the Fermi level increases with pressure up to ~450GPa when the direct gap closes. Our work partially supports the interpretation of recent experiments in high pressure hydrogen.

[1] Phys. Rev. Letts.1 24, 116401 (2020)
[2] Phys. Rev. B 101, 085115 (2020)

Field:

Language:

English

Oral presentations session / 22

Investigating dense matter using Neutron Star observations

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Neutron Stars are compact objects which interior is subject to extreme densities, gravitational fields and magnetic fields. As such conditions cannot yet be reproduced in laboratories, astronuclear physicists use multi-messenger astronomy to turn Neutron Stars into our very own extraterrestrial laboratories for dense matter. We present some recent results established from X-ray measurements

of Neutron stars observed in binary systems; a new nuclear hopothesis is established to try and reproduce the exhibited luminosities of sources that have only accreted small amounts of matter from their companion star. We also put into question some established relations between several macroscopic parameters of Neutron Stars when the nuclear model used for their interior is not consistently calculated for all parts of the star.

Field:

Astrophysics, nuclear physics, compact objects, dense matter

Language:

English

Oral presentations session / 17

A new born hypothesis for the Madden-Julian Oscillation (MJO)

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More than half of the globe is considered the tropics, thus a proper understanding of the tropical atmosphere is crucial for improved global forecasts as well as the projections of the global climate change. The tropical atmosphere is traditionally considered dominated by moist cumulus convection associated with strongly divergent horizontal flows. The Madden-Julian Oscillation (MJO) is the dominant slowly eastward propagating mode of intra-seasonal planetary scale variability in the tropical atmosphere. Previous theoretical studies, modeling, and field observations have contributed positively to our understanding of MJO; nevertheless, there is no robust theory for a few aspects of the dynamics of MJO such as its initiation, role of moist-convection on propagation speed, the barrier effect of the Maritime Continent on MJO propagation, and its slowly eastward propagation mechanism, which are poorly understood. Understanding the essential dynamics of the MJO is the "holy grail" in the study of tropical dynamics and atmospheric science research (Fuchs & Raymond, 2017). By using a hierarchy of models and theoretical studies, we raise this hypothesis that MJO-like skeleton can be generated in a self-sustained manner from a large-scale localized heating in the lower troposphere, over the warm pool, as a "hybrid structure". The latter is constituted by combination of a "equatorial modon" and convectively coupled by detaching baroclinic Kelvin wave that lasts for an interseasonal scale. The presentation includes a summary of five articles that have been published recently in some ISI journals by the authors.

Firstly, we show the construction of new improved moist-convective Rotating Shallow Water (mcRSW) model (Rostami and Zeitlin, 2018) and its well-balanced, shock capturing, front resolving, finite volume scheme features. Secondly, we explain one of the main observations of the authors that was discovery of a nonlinear dynamical regime in the Rotating Shallow Water (RSW) model which arises in the limit of small pressure variations and gives a slow propagating coherent dipolar structure so called "Equatorial Modon" (Rostami and Zeitlin, 2019a). Thirdly, we demonstrate that in the pioneering work by authors (Rostami and Zeitlin, 2019b) the Equatorial Modon's structure can also be emerged from the process of geostrophic adjustment of localized large-scale depression-type disturbance in the mcRSW model on the equatorial beta-plane. Other dynamical features of equatorial modons, such as loss of coherency, eastward propagating phase speed, role of bottom topography, etc have been investigated too (Rostami and Zeilin, 2020a). Finally, by reproducing "generation" of MJO-like structure from geostrophic adjustment of baroclinic disturbances in tropical atmosphere, we propose the aforementioned hypothesis as the backbone structure of the MJO (Rostami and Zeitlin, 2020b).

Field:

Geophysical Fluid Dynamics, Fluid Dynamics, Atmosphere Science, Tropical Extreme Events, Vorticity Dynamics, Atmosphere Modelling, Conservation Laws.

Language:

English

Oral presentations session / 21

JT-60SA Tokamak Toroidal Field Coils Quench Analyses with STREAM New Analytical Model

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For the commissioning of JT-60SA Tokamak (Japan, beginning of 2021, Project decided in the framework of Broader Approach to ITER Tokamak Project), all the superconducting coils have to be energized with a set of reduced and then nominal current after they became superconducting at 4.5 K cooling temperature with supercritical helium forced flow in Cable-In-Conduit Conductors (CICC). An important Issue is to predict the Joule Energy for the Toroidal Field Coils (TFC), in case of an incidental quench – transition from superconducting to resistive state- arises, as well as the respectively "hot spot" temperature, the maximal conductor temperature reached during the quench development.
For this analysis a Superconductor Thermohydraulical and Resistive Electrical Analytical Model (STREAM) new code has been developed. This code takes into account in first phase an isentropic compression of the so called "cold" helium volume by the "hot" or "heated" volume in the coil; the second phase being an expulsion (over pressure threshold) trough exhaust circuit of helium with limits to the sound velocity or atmospheric pressure. The propagation of quench, considering the "normal length" (quenched length of superconductors) is governed also by analytical and explicit correlation and model. STREAM analytical model permits more rapid quench calculation than SuperMagnet code (CryoSoft, CERN, finite element numerical model), including THEA (Thermohydraulic 1-D CICC) and Flower (external cryogenic cooling circuit model) which has also been used for comparison.
Some analyses have been performed on the acceptance quench test realized at the Cold Test Facility (CTF, CEA Saclay in 2018) on the spare coil TFC02. The quench test Joule energy has been evaluated with STREAM and SuperMagnet. The different calculation results, in particular helium temperature and pressure in upstream and downstream manifold are presented here and are in good agreement with the measurements.
In Tokamak configuration at nominal current and at maximal magnetic field location (at inlet of CICC over few meters), the initiation of the quench (with Minimum Quench Energy - MQE) is set as input on each first turn of the 12 Pancakes of the coil's Winding Pack. The integrated and detailed Joule Energy value depends strongly on the number of the entirely and rapidly quenched pancakes (maximal quench propagation velocity near 16 m/s). The maximal conservative quench Joule energy is determined to be near 7 MJ (12 times the maximal energy per pancake), which has to be compared and added to the eventual eddy currents losses, equal to 11 MJ, in the whole 18 TF Coil thick casing in case of a fast current discharge.
This analysis has been useful also for the JT-60SA Tokamak magnets energization and commissioning phase. This analysis confirms also, among others, that STREAM analytical model is valid for CICC coils cooled by forced flow of supercritical helium and can be useful for tokamak magnets protection during quench event and safe operation (WEST and ITER).

Language:

English

Field:

Fusion, Superconducting Magnets, Quench, Thermo-hydraulics

Oral presentations session / 23

Nonlinear neural network dynamics accounts for human confidence in a sequence of perceptual decisions

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Electrophysiological recordings during perceptual decision tasks in monkeys suggest that the degree of confidence in a decision is based on a simple neural signal produced by the neural decision process. Attractor neural networks provide an appropriate biophysical modeling framework (Wong and Wang 2006), and account for a variety of experimental results. Here we report on our work providing the first quantitative confrontation of an attractor neural network behavior with human behavior during full sequences of perceptual decisions, modelling reaction times, success rate and confidence. For this we experimentally investigate confidence formation and its impact on sequential effects in human experiments. Participants perform an orientation discrimination task on Gabor patches that deviates clockwise or counter-clockwise with respect to the vertical. In some blocks, after reporting their decisions, participants perform a confidence judgment on a visual scale. For the modelling, following Wei and Wang (2015), we assume that confidence is an increasing function of the difference, measured at the time the decision is made, between the mean spike rates of the two neural pools specific to one or the other of the two possible choices. We show that behavioral effects of confidence can be accurately estimated for each participant. Moreover, we find that the attractor neural network accurately reproduces an effect of confidence on serial dependence which is observed in the experiment: participants are faster (respectively slower) on trials following high (resp. low) confidence trials. Standard models of decision making are based on the biased diffusion of variables (neural activity levels) representing the accumulation of evidence in favor of one or the other choice. These models cannot account for sequential effects without ad-hoc changes of parameters from trial to trial. In contrast, our results show that a biophysical neural network accounts for these effects without any change of parameters in the course of the experiment. We conclude that the sequential effects result from the intrinsically non-linear nature of the underlying neural network dynamics.

Field:

Computational Neuroscience

Language:

English

Oral presentations session / 42

A thin solid hydrogen target for ion acceleration at a high repetition rate

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Laser-plasma acceleration is used to accelerate charged particles and can minimize the size of the next-generation accelerators. However, compared to radiofrequency accelerators, the energies of particles are still low. The ion beam produced by the interaction of the target medium and the high-power laser depends mainly on the laser parameters and the target characteristics. To enhance the ion energy, the target needs to be thinner to foster a radiative pressure acceleration scheme rather than other ions acceleration schemes. The low-temperature system department, DSBT, has developed the cryostat Elise, to produce a solid hydrogen target at 10 K with a thickness of a hundred micrometer. This target is extruded continuously through the nozzle using the hydrogen changes state. The low rise of the vacuum level during the experiment is compatible with the petawatt high repetition rate laser facility as Apollon or Eli-Beamlines. The current development to reduce the thickness is to use a 2200 nm laser to sublimate the target surface. The new target thickness will be measured by a Nomarski interferometer with two different wavelengths.

This talk will present two ions acceleration schemes, TNSA and RPA, the current development to reduce and measure the target thickness.

Field:

Language:

Awarding of the Young Researchers' Prizes from the French Physical Society / 4

Awarding of the Young Researchers' Prizes from the French Physical Society

Awarding of the Young Researchers' Prizes from the French Physical Society / 28

Chasing the cosmic accelerators with high energy astroparticles

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The advent of time-domain and multimessenger astronomy opens new perspectives to study the most energetic phenomena of our universe, and identify the mysterious sources of ultra-high-energy cosmic rays and high-energy neutrinos. In my thesis, I developed new analytical and numerical tools to study the production of cosmic rays, gamma rays and neutrinos from various populations of energetic sources. A general criteria for the detectability of neutrino flares allow us to identify promising sources for multimessenger emissions, namely pulsars and tidal disruption events. We demonstrate that millisecond pulsars can produce high-energy cosmic rays and, in the Galactic center region, the gamma rays observed by the H.E.S.S. observatory. Moreover, we show that an extragalactic population of tidal disruption events can produce the ultra-high-energy cosmic rays detected by the Pierre Auger observatory. Finally, I contribute to the development of novel methods to detect and reconstruct the properties of ultra-high-energy cosmic rays and neutrinos in the collaborations GRAND and POEMMA.

Field:

Language:

English

Awarding of the Young Researchers' Prizes from the French Physical Society / 27

Crafting magnetic skyrmions at room temperature : size, stability and dynamics in multilayers

Author: William Legrand[1]

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Magnetic skyrmions are nanoscale non-collinear configurations of the magnetic order, featuring specific topological properties. This talk will present how the proper balance of several magnetic interactions allows for their stabilization up to room temperature. One key ingredient is the presence of a Dzyaloshinskii-Moriya antisymmetric exchange interaction, which will be discussed from an experimental point of view. Further, different experiments will be presented, which show how the nucleation, displacement and detection of magnetic skyrmions can be associated in nanostructured electronic devices. Magnetic skymions are promising for high-density, low consumption large-scale electronic applications as well as for new computation architectures, and are thus at the basis of many proposals for novel functionalities in computing electronics, which will be briefly outlined.

Field:

Language:

English

Oral presentations session / 8

Unveiling nanoscale optical and structural properties of TMD monolayers using combined electron spectroscopies techniques

Authors: Noémie Bonnet[1]; Hae Yeon Lee[2]; Fuhui Shao[3]; Steffi Y. Woo[3]; Kenji Watanabe[4]; Takashi Taniguchi[4]; Alberto Zobelli[5]; Odile Stéphan[5]; Mathieu Kociak[3]; Silvija Gradecak-Garaj[2]; Luiz H. G. Tizei[3]

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In this contribution, we will present new results on optical and structural properties of WS2 (from the TMD semiconductor family) encapsulated monolayer, at the tens of nanometer scale. The strength of this work is the correlation of optical spectra at the nanoscale with structural and chemical maps, connecting what is usually available in optical diffraction limited techniques, such as photoluminescence (PL), and high spatial resolution techniques, such as electron microscopy or scanning tunneling microscopy.

To achieve this, high spatial and spectral resolution techniques were used in an aberation-corrected scanning transmission electron microscope (STEM). Electron energy loss spectroscopy (EELS) was used to obtain optical absorption (low loss range) and chemical analysis (core loss range).
Cathodoluminescence (CL), a nanoscale counterpart of PL, used was to measure light-emission at tens of nanometers scale. Both spectral information can be measured from the same regions in samples, at the tens of nanometer scale. With these combined information, one has access, for example, to the local Stokes shift, which is the difference between absorption and emission energies.

Using these optical absorption and emission techniques, we found very localized, down to ten nanometers, emission from the WS2 encapsulated monolayer, measured at 150K in a STEM microscope. To understand the origin of such localization, high resolution structural measurements were done, including atomically-resolved imaging and nanoscale diffraction, both giving access to local strain.

Field:

Nanophysics, nano-optics, electron microscopy, electron spectroscopy, optical spectroscopy

Language:

English

Oral presentations session / 9

Globluar clusters - Milky Way and beyond

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Stars are formed when a humongous molecular clouds collapses under its own gravity giving rise to multiple local collapses within the cloud itself. Stars are never formed in isolation and are always formed in groups. When one cloud collapses it gives rise to formation of multiple stars in the same system. When formed this way the stars share similar chemical properties and are of same ages since they share same parent cloud and the entire system hence evolves as a star cluster. Globular clusters (GCs) are the star clusters which are extremely old as compared to another category of star clusters which are relatively young and are known as Open Clusters. are the star clusters which are extremely old as compared to another category of star clusters which are relatively young and are known as Open Clusters. The object of this presentation is Globular clusters.

Since the stars in a GC share the same age and same metallicity, the stars in the same GC are expected to only differ with respect to their masses. The mass of a star govern the rate of its evolution. The stars in GC are thus a perfect tool to study and validate our theories of stellar evolution.

Evidently, the GCs are not only present in our galaxy but are ubiquitously found in almost all the galaxies, irrespective of the type of the galaxy. GC population of a galaxy is a signature of its formation and tumultuous past and hence a very important tool if one wants to study the galaxies and their properties.

In my presentation, I will give a brief introduction of the GC as an individual entity and its importance in studying life cycle of a star and then as part of a bigger system and their roles as one of the indicators of evolution of their parent system.

Language:

English

Field:

Astronomy

Oral presentations session / 30

Axion hot dark matter bound, reliably

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Axions originally emerged as low-energy remnants of the Peccei Quinn solution to the strong CP problem, but they also unavoidably contribute to the energy density of the Universe. The thermal axion population contributes to the effective number of extra relativistic degrees of freedom, whose value is constrained by cosmic microwave background (CMB) experiments.
In the talk I will discuss axion thermalization at temperatures below 150 MeV, where the main thermalization channel is the axion-pion scattering. Based on the leading order (LO) axion-pion chiral effective field theory (EFT), the highest attainable axion mass is approximately below the eV. However, this bound is found to be not reliable, since in a heat bath of 100 MeV the axion-pion scattering happens at center of mass energies above the validity of the 2-flavour chiral EFT.
To prove this, I will provide the full axion-pion thermalization rate to next-to-leading order, and show that the LO bound is indeed obtained by extrapolating the chiral expansion in a region of temperatures where the effective field theory breaks down.
Thus, in order to set targets for future CMB experiments, new strategies are required to obtain a reliable bound.
Based on arXiv: 2101.10330

Language:

English

Field:

Axions, Quantum field theory, Astroparticle physics, Cosmology

Oral presentations session / 36

Probing inflation with cosmological observations

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Inflation is a hypothetical very early period of the universe when it was expanding exponentially. It has been introduced to explain the homogeneity and the flatness of the observed universe. Remarkably, inflation provides a very nice explanation for the origin of the tiny fluctuations that we observe in the cosmic microwave background: all the known particles come from one single scalar field decay. These primordial fluctuations are the seeds of structure formation (filaments, clusters, galaxies…). In addition, the study of this epoch gives us a unique probe of very high energy physics of the order of $10^{15} - 10^{16} GeV$. We will explain two particularly interesting features of the primordial perturbations: Adiabatic/isocurvature and (non-)Gaussianity. A detection of non-Gaussianity and/or isocurvature modes would be interesting since both could rule out the simple single-field inflation models and demonstrate the presence of multiple fields interacting at very high energy and/or modified gravity. To study these features, we usually look at the statistics of the fields that we can

observe: temperature and polarization in the case of the CMB and galaxies and/or distribution of matter in the case of large-scale structure.

Field:

Cosmology

Language:

English

Oral presentations session / 12

New coarse grained approach to study polymer networks

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Resistance to fracture is an essential property for manufacturers, in particular those who work with elastomers. In a highly deformed crosslinked polymer, the force to which each chain is subjected depends on the local structure of the network (length of the chains, number of entanglements, local geometry, etc.). In general, a chain breaking is caused by extreme tension. Following a chain breaking, the prior stress supported by the chain is redistributed to its neighbors, who have their tensions increase and they will also end up breaking. An avalanche of ruptures follows which leads to a total rupture of the material. In order to study the behavior of elastomeric networks, we have developed models and numerical tools to simulate our systems at the crosslinked network scale. Our approach differs from historical analytical models by the use of coarse-grained models. One of our first results was to be able to measure the local stress distribution during elongation of the material.

Field:

Simulation - Mechanics - Polymers

Language:

English

Oral presentations session / 38

Nuclear Structure and alpha radioactivity

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Nuclear systems display a huge diversity of properties, proving the complexity of their structure. This complexity has multiple causes, the first one being the inner structure of protons and neutrons. Since they are constituted of quarks, the underlying theory of Quantum ChromoDynamics (QCD) plays an important role in the description of nuclei. However, at the energies involved in nuclear systems (~1 to 10 MeV), QCD is known to be non-perturbative, leading to many difficulties to obtain a reliable description of the interaction.

Another important aspect of atomic nuclei lies in their composition, in terms of multiple nucleons bound in a very complex way. The resulting quantum many body problem is extremely hard to tackle. Its solution cannot be obtained without approximations and the mean-field framework turns out to be a very powerful framework. Additionally, it can be coupled to many "beyond mean field" techniques allowing for a broader and better description of nuclear properties. However, as often in physics, many particles being involved in a coherent system gives rise to collective features. A nucleus does not circumvent this rule and many interesting aspects emerge from collectiveness (rotation, vibration, superfluidity, clustering, deformation, …).

Among the many properties studied in nuclear structure, radioactivity is of particular interest. More precisely, alpha decay remained, until last year, the only kind of radioactivity which was not entirely understood from the microscopic point of view. Its first description has been achieved using a covariant EDF framework in mid-mass nuclei, namely in the ^{108}Xe decay chain.

Field:

Nuclear Structure Theory

Language:

English

Oral presentations session / 25

EFT and Top quark spin observables

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Measurements of top quark spin observables in $t\bar{t}$ events represents a unique possibility to test the standard model (SM) predictions and probe the new physics effects. Potential deviations from the SM expectations are parametrized within the framework of the Effective Field Theory (EFT). In this presentation, we introduce how to measure the spin correlation between top quarks and we cover the impact of introducing dimension-six operators spin observables.

Field:

Physic analysis (ATLAS, CERN), Theoretical physics (EFT), Interpretation

Language:

English

Oral presentations session / 13

Multi-messenger Transient Astrophysics with very-high energy gamma rays

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When a cataclysmic event takes place in the Universe, like the coalescence of compact objects like neutron stars or black holes, it is unveiled through a variety of waves and rays emanating from it. These are considered as messengers that can be detected on Earth through different observatories. Each one of these emissions is a signature of a particular physical phenomenon that is taking place. For example, very-high energy gamma rays can probe cosmic ray acceleration processes at the site of the merger. A cosmic event like the merger of two compact objects has a multi-messenger aspect since it can potentially emit electromagnetic waves, gravitational waves, neutrinos, and cosmic rays with different information carried out by each type of messenger. The emitted messengers are characterized by their transient aspect, since they appear suddenly and show important variability through time.
In my contribution on Multi-messenger Transient Astrophysics, I explain how the combination of information from different messengers can help to better understand comic physical phenomena and study special sources. From my position in the H.E.S.S. collaboration, an array of Imaging Atmospheric Cherenkov Telescope dedicated to the study of photons in the GeV to TeV range, I present new methods to hunt multi-messenger transient events. I also present different analysis allowing to uncover the mystery behind non-thermal phenomena, concentrating my search on gravitational waves events, gamma ray bursts and Fast Radio Bursts. Finally, I show the results of observations of some particular events like the GW170817 binary neutron star merger and the GW170814 binary black hole merger. I also reveal details of recent studies on some particular Fast Radio Bursts and on some sources like SGR1935+2154 that recently triggered the interest of the astronomical society.

Field:

Astrophysics

Language:

English

Oral presentations session / 5

Survival probability of a run-and-tumble particle in the presence of a drift

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Brownian motion is certainly one of the most popular stochastic process to model particles in interaction with their surrounding environment. In its simplest form, Brownian motion is driven by an uncorrelated white noise induced by thermal fluctuations. Thanks to its universality, it has proven to be a successful model to describe a wide range of *first-passage* phenomena whereby a particular event, such as a financial stock reaching a stop price or a river overflowing its bank, relies on the system reaching a specified value *for the first time*. While many results exist on the first-passage time of the Brownian motion, very few are known for particles driven by correlated colored noise. In this talk, I will present recent analytical work on the first-passage times of *active particles* which are of timely interest as they naturally emerge in the context of living matter such as the E. coli bacteria, fish schools or bird flocks.

Field:

Statistical Physics

Language:

English

Oral presentations session / **29**

modeling and interpretation of spectral properties of primeval galaxies

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The James Webb Space Telescope will enable the direct exploration of primeval galaxies near the Epoch of Reionization, at the end of the Dark Ages. To best interpret these upcoming observations in terms of constraints on theories of galaxy formation and evolution, we require models of the light emitted by the first galaxies. A particularly critical task is to identify spectral diagnostics of the different ionizing sources capable of powering the first galaxies, such as young massive stars and accreting black holes, and of the leakage of ionizing radiation into the intergalactic medium. This is the focus of this presentation.

Language:

English

Field:

astrophysique

Oral presentations session / **33**

Study of Mott materials for neuromorphic applications using a simple circuit model

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Mott insulators are materials which should have metallic properties according to tight-binding calculations, but are found to have insulating properties instead. This discrepancy between theory and experiments can be explained with the failure of the independent-electron approximation to account for Coulomb interactions, which are not negligible in such materials. When this contribution is included in the calculation of the electronic structure, like in the Hubbard model, the half-filled band splits and a gap in the density of states opens up, explaining the insulating behavior. However, Mott materials such as transition metal-oxides, can be made to behave like metals under certain conditions, for example when the material is heated up by application of a voltage. The resistive collapse that follows the application of the bias voltage and signals the insulator-to-metal transition is of particular interest, since it occurs at room temperature, paving the way for the use of Mott materials in a variety of applications, such as next generation memories and neuromorphic devices.
In this presentation we describe the insulator-to-metal transition using numerical simulations based on the Mott resistor network, a phenomenological model that makes no use of microscopic equations and instead describes the sample as a circuit of resistors governed by classical laws. This makes the model easy to understand and tinker with. We showcase the ability of the model to reproduce experimental results, while also allowing to study the resistive collapse with greater temporal resolution

than that afforded by the instrumentation. Finally, a comparison is made between the dynamics of the resistive collapse and neuronal dynamics, showing how it may be possible to use Mott materials to build neuromorphic devices that mimic the behavior of biological neurons.

Field:

Strongly correlated electrons systems, Mott materials, neuromorphic computing

Language:

English

Oral presentations session / 19

SHG origin in Gold Nanoantennas

Author: Sanro Mathew[1]

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Second harmonic generation (SHG) is a nonlinear optical process that has been the basis of applications including frequency-doubling of laser sources, characterization of materials and it has also been a subject of fundamental research interest since decades.
Within this context, nonlinear plasmonics is one sub-domain of nanophysics wherein nonlinear optical processes such as SHG are generated and enhanced at the nano-scale using plasmonic nanostructures. While the theory of SHG in metals have been formulated since more than a few decades, the role played by certain second harmonic (SH) contributions in metal nanostructures has not been rightly attributed to SHG and has therefore resulted in sizeable disagreement in the literature.
In order to solve this longstanding problem, here, we investigate SH contributions via numerical simulations and compare them with the experimentally obtained SH response of gold nanostructures, in particular, rectangular double antennas and prism antennas.
The simulations are based on finite element methods wherein response due to individual SH contributions are obtained separately and followed by coherently summing up these contributions to account for constructive and destructive interferences among the nonlinear processes. On the experimental side, antennas are fabricated by electron beam lithography and chemical synthesis in order to investigate surface roughness and crystallinity which is believed to play an important role in SH contribution. The SH measurement is then performed on the antennas via an experimental setup developed to reach single particle sensitivity.
Thus in this regard, we are able to precisely identify and attribute the role of SH components in SHG from plasmonic nanoantennas by comparing the maps generated from the simulations and experiments.

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Field:

Nonlinear Plasmonics

Language:

English