Home page: https://www.nucleares.unam.mx/lasnpa2024/

Contact: lasnpa2024@nucleares.unam.mx

Local Organizing Committee

- Roelof Bijker (ICN-UNAM, chair)
- María Ester Brandan (IF-UNAM, co-chair)
- Paulina Amador (ININ)
- Libertad Barrón (IF-UNAM)
- Javier Mas (ICN-UNAM)
- Víctor Velázquez (FC-UNAM)

Members of IAC

1. Ricardo Alarcón (ASU, USA)
2. Hugo Arellano (U. de Chile, Chile)
3. José Miguel Arias (Sevilla, Spain)
4. Miguel Ángel Ávila Rodríguez (FM-UNAM, Mexico)
5. Michael Block (Mainz, Germany)
6. Leah Broussard (ORNL, USA)
7. Osvalo Civitarese (La Plate, Argentina)
8. Phil Cole (Lamar, USA)
9. Jutta Escher (LLNL, USA)
10. Alfredo Galindo Uribarri (ORNL, USA)
11. María José García Borge (CSIC, Spain)
12. Paul Garrett (U. Guelph, Canada)
13. Gabriel González Sprinberg (U. de la República, Uruguay)
14. Carlos Granja (Advacam, Czech Republic)
15. Atsushi Hosaka (Osaka, Japan)
16. Neelima Kelkar (U. de los Andes, Colombia)
17. Andrés Kreiner (TANDAR-CNEA, Argentina)
18. Silvia Lenzi (Padova, Italy)
19. Alinka Lépine (IF-USP, Brazil)
20. Rubens Lichtenthäler (IF-USP, Brazil)
21. Jorge López (UTEP, USA)
22. Augusto Macchiavelli (ORNL, USA)
23. Nilberto Medina (IF-USP, Brazil)
24. Arturo Menchaca (IF-UNAM, Mexico)
25. Oscar Naviliat-Cuncic (MSU, USA)
26. Antonio Ortiz (ICN-UNAM, Mexico)
27. Bernd Surrow (Temple, USA)
28. Diego Torres (UNAL, Colombia)
29. Ubirajara Van Kolck (IPN-Orsay, France)

Venue

Facultad de Ciencias, UNAM
Ciudad Universitaria

The plenary talks will take place in the main auditorium: Alberto Barajas Celís.

The parallel sessions and the poster session will be held in the Amoxcalli building.

Lunch will be served on the terrace of the Tlahuizcalpan building.

Wifi username: pcpuma
password: mango2022

Program Plenary Sessions

Latin American Symposium on Nuclear Physics and Applications (LASNPA)

Facultad de Ciencias, UNAM, June 17-21, 2024

	Monday June 17	**Tuesday June 18**	**Wednesday June 19**	**Thursday June 20**	**Friday June 21**
Chair	**Brandan**	**Lépine**	**Barrón**	**Marín**	**Menchaca**
09:00 - 09:30	Registro, café	P5: Garrett	P10: Broussard	P13: Acosta	P18: Ayala
09:30 - 09:40	Inauguración				
09:40 - 10:20	P1: Frank	P6: García Ruiz	P11: Naviliat	P14: Griffin	P19: Tapia Takaki
10:20 – 11:00	P2: Surrow	P7: Galindo	P12: Pocanic	P15: Guazzelli	P20: Gasques
11:00 - 11:30	Coffee	Coffee	Coffee	Coffee	Coffee
Chair	**Brandan**	**Medina**		**Civitarese**	**Naviliat**
11:30 - 12:10	P3: Alarcon	P8: Kalantar-Nayestanaki	Poster Session	P16: Gai	P21: Piekarewicz
12:10 - 12:50	P4: Moskal	P9: Block		P17: Van Kolck	P22: Delgado
12:50 - 15:00	Lunch	Lunch	Lunch	Lunch	Lunch
Chair					**Bijker**
15:00 - 15:30	Invitadas	Invitadas	Invitadas	UNAM excursion	P23: Menchaca 40 min
15:30 - 16:00	Invitadas	Invitadas	Invitadas		Clausura
16:00 - 16:30	Invitadas	Invitadas	Invitadas		
16:30 - 17:00	Invitadas	Invitadas	Invitadas		
17:00 - 17:30	Invitadas	ALAFNA	Invitadas		
17:30 – 18:00	Invitadas		Invitadas		
18:00				Banquet: Casa Club del Académico	

Program Parallel Sessions

Monday June 17	Salon 1	Salon 2	Salon 3
Chair	**Ortiz**	**Garrett**	**Guazzelli**
15:00 - 15:30	Montoya	Leistenschneider	Alva
15:30 - 16:00	King	Bijker	Ávila Rodríguez
16:00 - 16:30	Timóteo	García Ramos	González Sprinberg
16:30 - 17:00	Roig	Van Isacker	Stepien
17:00 - 17:30	Toledo	Johnson	Lugo
17:30 – 18:00	Palhares	Holt	Durini

Tuesday June 18	Salon 1	Salon 2	Salon 3
Chair	**Galindo**	**Piekarewicz**	**Alarcon**
15:00 - 15:30	Torres	Cline	Tarifeño Saldivia
15:30 - 16:00	García Flores	Nowakowski	Barrón Palos
16:00 - 16:30	Marín Lámbarri	Kelkar	Crawford
16:30 - 17:00	Díaz Rizo	Marzola	Civitarese
17:00 - 17:30		ALAFNA	
17:30 – 18:00			

Wednesday June 19	Salon 1	Salon 2	Salon 3
Chair	**Toledo**	**Gai**	**Acosta**
15:00 - 15:30	Christiansen	Lenzi	Cezaretto
15:30 - 16:00	Pruneau	McCoy	Brandao de Oliveira
16:00 - 16:30	Gómez Coral	Medina	Lichtenthäler Filho
16:30 - 17:00	Ortiz	Zielinska	Lubian
17:00 - 17:30	Serkin	Estrade	Romero Barrientos
17:30 – 18:00	García Trápaga		

Plenary Talks

1. Luis Armando Acosta (CSIC, España & IF-UNAM, Mexico, acosta@fisica.unam.mx)

   Title: Approaching interesting nuclear processes from the developing of new instrumentation

   Abstract: During the last 20 years, the nuclear physics has been benefited with the impulse of new technology: most of the large facilities dedicated to nuclear studies are presently under the upgrading of beam production, like new rare nuclear species and with enough rates to allow the performance of new measurements.

   In parallel, several collaborations have developed a number of new devices to take advantage of all these future beams and also for the beams presently available. Thus, detection arrays, different kind of targets and separator devices have beam created or they are under construction. In this presentation will be visited devices developed few years ago at IFUNAM, Mexico, and new ones led by Spanish institutions.

   The examples to be described are: the new array for nuclear dynamics studies called SIMAS, successfully used since 2019 for the measurements of weakly bound nuclei at TwinSol/TriSol facility; the supersonic jet target SUGAR, presently inside of the SUGAR@LNL collaboration to be developed in a near future at LNL-INFN; and finally, the very resent project called ISRS/MAGDEM, a future spectrometer which is under demonstration phase, which is expected to be installed as part of the beamline SEC at the HIE-ISOLDE facility. The present status of instrumentation developments and their perspectives along to very recent scientific results, will be presented on this work.

   This work has been partially supported by DGAPA-UNAM IG101423 (Mexico), the ISRS-ISOLDE (BOE-A-2023-16885), the Recovery, Transformation, and Resilience Plan (Spain), and NextGeneration Program (European Union).

2. Ricardo Alarcón (ASU, USA, ralarcon@asu.edu)

   Title: Measurements of Multiple Coulomb Scattering using Therapeutic Proton Beams

   Abstract: Proton Computed Tomography (pCT) stands as a significant advancement in medical imaging, yet its widespread adoption has been hindered by inherent limitations, notably its lower spatial resolution compared to established modalities such as X-Ray Computed Tomography. This resolution shortfall can largely be attributed to Multiple Coulomb Scattering (MCS) and other particle interactions encountered during proton beam traversal. In response, we propose a novel approach to characterize MCS behavior. Our method involves capturing a fraction of the isotropic luminescence emitted as exit protons pass through a 1.0 mm thick scintillator, utilizing a digital camera for precise measurement. Preliminary results from an experimental investigation, conducted at the Mayo Clinic Arizona research facility, are presented herein. We directed a 221.3 MeV therapeutic proton beam at acrylic slabs of varying lengths (5, 10, and 15 cm) along with other phantoms. Remarkably cost-effective and operationally straightforward, our proposed technique holds promise for yielding data conducive to the construction of proton images, thus advancing the trajectory toward clinical realization of pCT.

3. Alejandro Ayala (ICN-UNAM, ayala@nucleares.unam.mx)

   Title: The Multi-Purpose Detector: A window to study the dense and hot nuclear matter

   Abstract: The Multi-Purpose Detector (MPD) is the flagship experiment of the Nuclotron-based Ion Collider fAcility (NICA) currently under construction at the Joint Institute for Nuclear Research (JINR) in Dubna, Russia. The experiment is designed to run in the collider mode. The MPD will study heavy-ion collisions in the energy range $\sqrt{s}$NN = 4-11 GeV, starting with Xe-Xe collisions at $\sqrt{s}$NN = 9.2 GeV. Its initial stage of operation is planned to start at the beginning of 2025. The MPD is an international collaboration consisting of 34 institutions from 10 countries with more than 450 participants. The MPD focuses on the study of the high net-baryon density region of the QCD phase diagram, to search for the conjectured critical end point, the onset and nature of the deconfinement phase transition and the onset of chiral symmetry restoration. In this presentation, we will review the current status of the MPD and its physics program. Also, the feasible physics measurements along with the expected performance of the detector subsystems will be presented.

4. Michael Block (GSI & Mainz, Germany, block@uni-mainz.de)

   Title: Exploring the structure of the heaviest nuclei through laser spectroscopy and mass spectrometry

   Abstract: Exploring the limits of nuclear existence is at the forefront of contemporary nuclear physics. At the GSI in Darmstadt, we have explored the limit in the region of superheavy nuclei for more than 50 years resulting in the discovery of six new elements, for example. Recently, the program has been expanded towards a comprehensive investigation of the atomic, nuclear, and chemical properties of the heaviest elements. Pioneering experiments in Penning-trap mass spectrometry and resonance ionization laser spectroscopy have provided a wealth of new data for the elements from fermium to dubnium. Accurate mass measurements allowed us to investigate the nuclear shell structure evolution in the region of the $N = 152$ deformed shell gap. The high mass resolving power of SHIPTRAP also enabled studies on longer-lived nuclear isomers with low excitation energy in nobelium, lawrencium, and rutherfordium isotopes. Furthermore, changes in nuclear charge radii in a long chain of fermium isotopes were inferred from isotope-shift measurements by laser spectroscopy, while hyperfine laser spectroscopy provided information on electromagnetic moments in nobelium isotopes. I will present select highlights of the recent measurement campaigns at the GSI in Darmstadt, Germany, using the SHIPTRAP, RADRIS, and JetRIS setups and discuss future perspectives.

5. Leah Broussard (ORNL, USA, broussardlj@ornl.gov)

   Title: Search for Baryon Number Violation in Neutron Oscillations

   Abstract: Baryon Number Violation has not yet been observed in nature but is a necessary ingredient to explain how our universe evolved to contain only matter. The transformation of neutrons into antineutrons and/or hypothesized sterile neutrons may provide a mechanism to explain the lack of antimatter in the universe and offer insight into the particle nature of dark matter. I will describe the experimental efforts to search for these baryon number violating processes at Oak Ridge National Laboratory and explore possible connections to the long-standing discrepancy between cold neutron ("beam") and ultracold neutron ("bottle") techniques to measure the neutron lifetime. This program will inform a future high sensitivity search for neutrons transforming directly into antineutrons as part of the NNBAR experiment at the European Spallation Source, which is anticipated to improve sensitivity by up to three orders of magnitude.The beta-decay (and other strange disappearances) of the neutron

6. Andrea Delgado (ORNL, USA, delgado.andrea.21@gmail.com)

   Title: Quantum Frontiers in Nuclear Physics: Unleashing Precision through Quantum Computing

   Abstract: In this talk, we explore the transformative potential of quantum computing within the realm of nuclear physics, where conventional computational methods currently face insurmountable limits. As the demand for precision in nuclear physics calculations grows, so does the need for computational power beyond what even the largest classical computers can provide. We delve into cutting-edge developments in quantum algorithms specifically tailored for nuclear physics applications. These algorithms promise to breach current computational barriers and open pathways to precision calculations previously deemed unattainable.

Moreover, the talk will highlight the current state of the art in quantum computing as it applies to nuclear physics. We will discuss ongoing efforts to enhance algorithmic efficiency and accuracy, showcasing how these advancements are pivotal to the future of nuclear research. A significant focus will be placed on the potential of hybrid architectures that integrate High-Performance Computing (HPC) with quantum computing. This synergy enhances computational capabilities and catalyzes the development of quantum sensing technologies, further broadening our investigative tools in nuclear physics.

7. Alejandro Frank† (ICN & C3, UNAM, Mexico, frank@nucleares.unam.mx)

   Title: Phase transitions, scale invariance and criticality in self organized systems

   Abstract: Symmetry methods have been of crucial importance to physics. Group theory and conservation laws have become a fundamental language, all the way from quantum mechanical phenomena to general relativity. However, these ideas have had less impact in the biological domain. In this talk I present a view of self organized biological systems as characterized by and evolving towards critical points, in the language of phase transitions in physical systems. Self similar (or scale invariant) behavior seems to signal homeostatic dynamical equilibrium in living organisms.

   † Member of El Colegio Nacional

8. Moshe Gai (U. Conn, USA, moshe.gai@uconn.edu)

   Title: The Algebraic Cluster Model (^{12}C, ^{16}O, ^{20}Ne) and Cluster Shell Model (^{7,8,9}Be, ^{13}C, ^{19}F)

   Abstract: Bijker and Iachello's algebraic cluster model (ACM) [1,2] and its extension to the cluster shell model (CSM) [3], provides a new theoretical platform for the study of alpha-clustering in light nuclei. We will review the basic tenants of the ACM and the discovery of a D_{3h} symmetry in ^{12}C [4] and ^{20}Ne [5], with emphasize on the discovery in ^{12}C of a new g.s. rotational band with the spin sequence of: 0+, 2^+, 3^-, $4^\pm$ and 5^-, including the predicted 4^+ and 4^- parity doublet [4].

   Applications of the CSM shell model to one particle molecular orbits in ^{9}Be [3] and ^{13}C (D'_{3h} particle symmetry) [6], lead us to conjecture molecular hole states in ^{7}Be and ^{19}F (D'_{3h} hole symmetry). We observe in these nuclei the predicted phenomenological structure. And we further consider conjectured p-h states in ^{8}Be with the phenomenological p-h structure of rotational band at high excitations of approximately 20 MeV.

   We will discuss a new measurement of ^{8}Be at ISOLDE [7] and further tests of the ACM in ^{12}C, using a TPC operating with CO2 gas at the HIgS gamma-beams facility [8].

   The material presented here is based on work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics grants Number DE-FG02-94ER40870.

   [1] R. Bijker and F. Iachello, Phys. Rev. C 61, 067305 (2000).

   [2] R. Bijker and F. Iachello, Ann. Phys. 298, 334 (2002).

   [3] V. Della Rocca, and F.Iachello, Nucl. Phys. A 973, 1 (2018).

   [4] D.J. Marın-Lambarri, R. Bijker, M. Freer, M. Gai M, Tz. Kokalova, D.J. Parker, and C. Wheldon, Phys. Rev. Lett. 113, 012502 (2014).

   [5] R. Bijker and F. Iachello, Nucl. Phys. A 1006, 122077 (2021).

   [6] R. Bijker and F. Iachello, Phys. Rev. Lett. 122, 162501 (2019).

   [7] M. Gai, R. Smith, L.P. Gafney, D.K. Sharp and P.A. Butler, and ISS collaboration, ISOLDE Experiment, IS692, October, 2023.

   [8] M. Ćwiok, W. Dominik, A. Fijałkowska, M. Fila, Z. Janas, A. Kalinowski, K.Kierzkowski, M. Kuich, Ch. Mazzocchi, W. Okliński, M. Zaremba, M. Gai, D.K. Schweitzer, S.R. Stern, S. Finch,

U. Friman-Gayer, S.R. Johnson, T. Kowalewski, D.L. Balabanski, C. Matei, A. Rotaru, K.C.Z. Haverson, R. Smith, R.A.M. Allen, M.R. Griffiths, S. Pirrie, and P.S.R Alcibia, EPJ Web Conf. 279, 04002 (2023),

9. Alfredo Galindo Uribarri (ORNL, USA, uribarri@ornl.gov)

   Title: ORNL Neutrino Program

   Abstract: In the last decade Oak Ridge National Laboratory has taken a leading role for neutrino research. I will be summarizing the ORNL neutrino program including the final results from the PROSPECT experiment, I will briefly describe the status of the COHERENT suite of experiments and of the ton-scale high-resolution Ge detector experiment LEGEND searching for neutrinoless double-beta decay. The PROSPECT (Precision Reactor Oscillation and SPECTrum) Experiment was designed to detect antineutrinos produced in the radioactive decays of unstable fission product nuclei in an operating nuclear reactor. The PROSPECT collaboration conceived a detector and shielding arrangement at the High Flux Isotope Reactor (HFIR) designed to search for short-baseline, sterile neutrino oscillations and to make a precision measurement of the 235U reactor antineutrino spectrum. This talk will provide an overview of the PROSPECT detector, describe its performance and background rejection capabilities, and summarize the final scientific results. Over nearly two decades I have run an international internship summer program at ORNL hosting dozens of interns most of them from Latin America. I will highlight the important contributions made to the neutrino program during their internship or later as graduate students.

10. Ronald Garcia Ruiz (MIT, USA, rgarciar@mit.edu)

    Title: Probing the Electroweak Properties of Nuclei with Radioactive Molecules

    Abstract: Molecules containing nuclei with extreme proton-to-neutron ratios can be artificially created to enhance sensitivity to specific nuclear phenomena. The electronic structure of these molecules can be used to isolate the effects of the nuclear electroweak structure, enabling the possibility of measuring yet-to-be-discovered parity and time-reversal violating nuclear properties. In this talk, I will present recent highlights and perspectives from laser spectroscopy experiments on these exotic species. I will also discuss the relevance of these experiments in addressing open problems in nuclear and particle physics.

11. Paul E. Garrett (U. Guelph, Canada, garrettp@uoguelph.ca)

    Title: Multiple Shape Coexistence in Nuclei

    Abstract: It is now well understood that nuclei can possess shape coexistence, i.e., that states at low excitation energy in a nucleus that have distinct shapes, and that it occurs in many regions throughout the nuclear chart. Until very recently, there were only a few candidates suggested for nuclei possessing multiple, i.e., more than two, distinct shapes. Within the past several years, however, this has changed dramatically with detailed spectroscopy revealing structures not previously observed and results interpreted with the aid of state-of-the-art shell model or beyond-mean-field calculations. Examples of these candidates, from the light-mass Mg-Si region to the Au-Pb region will be highlighted.

12. Leandro Gasques (IF-USP, Brazil, lgasques@if.usp.br)

    Title: Reactions with weakly bound nuclei around the Coulomb barrier

    Abstract: Reactions involving stable weakly bound nuclei have been extensively studied over the last years. The low binding energies of these nuclei, leading to a significant effect of the coupling to continuum on different reaction channels, have been the main driving force in such studies. Although several models have been successfully used to explain particular reaction outcomes, the answers to many questions remain elusive. In this talk, an overview of the experimental program carried out at the Institute of Physics of the University of Sao Paulo (USP), using the 8 MV Pelletron accelerator installed in the Open Laboratory of Nuclear Physics, will be presented.

13. Chris Griffin (Triumf, Canada, cgriffin@triumf.ca)

    Title: Studying nuclear decays with storage rings

    Abstract: Studying the ways in which radioactive nuclei decay is key to unlocking a deeper understanding of the cosmic processes that lead to the creation of much of the material around us. Understanding nuclear properties, such as nuclear masses, lifetimes, and reaction rates, provides crucial insights into the synthesis of elements in various astrophysical environments, including stars, supernovae, and neutron star mergers. Storage rings can offer unique opportunities to probe a variety of nuclear properties.

    This talk will look at some recent experiments leveraging the unique capabilities of storage rings, and look forward to future possibilities.

14. Marcilei Aparecida Guazzelli (FEI, São Paulo, Brazil, marcilei@fei.edu.br)

    Co-authors: L.H. Avanzi[1], M. Nakamura[4], V.A.P. Aguiar[2], N.H. Medina[2], E.F. Chinaglia[1], S.H. Masunaga[1], M. T. Escote[3], F. Furlan[3], J.R.B. Oliveira[2], M.M. Toyama[4], R.B.B. Santos[1], K. Araki[4], V.B. Barbeta[1], F. Cappuzzello[5,6], M. Cavallaro[6], for the NUMEN collaboration

    [1] Centro Universitário da FEI, São Bernardo do Campo, São Paulo, Brazil
    [2] Instituto de Física da Universidade de São Paulo, São Paulo, Brazil
    [3] Universidade Federal do ABC, Santo André, São Paulo, Brazil
    [4] Instituto de Química da Universidade de São Paulo, São Paulo, Brazil
    [5] Dipartimento di Fisica e Astronomia "Ettore Majorana", Università di Catania, Catania, Italy
    [6] INFN-Laboratori Nazionali del Sud, Catania, Italy

    Title: Endurance of HOPG to Ionizing Radiation: Advancements in Target Development for Nuclear Reactions

    Abstract: Highly Oriented Pyrolytic Graphite (HOPG) is a material characterized by its unique structure and properties. It consists of thin layers of highly oriented pyrolytic graphite, which are formed through a controlled vapor deposition process. These layers exhibit a highly ordered crystalline structure, with graphene layers aligned parallel to each other. This alignment imparts unique physical characteristics to HOPG, including high thermal and electrical conductivity along the crystal planes, making it a valuable material in various scientific and technological applications. These thin foils find application in dissipating heat generated by high-intensity heavy ion beams in particle accelerators, particularly in nuclear reaction studies [1]. Notably, the NUMEN project, an international collaboration investigating double charge exchange nuclear reactions (DCE) at the LNS/INFN (Laboratori Nazionali del Sud, Catania, Italy), holds significance in neutrino physics and potential modifications to the Standard Model [2]. Given the project's interest in metallic targets with low melting points, employing HOPG foils as substrates becomes crucial to prevent target melting, rendering experiments infeasible. Therefore, this project aims to examine the crystalline structure damage of HOPG under heavy ion irradiation, particularly its effect on thermal conductivity reduction [3]. Monte Carlo simulations predict comparable damage intensities in HOPG foils achievable with the available ion beams and energies at the Pelletron Accelerator (IFUSP/DFN), São Paulo, SP, to those envisioned in the NUMEN project's high-intensity beam experiments. This facilitates assessing HOPG's durability and studying the extent of crystalline lattice damage and its implications for material properties [4, 5]. This study presents results from various characterization techniques applied to HOPG pre- and post-irradiation with a 14 MeV neutron flux, demonstrating

degradation in crystallinity over irradiation time, impacting its functionality as a heat dissipating agent. The investigation employed Raman Spectroscopy, X-ray Diffraction, Magnetoresistance, Atomic Force Microscopy and Scanning Microscopy. In addition to these unprecedented results, the instrumentation developed for the Pelletron accelerator, dedicated to monitoring the electrical and thermal properties of targets during experiments with heavy ions, will also be presented.

[1] HOPG. Available at: ¡http://nanoprobes.aist-nt.com/apps/HOPG

[2] Cappuzzello, F. et al., The NUMEN project: NUclear Matrix Elements for Neutrinoless double beta decay, EUROPEAN PHYSICAL JOURNAL A. , v.54, p.1/54 - 46, 2018.

[3] LoPresti, D.et al., Neutron radiation effects on an electronic system on module. REVIEW OF SCIENTIFIC INSTRUMENTS 91, 083301 (2020).

[4] Avanzi, L.H. et al.,Using TRIM-SRIM code simulations to determine defect density produced in HOPG irradiated with high energy heavy ions. JOURNAL OF PHYSICS CONFERENCE SERIES, v.2340, 012002 (2022).

[5] Baladim, Alexander A. Thermal Properties of Graphene, Carbon Nanotubes and Nanostructured Carbon Materials. 2011. Univ. of California. Accessed: 30/7/2021.

15. Nasser Kalantar-Nayestanaki (ESRIG, Groningen, the Netherlands, n.kalantar-nayestanaki@rug.nl)

    Title: Exploring the extremes with NUSTAR@FAIR

    Abstract: The upcoming FAIR facility in Darmstadt, Germany, will produce intense high-energy beams of exotic nuclei which will be used to explore the properties of new regions of the chart of nuclides of key importance for the investigation of nuclear structure and reactions, and nuclear astrophysics. Several experiments have been planned with the aim of addressing the scientific challenges. These experiments use a variety of techniques to answer the fundamental questions in the field. They are brought together in the NUSTAR [1] (NUclear STructure Astrophysics and Reactions) collaboration which maximizes the synergy amongst the sub-collaborations performing various experiments. With more than 600 scientists from more than 180 institutes located in 38 countries, the collaboration is well advanced and ready with the state-of-the-art instrumentation to start the measurements using the FAIR infrastructure in the next few years. Measurements are already being performed with detectors developed for FAIR and beams delivered by the present accelerators. The physics case and challenges for all the NUSTAR experiments will be briefly discussed in this presentation.

    [1] http://www.fair-center.eu/for-users/experiments/nustar.html

16. Pawel Moskal (Cracow, Poland, ufmoskal@googlemail.com)

    Title: First positronium imaging of humans using modular J-PET scanner

    Abstract: Jagiellonian PET (J-PET) is a novel cost-effective positron emission tomography technology based on plastic scintillators [1,2], and positronium imaging is a newly invented method of imaging the properties of positronium in living organisms [3,4,5]. Both methods were invented and are being developed at the Jagiellonian University. During positron emission tomography about 40 % of positron annihilations occur through the creation of positronium [6]. Positronium, which may be formed in human tissues in the intramolecular spaces, is an exotic atom composed of an electron from tissue and the positron emitted by the radionuclide. Positronium decay in the patient's body is sensitive to the nanostructure and metabolism of human tissues [6]. This phenomenon is not used in present PET diagnostics, yet it is in principle possible to exploit such environment-modified properties of positronium as diagnostic biomarkers for cancer assessment. The first ex-vivo positronium images have shown differences in the positronium mean lifetime and production probability in healthy and cancerous tissues, indicating that they may be used as indicators for in-vivo cancer

classification [3,7]. In the talk the method of positronium imaging and the pilot ex-vivo and in-vivo positronium images of patients obtained with the J-PET tomograph (the first portable PET system based on plastic scintillators capable of multi-photon imaging [8,9]) will be presented and explained. The basis of operation of the J-PET tomograph - the first device enabling imaging of positronium properties in living organisms will be also presented and explained. We will also present arguments demonstrating that the advent of high sensitivity total-body PET systems and the invention of the method of positronium imaging, open perspectives for the application of positronium as a biomarker for in-vivo assessment of the degree of hypoxia [10,11,12]. We will also present the first positronium images of the human brain in-vivo [13].

[1] P. Moskal et al., Phys. Med. Biol. 66, 175015 (2021).

[2] P. Moskal, E. Ł. Stępień, PET Clinics 15, 439 (2020).

[3] P. Moskal et al., Science Advances 7, eabh4394 (2021).

[4] P. Moskal et al., Phys. Med. Biol. 64, 055017 (2019).

[5] P. Moskal et al., EJNMMI Phys. 7, 44 (2020).

[6] P. Moskal et al., Nature Reviews Physics 1, 527 (2019).

[7] P. Moskal, E. Ł. Stępień, EJNMMI Phys. 10, 22 (2023).

[8] P. Moskal et al., Nature Communication 12, 5658 (2021).

[9] P. Moskal et al., Nature Communication 15, 79 (2024).

[10] P. Moskal, E. Ł. Stępień, Bio-Algorithms and Med-Systems 17, 311 (2021).

[11] P. Moskal, E. Ł. Stępień, Frontiers in Physics 10, 969806 (2022).

[12] S. Bass, S. Mariazzi, P. Moskal, E. Ł. Stępień, Reviews of Modern Physics 95, 021002 (2023).

[13] P. Moskal, . . . , E. Ł. Stępień, https://www.medrxiv.org/content/10.1101/2024.02.01.23299028v1

17. Arturo Menchaca (IF-UNAM, Mexico, menchaca@fisica.unam.mx)

Title: Cosmic antinuclei production studies; and pyramid muon-imaging

Abstract: Our group has participated in the Alpha Magnetic Spectrometer experiment since the beginning of its construction, in 1999. The device was installed in the International Space Station (ISS) in 2011. Since then AMS has detected 250 billion of cosmic rays [1], from electrons to iron nuclei, having preliminarily identified some light antinuclei. Our group has taken advantage of our membership in the ALICE Collaboration to investigate the production of these antinuclei in LHC-CERN proton-proton collisions, representing the main background for the search for more exotic signals in AMS, such as the annihilation of dark matter particles [2]. So far, our main result in this research line [3] is that the expected magnitude of such a background, in which interstellar transport effects have been included, is insufficient to explain the aforementioned preliminary AMS observations. Regarding instrumentation, our group is also working on the identification and kinematic characterization of antineutrons produced in ALICE [4]. Regarding applications, our group participates in the NAUM [5] collaboration that will install a muon tracker to explore the interior of the El Castillo pyramid, in Chichén Itzá. This talk will give a global vision of these projects.

The support of DGAPA-UNAM and CONAHCYT: Ciencia de Frontera, Sinergias Project 2042 is acknowledged.

[1] Eg. AMS on ISS: Results from the first seven years. Physics Reports 894 (2021)1-116, https://ams02.space/

[2] Diego Gómez Coral et al. PoS(ICRC2023)050

[3] Diego Gómez Coral et al. PRD 98(2018)023012, JPCS(2020)012005 and PhD Thesis (2019)

[4] Fabiola Lugo Porras et al. JPG 51(2024)035005, and MC Thesis (2023)

[5] Ej: https://www.symmetrymagazine.org/article/seeing-through-walls-and-breaking-down-barriers?languagecontententity=en

18. Oscar Naviliat-Cuncic (MSU, naviliat@frib.msu.edu)

Co-authors: E.A. George[1], T.E. Haugen[2] and P.A. Voytas[1]

[1] Department of Physics, Wittenberg University, Springfield, OH, USA

[2] Facility for Rare Isotope Beams and Department of Physics and Astronomy, Michigan State, USA

Title: Improved search for CP violation in ortho-positronium decay

Abstract: New mechanisms of CP violation are required to explain the matter-antimatter asymmetry in the Universe. Searches for CP (or T)-violation beyond the Standard Model (SM) are being carried out in precision measurements of electric dipole moments of particles, nuclei, atoms and molecules as well as in properly selected correlations in decay processes. Positronium (Ps) is a purely leptonic state that decays into photons. The observation of a CP violating correlation associated with the decay process would be a clear signature of physics beyond the SM. A CP violating correlation can be formed in Ps decay, involving the Ps tensor polarization and the momenta of the two highest energy photons in the three-photon decay of (ortho) Ps. This correlation has been measured twice in the past, reaching precision at the 10^{-2} and 10^{-3} levels. We have designed, and are currently installing, a new dedicated apparatus to search for CP-violation in ortho-Ps decay with an order of magnitude improved sensitivity relative to previous work. The apparatus consists of a positron source located between two fast scintillators for positron detection. These are followed by a powder or an aerogel for Ps formation. This source module is surrounded by an array of 48 LYSO photon detectors to measure the angular correlations between the decay photons. The LYSO crystals are read out with SiPM and the array is located inside a superconducting magnet with a large diameter warm bore, producing a maximum field of 2T. We present here the design and optimization of the photon detector array, the Ps formation tests and we discuss the improved sensitivity of the design compared to previous work.

This work is supported by the National Science Foundation under Grants No. PHY-1920065 and PHY-2013557.

19. Jorge Piekarewicz (FSU, USA, jpiekarewicz@fsu.edu)

Title: Applications of Machine Learning to Nuclear Theory

Abstract: A fundamental question animating nuclear science today is: What are the nuclear processes that drive the birth, life, and death of stars. Answering this question requires knowledge of physical observables that lie beyond the current experimental reach. To address this challenge, machine learning tools—such as Bayesian Neural Networks (BNN) and Reduced Order Models (ROM)—are being harnessed to refine and extend nuclear models to regions beyond their original applicability. In this presentation I will consider two specific examples: BNN for Refining Nuclear Masses and ROM for the calibration of Energy Density Functionals. By leveraging machine learning tools, nuclear science will continue to shape and advance our understanding of the universe.

20. Dinko Počanić (University of Virginia, USA, pocanic@virginia.edu

Title: Precision studies of the neutron beta decay in Nab and pNab1

Abstract: Neutron beta decay, one of the most fundamental processes in subatomic physics, continues to offer meaningful tests of the electroweak sector of the standard model (SM) and, hence, of SM limits and its possible extensions. Although incomparably successful, the minimal SM based on the $SU(3)_C \times SU(2)_L \times U(1)_Y$ gauge symmetries is known to be incomplete; additional particles and phenomena must exist. Examples of unanswered SM questions include: the number and

the couplings of quark generations (the Cabibbo-Kobayashi-Maskawa quark mixing matrix, CKM), couplings of lepton generations (lepton universality), existence on non-(V-A) interactions, upersymmetry. In these studies, nuclear physics probes nicely complement research at high energies, helping to complete the picture of fundamental physics at the smallest length scale.

Experimental study of the neutron beta decay provides the most sensitive means to evaluate the ratio of axial-vector to vector coupling constants $\lambda = g_A/g_V$. The precise value of λ is important in a number of applications of the theory of weak interactions, especially in astrophysics. Precise measurements of neutron beta decay parameters are important in the search for new physics. Measurement of the neutron decay rate Γ_n, or lifetime $\tau_n = 1/\Gamma_n$, in addition to λ, allows a determination of the CKM matrix element V_{ud} independent of nuclear models. Precise knowledge of V_{ud} is essential for testing the unitarity of the three-generation CKM matrix. CKM unitarity, in turn, provides independent limits on certain processes and particles not included in the standard model of elementary particles and interactions, i.e., on new physics.

This talk will review different approaches to measuring λ, focusing on the Nab experiment, set to complete commissioning and transition to data taking with unpolarized cold neutrons at the Spallation Neutron Source (SNS) in summer of 2024. Plans call for Nab to be followed by pNab, to study decays of polarized neutrons from the SNS. The discussion of Nab and pNab will be presented in the broader context of the field, including alternative methods and techniques for determining λ and V_{ud}. Finally, going beyond the CKM unitarity question, we will discuss the potential of Nab and pNab to produce additional independent SM tests.

21. Bernd Surrow (Temple, USA, surrow@temple.edu)

    Title: Status and Perspectives of the US-based Electron-Ion Collider Project

    Abstract: To understand the properties of nuclear matter and its emergence through the underlying partonic structure and dynamics of quarks and gluons requires a new experimental facility in hadronic physics known as the Electron-Ion Collider (EIC). The EIC will address some of the most profound questions concerning the emergence of nuclear properties by precisely imaging gluons and quarks inside protons and nuclei, such as the distribution of gluons and quarks in space and momentum, their role in building the nucleon spin, the nucleon mass, and the properties of gluons in nuclei at high energies.

    A new detector collaboration has been formed around one of two possible interaction regions, the ePIC collaboration. This presentation will discuss in detail the requirements for the ePIC detector, its design philosophy, and the EIC project's overall status and plans.

22. Daniel Tapia Takaki (Kansas, USA, jdtt@ku.edu)

    Title: Probing the nucleus and nucleons at high energies

    Abstract: In this talk, we will present recent results on vector meson photoproduction during ultraperipheral heavy-ion collisions (UPCs). We will provide a comprehensive overview of the recent developments. The intense electromagnetic fields generated by heavy-ions at the LHC result in significant cross sections for the exclusive photoproduction of vector mesons in UPCs. In particular, the photoproduction of charmonium serves as a tool to investigate the gluon distribution within the target nucleus. Recent measurements have studied the photoproduction cross section $\frac{d\sigma}{dt}$ at various rapidities, providing unprecedented insights on the gluon distribution, and also allowing for the potential mapping of gluon spatial distribution. Such studies may enhance our understanding of the physics dynamics such as nuclear shadowing and gluon saturation. By analyzing vector meson production alongside neutron emission or studying peripheral events, we can deduce the energy dependency of the photoproduction cross section. The latest results at the LHC and RHIC experiments will be presented. Furthermore, the first measurements consistent with sub-nucleonic fluctuations of the lead nucleus in UPCs will be discussed, along with the prospects of UPC studies with upcoming measurements at the LHC.

23. Ubirajara Van Kolck (ECT*, Italy, IPN-Orsay, France & U. Arizona, USA, vankolck@ijclab.in2p3.fr)

    Title: Quantum fractals

    Abstract: Quantum systems made of nonrelativistic particles interacting through short-range forces in the unitarity limit — where the two-body system is on the cusp of being bound — have an approximate discrete scale invariance (DIS), the symmetry underlying many fractals. Their dynamics is captured by an effective field theory with only contact two- and three-body forces at leading order (LO). The three-body force is on a limit cycle of the renormalization group and gives rise to nearly geometric towers of excited states, including the Efimov spectrum in the three-body system. It provides the single dimensionful parameter appearing at LO, which relates energies for different number of particles, an example being the Tjon correlation between three- and four-body binding energies. I show that DIS forms the basis to understand the properties of few-nucleon systems, and report on the extension to larger systems. I discuss saturation in bosonic clusters (such as 4He atoms) and clustering of multi-component fermions (such as nucleons).

    This material is based upon work supported in part by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under award DE-FG02-04ER41338.

Invited Talks

1. Héctor Alva (IF-UNAM, Mexico, halva@fisica.unam.mx)

   Title: Positron range and image quality in a hybrid PET/MR scanner

   Abstract: Positron range is a factor that influences the image quality of positron emission tomography (PET) studies. Positron range is the distance that positrons travel in matter before they annihilate with an electron, after which two 511 keV annihilation photons are emitted simultaneously and in opposite directions. This distance depends on the energy of positrons and on the physical density of the tissues they traverse. The range of high-energy positrons is an important factor impacting PET image quality in terms of spatial resolution and radiopharmaceutical uptake quantification. Today whole-body hybrid imaging systems that incorporate PET and magnetic resonance imaging (MR) are available in the clinic. The blending of the two modalities into a single gantry was the result of the development of PET detectors and other components that are insensitive to the magnetic field of the MR scanner. A collateral advantage arising from an integrated PET/MR system is the improvement of PET image spatial resolution because of the uniform magnetic field that modifies the trajectory of positrons, leading to a positron range reduction in the direction perpendicular to the magnetic field. In this work, the effect of the magnetic field of a PET/MR Siemens Biograph mMR 3 T scanner on the quality of PET images was studied. Quantitative analysis was carried out using image quality phantoms filled with F-18 and Ga-68 to measure uniformity, recovery coefficients (RC), and spill-over ratios (SOR). In addition, tissue equivalent phantoms, that mimic cortical and trabecular bone, water, adipose and lung (inhale and exhale) tissue were used. To evaluate the influence of the magnetic field, a comparison was made with images obtained with a Siemens Biograph Vision 600 PET/CT scanner, using the same radionuclides and phantoms. The results show an improvement in the image quality for Ga-68 when using a PET/MR system compared to those acquired with a PET/CT system due to the presence of the magnetic field.

2. Miguel Ángel Ávila Rodríguez (FM-UNAM, Mexico, avilarod@uwalumni.com)

   Title: Present status of cyclotrons for radionuclide production in Latin America

   Abstract: Given the short half-life of radionuclides used in Positron Emission Tomography (PET) is imperative an on-site or nearby cyclotron facility for their production. PET molecular imaging was introduced in 1976, however its widespread use became more feasible in clinical settings with the development of compact negative ions cyclotrons during the 1990s. The first compact cyclotron for PET radionuclide production in Latin America was installed in 1997 in Mendoza, Argentina, at Fundación Escuela de Medicina Nuclear (FUESMEN), followed by the installation in 2000 of the second compact cyclotron at Universidad Nacional Autónoma de México in Mexico City. Nowadays there are over 60 cyclotrons in the region. In this talk an overview of the characteristics of the different negative ion cyclotrons available in the region will be presented, including their production capabilities and related infrastructure for production of radionuclides and PET radiopharmaceuticals.

3. Libertad Barrón-Palos† (IF-UNAM, Mexico, libertad@fisica.unam.mx)

   Title: Search for a non-zero electric dipole moment in the neutron

   An outstanding problem in contemporary physics is the observed asymmetry between matter and antimatter in the Universe. A key ingredient in the explanation of this phenomena is finding new sources of violation of the Charge-Parity (CP) symmetry, for which a non-zero electric dipole moment in the neutron (nEDM) represents a via to test possible sources of CP violation. The nEDM@SNS is an international effort to search for the nEDM with unprecedented sensitivity. In

this talk I will describe the unique features of this experiment, proposed to take place at the Spallation Neutron Source (SNS) of the Oak Ridge National Laboratory.

† For the nEDM@SNS collaboration

4. Roelof Bijker (ICN-UNAM, Mexico, bijker@nucleares.unam.mx)

   Title: On β- and γ-bands in deformed nuclei

   Abstract: The study of one- and multi-phonon excitations in collective deformed nuclei continues to be a subject of much interest in nuclear structure. In this presentation I discuss the properties of β- and γ-vibrations in deformed nuclei in the framework of the IBM. The present work is an extension of a study in the rotational limit of the IBM [1,2] to the so-called consistent Q-formalism in which the same form of the quadrupole operator is used in the Hamiltonian and in the description of quadrupole transitions. The Hamiltonian in the consistent-Q formalism exhibits a first-order quantum-phase transition between a spherical and a deformed phase. It is found that for almost the entire parameter range the intrinsic energy of the β-vibration is larger than that of the γ-vibration, and that $\gamma \to g$ transitions are larger than $\beta \to g$ transitions. The consistent-Q formalism can account simultaneously for the ratio of the intrinsic energies of the β- and γ-bands in ^{162}Dy as well as the dominance of $\gamma \to g$ over $\beta \to g$ transitions observed in the same nucleus [3].

   [1] R. Bijker and A.E.L. Dieperink, Phys. Rev. C 26, 2688 (1982).

   [2] D.D. Warner and R.F. Casten, Phys. Rev. C 26, 2690 (1982).

   [3] A. Aprahamian, et al., Eur. Phys. J. A 60, 83 (2024)

5. José Roberto Brandão de Oliveira (IF-USP, Brazil, zero@if.usp.br)

   The G-NUMEN gamma spectrometer project - present status and demonstrator test

   Abstract: G-NUMEN is the gamma array of the NUMEN Project [1-8], an international collaboration led by the LNS/INFN, Catania, Italy. The main objective of NUMEN is to measure double charge exchange reactions of nuclear systems that can undergo double-beta decay, and obtain experimental constraints to the nuclear matrix elements which are of paramount importance to neutrino physics. The half-life of neutrino-less double beta decay is connected to the effective Majorana neutrino mass through these matrix elements. The G-NUMEN array will be used to detect gamma rays in coincidence with the projectile-like fragments which are detected and identified at the focal plane of the MAGNEX (LNS) high acceptance magnetic spectrometer, and will allow the separate measurement of reaction cross sections to the ground state of the system from those of excited states. The G-NUMEN array is proposed to consist of over a hundred LaBr3(Ce) scintillators [8]. The first detector prototypes were tested at high count rates [9], and the performance of the G-NUMEN Demonstrator Array, consisting of 15 of those detectors was evaluated in a high gamma background experiment at the ALTO Tandem accelerator of the IJCLab, Orsay, France, reproducing the conditions of the future NUMEN DCE measurements at very high beam intensities.

   [1] F. Cappuzzello, et al., Eur. Phys. J. A (2018) 54: 72

   [2] F. Cappuzzello, et al., IL NUOVO CIMENTO 42 C (2019) 57

   [4] J. R. B. Oliveira et al., 2018 J. Phys.: Conf. Ser. 1056 012040

   [5] F. Cappuzzello et al., Front. Astron. Space Sci., 8:668587 (2021)

   [6] C. Agodi et al., Universe 7 (2021) 3

   [7] P. Finocchiaro et al., Universe 6 (2020) 129

   [8] The NUMEN Technical Design Report, Int. J. of Mod. Phys. A 36 (2021) 2130018

   [9] E.M. Gandolfo et al., Instruments 2023, 7, 28

6. Kelly Cristina Cezaretto Pires (IF-USP, Brazil, kelly@if.usp.br)

   Co-authors: K.C.C. Pires, R. Lichtenthäler Filho, A.Lépine-Szily, O.C.B. dos Santos, U. Umbelino, A.S. Serra, B.P. Monteiro, H.F.G. Arruda, D.A. Santana, F.R. Loureiro and RIBRAS Collaboration

   Departamento de Fśica Nuclear, Instituto de Física, Universidade de São Paulo, 05508-090 São Paulo, Brazil

   Title: An overview of exotic nuclei studies using the "Radioactive Ion Beams in Brasil" (RIBRAS) facility

   Abstract: Investigations of nuclear reactions involving nuclei out of the stability valley is one of the most interesting areas in low-energy nuclear physics today. The RIBRAS facility is in operation since 2004 at the "Open Laboratory for Nuclear Physics and Applications" (LAFNA), which is the sole laboratory in Brazil dedicated to research in nuclear physics, covering both fundamental and applied aspects. The RIBRAS system consists of two superconducting solenoids with a maximum magnetic field of B=6.5 T, coupled to the 8UD-Pelletron tandem Accelerator installed at the Institute of Physics of the University of São Paulo (IFUSP), Brazil [1, 2, 3, 4]. The production mechanism of the radioactive ions is by transfer reactions, using 9Be, 3He, LiF, and other production targets. Particles of interest arising from the production reaction are selected and focused by solenoids into a scattering chamber. RIBRAS delivers light radioactive ion beams of 6He, 8Li, 7,10Be, 8,12B, with intensities ranging from 104 to 106 pps, which were used to study elastic, inelastic, and transfer reactions on a variety of light (9Be, 12C) medium (27Al, 51V, 58Ni) and heavy (natZr, 120Sn) secondary targets. In all cases, the measured cross sections have shown good agreement with sophisticated theoretical calculations. Furthermore, we have identified a substantial production of alpha particles during collisions induced by the neutron-rich 6He with several targets at low energies. These alpha particles can originate from the breakup of the 6He nucleus in the presence of the target nucleus, as well as from transfer reactions. A review of the research program carried out along the last years using the RIBRAS facility will be presented.

   [1] A. Lépine-Szily and et al. Eur. Phys. J. A. 50, 128 (2014).

   [2] R. Lichtenthäler and et al. The Eur. Phys. Jour.A25, suppl. 1, (2005), 1773.

   [3] A. Lépine-Szily and et al. Nuclear Physics News, v23, n3, 5-11 (2013).

   [4] R. Lichtenthäler and et al. Eur. Phys. J. A, v57, 92, (2021)

7. Peter Christiansen (Lund, Sweden, peter.christiansen@hep.lu.se)

   Title: QGP in small systems? Why we CLASH and what we have learned

   Abstract: The study of relativistic heavy-ion collisions has historically revealed a lot of novel phenomena that has been associated with the formation of a quark-gluon plasma (QGP), e.g., strangeness enhancement and collective elliptic flow. However, many of these phenomena has over the last decade also been found in small systems. In this presentation, I will first give a brief overview of the current status related to the question of QGP in small systems. The primary focus of this contribution will be describing how we in the Lund-based CLASH project confronted established pp phenomenology, such as the Lund string model, with QGP-based ideas and what we learned. Finally, I will give an outlook on the questions that I think need to be addressed in the coming years.

8. Osvaldo Civitarese (La Plata, Argentina, osvaldo.civitarese@fisica.unlp.edu.ar)

   Title: On the coupling between neutrinos and axions as the origen of the neutrino mass

   Abstract: Among cold dark-matter candidates are low-mass neutral bosons. The existence of such pseudo-scalar particles has been proposed long ago by Peccei and Quinn to explain the spontaneous

breaking of CP in the early Universe. In this talk we discuss a possible mechanism to explain for non-zero neutrino masses, which is based on the treatment of neutrino-axions interactions.From the known limits to the values of the neutrino mass, extracted from the nonobservation of the neutrinoless double beta decay, we set relations between the axion-neutrino coupling, the axion mass and the neutrino mass.

9. Ethan Cline (MIT, USA, ewcline@mit.edu)

   Title: DarkLight@ARIEL

   Abstract: The search for dark matter holds considerable interest in the physics community. Any laboratory-based evidence of Beyond the Standard Model physics would begin to illuminate the dark sector. Many experiments have searched for such evidence, but so far it has proven elusive. For the nuclear physics community the concept of a low mass dark photon has garnered considerable attention. Of particular recent interest are the well-known $g_\mu - 2$ anomaly and an excess observed in the decay of excited states of ^{4}He, ^{8}Be and ^{1}2C, which could be explained by a 17 MeV/c^2 mass dark boson. The proposed DarkLight experiment would search for this potential low mass force carrier at the TRIUMF ARIEL accelerator in the 10-20 MeV/c^2 e^+e^- invariant mass range. This talk will focus on the motivation, physics case, and experimental design of the DarkLight experiment.

10. Christopher Crawford (Kentucky, USA, c.crawford@uky.edu)

    Title: Measurements of the Neutron Electric Dipole Moment at PSI

    Abstract: The CP-violating neutron electric dipole moment (nEDM) is sensitive to physics beyond the Standard Model which is needed to explain the baryon asymmetry in our universe. The most precise measurement of the nEDM, carried out at Paul Scherrer Institute (PSI), is consistent with zero with an upper limit of 1.8×10^{-26} e cm at the 90 % confidence level. To reach an order of magnitude better sensitivity, the n2EDM experiment is being commissioned at PSI. It has been completely redesigned including a new magnetic shield room with spin transport/precession coils and an active magnetic shield, a double precession chamber with new HV electrodes and Hg-199 comagnetometers, 112 optically pumped Cs magnetometers, and two simultaneous spin analyzers with ultracold neutron detectors. I will discuss the current PSI nEDM result and progress towards the next generation n2EDM measurement.

11. Oscar Díaz Rizo (InSTEC-UH, U. La Habana, Cuba, odiazrizo@gmail.com)

    Title: Nuclear analytical techniques in environmental studies

    Abstract: Recent experiences in the study of different environmental problems using nuclear analytical techniques (NAT) are presented. The environmental analysis by means of Neutron and Gamma Activation analyses, X-ray Fluorescence and Low Background Gamma Spectrometry allows the most completed toxicological and radiological characterization of the sediments used for peloide therapy in the main Cuban spas. Additionally, the results of NAT studies of Cuban beach sands and urban dust from some Havana city municipalities are also presented.

12. Daniel Durini (INAOE, Mexico, ddurini@inaoep.mx)

    Co-authors: Gregorio Zamora-Mejía, Ruben Alfaro-Molina, Jose M. Rocha-Perez, Victor H. Carbajal-Gómez, A.I. Bautista-Castillo, Sergio A. Rosales-Nunez, A. Silva-Juárez, and L.C. Alvarez-Simon

    Title: SiPM Signal Acquisition System Based on a Sigma-Delta Modulator

    ABSTRACT: This work presents a SiPMs signal acquisition system based on a sigma-delta modulator. The proposed system is made-up of a mixed-mode ASIC, working as a front-end, and an FPGA-based processing stage. The ASIC provides a 1-bit modulated version of the SiPM's current, a flag indicating the start/end of the SiPM pulse, and a clock reference generated by an internal Phase Locked-Loop (PLL). The FPGA gets and decimates the signals from the analog front-end to complete data recovery. To provide the digital information, the SiPM current is converted to voltage by a 1.2 GHz bandwidth transimpedance amplifier whose gain can be switched between 30x and 800x, allowing a 0.1-10 mA dynamic input-range. The resulting voltage signal is applied to a Trigger Unit (TU) and to a 1-bit quantizer second-order sigma-delta modulator ($\Sigma\Delta$-M) that exhibits an Equivalent Number Of Bits (ENOB) of 6.24. This type of modulator was selected to have a single line instead of a bus with many lines, this is important in applications where the number of sensors is very large. The TU circuit sends a start/end bit flag by comparing the SiPM voltage signal with an 8-bit programmable voltage reference. The 10 MHz bandwidth $\Sigma\Delta$-M uses an Over Sampling Ratio (OSR) of 50 and a 1 GHz sampling clock that is generated by a PLL using an off-chip 100 MHz reference. Due to its high decimation rates, the decimator uses a Cascade Integrator Comb (CIC) filter that is adequate to process sigma-delta modulated signals. The recovered signal is presented in a Graphical User Interface (GUI) developed in a Matlab® environment. The ASIC was designed in a 180 nm CMOS standard process using Cadence® software and the processing stage was implemented in a Kintex-7 FPGA.

The authors thank CONAHCyT-Mexico for the support to G. Zamora-Mejía and V. H. Carbajal-Gómez through the "Investigadoras e Investigadores por México" program and the support to A. Silva-Juarez, and L. C. Alvarez-Simon through the "Estancias Posdoctorales por México" program.

13. Alfredo Estrade (Central Michigan U, USA, estra1a@cmich.edu)

Co-authors: Leandro Bruno[2], Shree Neupane[1], Carolina Rabin[2], Sithira Samaranayake[3] and Kai-long Wang[1,3]

[1] Department of Physics, Central Michigan University, USA
[2] Instituto de Física, Facultad de Ciencias, Universidad de la República, Uruguay
[3] Institute of Modern Physics, Chinese Academy of Sciences, China

Title: High-precision time-of-flight measurement: from neutron star mergers to medical imaging applications

Abstract: Time-of-flight (TOF) measurements are an important tool in basic nuclear physics research and its applications. Steady progress in radiation detectors and instrumentation has made it possible to construct devices with timing resolution at the level of 10 picoseconds, opening new opportunities for experiments and applications. In experiments with ion beams TOF measurements are key to derive the mass-to-charge ratio of the particles in the beam and to identify them. If a high-resolution TOF measurement can be combined with a measurement of magnetic rigidity, as is the case in experiments with the TOF-Br technique, then one can determine the nuclear mass of the ions in the beam. We have developed new timing scintillators for TOF-Br experiments with a resolution of 8 ps, which allowed our collaboration to reach a mass resolution of 1×10^{-4} in experiments with the S800 spectrometer at the National Superconducting Cyclotron Laboratory (NSCL) [1,2]. Combined with the potential of the technique to measure very short-lived isotopes with relatively low beam intensities makes, the TOF-Br technique is an effective tool to study very unstable neutron-rich isotopes relevant to astrophysics applications. We will present recent results of measurements of isotopes near $N = 70$ relevant to nucleosynthesis of heavy elements during the rapid neutron-capture process [2] and discuss plans of the collaboration for upcoming experiments at the Facility for Rare Isotope Beams (FRIB). Intense research and development efforts are currently underway to obtain a similar timing resolution of 10 ps for the detection of γ-rays [3]. A coincidence measurement of the back-to-back γ-rays emitted in positron emission tomography (PET) would have a transformative effect in medical physics, allowing for reconstruction-less imaging using the information of the TOF between the two γ-rays. We will discuss the status of our

recent project to evaluate the resolution of scintillator detector designs with depth-of-interaction capabilities for PET applications.

[1] K.-L. Wang et al, Nucl. Inst. and Meth. in Phys. Res. A 974, 164199 (2020)

[2] K.-L. Wang et al, Phys. Rev. C 109, 035806 (2024)

[3] Paul Lecoq et al, Phys. Med. Biol. 65, 21RM01 (2020)

14. Araceli García Flores and Daniel Marín (IF-UNAM, Mexico, araceligf@fisica.unam.mx)

Title: Ion Beam Characterization by AMS

Abstract: The "Laboratorio Nacional de Espectrometría de Masas con Aceleradores" (LEMA) at the Institute of Physics of the National Autonomous University of Mexico (IFUNAM) consists of two mass spectrometers coupled to a 1 MV tandem accelerator [1]. The main use of the facility is ^{14}C dating, but also other cosmogenic isotopes are used; ^{10}Be, ^{26}Al, ^{129}I, ^{239}Pu, the second spectrometer belongs to the nuclear physics experimental beam line [2]. In this facility it is possible to get a highly stable, elemental and molecular ion beams with a wide range of low energies, depending on the charge state and current intensities, from nA to few μA. In this project we present the characterization of Fe and Ni beams production. The isotopic species for Fe and Ni were defined by charge state, energy, and mass and were identified and counted one by one using the Rutherford Back Scattering (RBS) technique.

[1] Solís C. et. al. "A new AMS facility in Mexico". In: Nucl. Inst. and Met. in Phys. Res. B 331 (2014), p. 233. doi: https://doi.org/10.1016/j.nimb.2014.02.015.

[2] Reza G. et. al. "Characterization of the new hybrid low-energy accelerator facility in Mexico". In: Eur. Phys. J. Plus 134:590 (2019). doi: https://doi.org/10.1140/epjp/i2019-12950-1.

15. José Enrique García-Ramos (Huelva, Spain, enrique.ramos@dfaie.uhu.es)

Title: On the nature of shape coexistence and quantum phase transition phenomena

Abstract: The shape coexistence phenomenon is related with the presence in the same energy region of eigenstates with different deformations. The lead region is considered as a paradigm for shape coexistence and several decades of experimental effort have supported this believe. In particular, long chains of the Pb, Hg, Pt and Po isotopes have been measu- red and a rich experimental body of data concerning, excitation energies, electromagnetic transition rates, radii, magnetic g-factors, alpha-hindrance factors and Coulomb excitation reactions, has been obtained.

In the case of Pb and Hg, the presence of intruder states is self-evident inspecting the parabolic energy systematics of the intruder states. However, in the case of Pt and Po, the presence and influence of intruder states is not obvious.

On the other hand, the concept of quantum phase transition (QPT), which has gained a lot of attention in nuclear physics, among other fields, during the last twenty years, appears when the Hamiltonian that describes the quantum system can be written in terms of two pieces, at least, each one with a given symmetry, and a Hamiltonian parameter, i.e., a control parameter, allows to pass from one to the other symmetry. This passing supposes a sudden change in a control parameter and a discontinuity in the ground-state energy or in some of its derivatives.

The rare-earth region around $N = 90$ is very well known for containing examples of QPT's, in particular, the even-even isotope chains of Nd, Sm, or Gd show first order QPTs. In other regions, as in Ba or Ru even-even isotope chains, second order QPTs appear.

The goal of this seminar is to try to clarify the connection between shape coexistence and QPT, two seemingly unrelated phenomena, but that, once studied in deep, share common aspects: the rapid change in the ground state structure when going through an isotope chain or the presence in the

mean-field energy surface of several minima. To illustrate the similarities and differences between both phenomena, we will focus in the Zr and Sr region (including also Mo and Ru) which is known for the rapid change of the ground state deformation and also for the presence of intruder states coming from two-particle two-hole excitations across Z=40 shell closure. We will also consider the lead mass area as a region where shape coexistence is of major importance, but no evidences of phase transitions are observed.

[1] J.E. García-Ramos y K. Heyde, "The Pt isotopes: Comparing the Interacting Boson Model with configuration mixing and the extended consistent-Q formalism", Nuclear Phy- sics A 825, 39-70 (2009).

[2] J.E. García-Ramos y K. Heyde, "Nuclear shape coexistence: A study of the even- even Hg isotopes using the interacting boson model with configuration mixing", Physical Review C, 89, 014306-24pp (2014).

[3] J.E. García-Ramos y K. Heyde, "Quest of shape coexistence in Zr isotopes", Physical Review C 100, 044315-25p (2019).

[4] J.E. García-Ramos y K. Heyde, "Subtle connection between shape coexistence and quantum phase transition: The Zr case", Physical Review C 102, 054333-16p (2020).

[5] E. Maya-Barbecho and J.E. García-Ramos, "Shape coexistence in Sr isotopes", Physical Review C 105, 034341 (2022).

[6] E. Maya-Barbecho, S. Baid, J. M. Arias, and J.E. García-Ramos, "At the borderline of shape coexistence: Mo and Ru", Physical Review C 108, 034316 (2023).

16. César Eduardo García Trápaga (InSTEC-UH, U. La Habana, Cuba)

    Title: Role of flavor in production of Z^0 Bosons in pp, pA and AA collisions

    Abstract: This contribution is devoted to analyzing the Z^0 bosons production in hadron collisions at LHC energies, focusing on aspects such as the flavor role and the effect of the nuclear medium. All are based on the comparison of simulations with experimental data. The focus on using simulations and detailed analysis of specific observables, such as the invariant mass and transverse momentum of the dilepton, as well as the multiplicity of charged particles in the final state, provides insight into subatomic interactions in high-energy and high-information environments valuable to characterize the properties of the collisions studied. By relating the relative contributions of flavor to experimental results, the work contributes to bridging the gap between theory and experiment. Supported by the results discussed, it is conjectured that the effects of the nuclear environment and asymmetry distinguish quarks by their flavor. However, the exact reason or form of these dependencies remains to be determined, highlighting the need for further analysis and future research. As part of this contribution, I want to briefly mention the scope of the InSTEC's activities in the field of HEP.

17. Diego Mauricio Gómez Coral (IF-UNAM, Mexico, dgomezco@fisica.unam.mx)

    Title: Cosmic deuterons measured by the AMS experiment and predictions by current propagation models

    Abstract: Cosmic-ray deuterons (D) are one of the most abundant secondary nuclei in the Galaxy and are expected to be produced by the fragmentation of primary cosmic-ray Helium (He) with the interstellar medium. Therefore, the D/He4 flux ratio provides unique information to verify and constrain cosmic-ray propagation models, in addition to the traditionally used Boron-to-Carbon flux ratio (B/C). In this work, unexpected properties of deuterons and the D/He4 flux ratio are presented based on 21 million D nuclei in the rigidity range from 1.9 to 21 GV collected by the Alpha Magnetic Spectrometer (AMS) on the International Space Station. The results are compared to state-of-the-art propagation models, showing discrepancies that highlight the importance of a better understanding of cosmic-ray propagation and the need for cross-section measurements.

18. Jason Holt (TRIUMF, Cananda, jholt@triumf.ca)

    Title: Global ab initio calculations for the structure of exotic and heavy nuclei

    Abstract: Breakthroughs in our treatment of the many-body problem and nuclear forces are rapidly transforming modern nuclear theory into a true first-principles discipline. This allows us to address some of the most exciting questions at the frontiers of nuclear structure and physics beyond the standard model.

    In this talk I will briefly outline our many-body approach, the valence-space in-medium similarity renormalization group, and how recent advances now allow for global converged calculations of open-shell nuclei to the ^{208}Pb region and beyond. I will focus on key topics in nuclear structure such as predictions of the proton and neutron driplines and evolution of magic numbers throughout the light and medium-mass regions, including new insights on the nature and existence of ^{28}O including continuum degrees of freedom. In addition, I will discuss how correlation of the neutron skin and dipole polarizability in heavy nuclei to ^{208}Pb provide first ab initio constraints on symmetry energy parameters for determining neutron star properties as well as opening paths to predictive nuclear theory for searches for physics beyond the standard model.

19. Calvin Johnson (San Diego State, USA, cjohnson@sdsu.edu)

    Title: Deconstructing nuclear wave functions

    Abstract: With modern computers, we can calculate ever-more complicated models of the quantum wave functions of atomic nuclei. But the purpose of computing should be insight, not just lots of numbers (Hamming). I will discuss how one can use group theory and ideas from quantum information to illuminate the structure of atomic nuclei without assumptions, and to tease out similarities and differences across nuclides, model spaces, and interactions.

20. Neelima Kelkar (U. de los Andes, Colombia, nkelkar@uniandes.edu.co)

    Title: Nuclear decay rates at elevated temperatures

    Abstract: Nuclear decays play an important role in the description of different physical phenomena ranging from heat production in the centre of the earth, radioactive dating and medical applications to cosmochronology and nucleosynthesis. Heavy elements beyond iron are speculated to be produced in the r-process nucleosynthesis following core-collapse supernovae and neutron star mergers. Kilonovae, the electromagnetic emissions produced from these mergers, are powered by the radioactive decay of heavy elements synthesized in the ejecta from the merger. A good knowledge of the nuclear decay rates is therefore of foremost importance for nucleosynthesis calculations as well as kilonova modelling. Since nucleosynthesis of heavy elements is expected to take place at temperatures of the order of Giga Kelvin, abundance of elements is calculated through a network of coupled differential equations involving nuclear reaction rates at elevated temperatures. However, decay inputs are taken from terrestrial half-lives. In this talk, we shall discuss stellar decay rates evaluated from available data on excited nuclei as well as some models for evaluating the half-lives of thermally excited nuclei.

21. Garrett B. King (Washington University in St. Louis, USA, kingg@wustl.edu)

    Title: Electroweak reactions with quantum Monte Carlo methods

    Abstract: Precision measurements involving nuclei are at the cutting edges of nuclear physics and testing the Standard Model (SM) of physics. For instance, precision beta decay measurments have the potential to constrain beyond SM physics at TeV scales. To interpret these experiments, it is crucial to have comparably accurate theoretical predictions of relevant quantities along with an accurate understanding of the underlying nuclear dynamics. In this contribution, I will overview recent calculations of electroweak processes with quantum Monte Carlo (QMC) computational methods used to solve the many-body Schrödinger equation. The QMC approach retains the complexity of many-nucleon dynamics and provides highly accurate results for light nuclei. I will discuss calculations of observable quantities with readily available data–such as beta decay, muon capture, and electromagnetic reactions–used to validate models of nuclear many-body interactions and electroweak currents. I will then present QMC calculations of the ^{6}He beta decay spectrum and show that the estimated theoretical uncertainties are comparable to the experimental precision, thus allowing for further constraints of new physics at TeV scales.

22. Erich Leistenschneider (LBL, USA, erichleist@lbl.gov)

    Title: Precision Spectroscopy of Heavy and Superheavy Elements with AETHER

    Abstract: Superheavy elements edge the limits of matter's existence. Their extreme proton content presents opportunities to delve into fundamental questions across chemistry, atomic physics, and nuclear physics. For instance, we ponder how enhanced relativistic effects impact atomic structure and chemical properties, or how nuclear shell effects evolve under such extreme conditions. Yet, the journey to uncover these answers is fraught with challenges. Typically, only a handful samples of such elements are produced each day or even less. These conditions drives continuous innovation in instrumentation and development of new methodologies, especially pushing for higher experimental sensitivity. In my talk, I will present the novel avenues under construction at Barkeley Lab to probe heavy and superheavy elements though modern precision spectroscopy techniques. The new project, Advanced Electrostatic Trap for Heavy Element Research (AETHER), will initially focus on measuring nuclear binding energies with precision mass spectrometry, aiming to address nuclear structure questions at the upper end of the table of nuclides. Looking ahead, we plan to capitalize on the remarkable sensitivity recently demonstrated by the Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy (MIRACLS) methodology to achieve groundbreaking measurements of electron affinities for rare elements — an essential atomic property that remains unknown across approximately one-third of the periodic table.

23. Silvia Lenzi (Padova, Italy, silvia.lenzi@pd.infn.it)

    Title: The Island of inversion at the $N \sim Z$ line

    Abstract: The region of deformation around ^{80}Zr has been studied experimentally. For the first time, the lifetime of the $N = Z = 42$ ^{84}Mo and the $N = Z + 2$ isotope ^{86}Mo have been measured at NSCL with the plunger method. This measurement reveals a very sudden shape change between the two isotopes, contrary to what is observed in lighter $N = Z$ and $N = Z + 2$ nuclei from Ge to Zr. The data have been interpreted with different theoretical methods, putting in evidence that the structure of the ground states in these nuclei is of intruder nature, where many particle-hole excitations across $N = Z = 40$ are induced by quadrupole correlations and shell evolution. In analogy to the Island of Inversion around ^{64}Cr in the neutron-rich side of the nuclear chart, we recognize the region of deformation around ^{80}Zr as an Island of Inversion where both protons and neutrons coherently contribute to the development of deformation. The sudden change in deformation between ^{84}Mo and the $N = Z + 2$ isotope ^{86}Mo is interpreted as a fingerprint of the effect of three-body forces.

24. Rubens Lichtenthäler (IF-USP, Brazil, rubens@if.usp.br)

    Title: Inclusive breakup reactions in low energy unstable nuclei collisions

    Abstract: Light stable nuclei such as helium, Lithium, Berilium and their isotopes usually present pronounced cluster structures and very small breakup energies (1– 3 MeV) compared to breakup energies found in heavier nuclei. The so-called exotic isotopes such as ^{6}He, ^{11}Be, ^{11}Li are composed of a stable core surrounded by a 'neutron halo' and even smaller breakup energies (below 1 MeV). Inclusive breakup reactions is a denomination for reactions induced by such weakly bound and exotic projectiles when only one of the projectiles fragment is detected. The measurement of the energy and angular distributions of the charged fragment provides information of the recoil (undetected) system. We will present data of alpha particle and ^{7}Li distributions from the collision of ^{6}He and ^{8}Li on several targets at low energies (3-5 MeV/A). The measurements have been performed in RIBRAS (Radioactive Ion Beams in Brasil) system [1]. The measured energy and angular distributions of the fragments indicate that the projectile breakup and neutron transfer reactions are competing at low energies [2-4]. The data have been analysed by continuum discretized coupled channels (CDCC) and coupled reaction channels calculations (CRC) and the effect of the projectile breakup and neutron transfer reactions in the elastic scattering is shown. Successful Ichimura, Austern, Vincent (IAV) calculations have been performed indicating a strong excitation of the recoil system during the collision. Comparison with recent data of more exotic (^{11}Be and ^{8}B) beams on heavy targets will be presented [5-6].

[1] Lichtenthäler, R. et. al. ;European Physical Journal A, v. 57, p. 92, 2021.

[2] Appannababu, S. et. al. Physical Review C, v. 99, p. 014601, 2019.

[3] Santos, O. C. B. et. al. ; Physical Review C, v. 103, p. 064601, 2021.

[4] Santos O. C. B. European Physical Journal A, v. 59, p. 48-59, 2023.

[5] L. Yang et al. Nature Communications; https://doi.org/10.1038/s41467-022-34767-8

[6] F. F. Duan et. al. ; Physics Letters B 811 (2020) 135942

25. Jesus Lubian (Fluminense, Brazil, jlubian@id.uff.br)

Title: Breakup effects on fusion. Reduction methods and quantum-mechanical methods for the CF and ICF calculation

Abstract: We discuss the effect of weakly bound projectiles' breakup (BU) channels on complete and total fusion. For that, we report our fusion method based on the Wong formula, which allows for comparing reduced experimental data to the universal fusion function to find the effect of the BU channel on fusion. We report a recent improvement to the Wong formula to upgrade our reduction method and introduce the classic line benchmark for energies above the Coulomb barrier.

A new theoretical method for the calculation of complete (CF) and incomplete fusion (ICF) recently proposed by us will be presented. This method is based on the continuum discretized coupled channel method plus a classical statistic to derive the corresponding probabilities. The method will be used to derive the CF and ICF of the reactions induced by ^{6,7}Li on heavy targets. The capability to describe the experimental data for the reactions induced by neutron halo projectiles will also shown. Finally, we will also show that from the inclusive alpha emission cross section from ^{6}Li + ^{90}Zr at near barrier energies, the deuteron-ICF can be derived, and the theoretical prediction agrees very well with this indirect experimental quantity.

26. Fabiola Viridiana Lugo Porras (IF-UNAM, Mexico, lugofabiola@estudiantes.fisica.unam.mx)

Coauthor: Arturo Menchaca-Rocha

Title: Study to characterize the production of antineutrons in high energy *pp* and Pb-Pb collisions through charge exchange interactions

Abstract: Simulations to evaluate the feasibility of antineutron ($\bar{n}$) identification and kinematic reconstruction via the hadronic charge exchange (CEX) interaction $n+\bar{n} \to p+\bar{p}$ were carried out. The target neutrons are those composing the silicon nuclei of which inner tracking devices present in the LHC experiments ALICE, ATLAS, and CMS, are made. Simulations of collisions in PYTHIA were carried out at different energies to investigate $\bar{n}$ production and energy spectra. Two types of GEANT4 simulations were performed, placing an $\bar{n}$ point source at the primary vertex located in

the center of an ALICE ITS-like detector, taken as a working example. In the first simulation, the kinetic energy E_k was kept at an arbitrary (1 GeV) fixed value to develop an $\bar{n}$ identification and kinematics reconstruction protocol. This protocol was focused on the p CEX-partner identification, which was challenging because of the presence of silicon nucleus-fragmentation protons. Momentum correlations between the $\bar{n}$ and all possible $p\bar{p}$ pairs showed that p CEX-partner identification and $\bar{n}$ kinematics reconstruction correspond to minimal momentum-loss events. The final protocol was applied to a realistic second GEANT4 simulation, which use the resulting PYTHIA at $\sqrt{s_{pp}} = 13$ TeV $\bar{n}$ energy spectra. An $\bar{n}$ identification and kinematic reconstruction efficiency of 0.006 %, based solely on $p\bar{p}$ pair observable, was obtained. If applied to the ALICE minimum-bias RUN2 pp at $\sqrt{s_{pp}} = 13$ TeV data sample, this technique is found to have the potential to identify and reconstruct the kinematics of 4.3×10^8 $\bar{n}$'s, illustrating the feasibility of the method. The developed protocol was applied to study Monte Carlo pp and Pb-Pb productions from ALICE's second run to corroborate the eOiciency obtained. These Monte Carlo simulations also allow us to study all the reactions that constitute the possible background.

27. Daniel Marín Lámbarri (IF-UNAM, Mexico, marinlambarri@gmail.com)

    Title: Experimental Nuclear Physics in Mexican Facilities

    Abstract: There are only five accelerators in Mexico, three of them at the Institute of Physics at the National Autonomous University of Mexico, a 3 MV Tandem Pelletron, a single-ended 5.5 MV CN-Van de Graaff and a 1 MV Tandetron. In this talk I will present the ongoing projects at the last two mentioned facilities.

28. Isabella Marzola (Instituto Tecnológico de Aeronáutica, Brazil, bella.marzola0@gmail.com)

    Co-authors: Everson H. Rodrigues, Anderson Coelho and Odilon Lourenço

    Title: Dark matter applied in strange stars

    Abstract: Strange stars are hypothetical stellar objects, composed primarily of strange quark matter [1, 2], that challenge the boundaries of science and allow us to investigate the unknown nature of dark matter. This is because compact objects (e.g. neutron stars, hybrid stars and the aforementioned strange stars) are unique environments where the presence of dark matter could leave observable imprints [3–7]. In this work we study the effects of dark matter in strange stars through a density dependent quark matter model called "equiparticle model (EQP)" [8–11], where dark matter is introduced as a bosonic fluid [12] with its equations of state (EOS) being a fraction of the total one. We present the theoretical framework and examine various scenarios of dark matter interaction with strange quark matter along with the mass-radius profiles with the most recent observational data provided by LIGO and Virgo Collaboration [13–15], and the NICER mission concerning the millisecond pulsars PSR J0030+0451 [16, 17], and PSR J0740+6620 [18, 19].

    [1] A. R. Bodmer. Collapsed nuclei. Phys. Rev. D, 4:1601–1606, Sep 1971.

    [2] Edward Witten. Cosmic separation of phases. Phys. Rev. D, 30:272–285, Jul 1984.

    [3] John Ellis, Gert Hütsi, Kristjan Kannike, Luca Marzola, Martti Raidal, and Ville Vaskonen. Dark matter effects on neutron star properties. Phys. Rev. D, 97:123007, Jun 2018.

    [4] Ben Kain. Dark matter admixed neutron stars. Phys. Rev. D, 103:043009, Feb 2021.

    [5] O. Ivanytskyi, V. Sagun, and I. Lopes. Neutron stars: New constraints on asymmetric dark matter. Phys. Rev. D, 102:063028, Sep 2020.

    [6] Davood Rafiei Karkevandi, Soroush Shakeri, Violetta Sagun, and Oleksii Ivanytskyi. Bosonic dark matter in neutron stars and its effect on gravitational wave signal. Phys. Rev. D, 105:023001, Jan 2022.

[7] Giangrandi E. Ivanytskyi O. Lopes I. Sagun, V. and K. Bugaev. Constraints on the fermionic dark matter from observations of neutron stars. PoS, PANIC2021:313, 2022.

[8] C. J. Xia, G. X. Peng, S. W. Chen, Z. Y. Lu, and J. F. Xu. Thermodynamic consistency, quark mass scaling, and properties of strange matter. Phys. Rev. D, 89:105027, May 2014.

[9] Betânia C Backes, Eduardo Hafemann, Isabella Marzola, and Débora P Menezes. Density-dependent quark mass model revisited: thermodynamic consistency, stability windows and stellar properties. Journal of Physics G: Nuclear and Particle Physics, 48(5):055104, apr 2021.

[10] Isabella Marzola, Sérgio Barbosa Duarte, and Odilon Lourenço. Deconfinement phase transition in a thermodynamically consistent quark matter model. PoS, XVHadronPhysics:065, 2022.

[11] Isabella Marzola, Sérgio B. Duarte, César H. Lenzi, and Odilon Lourenço. Quark confinement in an equiparticle quark model: Application to stellar matter. Phys. Rev. D, 108:083006, Oct 2023.

[12] Nathan Rutherford, Geert Raaijmakers, Chanda Prescod-Weinstein, and Anna Watts. Constraining bosonic asymmetric dark matter with neutron star mass-radius measurements. Phys. Rev. D, 107:103051, May 2023.

[13] B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, et al. Gw170817: Observation of gravitational waves from a binary neutron star inspiral. Phys. Rev. Lett., 119:161101, Oct 2017.

[14] B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, Ackley, et al. Gw170817: Measurements of neutron star radii and equation of state. Phys. Rev. Lett., 121:161101, Oct 2018.

[15] B. P. Abbott, R. Abbott, T. D. Abbott, S. Abraham, F. Acernese, et al. Gw190425: Observation of a compact binary coalescence with total mass 3.4 m. The Astrophysical Journal Letters, 892(1):L3, mar 2020.

[16] T. E. Riley, A. L. Watts, S. Bogdanov, P. S. Ray, et al. A nicer view of psr j0030+0451: Millisecond pulsar parameter estimation. The Astrophysical Journal Letters, 887(1):L21, dec 2019.

[17] M. C. Miller, F. K. Lamb, A. J. Dittmann, S. Bogdanov, et al. Psr j0030+0451 mass and radius from nicer data and implications for the properties of neutron star matter. The Astrophysical Journal Letters, 887(1):L24, dec 2019.

[18] Thomas E. Riley, Anna L. Watts, Paul S. Ray, Slavko Bogdanov, et al. A nicer view of the massive pulsar psr j0740+6620 informed by radio timing and xmm-newton spectroscopy. The Astrophysical Journal Letters, 918(2):L27, sep 2021.

[19] M. C. Miller, F. K. Lamb, A. J. Dittmann, S. Bogdanov, et al. The radius of psr j0740+6620 from nicer and xmm-newton data. The Astrophysical Journal Letters, 918(2):L28, sep 2021.

29. Anna McCoy (ANL, USA, amccoy@anl.gov)

Titel: The beryllium isotopic chain: a microcosm of nuclear structure.

Abstract: Beryllium isotopes demonstrate a variety of nuclear phenomena arising from competition between single particle shell structure and collectivity. Such phenomena include the emergence of nuclear rotational bands with very different moments of inertia (shape coexistence), parity inversion in ^{11}Be and ^{13}Be, and a normal parity intruder ground state in ^{12}Be. Such phenomena emerge from ab initio calculations in which there is no a priori assumption of shell structure or collectivity. In this talk, I delve into the underlying correlations and symmetries which give rise to the exotic structure of the low lying spectrum of neutron rich beryllium isotopes from an ab initio point of view.

30. Nilberto H. Medina (IF-USP, Brazil, medina@if.usp.br)

Co-authors: R. Escudeiro[1,2], S. Lenzi[2] and F. Recchia[2]

[1] Instituto de Física da USP, São Paulo, SP, Brazil
[2] Università Degli Studi di Padova, Padova, Italy

Title: Nuclear Excited State Lifetime Measurements in $A = 50$ Mass Region

Abstract: For a better understanding and search for new phenomena in nuclear structure, studies are carried out using gamma-ray spectroscopy, in which collective structures in nuclei are investigated and the electromagnetic properties of their nuclear states are determined. Electromagnetic properties are linked to charge and current distributions in the nucleus and are dependent on the excited state wave functions. Electric quadrupole moments, $B(E2)$, are related to nuclear deformation and indicate the degree of collectivity of nuclear levels. The $B(E2)$ values can be determined via lifetime measurements. In the last years, the study of the nuclear deformation for nuclei between ^{40}Ca and ^{56}Ni, characterized by valence nucleons occupying the $f_{7/2}$ shell, has played a fundamental role in developing the understanding of nuclear structure in this mass region. On the other hand, conservation and breaking effects of the so-called isospin symmetry in mirror nuclei allowed the explanation of several nuclear phenomena and provided a powerful probe for the study of the nuclear force. The study of these effects is important to know details about the nuclear interaction. Mirror nuclei are especially useful to compare since these nuclei can be treated using a perturbation approach, where the strong interaction determines the structure of each state that is the same for each nucleus. In this talk, several lifetime measurement techniques will be shown, depending on the lifetime range of the excited nuclear states, for example: Recoil Distance Method (RDM), Doppler Shift Attenuation Method (DSAM), Plunger method, Pulsed beam and sample activity techniques [1]. Nuclear isomeric states for example, are nuclear states which decays with long lifetimes ($T_{1/2} > 10$ ns) and reveals, generally, a large change in the angular momentum, a small matrix element or a small transition energy [2]. A system for measuring isomeric states lifetimes was developed at the Laboratório Aberto de Física Nuclear e Aplicações (LAFNA) which uses delayed coincidence between evaporated particles from a nuclear reaction and the gamma rays emitted from an isomeric state and it is sensitive to lifetimes ranging from 10 ns to 2 μs [3]. In this talk it will be detailed also an experiment to measure lifetimes of mirror pairs excited states using the DSAM method. The excited states of the mirror pairs ^{49}Cr-^{49}Mn and 47V-^{47}Cr have been populated using a fusion-evaporation reaction where a 115 MeV ^{36}Ar beam bombarded a CaO target [4]. The detection of the gamma rays emitted from these reactions has been performed with the gamma-ray spectrometer AGATA (Advanced Gamma Tracking Array) [5]. The lifetimes of some excited states of the mirror pairs ^{49}Cr-^{49}Mn and ^{47}V-^{47}Cr, were measured and the results were interpreted by comparison to the Large Scale Shell Model with the use of the ANTOINE code and the effective interaction KB3G, which allows the interaction of nucleons in the full fp space and includes the effects of the Coulomb interaction. From the comparison of experimental data and Large Scale Shell Model calculations, it was possible to obtain new values for the effective charges of protons and neutrons.

[1] Morinaga, H. and Yamazaki, T. In-beam Gamma-ray Spectroscopy. New York:NorthHolland Publishing Company, 1976.

[2] Dracoulis, G.D. , Phys. Scripta T152 (2013) 014015.

[3] Toufen, D. L. et al., Rev. Sci. Instrum. 85(7) (2014) 073501.

[4] Escudeiro, R., Ph.D Thesis, USP and UNIPD, (2023) and to be published.

[5] Akkoyun, S. et al., Nucl. Instrum. Meth. in Phys. Res. A, 668 (2012) 26–58

31. Modesto Montoya (National University of Engineering, Peru, mmontoya@uni.edu.pe)

Co-authors: Mario Álvarez and Miguel Roca

Title: Mass Distribution and Total Kinetic Energy of Fragments from the Reaction ^{235}U(nth, f) Compatible with Results Obtained Using the 2E and ME Techniques, Respectively

Abstract: Using a Monte Carlo simulation algorithm, a distribution of mass, total kinetic energy, and neutron multiplicity is found that reproduces the experimental results associated with 1) the average kinetic energy and the standard deviation of its corresponding distribution as a function of the fragment post-neutron mass m [1] and 2) the average multiplicity of prompt neutrons as a function of the fragment pre-neutron mass A of the fragments [2]. To replicate the peak in the standard deviation of the kinetic energy distribution around mass 109, the results suggest that the pre-neutron total kinetic energy values are higher in the region of light primary masses $A = 104-108$ and that there is a drop of 20 MeV between 108 and 110, which is much more pronounced than the drop obtained by the $2E$ technique. On the other hand, it is found that the maximum experimental value of the average neutron multiplicity near symmetry is shifted by +2 uma and the minimum value is shifted by −2 uma with respect to the associated primary mass. This suggests that, based on the results obtained with the $2E$ technique, the minimum value of the multiplicity corresponds to the mass of 132 uma, associated with the magic numbers $Z = 50$ and $N = 82$.

[1] M. Montoya et al., "Effects of Neutron Emission on Fragment Mass and Kinetic Energy Distribution from Thermal Neutron-Induced Fission of [sup 235]U," in AIP Conference Proceedings, 2007, vol. 947, pp. 326–329.

[2] A. Al-Adili et al., "Prompt fission neutron yields in thermal fission of U 235 and spontaneous fission of Cf 252," Phys. Rev. C, vol. 102, no. 6, 2020.

32. Marek Nowakowski (Universidade Federal de São Paulo, Brazil, marek.nowakowski@ictp-saifr.org)

Title: Decay law of particles in flight revisited

Abstract:The exponential decay law $e^{-t/\tau}$ (where τ is the mean lifetime) of an unstable system in its rest frame is a simple and basic tool the physicists use to study unstable particles and nuclei. It is known that quantum mechanics changes this law to power laws at small and large times. If the particle decays in flight we mostly employ for the survival probability, the time dilation formula, $e^{-t/\gamma\tau}$, where $\gamma = 1/\sqrt{1 - v^2/c^2}$ is the Lorentz factor. However, starting from the basic principles of quantum mechanics, we will show that the time dilation formula is only an approximation, albeit, a very good one for most of the particles, hadrons and nuclei. At the same time, for very short and large times, the survival probability in flight displays new peculiar features worth a more detailed study of which we present here the most important elements. We exemplify the theory using the gauge boson Z^0, the lepton μ^- and the hadrons ρ and Δ.

33. Antonio Ortiz (ICN-UNAM, Mexico, antonio.ortiz@nucleares.unam.mx)

Title: Small systems: an open issue in heavy-ion collisions

Abstract: Data from proton-proton (pp) collisions at the LHC energies unveiled fluid-like behavior. Since the last decade, we have tried to understand the origin of the new effects. In this talk, I will discuss several approaches which I have been implemented to better understand the data. They include the relative transverse activity classifier, and more recently, I proposed a new way to classify the pp collisions aimed at hunting parton energy-loss effects in pp collisions. Results using Monte Carlo simulations will be presented, as well as the first measurements reported by the ALICE collaboration.

34. Leticia Palhares (UERJ, Brazil, leticiapalhares@gmail.com)

Title: Quark and proton anomalous magnetic moments in confining models

Abstract: We present one-loop results for corrections from Strong Interactions to the quark-photon vertex using different confining models for the exchanged gluon. This calculation allows for the prediction of confinement effects in form factors and observables like the proton anomalous magnetic moment. We show that a range of confining models with dynamical gluon masses and even complex-conjugated poles present predictions that are fully compatible with observables and discuss to what extent model parameters may be constrained by this comparison.

35. Claude Pruneau (Wayne State, USA, aa7526@wayne.edu)

Title: Working with Balance Functions

Abstract: Balance functions were introduced in heavy-ion physics as a tool to identify the production of a QGP phase in the midst of high energy nucleus-nucleus collisions. In this talk, I will briefly summarize existing measurements and propose new ideas and use of balance functions to probe the collisions dynamics and properties of the medium formed in nuclear collisions. I will in particular discuss the use of mixed species charge, strangeness, and baryon balance functions, as well as the notion of multi-particle balance functions and how such new observables might be used to probe the correlation length of quarks in the Quark Gluon Plasma.

36. Pablo Roig (CINVESTAV, Mexico, paroig@gmail.com)

Title: Nuclear physics input to charged lepton flavor violation searches

Abstract: Lepton flavor violation (LFV) has only been observed so far through neutrino oscillations, implying tiny but non-vanishing neutrino masses. The discovery of this violation in the charged lepton sector (cLFV), so far elusive, would have tremendous implications for the mechanism generating neutrino masses and possibly for understanding the universe matter-antimatter asymmetry, at energy scales prone to Grand Unification. In the near future, the best bounds on muon to electron transitions will be obtained from their conversions in nuclei, highlighting the importance of the overlap integrals between the lepton wave functions under the nucleus Coulomb potential and the nucleon densities. I will also mention the tau to electron/muon conversion (that will soon start to be searched for), that will benefit from improved nuclear PDFs.

37. Jaime Romero-Barrientos (Chilean Nuclear Energy Commission, Chile, jaime.romero@cchen.cl)

Title: OpenMC(TD): Current status, future plans and experimental benchmarking in Monte Carlo simulations

Co-authors: F. Molina[1,2,3], M. Zambra[1] and F. L ópez-Usquiano[1,2]

[1] Comisión Chilena de Energía Nuclear, Nueva Bilbao 12501, Santiago, Chile
[2] SAPHIR Institue, Fern ández Concha 700, Santiago, Chile
[3] Departamento de Ciencias Físicas, Universidad Andres Bello, Sazíe 2212, 837-0136, Santiago, Chile

Abstract: This work presents the current state and the planned stages in the development of the modified Monte Carlo code OpenMC(TD) [1], a modified version of the OpenMC code [2]. OpenMC(TD) includes the time dependence related to the emission of β-delayed neutrons, but instead of simulating these neutrons using the traditional 6-group [3] (or 8-group) structure for grouping the delayed neutron precursors, it features an implementation where delayed neutrons are inserted into the simulation as individual precursors decay. This code is currently in development, but already shows promising results. The upcoming development stages for OpenMC(TD) have two complimentary aspects, one related to the Monte Carlo code and another related to experimental measurements at the RECH-1 research nuclear reactor [4]. Regarding the code, it is planned to implement the branchless collision [5] variance reduction technique to run a transient simulation of the RECH-1 nuclear reactor at a supercomputing facility. To validate the simulations, transient experiments will be performed at the RECH-1 research nuclear reactor.

J. Romero-Barrientos acknowledges support from ANID Fondecyt Iniciación Project 11230321. F. Molina acknowledges support from ANID FONDECYT Regular Projects 1171467 and 1221364. F. Molina also acknowledges support from ANID - Millennium Science Initiative Program - ICN2019 044.

[1] J. Romero-Barrientos et al., Nucl. Eng. and Technology 55 (5) (2023) 1593–1603.

[2] P. K. Romano, et al., Ann. of Nucl. Eng. 82 (2015) 90 – 97.

[3] G. Keepin et al., Journal of Nucl. Eng. (1954) 6 (1) (1957) 2 – 21.

[4] F. Molina et al., Appl. Rad. and Iso. 129, 28 (2017).

[5] B.L. Sjenitzer et al., Ann. of Nucl. Eng. 38, 2195 (2011).

38. Leonid Serkin (ICN-UNAM, Mexico, leonid.serkin@correo.nucleares.unam.mx)

    Title: Fostering educational efforts in Latin America through the use of CERN Open Data

    Abstract: The CERN Open Data portal (opendata.cern.ch) serves as the gateway to an expanding array of open data and other content related to nuclear and subnuclear physics, generated through research conducted at CERN. In my talk, I will highlight the aim of CERN Open Data, which is to provide data and tools to high school, undergraduate, and graduate students, as well as teachers and lecturers, to help educate and exercise them in physics analysis techniques used in experimental physics. Additionally, I will discuss the educational workshops and schools we have conducted using CERN's open data in Argentina, Colombia, Ecuador, Peru, Uruguay, Venezuela, and Mexico.

39. Gabriel González Sprinberg (U. de la República, Uruguay, gabriel.gonzalez.sprinberg@gmail.com)

    Title: Security and safety in medical applications: diagnosis and therapies

    Abstract: Security and safety represent important elements within medical applications, encompassing both in therapies and diagnostics procedures. However, the procedures and policies concerning these aspects remain underdeveloped across some of our countries. For one hand, at the educational level security and safety are not properly included in the curricula and postgraduate studies. Moreover, several issues pertaining to regulatory authority policies warrant consideration within these practices. In this presentation, I will examine the challenges facing the field of medical physics concerning security and safety, while also exploring the intricate relationship between these elements and regulatory policies.

40. Ewa Ł. Stępień (Cracow, Poland, e.stepien@uj.edu.pl)

    Title: Testing positronium biomarker in preclinical and clinical studies

    Abstract: In my presentation I intend to show whether the ortho-positronium (o-Ps) atom may serve as a biomarker for the diagnosis of various diseases and metabolic stages. Positronium atoms are copiously produced in the intra-molecular spaces during the positron emission tomography (PET). Positronium annihilation lifetime spectroscopy (PALS) involves the study of the time required for positronium to annihilate, providing information about the nanostructure of the surrounding environment. The mean o-Ps lifetime is correlated with the size of voids (free intramolecular volume) and the intensity of o-Ps is correlated with voids density present in a sample.

    In our preclinical studies, we use various in vitro and ex vivo models: human plasma clots, monolayer cell cultures of normal cells, primary and metastatic cell lines (melanoma), 3D cell models of culture (spheroids). In the clinical studies, we determine human colon cancer and cardiac myxoma

tissues. We compered the mean o-Ps with different physical, biochemical and biological parameters: temperature (fibrin clots), cell metabolism and tissue structure (melanocytes, melanoma, colon and myxoma samples).

We observed significant differences in the mean o-Ps lifetime between normal and neoplastic cells and tissue composition, in the case of cancer cells we observed a tendency to shorten the o-Ps lifetime, but these differences are altered by tissue composition and cell organisation. Surprisingly, temperature as an important clinical indicator of inflammatory processes does not affect the lifetime of o-Ps in organised plasma clots.

In conclusion, we have demonstrated that the positronium characteristic, the o-Ps mean lifetime, can be used as a novel biomarker to test nanometer-level tissue and cell structure and metabolic processes.

41. Ariel Tarifeño-Saldivia (IFIC,Valencia, Spain, atarisal@ific.uv.es)

    Title: High efficiency neutron spectrometry for underground physics, space weather and environmental dosimetry

    Abstract: Neutrons, as highly penetrating radiation, engage in complex interactions with matter depending on their energy and nuclear structure. In underground facilities, fast neutrons originate from nuclear reactions induced by the intrinsic radioactivity of rock and cavity walls, as well as from the constituent materials of detectors, shieldings, and supporting structures. Consequently, radiogenic neutrons constitute an important background that limits low counting rate experiments in dark matter and neutrino searches, as well as in experimental nuclear astrophysics. Understanding and quantifying the production of these radiogenic neutrons is essential for assessing or mitigating the neutron background affecting experiments in underground physics. On the other hand, secondary neutrons, spanning a wide energy range from hundreds of keV to hundreds of MeV, are continuously produced from cosmic-ray interactions in the upper atmosphere. This component dominates the ambient neutron flux observed at ground level or higher altitudes. The measurement of cosmic-ray neutrons is thus connected with various fields such as cosmic-ray physics, space weather monitoring, the study of single event upsets (SEUs) in microelectronics, and environmental dosimetry. In this contribution, the HENSA project (www.hensaproject.org) is introduced. The High Efficiency Neutron Spectrometry Array (HENSA) is a state-of-the-art detection system that provides spectral sensitivity across a wide neutron energy range, from meV to GeV, which is 5-15 times greater than that of conventional spectrometers. In underground laboratories, HENSA facilitates the study of background neutrons, providing crucial information for the design and data analysis of underground physics experiments. For cosmic-ray neutrons, HENSA allows for near real-time measurements of the neutron spectrum on a timescale of tens of minutes to a few hours, thus enabling potential applications in space weather research as a neutron monitor with spectral sensitivity. An overview of the research with HENSA in underground facilities is presented, focusing on the latest results from experiments at the Canfranc Underground Laboratory (LSC, Spain) and the INFN Gran Sasso National Laboratory (LNGS, Italy). Furthermore, the study of cosmic-ray neutrons with HENSA is discussed, including the mapping of cosmic-ray neutrons across Spain (vertical cutoff rigidities 5-9 GV) during quiet solar conditions at the beginning of solar cycle #25, and the development of a new HENSA version, called HENSA++, optimized for space weather and environmental dosimetry applications. Finally, the future perspectives of the HENSA project are outlined in this talk

42. Varese Timóteo (Campinas, Brazil, varese@unicamp.br)

    Title: Matching effective models to lattice QCD: few-body and many-body physics

    Abstract: We show that effective models can be constrained by lattice QCD in both few- body and many-body physics. Here we discuss the three-nucleon binding and the magnetized quark matter as examples where we can match effective models to lattice QCD.

43. Genaro Toledo (IF-UNAM, Mexico, toledo@fisica.unam.mx)

    Co-author: Antonio Rojas

    Title: The rho-meson magnetic dipole moment from Babar $e^+e^- \to \pi^+\pi^-\pi^0\pi^0$ cross section measurement

    We obtain the value of the magnetic dipole moment of the rho-meson using data from the BaBar Collaboration for the $e^+e^- \to \pi^+\pi^-2\pi^0$ process, in the center of mass energy range from 0.9 to 1.8 GeV. We describe the $\gamma^* \to 4\pi$ vertex using a vector meson dominance model, including the intermediate resonance contributions relevant at these energies. We find $\mu_\rho = 2.7 \pm 0.3$ in $e/2m_\rho$ units. We improve on the previous extracted value using preliminary data from the same collaboration, by using a better grounded parameters and explicitly gauge invariant description of the process.

44. Diego Torres (UNAL, Colombia, datorresg@unal.edu.co)

    Title: Innovation, Knowledge Transfer and Entrepreneurship from Nuclear Physics to the World

    Abstract: Since the beginning of the study of the atomic and nuclear structure, the broad uses of ionizing radiation in areas such as human health, security, quality processes, and communication technologies have been clear. Despite the outstanding results in nuclear sciences and the notable growth in its applications for the benefit of society, there is a persistence in the problem of the identification of innovations and the so-called "knowledge transfer" to society in nuclear science.

    The origin of the problem is more than just the well-known demonization of nuclear technologies. The lack of early-stage identification of innovations, the absence of programs for knowledge transfer from universities and research centers, and the poor development in intellectual property regulation are some reasons to mention as the origin of the problem of consolidation of a natural ecosystem of knowledge transfer from nuclear sciences to the society.

    This talk will present the efforts to consolidate an ecosystem of innovation, knowledge transfer, and entrepreneurship in the Colombian context. The importance of basic science for the creation of an efficient system of innovation in knowledge transfer will be highlighted.

45. Piet van Isacker (GANIL, France, isacker@ganil.fr)

    Title: Seniority isomers in nuclei and particle-hole conjugation

    Abstract: In a nucleus seniority refers to the number of nucleons that are not in pairs coupled to angular momentum $J = 0$. As shown by Racah, it is a symmetry exhibited by the pairing interaction and, more generally, is approximately valid for a general interaction between either neutrons or protons. In this talk I review the conditions for the conservation of seniority and show that they are related to particle-hole conjugation. The symmetry of seniority gives rise to selection rules in the electromagnetic decay of nuclei that may lead to the formation of isomers. Examples of seniority isomers occur in the nickel and lead isotopes, and in the $N = 50$, 82 and 126 isotones. It is shown that a strong attractive quadrupole matrix element of the nucleon-nucleon interaction disfavours the existence of seniority isomers.

46. Magda Zielinska (CEA, Saclay, France, magda.zielinska@cea.fr)

Title: Shape coexistence studied with Coulomb excitation and AGATA

Abstract: The history of Coulomb-excitation measurements with the new-generation European γ-ray spectrometer AGATA dates back to the very first physics experiment with this array, which took place in April 2010 and aimed at investigation of a highly-deformed structure in ^{42}Ca [1,2]. The measurement provided magnitudes and relative signs of numerous $E2$ matrix elements coupling the low-lying states in ^{42}Ca. The shape parameters obtained for the 0_2^+ and 2_2^+ states confirm that the excited structure possesses a strikingly large elongation, similar to that established for superdeformed bands in this mass region, and a slightly non-axial character. In contrast, those for the ground state are consistent with large fluctuations about a spherical shape. During the AGATA campaign at GANIL (2014-2021) Coulomb-excitation data were collected as a by-product of experiments performed at near-barrier beam energies. Notably, the analysis of slightly "unsafe" Coulomb-excitation data on ^{106}Cd, collected during an experiment aiming at lifetime measurements in ^{106,108}Sn [3], provides information on the collectivity of the presum- ably oblate structure built on the 0_3^+ state, as well as on the role of octupole correlations in this nucleus [4].

In the recent months, three Coulomb-excitation measurements were per- formed with AGATA at LNL, aiming at verification of the multiple shape- coexistence scenario in 110Cd and 74Se, and that of the type-II shell evolution in ^{96}Zr. In May 2024, we will also attempt to study the latter nucleus via unsafe Coulomb excitation in order to maximise population of higher-spin states, and in particular inverstigate if the 6+ state arises from a two-phonon octupole vibration. The status of the on-going analysis will be briefly pre- sented.

[1] K. Hadyńska-Klęk et al., Phys. Rev. Lett. 117, 062501 (2016).

[2] K. Hadyńska-Klęk et al., Phys. Rev. C 97, 024326 (2018).

[3] M. Siciliano et al., Phys. Lett. B 806, 135474 (2020).

[4] D. Kalaydjieva, PhD thesis, Université Paris-Saclay, 2023.

Poster Session

1. Alejandro Arias (UDLAP, Mexico, aarias.jimenez15@gmail.com)

   Co-author: Roelof Bijker

   Title: On the nature of the heavy baryon $\Xi_c(2970)^+$

   Abstract: In recent years, a lot of progress has been made in the study of heavy baryons and its implications for the understanding of hadron structure, the dynamics of the strong interaction and heavy quark symmetry. So far, only in one occasion has the spin and parity been determined experimentally: the most likey values of the spin and parity of $\Xi_c(2970)^+$ were found to be $J^P = \frac{1}{2}^+$ [1].

   We develop a collective string-like model of heavy baryons as systems of two light quarks in combination with a heavy quark. We explore two different scenarios for the interpretation of $\Xi_c(2970)^+$ and calculate the corresponding form factors which are relevant both for electromagnetic and strong couplings.

   [1] T.J. Moon et al. (Belle Collaboration), Phys. Rev. D 103, L111101 (2021).

2. Uri Carachure Gómez (IF-UNAM, Mexico, carachure@estudiantes.fisica.unam.mx)

   Title: New ion source control system for the 5.5 accelerator using lasers

   Co-authors: R. Espejel[1], R. Gleason[1], J. Mas-Ruiz[2], E. Andrade[1] and E. Chávez[1]

   [1] Instituto de Física (IF-UNAM)
   [2] Instituto de Ciencias Nucleares (ICN-UNAM)

   Abstract: One of the key features that makes the 5.5 MV Van de Graaff accelerator more significant in our region (Mexico) is the use of deuterium and noble gas nuclei (Ne, Ar, Kr, Xe) as projectiles. This is because it is the only facility equipped with the capacity and radiological safety for their utilization. However, the accelerator faces a limitation inside the tank due to unknown operating conditions. This arises from the difficulty in transmitting signals outside the tank because of the high voltage. To address this challenge, a laser-based communication system has been constructed. This system allows the transmission of operational status (voltages, currents, temperatures, etc.) of the ion source and other components to the outside of the tank. This contributes to greater certainty and confidence in the control of gases, especially deuterium.

   This work has been made possible by financial support from PAPIIT-UNAM projects with numbers IG102023, IG101423, IN112023. The authors acknowledge the support received from the UNAM Central Electron Microscopy Laboratory under the coordination of Samuel Tehuacanero and the involvement of technician Diego Quintero. The authors are grateful to Sergio Martínez Gonzales for assistance in the preparation of graphite cathodes. JMR wishes to acknowledge the scholarship received from LEMA-CICUNAM.

3. Erick Cisneros-Linares (IF-UNAM, Mexico, erickcisneros270599@ciencias.unam.mx)

   Co-authors: Tirso Murrieta-Rodríguez, Arnulfo Martínez-Dávalos, Mercedes Rodríguez-Villafuerte and Héctor Alva-Sánchez

   Title: Experimental study of the non-linear response of LYSO and LaBr scintillation crystals to low energy electrons

   Abstract: Lutetium–yttrium oxyorthosilicate (LYSO) is still the scintillation crystal of choice in radiation detectors for preclinical and clinical systems for positron emission imaging, including positron emission tomography (PET) scanners. Lanthanum bromide (LaBr) is a very bright, high-energy resolution scintillator, but with elevated production costs, which could be also used in medical imaging. These crystals show an almost linear response to photons in a wide range of energies, above 100 keV. Nevertheless, it is known that this response ceases to be linear for photons with energies below 100 keV, and the non-linear behavior depends on the crystal structure and chemical composition. The aim of this work is to study the non-linear response, defined as the scintillation light production with the amount of energy deposited, of LYSO and LaBr crystals to low energy, monoenergetic electrons (from 29 to 457 keV). To this purpose a modified version of the Compton coincidence technique, using positron sources, that requires a triple coincidence, was developed. This sophisticated experimental setup was intended to eliminate the contribution of the studied crystals' intrinsic radiation, due to Lu-176 in LYSO and La-138 in LaBr, from the measurements. The crystal response of both scintillators to low-energy electrons was compared to the photon response (26 to 662 keV) using sealed gamma-ray sources. This information will improve the preciseness in the calibration of PET detectors, making use solely of the intrinsic radiation spectrum of its crystals. These results could have a positive impact on the quality of medical imaging systems and on the implementation of quality controls for these detectors.

4. Cristian Felipe Cruz García (IF-UNAM, Mexico, cris-106-fis@ciencias.unam.mx)

   Co-authors: M.A. García[2], E. Casanova-González[1], J. Rickards[1], L.R. de la Vega[3], J. Cañetas-Ortega[1], J.G. Morales-Morales[1] and L. Rodríguez-Fernández[1]

   [1] IF-UNAM, Mexico
   [2] FC-UNAM, Mexico
   [3] Academia de Matemáticas, UACM, Mexico

   Title: Bubble formation in glass by 1 MeV Si ion irradiation

   Abstract: Typical transparent glasses have many applications in industrial and optical application. Also, they are used for radioactive waste encapsulation. During alpha decay, the recoil nucleus and the alpha particle interacts with the surrounding atoms generating damage in the glass, increasing the interstitial sites which acts as traps for gas molecules created by radiolytic processes and leading to a decrease in the matrix density. Due to the variety of processes involved the understanding for the bubble formation in glasses is a challenging problem still. This is an important quest for the long term stability of the radioactive waste using glass confinements.

   In order to contribute to the understanding of this phenomenon, in this work we present the study of bubble formation in soda-lime glass by 1 MeV Si ion irradiation focusing on the electronic stopping and ballistic collisions between the ions and atomic nucleus. The glass samples were irradiated at an impinging angle of 70° with different ion doses at room temperature keeping the beam current density around 1500 nA/cm^2 using the Pelletron Tandem Accelerator at the Instituto de Física, UNAM. The samples were characterized by optical microscopy, Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Raman Spectroscopy and mechanical surface hardness.

   As a result, the ion irradiation produced the swelling of the glass and the formation of ripples patterns on the surface. The bubbles formation was not only occurred in the irradiated region, also they were observed on the sample surface several hundred of micrometers away around the irradiation region following a distinguishable pattern distribution. This result indicates that processes occurred in the irradiated region by ballistic collisions and the temperature raising by electronic excitation can produce away changes in the glass structure. This phenomenon has to be more studied to understand the diffusion species in the glass to create bubbles far from the ion spots. Although, these results involve only the irradiation by Si ions, should be interesting to know if the alpha particles and recoil nucleus in high level radioactive waste are able to produce similar effects in the glass far from the hot region.

The authors acknowledge the technical assistance of F. Jaimes in the operation of the 3MV Pelletron accelerator and S. Tehuacanero-Cuapa for assistance in SEM– EDS measurements at the Laboratorio Central de Microscopia (LCM). To LANCIC for its support in the analysis by Raman spectroscopy.

5. Hernán Dávila (Universidad Pedagógica y Tecnológica de Colombia, Colombia, hernan.olaya@uptc.edu.co)

   Co-author: Asael Rodriguez Hernández

   Title: Study of the physical and biochemical properties of strawberry (fragaria x ananassa) using the gamma irradiation technique

   Abstract: The species (Fragaria x ananassa) are one of the most coveted and widespread fruits in the world due to their delicate balance of flavor, texture and nutritional value. However, strawberries suffer significant losses during transportation, storage and shelf time at the supermarket because they have a high transpiration rate that determines their short useful life. However, the fruit is not exempt from contamination by pathogenic agents that are incorporated after harvest. Therefore, several batches of strawberries were subjected to different doses of gamma radiation to slow down the ripening process, without affecting their quality in terms of flavor, texture and nutrients. The samples were irradiated with a ^{60}Co source of approximately 9 Ci, performing short-distance dosimetry. The purpose of this work is to extend to an industrial level the practice of irradiation, which is accepted worldwide in international markets and endorsed by the FAO and which would create a benefit in food security processes in Colombia. The batches were irradiated with doses from 0.3 kGy to 1 kGy and their storage temperatures were controlled between 1° to 3° C. The parameters of weight, pH, sweetness, firmness, colorimetry and acidity of the strawberries were evaluated during the study period. A sensory evaluation was also carried out with expert strawberry consumers. Positive results were found in the quality of irradiated strawberries, especially for doses close to 1kGy and a significant delay in ripening of approximately 8 days was obtained.

6. Omar Alejandro Díaz Caballero (ICN-UNAM, Mexico, odiazcab@gmail.com)

   Co-author: Roelof Bijker

   Title: The structure of ^{10}Be and ^{10}B in the Cluster Shell Model

   This work describes the energy spectra given by the eigenstates of the neighbouring nuclei ^{10}B and ^{10}Be in the frame of the Cluster Shell Model, here the nucleous is described as an alpha particles cluster configuration with axial symmetry plus two nucleons, neutron-neutron for Berilium and neutron-proton for Boron. Taking in account the residual interaction as a surface delta interaction, and having isospin as a good quantum number, the allowed states are well characterized by parity and the projection of the total angular momentum. This results are compared with experimental data to check the accuracy of the model.

7. Laura Duque Herrera (CINVESTAV, Mexico, laura.duque@cinvestav.mx)

   Title: A preliminary approach to enhancing precision in CEνNS studies using zinc and silicon isotopic detectors

   Abstract: In the Coherent Elastic Neutrino-Nucleus Scattering (CEνNS), neutrinos scatter nuclei as a whole, resulting in low momentum transfer and small nuclear recoil energy. Despite its large cross-section, experimental measurement poses challenges due to the subtle recoil energy involved. In 2017, the COHERENT collaboration measured it for the first time using CsI detectors and later, in 2020, with liquid argon (LAr) detectors. Our proposal suggests using detector arrays made of the same element but differing in neutron number (isotopes), thereby generating detectors with correlated systematic uncertainties. Our study involves two detector arrays: one using two zinc (Zn) isotopes and the other using two silicon (Si) isotopes. This correlation would improve the precision

of measurements, particularly in testing predictions of the Standard Model, nuclear physics, and new physics scenarios.

8. Eduardo S. Fraga (UFRJ, Brazil, fraga@if.ufrj.br)

   Co-authors: Letícia F. Palhares and Tulio E. Restrepo

   Title: Hot perturbative QCD in a very strong magnetic background

   Abstract: We compute the pressure, chiral condensate and strange quark number susceptibility from first principles within perturbative QCD at finite temperature and very high magnetic fields up to two-loop and physical quark masses. We study the convergence of the perturbative series for the pressure for different choices of renormalization scale in the running coupling. Our results for the chiral condensate and strange quark number susceptibility can be directly compared to recent lattice QCD data away from the chiral transition. Even though current lattice results do not overlap with the region of validity above, perturbative results seem to be in the same ballpark [1].

   [1] Eduardo S. Fraga, Leticia F. Palhares and Tulio E. Restrepo, Phys. Rev. D 108, 034026 (2023).

9. J. Rodrigo Fuentes Carreón (IF-UNAM, Mexico, rodrigofuentes123@ciencias.unam.mx)

   Co-authors: J. Mas-Ruiz[1], L. Acosta[2], J. Cruz[3], L.Y. Reyes-Miranda[1], A. Huerta[2], D.J. Marín-Lámbarri[2], S. Muhl[3] and E. Chávez[2]

   [1] Instituto de Ciencias Nucleares (ICN-UNAM)
   [2] Instituto de Física (IF-UNAM)
   [3] Instituto de Investigaciones en Materiales (IIM-UNAM)

   Title: Characterization of thin natSi targets

   Abstract: ^{26}Al is direct proof of the existence of stellar nucleosynthesis processes. For the study of the production of ^{26}Al by the ^{28}Si(d, α) reaction at energies close to and below the Coulomb barrier, thin silicon targets are required. In this work, the characterization of thin silicon targets is reported to study the production of 26Al. The characterization is carried out using the RBS technique (Rutherford Backscattering Spectrometry), using proton beams, ^{12}C and ^{28}Si, at a dispersion angle of 140° and in an energy range from 841 keV to 7105 keV. This experiment is carried out along the line of Nuclear Physics of the National Laboratory for Mass Spectrometry with Accelerators (LEMA) from the UNAM Physics Institute (IFUNAM). Four targets are characterized, (C11, C21 and C31), manufactured at the Materials Research Institute (IIM), and (F11), manufactured in the IFUNAM Microscopy Laboratory. For C11, C21 and C31 targets, the thickness is 1016 atoms/cm^2. For white F11, there is a thickness of 1017 atoms/cm^2, this being the more suitable for later use in the study of ^{26}Al production.

10. E.A. George (Wittenberg U., USA, naviliat@frib.msu.edu)

    Co-authors: T.E. Haugen[2], O. Naviliat-Cuncic[2,3] and P.A. Voytas[1]

    [1] Department of Physics, Wittenberg University, Springfield, OH, USA
    [2] Facility for Rare Isotope Beams and Department of Physics and Astronomy, Michigan State University, East Lansing, MI, USA
    [3] International Research Laboratory for Nuclear Physics and Nuclear Astrophysics, CNRS-MSU, East Lansing, MI, USA

    Title: Comments on the publication "Discrete symmetries tested at 10^{-4} precision using linear polarization of photons from positronium annihilations" by P. Moskal et al.

    In Ref. [1], P. Moskal and the J-PET collaboration present the measurement of a triple momentum correlation involving photons from ortho-positronium decay. In this contribution we comment on a number of statements and claims contained in that paper. We address specifically: 1) the properties of the effectively measured correlation; 2) the properties of the Compton scattering process; 3) the identification made in that paper of the normal to the Compton scattering plane as the photon polarization; and 4) the absence of characterization of the Compton polarimeter sensitivity. We finally review previous work, pointing out that measurements of the polarization of photons from ortho-positronium decay have been performed in the past by properly implementing the Compton polarimetry technique and that such measurements do not provide tests of discrete symmetries in o-Ps decay.

This work is supported by the National Science Foundation under Grants No. PHY-1920065 and PHY-2013557.

[1] P. Moskal et al., Nature Communications 15, 78 (2024); https://doi.org/10.1038/s41467- 023-44340-6

11. William Hatano (Universidade de São Paulo, Brazil, williamhatano@usp.br)

Title: Study of ^{10,11}B + ^{119}Sn reactions at energies around Coulomb barrier

Co-authors: L.R. Gasques[1], V. Scarduelli[1], L.C. Chamon[1], J.K.L Chaves[1], L.M. Martinis[1], M.G. Matias[1], J.M. Brandao Neto[1] and J.P. Fernandez-García[2]

[1] Instituto de Física, Universidade de São Paulo, Brasil
[2] Universidad de Sevilla, Spain

Abstract: The present project consists of the study of different reaction channel for the ^{10,11}B +^{119}Sn systems at energies around the Coulomb barrier, using techniques already well established in the Nuclear Physics field. Measurements of angular distributions of elastic scattering, inelastic scattering and nucleon transfers for the mentioned systems have been conducted, aiming to better understand the mechanisms of nuclear interactions and to test hypotheses and models developed for such interactions. The experiments were carried out at the Laboratório Aberto de Física Nuclear (LAFN) at the Instituto de Física, Universidade de São Paulo, where the reformed 30B's beamline was used, together with appropriate electronics. Additionally, a new detection system, the STAR 2.0 (Silicon Telescopes Array for Reactions), was characterized and utilized for these experimental measurements. The new detector consists of a large-area detector with 256 high resolution pseudo telescopes. Theoretical analyses of the data presented in this work will be conducted based on the coupled channel formalism [1], using the São Paulo potential [2] as the model for nuclear interactions. Finally, we also intend to characterize and utilize the new detector OSCAR (hOdoscope of Silicon for Correlations and Reaction Analysis) [3], which is being constructed in collaboration with Italian researchers from the Istituto Nazionale di Fisica Nucleare (IFN) in Legnaro, to complement the presented data.

[1] Satchler, George Raymond. "Introduction to nuclear reactions."Introduction to Nuclear Reactions. Palgrave Macmillan, London, 1990. 21-88.

[2] Gasques, L. R. "Celebrating 20 Years of the Sao Paulo Potential."Brazilian Journal of Physics 51.2 (2021): 269-276.

[3] Dell'Aquila, D. "An overview of OSCAR: a new hodoscope of silicon detectors for low energy charged particles."Journal of Physics: Conference Series. Vol. 1561. No. 1. IOP Publishing, 2020.

12. Diego Fernando Hernández Porras (U. de los Andes, Colombia, df.hernandezp1@uniandes.edu.co)

Co-author: N.G. Kelkar

Title: Analysis of the energy generation rate due to alpha and beta decays in kilonovae

Abstract: After the merger of neutron stars, a portion of their mass is ejected. This ejected material, subjected to extreme and exotic conditions, is considered one of the primary candidates

for the origin of heavy elements in the universe [1]. It is within this material that the synthesis and subsequent decay of these heavy elements give rise to an optical transient phenomenon known as a kilonovae [2]. The latter are powered by different radioactive decay modes. Focusing on two particular decay modes, we utilized databases of beta and alpha decay for heavy nuclei to evaluate the energy generation rate in the ejecta. This was done using the Li-Xin Li and B. Paczynski model [3]. We estimated the temperature and luminosity of the kilonovae as a function of time. Then these estimates were compared with experimental data from the GW170817 event [4]. In addition, the relative importance of the contribution of different nuclei is studied and the nuclei which are most important for energy production are identified.

[1]. Cowan, J. J. et al. Origin of the heaviest elements: The rapid neutron-capture process. Rev. Mod. Phys. 93, 015002 (2021).

[2]. Metzger, B. D. et al. Electromagnetic counterparts of compact object mergers powered by the radioactive decay of r-process nuclei: Transients from compact object mergers. Monthly Notices of the Royal Astronomical Society 406, 2650–2662 (2010).

[3]. Li, L.-X. & Paczyński, B. Transient Events from Neutron Star Mergers. The Astrophysical Journal 507, L59–L62 (1998).

[4] Drout, M. R. et al. Light curves of the neutron star merger GW170817/SSS17a: Implications for r-process nucleosynthesis. Science 358, 1570–1574 (2017).

13. Franco López-Usquiano (Universidad Andrés Bello, Chile, f.lopezusquiano@uandresbello.edu)

Co-authors: F. Molina[1,2,3], M. Zambra[1,4] and J. Romero-Barrientos[1]

[1] Centro de Investigación en Física Nuclear y Espectroscopía de Neutrones (CEFNEN), Comisión Chilena de Energía Nuclear, Nueva Bilbao 12501, Las Condes, Santiago, Chile.
[2] Departamento de Ciencias Físicas, Universidad Andrés Bello, Sazíe 2212, 837-0136, Santiago, Chile.
[3] Millenium Institute for Subatomic Physics at High-Energy Frontier (SAPHIR), Fernández Concha 700, Las Condes, Santiago, Chile.
[4] Universidad Diego Portales, Manuel Rodríguez Sur 415, Santiago, Chile.

Title: Cosmic Ray Neutron Spectroscopy and Local Variables simultaneous measurement studies throughout Chile: Atacama region

Abstract: The neutron field at ground level originates principally from the interaction of primary cosmicrays with the atmosphere's nuclei. The high-energy neutron component historically has been measured by Neutron Monitors (IGY and NM-64 Type) since the 1950s [1]. Later Monte Carlo simulations of the NM-64 monitor [2] showed that 5-10 % of the neutron counting rate measured corresponds to neutrons below 20 MeV. Both experimental measurements [3] and simulations [4] show that the neutron spectrum at ground level can be affected by local variables such as soil moisture, air humidity, soil composition, among others, whose effects can be observed across all energy spectrum. Due to the high variability in environmental conditions, diversity of soil composition, different site altitudes, Chile is an ideal place to perform field measurements of neutron spectra together with local variables. In this work, the results from the experimental campaign perform in winter 2023 at the Atacama region are presented, correlating the local variable measurements with neutron spectra every 15 minutes. As results, is of particular interest the relation between the decrease of the integral flux of the fast and epithermal energy region within the neutron spectrum, up to 18 % and 20 % respectively, and the increase of the integral flux of the thermal region by up to 37 %, from the neutron field measured in dry conditions to the rise of soil humidity caused by rain and snowfall.

F. Molina acknowledges support from ANID FONDECYT Regular Pro- jects 1221364 and ANID - Millennium Science Initiative Program - ICN2019 044.

[1] J. A. Simpson, Space Science Reviews, vol. 93, no. 1/2, pp. 11–32, 2000.

[2] C. Pioch, et al., NIM A, vol. 626–627, pp. 51–57, Jan. 2011.

[3] W. Ruhm, et al., Radiation Protection Dosimetry, vol. 136, no. 4, pp. 256–261, Oct. 2009.

[4] T. Sato, PLoS ONE, vol. 10, no. 12, p. e0144679, Dec. 2015.

14. Luis Enrique Martínez Navarro (IF-UNAM, e_navarro@ciencias.unam.mx)

Co-authors: D.J. Marín-Lámbarri, B. Leal, C. Valencia, R. Gleason, E. Chávez, E. and A. Huerta

Title: In situ measurement of intense gamma radiation fields using an organic scintillator

Abstract: This work describes the design, construction, and characterization of a plastic scintillator detector for intense gamma radiation fields. The detector consists of a BC-408 plastic scintillator and a PMMA optical guide, which serves as a coupling between the scintillator and a photomultiplier tube. The assembly of these components utilized 3D-printed parts designed for experimental coupling. Tests were conducted with different lengths of optical fiber and different sizes of cylindrical scintillators using certified gamma ray sources of various intensities and isotopes such as ^{60}Co, ^{137}Cs, and ^{241}Am. Additionally, the integral of the counts per channel was measured for each test, establishing a relationship between the counting rate and the size of the scintillators. The first "in situ" measurement of an intense gamma radiation source was also performed.

15. Ezequiel Martínez Resendiz (UAEH, Mexico, ma421317@uaeh.edu.mx)

Co-authors: V.E. Cerón (UAEH) and J.G. Hirsch(ICN-UNAM)

Title: Simple models of nuclear masses

Abstract: We employ three versions of the drop model to describe nuclear masses. The first two include modified Coulomb and symmetry terms, with one additionally incorporating isospin asymmetry effects [1]. The third version also includes empirical corrections associated with the shell model [2].

The model parameters are obtained by least squares fits to the binding energies measured for 2457 nuclei reported in AME2021 [3]. The root mean square deviation is greater than 2000 keV for the first two models and is halved when shell effects are included.

[1] C. Barbero, J. G. Hirsch, A. E. Mariano, Nucl. Phys. A 874 (2012) 81-97.

[2] J. Mendoza-Temis, et al, Nucl. Phys. A 812 (2008) 28-45.

[3] Meng Wang et al Chinese Phys. C 45 (2021) 030003.

16. Nicholas Mendez (FRIB-MSU, USA, mendezn@frib.msu.edu)

Title: Simulations of Neutron Unbound Physics for Geant4

Abstract: The study of neutron unbound systems via the invariant mass technique is the primary focus of the MoNA Collaboration, which built and operates the Modular Neutron Array (MoNA) and the Large multi-Institutional Scintillator Array (LISA) at FRIB. Advancements in nuclear structure from theory and experiment along the neutron dripline have presented opportunities to understand the nature of unbound systems in higher mass nuclei. The GEometry And Tracking (Geant4) platform has been used in high-energy and nuclear physics to simulate particle interaction with as much detail as the user desires. Geant4 currently does not have a physics class to simulate neutron unbound systems. Given the advancement of accelerator facilities and active searches along the neutron dripline, detailed simulations to study the breakup of neutron unbound systems, are necessary. [MN1] The implementation of the breakup of neutron unbound systems in Geant4 will be presented.

17. Jonathan Méndez García (IF-UNAM, Mexico, jonathanmg3005@gmail.com)

    Co-authors: D.J. Marín-Lámbarri, H. Alva-Sánchez, L.C. Álvarez-Nuñez, E. Chávez, A. Farah-Simón, A. Huerta, T. Murrieta-Rodríguez and C. Valencia

    Title: Characterization of coated scintillators with different materials for astrophysics reactions detectors

    Abstract: Identical plastic scintillators coated with different materials with specific optical properties were studied and compared in order to measure the maximum number of photons to improve the design and construction of an active shielding for low energy nuclear physics experiments at the "Laboratorio Nacional de Espectrometría de Masas con Aceleradores" (LEMA).

18. José Antonio Pérez Velasco (UAEM, Mexico, jantonio99@gmail.com)

    Co-authors: J.C. Morales-Rivera[1] and E. Martínez-Quiroz[2]

    [1] Facultad de Ciencias, Universidad Autónoma del Estado de México, México
    [2] Departamento de Aceleradores y Estudio de Materiales, Instituto Nacional de Investigaciones Nucleares, México.

    Title: Calculus of the RMS of the ^{7}Li nucleus with the Asymptotic Normalization Coefficient Method

    Abstract: We present a theoretical study of the nuclear structure of ^{7}Li with the purpose of calculating the RMS and describing the asymptotic behavior of this Lithium isotope in nuclear reactions of interest. The ^{7}Li nucleus was studied as a cluster through the ^{6}Li$(d,p)^7$Li transfer reaction, in order to calculate the elastic scattering and the transfer angular distributions. We usethe Fresco Code to perform the reaction and we applied the Asymptotic Normalization Coefficient method (ANC) to describe its peripheral behavior on the ground and the first excited states. We found the optical model parameters which best fits with the transfer and the elastic angular distributions. With these parameters we extracted from Fresco the ANC in the single particle model for every allowed angular momentum value. The spectroscopic factor and the nuclear ANC were obtained and the RMS for both states were calculated.

19. Frida Quintero Villegas (IF-UNAM, Mexico, fridaqv@ciencias.unam.mx)

    Co-authors: D.J. Marín-Lámbarri, O.E. López-López, E. Chávez, A. Huerta and C. Valencia

    Title: A prototype detector array for gamma-ray spectroscopy for nuclear physics experiments at low energies

    Abstract: The design and assembly of a prototype detector array for gamma-ray spec- troscopy was performed at the "Laboratorio Nacional de Espectrometría de Masas con Aceleradores" (LEMA). The array was tested with the natMg(p,γ) nuclear reaction, the preliminary analysis of the results are presented. This prototype is the basis for the design and construction of a more robust model, which will consist of a $LaBr_3$ detector, covered by an active and passive shielding and will be commissioned at LEMA for nuclear physics experiments at low energies.

20. Luis Yaid Reyes Miranda (IF-UNAM, ICN-UNAM, Mexico, yaid@estudiantes.fisica.unam.mx)

    Co-authors: J. Mas Ruiz[2], G. Reza Martínez[1], R.J.R. Gleason Villagrán[1], C. Valencia Morales[1], D.J. Marín Lámbarri[1], A. Huerta Hernández[1], E. Andrade Ibarra[1], E.R. Chávez Lomelí[1]

    [1] Instituto de Física, UNAM, Mexico
    [2] Instituto de Ciencias Nucleares, Mexico

    Title: Characterization of MONDE-II for fast neutron detection

    Abstract: MONDE-II is an organic scintillator detector designed and built at IFUNAM as complementary equipment for experiments with beams from the 5.5 MV Van de Graaff accelerator

(the 5.5, located in the IFUNAM tower) in basic and applied nuclear physics research. It has the ability to detect fast neutrons ($E_n > 1$ MeV) and is position sensitive. When there is a temporal reference (coincidence or RF) it is possible to obtain complete information on the moment vector of the detected neutron. This work presents the characterization of the positional resolution of the system, using a radioactive AmBe source. We describe the experimental device, electronics, data, their reduction and interpretation along with results and conclusions.

This work has been possible thanks to the financial support from PAPIIT-UNAM projects numbers IG102023, IG101423, IN112023.

21. Octavio Augusto Rico-Trejo (ICN-UNAM, Mexico, octavio.augusto@ciencias.unam.mx)

    Co-authors: T. Yépez-Martínez, P.O. Hess and O. Civitarese

    Title: Meson-like spectrum at low energies: the use of many-body methods for the description of hadronic masses and their associated widths.

    Abstract: The study of properties for the low-energy regime of hadronic spectra is a challenging task; even today, the realm of non-perturbative QCD remains a difficult subject to approach using existing methods. In this work, we present preliminary results of employing many-body techniques to endow effective mass to the quarks and anti-quarks composing mesonic particles, followed by the calculation of the spectrum and its associated widths. This effort is motivated by previous works that explored the scope of a model structured in the $SO(4)$ symmetry group for calculating these same mesonic-type spectra.

22. José Ricardo Rizo Tello (IF-UNAM, Mexico, ricardorizo@estudiantes.fisica.unam.mx)

    Co-authors: E. Andrade, R. Gleason, J. Mas, D.J. Marín, G. Reza, R. Espejel, L. Acosta, C. Valencia and E.R. Chávez

    Title: Ions in high charge states of charge in an Electron Cyclotron Resonance (ECR) plasma as an ion source for a Van de Graaff accelerator

    Abstract: This work presents the status of the IFUNAM-JINR collaboration for the design, construction and installation of an ECRIS (Electron Cyclotron Resonance Ion Source). This device will provide ions in very high charge states, for instances: $^{40}Ar^{16+}$ or $^{179}Au^{+60}$ to our 5.5 MV Van de Graaff accelerator, resulting in beams of 90 or 300 MeV respectively. Ion Beams with these energies open the door to new research areas in basic, applied, and interdisciplinary science.

    In nuclear physics, we can take advantage of the high energy beams to study nuclear reactions using the inverse kinematics technique. For instances:
    - In astrophysics: the measurement of nuclear reaction cross sections of interest in stellar nucleosynthesis calculations.
    - In nuclear dynamics: the determination of hadronic radius of different nuclei.
    - Study of the internal structure of light nuclei (cluster states for instances)

    Also, the production of isotopically selected implanted targets for different applications becomes possible, especially the case of noble gases.

23. Regina Romero and C.G. Méndez-García (IF-UNAM, Mexico, liviaromero@estudiantes.fisica.unam.mx)

    Title: Preliminary analysis for Pu isotopes measurement by AMS

    Abstract: A variety of isotopes of plutonium (Pu) are present in the environment due to their applications in nuclear energy, mainly on account of emissions from nuclear reactors, accidents related to these, and exposure from weapons tests. The measurement of the isotopic ratios of Pu isotopes ($^{240}Pu/^{239}Pu$) in environmental samples has provided valuable information on the characteristics of their origin and the remaining contribution caused by the uses of this radioisotope, as well as its possible impact on health human. The measurement of Pu using alpha spectrometry is limited by its resolution, which makes Accelerator Mass Spectrometry (AMS) the optimal tool given its high sensitivity and low uncertainty. This research aims to optimize the radiochemical treatment and the electrodeposition process of Pu radioisotopes to open the research line of this element at the National Laboratory of Mass Spectrometry with Accelerators (LEMA).

24. Oscar Ruge (Universidad Pedagógica y Tecnológica de Colombia, Colombia, oscar.ruge@uptc.edu.co)

    Co-authors: H. Olaya and S. Chaparro

    Title: A review to analytical techniques of stable isotopes and their application in wine authenticity

    Abstract: The importance of stable isotopes have a wide application in material sciences and plays a fundamental role in the study of quality in wines and these techniques provide a valuable information about their geographical origin, production process, and authenticity. Stable isotopes are variations of the same chemical element, having an equal number of protons but a different number of neutrons in their nucleus, which does not affect their chemical characteristics during its use. Isotopic studies are of great interest in wine research because of chemical elements present in the soil, water, and air of a specific region exhibit characteristic proportions of certain stable isotopes. These proportions are reflected in the grapes used to make wine. The stable isotopes of interest are elements such as oxygen, hydrogen and carbon in wine. The origin of the grapes can be determined and thereby verifying the authenticity of the wine's designation of origin. Additionally, the study using stable isotopes allows the identification of water, sugars, colorants, or alcohol that have been added to the wine, as these changes alter the original isotopic ratios, consequently, isotopic analysis reveals whether the wine is authentic or not. In this work are studied techniques that can be used in Colombia with specialized laboratories as IRMS and OA-ICOS.

25. Erika Ruiz Martínez (IF-UNAM, Mexico, erikaruiz@estudiantes.fisica.unam.mx)

    Co-author: Libertad Barrón

    Title: Simulation of the Magnetic Environment for the search of the neutron Electric Dipole Moment by COMSOL Multiphysics®

    Abstract: Focusing in CP violation, many experiments have been conducted to search for the neutron Electric Dipole Moment and to explain the origin of the baryonic matter. These experiments need to be very careful shielding magnetic fields from the environment. In the nEDM@SNS experiment, we have a system to shield from environmental magnetic fields, that is an experimental room, called Magnetic Shield Enclosure, composed by two layers of μ-metal, and a system of coils to compensate the earth's magnetic field on the external surface of the MSE. With COMSOL Multiphysics® we can study the performance of the shielding system by simulating the condition of the place where the experiment takes place. In this work we show the results of the simulation of the shielding system and propose an optimization to have lower values of magnetic field gradients inside the MSE.

26. Adan Torralba-Ayance (INAOE, Mexico, adan.torralba1@gmail.com)

    Co-authors: Sergio A. Rosales-Nunez, Alejandro Bautista-Castillo, Alejandro Diaz-Sanchez, Gregorio Zamora Mejía, Jose M. Rocha-Perez, Jose de J. Rangel-Magdaleno and Daniel Durini

    Title: Current-Mode Input-Stage Front-End for Silicon Photomultipliers

    Abstract: This work presents a current-mode input-stage based on the Flipped Voltage Follower Current Sensor (FVFCS) circuit configuration, aimed at radiation detection applications requiring near single-photon counting capabilities and very high timing resolutions, as those encountered in atmospheric Cherenkov telescopes based on SiPM arrays, the application that motivated the present study. Because of the very low input impedance, great current sink capability, and low

design complexity, the proposed FVFCS circuit results ideal when implemented as the first block of the input current buffer in readout circuits designed, e.g. for Silicon Photomultiplier (SiPM) sensors. A prototype of the proposed FVFCS was designed and implemented in TSMC 180 nm CMOS technology. Experimental results obtained meet the expectation.