XLIV Symposium on Nuclear Physics, January 9-12th 2023

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Speakers

Speaker	Affiliation
1. Philip Adsley	Texas A&M
2. Elí Aguilera	ININ
3. Ani Aprahamian	University of Notre Dame
4. Libertad Barrón-Palos	IF-UNAM
5. Tobias Beck	FRIB/MSU
6. Carlos Bertulani	Texas A&M
7. Andreas Best	Università degli Studi di Napoli
8. Leah Broussard	ORNL
9. Efraín Chávez	IFUNAM
10. Osvaldo Civitarese	Universidad de La Plata
11. Nabanita Dasgupta	UMSNH
12. James deBoer	University of Notre Dame
13. Daniele Dell'Aquila	INFN- Sezione di Napoli
14. Alessia Di Pietro	INFN-LNS
15. Andreas Ekström	Chalmers
16. Martin Freer	University of Birmingham
17. Luca Guardo	INFN-LNS
18. Gaute Hagen	ORNL
19. Daniel J. Marín-Lámbarri	ICN-UNAM
20. Grant Mathews	University of Notre Dame
21. Daniele Mengoni	Università degli Studi di Padova
22. Patrick O'Malley	University of Notre Dame
23. Emmanuel Ortiz Pacheco	Institut Jozef Stefan
24. Gianluca Pizzone	INFN-LNS
25. Fabio Risitano	INFN-Sezioni di Catania and U. Messina
26. Adrian Santana Valdés	ICN-UNAM
27. Christian Schubert	CIC, Cuernavaca
28. Vasilis Soukeras	INFN-LNS
29. Javier Valiente	INFN-LNL
30. Diego Venegas Vargas	UT Knoxville
31. Michael Wiescher	University of Notre Dame
32. Tochtli Cuauhtli Yépez	UACM

Abstracts

Talks

1. **Philip Adsley**

   Texas A&M, USA

   Title: **Nuclear astrophysics with the K600 and other magnetic spectrometers**

   Abstract: The combination of magnetic spectrometers and ancillary detectors is a powerful tool for probing the excited nuclear states which mediate nuclear reactions in a number of different astrophysical environments. In this talk, I will give a brief overview of the K600 spectrometer at iThemba LABS and the ancillary detectors used with this device, and discuss some recent results obtained from the K600 relating to different astrophysical problems such as the isovector giant dipole response and carbon fusion. Finally, I will discuss developments with another magnetic spectrometer, the MDM at the Texas A&M University Cyclotron Institute, for future coincidence measurements.

2. **Elí Aguilera[1], F. Torabi[2] and J. C. Morales[3]**

   1. Departamento de Aceleradores y Estudio de Materiales, Instituto Nacional de Investigaciones Nucleares, Apartado Postal 18-1027, 11801, México, D.F., México

   2. Departamento de Física, Instituto Tecnológico de Aeronáutica-CTA, 12228-900, São José dos Campos, SP, Brazil

   3. Facultad de Ciencias, Universidad Autónoma del Estado de México, Instituto Literario 100, Código Postal 50000, Toluca, México

   Title: **Threshold anomalies in low-energy reactions with loosely-bound projectiles**

   Abstract: Recent simultaneous analyses of fusion and elastic scattering data for low-energy neutron-halo ^{6}He and weakly-bound ^{6}Li projectiles, colliding with medium mass targets, have shown an interesting behavior of the energy dependence of the corresponding optical model potentials. The extended optical model (EOM) was used, which includes two complex polarization potentials, one associated to fusion couplings and the other one associated to direct reaction couplings. Analyses were carried out for ^{6}Li + (^{58}Ni, ^{59}Co, ^{64}Ni, ^{64}Zn) and ^{6}He + ^{64}Zn. In all cases, the fusion part of the potential presented a normal Threshold Anomaly (TA), while the behavior of the direct reaction part was consistent with the Breakup Threshold Anomaly (BTA). The dispersion relation was verified for all systems and it was actually shown that the constriction of having dispersive potentials is useful to identify seemingly unphysical data. For the particular case of the neutron-halo projectile, a strikingly irregular BTA was observed for the direct reaction part of the potential, which lead to the conclusion that an unexpected transition in the corresponding direct reaction mechanisms is present. The results of the above mentioned analyses are briefly reviewed in the present work.

3. **Ani Aprahamian[1,2] and S. R. Lesher[3]**

1. Nuclear Science Laboratory, University of Notre Dame

2. A. Alikhanyan National Science Laboratory of Armenia

3. Physics Department University of Wisconsin - LaCrosse

Title: **Dynamics of Nuclei**

Abstract: The nucleus is a complex many-body system with some remarkable emergent collective properties of multiple nucleons acting together. Bohr & Mottelson [1] provided a description of collective motion in nuclei based on geometrical shapes with superimposed oscillations around those shapes. Later, Lie algebras and symmetries [2] were used to describe nuclear dynamics, followed by advances in the shell model approach [3] with new effective nucleon-nucleon two and three body interactions, and more recently with Hartree-Fock-Bogoliubov approximation within the extended generator coordinate method [4]. Yet, the underlying science question has remained the same. In nuclei, where there is explicit deformation in the ground state, are the low-lying 0^+ states collective vibrations built on the ground state or are they minima of a coexisting shape? Ref. [4] has shown that for a significant percentage of K=0^+ excitations built on the deformed g.s. should in fact be collective vibrations. The question has remained open due to sufficiently convincing experimental data with lifetimes, transfer reaction cross sections, and E0 transitions [5]. My talk will give an overview of the present experimental situation.

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4. **Libertad Barrón-Palos**

Instituto de Física, Universidad Nacional Autónoma de México (UNAM), Av. Universidad 3000. 04510, Cd. de México, México

Title: **TRIV searches using neutrons**

Abstract: CP violation is an importan ingredient in understanding the matter-antimatter asymmetry observed in the Universe. Existing evidence of CP violation is currently too small to explain the size of the asymmetry, in addition to being limited to processes that are mediated by the weak interaction. The observation of TRIV through the measurement of a nonzero electric dipole moment in the neutron, or in the interaction of polarized neutrons with polarized targets, would constitute, independently, evidence of CP violation in the strong sector. In this talk I will describe the work of the nEDM@SNS and the NOPTREX collaborations towards this end.

5. **Tobias Beck** Facility for Rare Isotope Beams, Michigan State, USA

   Title: **New signatures for quantum phase transitions from mixed-symmetry states**

   Abstract: Mixed-symmetry states have proven their sensitivity to the shape evolution across quantum phase transitions. Especially the electromagnetic transitions between the 1^+ scissors mode and the 0+2 state are strongly affected by the amount of nuclear deformation. Also the elusive E2 properties of mixed-symmetry states can be established as novel signatures for phase-transitional behavior. First experimental information on such, which is obtained from high statistics nuclear resonance fluorescence experiments, is discussed for the transitional nucleus ^{154}Gd and the quadrupole deformed nuclei ^{162,164}Dy in connection with calculations in the IBM-2.

6. **Carlos Bertulani**

   Texas AM University-Commerce, USA

   Title: **Probing photo-nuclear reactions with relativistic heavy ions**

   Abstract: The aim of relativistic heavy ion accelerators is to study nuclear matter under extreme conditions. However, very strong electromagnetic fields for a very short time duration are present in distant collisions with no nuclear contact. Such strong fields can lead to nuclear fragmentation through the excitation of giant resonances or direct dissociation of light nuclei. This process can be used to study nuclear structure properties which are not accessible by other means. The creation of particles is also of interest due to the large cross sections, specially the case of electron-positron pair creation. Meson production and the search for new exotic mesons has been an area of strong interest in recent years. I will discuss the application of the EM fields generated by relativistic heavy ions in a plethora of problems of actual interest in physics.

7. **Andreas Best**

   Università degli studi di Napoli, Italy

   Title: **Underground nuclear astrophysics at LUNA MV**

   Abstract: The INFN LUNA MV facility at the Gran Sasso National Laboratory in Italy is rapidly approaching operating conditions: the 3.5 MV single-ended accelerator has been installed in the deep underground location and is currently undergoing conditioning and beam tests. The accelerator is designed to produce high beam currents and high energy and beam current stability and can provide hydrogen, helium and carbon beams.

   The strong background reduction underground and the state-of-the-art accelerator open a wide field of opportunities for improved measurements of critical reactions for nuclear astrophysics, including, but not limited to, the following reactions: ^{14}N(p,γ)^{15}O, ^{13}C(α,n)^{16}O, ^{12}C+^{12}C fusion and the ^{22}Ne+α reactions. We provide an overview of the capabilities of the facility, an updated timeline and discuss the experimental program.

8. **Leah Broussard**

   Oak Ridge National Laboratory, USA

   Title: **New Searches for Neutron Oscillations**

   Abstract: Two critical questions in particle physics remain unanswered -what is the particle nature of dark matter, and why is there no antimatter in the universe? Searches for neutron oscillations are an essential component of the worldwide program to understand baryon number violation and what comprises dark matter, but are underexplored experimentally. If dark matter is made up of a rich hidden sector such as "mirror matter," neutral particles such as the neutron might oscillate into their dark twin. This phenomenon was suggested as the source of the long-standing discrepancy between the cold neutron appearance ("beam") and ultracold neutron disappearance ("bottle") techniques for measuring the neutron lifetime. I will describe a new search for mirror neutron oscillations recently performed at ORNL's Spallation Neutron Source that has ruled out this explanation of the neutron lifetime puzzle. I will also discuss plans to improve these searches at ORNL and the European Spallation Source, including searches for neutrons transforming into mirror neutrons and back into antineutrons. This program will inform a future high sensitivity search for neutrons transforming directly into antineutrons as part of the NNBAR experiment, which is anticipated to improve sensitivity by three orders of magnitude over the previous direct search.

9. **Efraín Chávez[1], L. Acosta[1], E. Andrade[1], V. I. Araujo-Escalona[1], L. Barrón Palos[1], R. Gleason[1], A. Huerta[1], D. J. Marín-Lámbarri[2], J. Mas-Ruiz[1], C. G. Méndez[1], S. Padilla[1], G. Reza[1], M. Rodríguez-Ceja[1], C. Solís[1] and O. A. Valdez[1].**

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   2. Instituto de Ciencias Nucleares, UNAM, 04510 Coyoacán, Ciudad de México, México

   Title: **Nuclear reaction cross-section measurements for stellar nucleosynthesis using AFAMS**

   Abstract: Activation Followed by Accelerators Spectrometry (AFAMS) has evolved to be an important resource to measure small (sub-nanobarn) nuclear reaction cross sections. Becoming in this way an interesting tool to access information required for stellar nucleosynthesis calculations. In this presentation, we briefly describe four Mexican facilities involved in this AFAMS method:
   •At IFUNAM: "Instituto de Física, Universidad Nacional Autónoma de México"
   - LEMA: "Laboratorio Nacional de Espectrometría de Masas con Aceleradores"
   - "El 5.5": 5.5 MV Single ended Van de Graaff Accelerator Laboratory
   • At ININ: Instituto Nacional de Investigaciones Nucleares
   - TRIGA-MARK-III 1 MW nuclear research reactor.
   - 6 MV Tandem Van de Graaff Accelerator Laboratory
   LEMA is a national laboratory responsible for the precise measurement, in a variety of samples, of the concentration of radioactive isotopes like: ^{26}Al,^{10}Be and ^{14}C. Taking advantage of this capability, we developed a project with the aim to measure nuclear reaction cross sections whose residues were such radioactive isotopes. In this work the ^{28}Si(d,α)^{26}Al, ^{9}Be(n,γ)^{10}Be and the ^{14}N(n,p)^{14}C nuclear reactions are presented as examples. Neutron (thermal) activations can be carried out at the nuclear research reactor facility while charged particle activation (proton and deuteron) are performed in one of our low energy electrostatic accelerators both at ININ and at IFUNAM.

10. **Osvaldo Civitarese**

    Departamento de Fisica. Uiversidad de la Plata, Argentina

    Title: **Peccei and Quinn's axions and the neutrino mass**

    Abstract: We study the interaction of neutrinos with non-relativistic axions. Axions are low-mass neutral bosons whose existence has been proposed long ago by Peccei and Quinn to explain the spontaneous breaking of the CP symmetry in the early Universe. We treat them as pseudo-scalar particles, which could be one of the constituents of cold dark matter. The interactions between axions and neutrinos may be a mechanism to explain for finite neutrino masses. The analysis combines the limits for the neutrino mass extracted from $(0\nu\beta\beta)$ decay studies with the ones resulting from the coupling between axions and neutrinos. We calculate neutrino-axion interactions, up to second order diagrams, and extract the values of both the axion and neutrino masses by taking from the literature representative values of the strength of the couplings and of the matrix elements of the operators participating in the currents.

11. **Nabanita Dasgupta[1], J. L. Rodríguez Alejandre[1], I. E. Serrato Mireles[1], V. R. Sharma[2] and L. Acosta[3]**

    1. Facultad de Físico Matemáticas, Universidad Michoacana (UMSNH), Morelia, México

    2. Instituto Nazionale de Física Nucleare, Laboratori Nazionali del Sud, Catania 95125, Italy

    3. Instituto de Física, UNAM, Cd. de México, México

    Title: **Total Reflection Xray Fluorescence (TXRF) spectrometry as a powerful and broad-spectrum analytical tool in the nuclear sciences**

    Abstract: X-ray spectroscopy is widely used in nuclear reaction and structure studies, as for example X-ray isotope shifts for nuclear charge distributions, the study of EC decay, mu-mesic atoms and synchrotron processes, X-gamma-alpha coincidence spectroscopy for product Z identification in Super Heavy Nuclear synthesis and X-ray bursts from thermonuclear processes in accreting neutron stars. To aid such studies the technological envelope is continually being pushed to achieve higher quality such as superior power and brilliance, higher resolution and sensitivity. We present the discussion of a relatively new form of bench-top analytical X-ray spectrometry that uses the property of the total reflection of a grazing X-ray beam on a perfectly reflective sample-containing substrate, to achieve analytical sensitivities of the order of parts per billion (ppb) and line-shape parameters that permit the possible identification of Chemical Shift effects, in the energy dispersive mode of X-ray fluorescence spectrometry. Two extreme cases of sample complexity will be presented, that correspond to experiments carried out in our laboratory. One, the assay of Se in the form of the ion Selenate and the amino acid DL-Selenomethionine in a plain water or in the mineral rich medium of artificial human urine (AHU); the other, the concentrations of Copper in the tissue of the plant B. juncea that had been grown in highly copper contaminated soil that had also been treated by nano and meso structured Carbon allotropes, viz. Multiwalled Carbon Nanotubes and Activated Carbon respectively. The discussion of the latter work will also include an allusion of the adaptation of the Verhulst model of population dynamics applied to the concentration domain developed by this group to treat the vegetative accumulation of heavy metals.

12. **James deBoer**

University of Notre Dame, USA

Title: **New angular distribution measurements of the ^{13}C$(\alpha, n)^{16}$O reaction over a wide energy range**

Abstract: The ^{13}C$(\alpha, n)^{16}$O reaction is one of the main sources of neutrons for the astrophysical s-process. In addition, it can be a source of background for neutrino and dark matter detection in ton scale experiments, induced from the high energy α decays of trace actinides in support structures and the detection volumes. Recent experimental studies have put the spotlight on the ^{13}C$(\alpha, n)^{16}$O reaction, both through the measurement of new very low energy cross sections at underground facilities and by new types of measurements at higher energies, both of which resolve inconsistencies in past measurements. In this talk, I will review these latest measurements, discuss how they contribute to the overall evaluation of the reaction over a wide energy range, and show results from MCMC R-matrix analysis, using the newly developed BRICK code, to estimate the effect of these new data on the extrapolation of the low energy S-factor to stellar energies. In particular, new measurements made at the University of Notre Dame, 20 point angular distributions covering a center-of-mass range from 0.6 to 6.5 MeV using ODeSA, will be presented.

13. **Daniele Dell'Aquila[1,2], B. Gnoffo[3], I. Lombardo[3,4], F. Porto[4,5] and M. Russo[3,4]**

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4. Dipartimento di Fisica e Astronomia "Ettore Majorana", Università degli Studi di Catania, Catania, Italy

5. INFN-Laboratori Nazionali del Sud, Catania, Italy

Title: **Understanding Heavy-ion Fusion Cross Section Data Using Novel Artificial Intelligence Approaches**

Abstract: An unprecedentedly extensive dataset of complete fusion cross section data is modeled via a novel artificial intelligence approach. The analysis was focused on light-to-medium-mass nuclei, where incomplete fusion phenomena are more difficult to occur and less likely to contaminate the data. The method used to derive the models exploits a state-of-the-art hybridization of genetic programming and artificial neural networks and is capable to derive, in a data-driven way, an analytical expression that serves to predict integrated cross section values. For the first time, we analyzed a comprehensive set of nuclear variables, including quantities related to the nuclear structure of projectile and target. In this talk, we describe the derivation of two computationally simple models that can satisfactorily describe, with a reduced number of variables and only a few parameters, a large variety of light-to-intermediate-mass collision systems in an energy domain ranging approximately from the Coulomb barrier to the oncet of multi-fragmentation phenomena. The underlying methods are of potential use for a broad domain of applications in the nuclear field.

14. **Alessia Di Pietro**

INFN-Laboratori Nazionali del Sud, Catania, Italy

Title: **Nuclear structure and dynamics with light exotic beams**

Abstract: The region of the nuclear chart corresponding to light radioactive nuclei has, over the years, yielded many surprising results, among others the discovery of the halo structure in neutron and proton dripline nuclei. This region of the nuclear chart is also rich of many other phenomena like the appearance of molecular-like structures where α-particle-clusters are bound together by the exchange of neutrons or the existence of cluster configurations where at least one of the clusters is a weakly bound nucleus. The availability of post-accelerated radioactive ion beams has opened the opportunity to study nuclear structure and reactions of such peculiar nuclei. Moreover, to be able to describe the physics observables extracted from experiments, state-of-the-art theory has to be used to advance our understanding of the nuclear structure and reaction dynamics. In this talk an overview of some of the new phenomena involving light exotic RIBs will be given and future perspectives discussed.

15. **Andreas Ekström**

Chalmers University of Technology, Sweden

Title: **Linking finite nuclei and nuclear matter through nuclear forces**

Abstract: A central problem in nuclear physics is to understand why some descriptions of the nuclear interaction, calibrated to reproduce similar data, work better than others for predicting fundamental nuclear quantities such as binding energies, radii, and the properties of nuclear matter. Recent developments in quantum many-body methods put 208Pb within reach of ab initio computation [1]. The development of accurate emulators [2,3] allows to efficiently mimic the outputs of many-body solvers and therefore enables detailed statistical analyses of how realistic two- and three-nucleon forces act in finite nuclei and nuclear matter. I will present results from an ab initio study [4] that links the neutron-skin thickness of ^{208}Pb and the properties of nuclear matter at saturation densities through nuclear forces using statistical tools and emulator technology. The results rule out a very thick skin of ^{208}Pb.

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16. **Martin Freer**

School of Physics and Astronomy, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK Title: **An examination of symmetries of light nuclei**

Abstract: The ability to model the nature of the strong interaction at the nuclear scale using ab intio approaches and the development of high performance computing is allowing a greater understanding of the details of the structure of light nuclei. The nature of the nucleon-nucleon interaction is such that it promotes the creation of clusters, mainly α-particles, inside the nuclear medium. The emergence of these clusters and understanding the resultant structures they create has been a longstanding area of study. At low excitation energies, close to the ground-state, there is a strong connection between symmetries associated with mean-field, single-particle, behaviour and the geometric arrangement of the clusters, whilst at higher excitation energies when the cluster decay threshold there is a transition to a more gas-like cluster behaviour. State-of-the-art calculations now guide the thinking in these two regimes, but there are some key underpinning principles that they reflect. The present talk will build from the simple ideas to the state-of-the-art creating a thread by which the more complex calculations have a foundation, developing a description of the evolution of clustering from α-particle to ^{16}O clusters.

17. **Luca Guardo[1,2], M. La Cognata[1], L. Lamia[1,2,3], R.G. Pizzone[1], G. D'Agata[1,2], A. DiPietro[1], P. Figuera[1], M. La Commara[4,5], D. Lattuada[1,6], M. Mazzocco[7,8], A.A. Oliva[1,2,3], S. Palmerini[9], G.G. Rapisarda[1,2], S. Romano[1,2,3], M.L. Sergi[1,2], R. Spartá[1] and A. Tumino[1,5]**

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8. INFN-Sezione di Padova, Padova, Italy
9. Dipartimento di Fisica e Geologia, Università di Perugia, Perugia, Italy

Title: **Developing system arrays for new experimental approach in nuclear astrophysics**

Abstract: The advent of facilities providing high-intensity and high-resolution gamma ray beams and/or ultra-short and high-repetition laser pulses can potentially open a new path of astro-physical research. Indeed, a pencil size gamma beams with tunable energies from few keV up to tens MeV will provides unique opportunities to perform accurate measurements of small cross sections (order of mub or even less) of nuclear reactions of astrophysics interest and hence of the astrophysical S-factors that are essential for stellar evolution modeling. On the other hand, the possibility to mimic the stellar conditions by laser-matter interaction generating a controlled laboratory plasma with thermodynamical status not too different from stellar conditions will open the way for the study of nuclear reactions of outmost importance for nuclear astrophysics.

In the case of photonuclear reactions of astrophysical relevance, since photodissociations are induced at photon energies slightly larger than particle emission thresholds owing to the typical temperatures in stars, the emitted fragments have low energies, ranging from few hundreds keV to few MeV. Therefore, low-threshold detectors are necessary. Also, in the case of laser-induced reactions, in order to detect the fusion products and to measure the laser-accelerated ion distribution a proper system of detection is needed. Depending on the available exit channels of the nuclear reaction of interest, both charged particles and neutrons are foreseen. Here, we present the Asfin's efforts on developing new detectors arrays suitable for the experimental requirements in these challenging measurements. Indeed, an experimental campaign is ongoing in order to test the feasibility of excitation functions and angular distributions determinations using versatile silicon strip arrays (namely LHASA and/or ELISSA).

Moreover, extensive studies and simulations will be presented regarding the developing of a dedicated detection system comprising a cryogenically cooled supersonic nozzle, an appropriate interaction chamber, an array of neutron and charged particle detectors and two compact ion spectrometers for performing systematic study of laser-induced nuclear fusion reactions.

18. **Gaute Hagen**

Oak Ridge National Laboratory, USA

Title: **Advances in coupled-cluster computations of nuclei**

Abstract: High performance computing, many-body methods with polynomial scaling, and ideas from effective-field-theory is pushing the frontier of ab-initio computations of nuclei. Here I report on advances in coupled-cluster computations of nuclei starting with chiral Hamiltonians with two- and three-nucleon forces. Global surveys of bulk properties of medium-mass and neutron-rich nuclei from ab-initio approaches are now becoming possible by using reference states that break symmetries. These calculations have revealed systematic trends of charge radii in various isotopic chains, questioned the existence of certain magic shell closures in neutron-rich nuclei, and confrontation with data have exposed challenges for ab-initio theory. The restoration of broken rotational symmetry in coupled-cluster calculations allow us to address rotational structure of nuclei, and with this approach we recently have made predictions for excited states in neutron-rich neon isotopes. I will also report on new ways to make quantified predictions by the development of accurate emulators of ab-initio calculations. These emulators reduce the computational cost by many orders of magnitude allowing for billions of simulations of nuclei using modest computing resources. This allows us to perform global sensitivity analysis, quantify uncertainties, and use novel statistical tools in predicting and understanding properties of nucleonic matter.

19. **Daniel José Marín-Lámbarri for the SUGAR@LNL Collaboration**

Instituto de Ciencias Nucleares, UNAM, 04510 Coyoacán Ciudad de México, México.

Title: **The SUGAR@LNL Project: A windowless gas jet target for astrophysical experiments at Legnaro.**

Abstract: The SUGAR@LNL Project is an Italian Mexican initiative to use the gas jet target SUGAR at zero degrees line of the Legnaro Tandem. In the present period this meaning a unique opportunity to perform very complete measurements using the strong capacities of AGATA and NEDA arrays, as well as a dedicate silicon array. This combination will allow the simultaneous measurement of charge particles, gamma rays and neutrons, given access to the study of very particular nuclear reactions. At the same time, the purity reached with the Mexican windowless jet target will make possible to isolate exclusive reaction channels, practically impossible when solid targets are used. During 2022 the Project was structured, and presently, we have 4 physics case to be proposed as well as a series of modifications necessary to coupled SUGAR to Legnaro beamline and its configuration as part of the AGATA setup. The collaboration is formed presently of 27 participants from different institutions. In the spring of 2023, a TDR to support the project will be presented to the LNL-AGATA coordinators. In the present work, the project and all the work developed till this moment (physics cases, mechanical modifications, simulations) will be presented.

Supporting projects: CONACyT 315839 and DGAPA-UNAM IN107820, IG101120.

20. **Grant Mathews**

University of Notre Dame, USA

Title: **Core-collapse Supernovae, Binary Neutron Star Mergers and the Nuclear Equation of State at High Density**

Abstract: The properties of nuclear matter at extremely high densities and temperatures are still fraught with unknowns. Nevertheless, there are two environments in Nature for which the densest forms of nuclear matter can be found; these are during the collapse of the core of a massive star to form a supernova or black hole, and during the merger of two neutron stars to form a black hole. This talk will highlight recent progress by our group on exploring the nuclear equation-of-state effects in these two environments. In particular, new insight into what determines the explodability of supernova progenitors and the possibility to probe the non-perturbative regime of quark matter in the emitted gravitational radiation are discussed.

21. **Daniele Mengoni**

INFN-University of Padova, Italy

Title: **Physics results with the ultimate AGATA-MUGAST-VAMOS setup and ISOL beams at GANIL**

Abstract: The AGATA-MUGAST-VAMOS set-up, which was recently available at GANIL for a direct reaction campaign, combined the state-of-the-art γ-ray tracking array AGATA with the highly-segmented silicon array MUGAST and the large-acceptance magnetic spectrometer VAMOS. The mechanical and electronics integration provided a maximum efficiency for each device. The superb sensitivity of the complete set-up offered a unique opportunity to perform exclusive measurements of direct reactions with radioactive beams delivered by the SPIRAL1 facility.

An experimental campaign using radioactive ISOL beams was perfomed during 2019-2021 using the cutting-edge combined setup, covering physics cases ranging from ^{14}O to ^{46}Ar, and topics from nuclear structure and dynamics to astrophysics.

In this contribution I'll review the performance of the setup an focus on the physics results of the experimental campaign.

22. **Patrick O'Malley**

University of Notre Dame, USA

Title: **TriSol: Improved RIBs for enhanced Nuclear Science**

Abstract: *TwinSol*, a pair of coupled superconducting solenoids at the University of Notre Dame Nuclear Science Laboratory, has been a powerful tool for producing unstable beams. For the past couple of decades there was an abundance of work done to study the structure of nuclei, both stable and unstable. In order to meet the need for more precision nuclear data, the system has been upgraded with the addition of a 15 degree bending magnet, a third solenoid, and a set of variable slits. The improvements to beam quality that this upgraded system, *TriSol*, yields has been systematically studied. A variety of radioactive ion beams have been studied with *TriSol*, including ^{8}B, ^{11}C, ^{14}O, and ^{17}F. The details of the new system will be presented and some of the future scientific efforts will be discussed.

23. **Emmanuel Ortiz Pacheco**

Institut Jozef Stefan, Ljubljana, Slovenia

Title: **Study of heavy baryons and pentaquarks**

Abstract: We address an extensive study on two types of hadronic systems, baryons, and pentaquarks. For the former ones, seen as the S- and P-wave baryon states with a single heavy quark content (either charm or bottom), we obtain their mass spectra and provide the radiative and strong decays allowed by the selection rules. Our results are compared with the current experimental data.

For the pentaquarks, the interest is on the calculation of their radiative decay widths $\Gamma(p(uud)+\gamma \to P_c(uudc\bar{c}))$ whose current interest is relevant for confirmation in new experiments. For this purpose, we made a complete classification of ground and one orbital excited states for the hidden charm pentaquark with total angular momentum $J^P = 3/2^-$, and for configurations with flavor content $uudc\bar{c}$. In the end, we found that from a large number of states, 5 for ground states and 19 for radially excited states, only 3 can contribute to the photoproduction of pentaquarks. We provide their decay widths as a function of their yet unobserved charge radius.

24. **Gianluca Pizzone**

INFN-LNS, Italy

Title: **Indirect studies of the Early Universe through nuclear physics**

Abstract: Big Bang Nucleosynthesis (BBN) requires several nuclear physics inputs and nuclear reaction rates. An up-to-date compilation of direct cross sections of d(d,p)t, d(d,n)^{3}He and ^{3}He(d,p)^{4}He reactions was given in past years, being these ones among the most uncertain bare-nucleus cross sections. Nevertheless many reaction rates still carry large uncertainties especially the ones involving neutron interactions with stable or especially unstable nuclei.

An intense experimental effort has been carried on in the last decade to apply the Trojan Horse Method (THM) to study reactions of relevance for the BBN and measure their astrophysical $S(E)$-factor. The reaction rates and the relative error for the four reactions of interest are then numerically calculated in the temperature ranges of relevance for BBN ($0.01 < T9 < 10$). These value were then used as input physics for primordial nucleosynthesis calculations in order to evaluate their impact on the calculated primordial abundances and isotopical composition for H, He and Li. New results on the ^{7}Be(n,α)^{4}He and ^{7}Be(n,p)^{4}He reaction rates will be reviewed together with recent studies on ^{3}He(n,t)H.

These indirect experimental results will be compared with available direct measurements (if available) and estimates on the observational primordial abundance estimates will be given.

25. **Fabio Risitano[1,2,*], L. Acosta[1,3], G. Cardella[1], E. De Filippo[1], D. Dell'Aquila[4,5], F. Favela[1,3], E. Geraci[1,6], B. Gnoffo[1,6], I. Lombardo[1], C. Maiolino[5], N.S. Martorana[5,6], A. Pagano[1], E.V. Pagano[5], M. Papa[1], S. Pirrone[1], G. Politi[1,6], F. Rizzo[5,6], P. Russotto[5], A. Trifirò[1,2] and M. Trimarchi[1,2]**

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Title: **Clustering states in neutron-rich nuclei**

Abstract: An important subject of research in the field of nuclear physics is the study of clustering states in neutron-rich nuclei by means of break-up reactions. Such reactions are in fact important for the characterization of exotic states in radioactive light nuclei, like neutron halos around stable cores, α-clustering structures with so-called "valence" neutrons, or exotic clusters. At INFN Laboratori Nazionali del Sud (LNS) the CLIR (Clusters in Light Ion Reactions) experiment has been performed [1], aiming at the investigation of such cluster structures in light radioactive neutron-rich nuclei, produced by the FRIBs facility [2]. A radioactive beam containing different species of interest such as ^{10}Be [3], ^{13}B, or ^{16}C has been produced by the In-Flight fragmentation of a ^{18}O primary beam on a 1500 μm ^{9}Be target. After being identified by a tagging system, the cocktail beam isotopes reacted with a polyethylene (C_2H_4, protons) target. Reaction products have been detected by the CHIMERA multidetector [4], coupled with four FARCOS telescopes [5], placed at small angles. Calibrations on the tagging system and on the different stages of FARCOS telescopes have been performed, decisive for this study as the break-up fragments are emitted at small angles around the beam axis. Some results on the analysis will be presented. In the forthcoming years it will also be possible to further enrich this field of research, thanks to the availability of the new fragment separator FRAISE [2] and the complete FARCOS detector [5]. Moreover, it will also be possible to investigate the neutron decay channel with the help of the new prototype of neutron detector currently under development [6].

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26. **Adrian Santana Valdés**

Instituto de Ciencias Nucleares, UNAM, 04510 Coyoacán, Ciudad de México, México

Title: **Structure of ^{13}C in the framework of the Cluster Shell Model**

Abstract: We study the structure of ^{13}C in the framework of the Cluster Shell Model. A comparison of the available experimental data with our model is made. Some predictions for level ordering and form factors are presented.

27. **Christian Schubert**

Centro Internacional de Ciencias A.C. UNAM-UAEM, Cuernavaca, México

Title: **Photon-photon scattering**

Abstract: The existence of photon-photon scattering historically was one of the first non-trivial predictions of QED. However, since the cross section is very small at low energies it was only in 2017 that a direct measurement was achieved in heavy-ion collisions at the LHC [1]. After a short discussion of this experiment, I discuss the general structure of the four-photon tensor [2], which also serves as the prototype for all vertices of four gauge bosons, and present a compact tensor decomposition of the four-gluon vertex [3]. I shortly comment on the signifcance of [1] to constrain certain SM extensions such as theories of the Born-Infeld type.

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28. **Vasilis Soukeras, for the NUMEN collaboration**

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2. Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali del Sud (INFN - LNS), Catania, Italy (INFN-LNS, Italy)

Title: **A multi–channel study of the ^{20}Ne + ^{130}Te system within the NUMEN project**

Abstract: The NUMEN project [1] aims to measure specific reaction cross sections to provide experimentally driven information about nuclear matrix elements (NMEs) of interest in the context of neutrinoless double beta decay ($0\nu\beta\beta$). In particular, it was proposed to use heavy-ion induced double charge exchange (DCE) reactions as tools towards the determination of information on the NMEs of $0\nu\beta\beta$, strongly motivated by a number of similarities between the two processes [2,3]. To this extent, the ^{20}Ne + ^{130}Te system was experimentally investigated in a global approach by measuring the complete net of reaction channels, namely DCE [4], single charge exchange (SCE), elastic and inelastic scattering [5], one- and two- nucleon transfer reactions, characterized by the same initial projectile and target nuclei. The goal of such a study is to fully characterize the properties of the nuclear wavefunctions entering in the $0\nu\beta\beta$ decay NMEs. The obtained results for the ^{20}Ne + ^{130}Te system will be presented and discussed.

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29. **Javier Valiente**

INFN-LNL, Italy

Title: **The γ-ray tracking array AGATA at LNL**

Abstract: Gamma-ray spectroscopy represents one of the most powerful methods to study nuclear structure since a large fraction of the de-excitation of the excited nuclear levels goes via γ emission. The precise measurement of the γ-rays emitted from nuclear levels can provide a large amount of information of the nuclear structure of the specific nucleus under study. The continuous improvement in germanium γ-array performances and in their associated instrumentation has allowed an enormous increase of the experimental sensitivity. The current forefront Ge γ-array in Europe is AGATA [1] which is based on the new concept of γ-ray tracking. It can identify the gamma interaction points (pulse shape analysis) and of reconstructing via software the trajectories of the individual photons (γ-ray tracking). The state-of-the-art γ-ray tracking AGATA array had it first implementation at Laboratori Nazionali di Legnaro (LNL) in 2009 with 5 AGATA triple Clusters, the so called AGATA demonstrator [2]. The AGATA γ spectrometer has return to LNL with the new 2π solid angular coverage configuration. The first physics campaign started in spring 2022 where AGATA was coupled to the magnetic spectrometer PRISMA and other compatible ancillary detectors. In this presentation, a review on the achievements in nuclear structure physics and future physics campaigns with the γ-ray tracking AGATA will be discussed.

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30. **Diego Venegas Vargas**

University of Tennessee Knoxville / Oak Ridge National Laboratory, USA

Title: **Improved ^{235}U Spectrum Measurement from the PROSPECT-I Data Set**

Abstract: PROSPECT is a reactor antineutrino experiment consisting of a 4-ton liquid scintillator antineutrino detector divided into an 11x14 array of optically separated segments. The detector was designed to probe the existence of sterile neutrino oscillations and precisely measure the antineutrino spectrum resulting from ^{235}U fission. Data was taken in 2018 and 2019 with a first-generation detector called PROSPECT-I that was located on the Earth's surface roughly 7 m from the 85 MW, compact, highly-enriched High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory. This dataset has already had a substantial impact by placing stringent limits on sterile neutrino oscillations at the eV scale, setting new direct limits on boosted dark matter models, providing a precision ^{235}U spectral measurement, and demonstrating unique neutrino detection capabilities. During the data collection period, information coming from a small number of PMTs had to be excluded causing an overall statistical impact on previous results. To recover this otherwise lost information, two new data analysis tools known as Data Splitting and Single Ended Event Reconstruction have been implemented resulting in a multi-period analysis with improved antineutrino event selection criteria. This presentation will review the impact of this new analysis effort in the measurement of the ^{235}U spectrum, as well as the strategy for new oscillation and flux analyses. This work is supported by the US DOE Office of High Energy Physics, the Heising-Simons Foundation, CFREF and NSERC of Canada, and internal investments at all institutions.

31. **Michael Wiescher**

University of Notre Dame, USA

Title: **Nuclear clusters as the first stepping stones for the chemical evolution of our Universe**

Abstract: Nuclear reactions in stars have facilitated the chemical evolution of the universe from the Big Bang to present times. This evolution can be mapped by the spectroscopic observation of old to present stars and the present level is reflected in the radioactive glow of the Milky Way. However, there are still fundamental questions about the first step in this development, the conversion of the primordial hydrogen, helium and lithium abundances into the carbon, nitrogen and oxygen that characterize the abundance distributions in oldest stars observed so far. This step took place in the first generation of stars that also ended the dark age of the universe some 300 million years after the Big Bang. This step requires nuclear reaction processes that bridge the mass 5 and mass 8 gaps of instability. The key is in the existence of nuclear cluster configurations in light nuclei that serve as stepping stones for α induced reaction processes helping to bridge the gap. I will summarize the various processes that are presently being discussed and describe the experimental evidence that support this interpretation.

32. **Tochtli Cuauhtli Yépez**

Instituto de Educación Media Superior CDMX, México

Title: **The BCS many-body method and meson-like states up to 2 GeV**

Abstract: The search of theoretical approximations adequate to the description of the nonperturbative regime of QCD, that is the low-energy portion of the hadron spectrum, requires the adoption of notions more frequently applied to other, more conventional, quantum many body systems, like the atomic nucleus, solid state systems, etc. The identification and the use of effective degrees of freedom is one of the notions whose limitations we shall explore in this work. Here, we propose the use of the harmonic oscillator basis and emphasize its advantages. The starting Hamiltonian is the effective Coulomb plus linear potential, for which we proceed by pre-diagonalizing the Hamiltonian to build a single particle spectrum, namely: the spectrum of effective quark degrees of freedom, starting from arbitrary chosen quark masses, which are later on re-normalized. Then, quark-pair correlations are described in the context of the well-known Bogoliubov transformations. The resulting quasiparticle states are then used to construct meson-like states, without adding interactions among them, we built twoquasiquark states in order to get a feeling about the density of meson-like states. The dependence of the results upon the parameters that enter in the calculations is explored in detail.

Poster Session

1. Eduardo Andrade (IF-UNAM)
2. Tatiana Belyaeva Leovnidovna (UAEMEX)
3. Jorge Israel Castro Alatorre (BUAP)
4. Luis Enrique Charón (IF-UNAM)
5. Karen de los Ríos (IF-UNAM)
6. Omar Alejandro Díaz Caballero (ICN-UNAM)
7. Carlos Andrés Esquivel Carrillo (IF-UNAM)
8. David Godos-Valencia (IF-UNAM)
9. Salomón Gómez-Rivera (UAEMEX)
10. Luis Enrique Martínez (IF-UNAM)
11. Javier Mas-Ruiz (IF-UNAM)
12. Jonathan Méndez (IFUNAM)
13. Felipe G. Ortega-Gama (WM)
14. Guadalupe Reza (IFUNAM)
15. Jorge Luis Rodríguez Alejandre (UMSNH)
16. Livia Regina Romero Martínez (IF-UNAM)
17. Antonio Sebastian Rosado González (BUAP)
18. Sinhué Sandoval-Hipólito (IF-UNAM)
19. Omar Valdez (IF-UNAM)
20. Luis Roberto Valencia (IF-UNAM)

Abstracts

Poster Session

1. **Jorge Israel Castro Alatorre**

   BUAP, Puebla

   Title: Weak-neutral currents, e-p scattering, and quantum demons

   Abstract: A scattering problem caused by momentum-dependent weak-neutral currents breaks parity and time reversal. However, such a problem is invariant under the application of both. Therefore, a toy system is studied in which the eikonal approximation becomes one-dimensional, and therefore the Green's function can be calculated analytically and its antisymmetric part can be identified as responsible for irreversibility effects. Such Green's functions can also be found in the field of electromagnetic cavities.

2. **Luis Enrique Charón**

   Instituto de Física, UNAM, 04510 Coyoacán, Ciudad de México, México

   Title: **P-even and -odd asymmetries on ^{117}Sn at the vicinity of the p-wave resonance $E_p = 1.33$ eV**

   Abstract: The theory of resonance mixing of a p-wave neutron-nucleus resonance embedded in a sea of s-wave resonances is an essential component of the description of parity and time reversal violation in neutron-nucleus resonances. This theory makes correlated predictions for the results of various angular distributions in (n,γ) reactions. The 1.33 eV p-wave resonance in n + ^{117}Sn is one of the few p-wave resonances where enough measurements have been performed to allow a nontrivial test of the internal consistency of this theory. We present the results of a global analysis of the several different asymmetry and angular distribution measurements in (n,γ) reactions on the 1.33 eV p-wave resonance in n + ^{117}Sn conducted over the last few decades. We show for the first time that the resonance mixing theory can give an internally consistent description of all observations made in this system to date within the experimental measurement errors. We also confirm the conclusions of previous analyses that a subthreshold resonance in n + ^{117}Sn dominates the physics. We discuss the implications of these results for future searches for time reversal violation in this system.

3. **Karen de los Ríos[1,2], P. Ordóñez[2] and L. Acosta[1]**

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2. Instituto de Ciencias de la Atmósfera y Cambio Climático (ICAyCC). Universidad Nacional Autónoma de México. Apartado Postal 20-364, Cd.Mx 01000 México.

Title: **Evaluation of water vapour and deuterated water vapour concentrations for climatological analyses**

Abstract: Water Vapor (WV) is a greenhouse gas whose concentration has increased over the last decades in the atmosphere. In the case of the stratosphere, experimental studies have shown that the lower stratosphere (LS) has become more humidified than predicted. However, the contribution of the various physical transport phenomena that carry WV to the LS has not been fully explained. The excess deuterium (δD) is a tracer of humidification processes in the atmosphere and is correlated with large-scale convective processes. Various satellite instruments can measure WV and its isotopologues in the atmosphere (H_2O, HDO). Infrared spectroscopy is the most popular method to obtain the concentration of these molecules. Currently, there are several databases containing H_2O and HDO data. However, there are only three reliable databases in the LS region. Two databases, MIPAS-ESA v 8.0 and MIKAS-IMK v 5.0, were evaluated, and the ACE-FTS v 4.0 database was taken as a reference since the HDO was previously validated. Coincident profiles were compared, and statistical methods were applied, such as bias, correlations, vertical behaviour and the corresponding statistical errors.

Finally, the global behaviour of H_2O and HDO concentration was analyzed employing climatological maps, such as global seasonal maps, seasonal cross-sectional maps and maps of the temporal evolution of concentrations. The results show high reliability for H_2O to compare the three databases with the statistical methods proposed here. For the HDO, the biases are less than 10 % in the stratosphere for all cases. The average correlations are 0.6 for both ACE-FTS vs MIPAS-IMK and vs MIPAS-ESA. This result indicates that it is possible to use the HDO data for MIPAS-IMK v 5.0 and MIPAS-ESAv 8.0, taking special care with the temporal analysis of MIPAS-IMK from 2004 to 2005.

Financial support: DGAPA-PAPIIT projects IN113222 and IN107820.

4. **Omar Alejandro Díaz Caballero and Roelof Bijker**

Instituto de Ciencias Nucleares, UNAM, 04510 Coyoacán, Ciudad de México, México

Title: ^{10}**Be in the Cluster Shell Model**

Abstract: We present a study of the nucleus od ^{10}Be in terms of two neutrons coupled to the framework of the Cluster Shell Model. The residual interaction between the two neutrons is approximated by a Surface-Delta Interaction. The model is applied to the energy spectrum, electromagnetic transitions and moments. The electric transitions allows to test the wavefunctions obtained once our model have been adjusted to the experimental energies, by adjusting the strength of the neutron-neutron interaction this functions are sensible to changes and we have data of the $B(E2; 0^+ \rightarrow 2^+)$ transitions to put to the test our results.

5. **C. Esquivel-Carrillo, A. O. Valdez, E. Andrade, A. Huerta, G. Reza, J. Mas-Ruiz, S. Sandoval-Hipólito, M. G. Rodríguez Ceja, Corina Solís and E. Chávez**

Instituto de Física, UNAM, 04510 Coyoacán, Ciudad de México, México

Title: **On the use of the implantation method in the production of isotopically pure targets for the study of double charge exchange nuclear reactions**

Abstract: In this work, two isotopically pure targets were prepared implanting the respective isotopes ^{79}Br and ^{81}Br (the two stable isotopes of bromine) in graphite matrices. The Sputter Negative Ion Caesium Source (SNICS) of the "Laboratorio de Espectrometría de Masas con Aceleradores del Instituto de Física UNAM", (LEMA-IFUNAM) was loaded with several sodium bromide cathodes to deliver beams of the selected Bromine isotopes. All implantations described in this work were carried out at energies of 1535 keV. For the characterization of the targets, Rutherford Backscattering Spectroscopy (RBS) was used with ^{1}H, ^{12}C and ^{28}Si beams at energies of 1537, 5085 and 7105 keV, respectively. Both ^{79}Br and ^{81}Br ions were considered for their similarity with isotopes of selenium and krypton identified as candidates for the study of double charge exchange nuclear reactions of the NUMEN project (Nuclear Matrix Elements for the Neutrino-less double beta decay).

6. **David Godos-Valencia[1,5,*], L. Acosta[1,5], P. Ascher[2], B. Blank[2], J. Giovinazzo[2], F. de Oliveira Santos[3], C. Fougères[4], A.M. Sánchez-Benítez[5]**

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Title: **Beta-decay experimental studies of the ^{46}Mn and its connection with CCSN**

Abstract: Stars with initial mass greater than 8 $M_{\odot}$ end their lives through a Core Collapse Supernova (CCSN) explosion. Besides, ^{44}Ti nucleosynthesis takes place in CCSN; making this nucleus a good gamma astronomy tracer for Super Nova (SN) events due to the characteristic gamma rays emitted on its decay chain. Furthermore, the comparison between observations and models of the synthetized ^{44}Ti in CCSN gives important constrains to the models. In the later, reaction networks are used for modelling nucleosynthesis occurring in the last stages of those stars with thermonuclear reaction rates as its inputs [1,2,3]. Unfortunately, a direct measurement of the cross section for a given thermonuclear reaction is extremely difficult in the current laboratories worldwide. Therefore, indirect methods can be used for this purpose, especially when the reaction rate is dominated by a narrow isolated resonance. In this context, beta-delayed proton emission is very useful with (p,γ) reactions involving low and medium mass proton-rich radioactive nuclei. That is a consequence of the fact that in those reactions narrow isolated resonances are likely to occur [1,4]. In this work we present the preliminary results of analysing the ^{46}Mn decay channel as a way to study the ^{45}V(p,γ)^{46}Cr reaction. This is due to the thought that nucleosynthesis of ^{44}Ti in CCSN explosions is quite sensitive to that reaction [5]. The 46Mn was selected among other species in the cocktail beam delivered by LISE fragment separator at GANIL (Caen, France) in order to study its beta decay and the excited states of his daughter nucleus ^{46}Cr. We present the proton and gamma emission peaks related to the 46Mn decay and compare them with the work from references [6,7].

Acknowledgements: This work is supported by DGAPA-UNAM IN107820 and CONACyT 314857 projects.

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7. **Salomón Gómez-Rivera and T. L. Belyaeva**

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Title: **Analysis of elastic scattering cross sections for the α + ^{16}O**

Abstract: The analysis of the differential cross sections of the α + ^{16}O elastic scattering data at the incident energies $E_{\rm lab} = 50 - 80$ MeV [1] is carried out in the semi-microscopic dispersive model, in which a semi-microscopic optical potential takes a form $U = V_F + V_P +_i W + V_c$, [1] where the first term is the mean-field potential for the interaction of alpha-particle with ^{16}O nucleus calculated within the double-folding model with allowance for exchange effects. The second term is the real part of the phenomenological dynamical polarization potential (dispersive correction) (DPP). The third term is its imaginary part, which includes the volume W(E) and the surface W_D(E) components that are represented by, respectively, the Woods–Saxon form and its derivative. The last term is the Coulomb potential of the uniformly charged sphere. The mean-field potential was calculated using the M3Y model of effective nucleon–nucleon interactions in the BDM3Y1 version [2]. A normalized empirical charge density in a three-parameter modified Fermi form was used for alpha particle. For target nuclei, we used an empirical density model that was constructed on the basis of a global parametrization considered in [3]. The real and imaginary parts of the DPP are related by dispersion relations and can be chosen to be proportional using the scaling parameters. In the semi-microscopic optical potential [1], it is assumed that the depths of the imaginary potential and the scaling parameters for calculating the real part of DPP have an energy independence, which is controlled by, for example, the energy dependence of their volume integrals at fixed geometric parameters.

The data at $E_{\rm lab} = 49.5$, 69.5, and 80.7 MeV [1] were compared with the calculated (using computer code FRESCO [4]) differential cross sections for elastic α + ^{16}O scattering. The reasonable energy independence of the parameters were obtained based on the good description of the data. Likewise, the importance of using a phenomenological approach is to build an effective potential that depends on different parameterizations that allow to better describe the experimental data.

Likewise, the importance of using a phenomenological approach is to build an effective potential that depends on different parameterizations that allow to better describe the experimental data.

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8. **Luis E. Martínez[2], Jonathan Mendez[2], E. Andrade[2] and J. Ferrer[1]**

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Title: Experimental measurements of Si(p,p)Si and N(p,p)N differential cross section at 165°, 150° and 135° in the energy range 2.75-3.25 MeV.

Abstract: The lack of experimental measurements of the differential cross section for the elastic process Si(p,p)Si at 165° and the discrepancies between the measurements referred by Amirikas et al. [1], are the main motivation to provide new experimental data for the resonance in the 3.10 MeV. In the case of N(p,p)N no experimental data are found at 135° for the resonance around 3.20 MeV and difference data are reported experimentally by Jiang et al. [3] and Bogdanovic et al. [2] The experimental work was carried out in the universal line of the 3MV Tandem accelerator of "Centro Nacional de Aceleradores" (National Center of Accelerators, Seville, Spain) using a Passivated Implanted Planar Silicon (PIPS) detector, 100 µm thickness, and SiO_2 and Si_3N_4 thin films targets. The first target was deposited over a vitreous C substrate and the second one is a self-supported commercially available film used normally as window entrance in gas detector employed in the accelerator mass spectrometer. Both of them were covered with an Au layer deposited by evaporation to compare the Au(p,p)Au Rutherford cross section.

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9. **Javier Mas-Ruiz**

Instituto de Física, Universidad Nacional Autónoma de México (UNAM), Av. Universidad 3000. 04510, Cd. de México, México

Title: Proton elastic differential cross section measurement from aluminium for 135°-170° in 0.8-2.1 MeV energy range

Abstract: Cross section for elastic proton scattering in $^{27}Al(p,p)^{27}Al$ aluminium was measured for scattering angles of 135°, 140°, 145°, 150°, 155°, 160°, 165° and 170° in the energy range 0.8 MeV to 2.1 MeV (in the line of nuclear physics at LEMA). These recent results were congruent with previously measured data and reinforced some angular regions where there was little reported data, thus improving the statistics that can be used by databases such as IBANDL.

10. **Felipe G. Ortega-Gama**

William & Mary, USA

Title: **Transitions of two-hadron states: a measuring instrument for resonances**

Abstract: Much of the current understanding of the hadronic spectrum beyond the ground states of QCD relies on the extraction of the resonant content within scattering amplitudes. In order to achieve a more detailed characterization of these states we propose to analyze a more general set of amplitudes involving external electroweak insertions on top of the two-hadron states already present in the scattering amplitude. Access to these types of amplitudes can be achieved in certain experimental conditions, as well as in the numerical non-perturbative calculations of Lattice QCD. In this work we present an analysis of the analytical behavior of a couple of these amplitudes, $2 + J \to 2$, $1 + J \to J + 2$, where the number represents the number of hadrons, and J is a generic local current insertion. We will also include a review of the well-known behavior of elastic scattering, and photoproduction, i.e. $2 \to 2$, $1 + J \to 2$. The derivation of an analytic decomposition of these amplitudes allows to describe parametrizations that respect unitarity and causality; it also guides the formalism that must be realized to extract them from a finite volume calculation in Lattice QCD. Finally, to be able to rigorously extract the form factors that describe the structure of a resonance this analytic description is essential because they can only be accessed via an analytic continuation of the transition amplitude.

11. **Guadalupe Reza, J. Mas-Ruiz, A. O. Valdez-Guerrero, D. J. Marín-Lámbarri, L. Acosta, E. Andrade, A. Huerta, C. G. Méndez, M. Rodríguez-Ceja, C. Solís and E. Chávez**

Instituto de Física, Universidad Nacional Autónoma de México, Av. Universidad 3000, 0450 Mexico City, Mexico

Title: **The importance of the AMS technique in the measurement of cross-sections of interest in nuclear astrophysics: the case of ^{28}Si(d,α)^{26}Al reaction near to the Coulomb barrier**

Abstract: The Activation Followed by Accelerator Mass Spectrometry method (AFAMS) has become a valuable protocol to measure nuclear reaction cross sections [1]. Long-lived radioisotopes are produced by nuclear reactions induced mostly by accelerated charged particles or neutrons (activation). AMS offers then the best sensitivity available to count even a very small number of such products. In previous years, we attempted AFAMS to measure the ^{28}Si(d,α)^{26}Al reaction cross section at low energies [2-5]. The LEMA-IFUNAM (Laboratorio Nacional de Espectrometría de Masas con Aceleradores del Instituto de Física, Universidad Nacional Autónoma de México) was used to count the ^{26}Al ions produced in targets of $5\times5\times0.3$ mm^3 silicon wafers after irradiation with a deuteron beam from the EN-Tandem accelerator at ININ (Instituto Nacional de Investigaciones Nucleares) with energies between 3.4 and 4.8 MeV. Considering that the Coulomb repulsion energy for touching spheres for the ^{28}Si-^{2}H system is around 4.7 MeV, our experiment explores the energy interval below the barrier, which is the one of interest for stellar nucleosynthesis calculations. In this work we present a summary of our results, together with a brief review of the history and present state of the use of AFAMS in connection with stellar nucleosynthesis following [1].

This work has been partially funded by CONACYT-UNAM 271802, 280760, 299073, 299186, 294537 and DGAPAUNAM IA103218, IG101016, IG101120 and IG102023.

[1] Accelerator Mass Spectrometry, an ultrasensitive tool to measure cross sections for stellar nucleosynthesis. E. Chávez et al. NIM B 526 (2022) 77–82

[2] 26Al production: The Allende meteorite (Chihuahua)stellar nucleosynthesis and solar models. V. Araujo-Escalona et al. AIP Conf. Proc. 1671 (2015) 030003.

[3] The ^{28}Si(d,α) reaction. V. Araujo-Escalona et al. J. Phys. CS. 730 (2016) 012003

[4] Study of the ^{28}Si(d,α)^{26}Al nuclear reaction at low energies. V. Araujo-Escalona et al. Physics Procedia 90, 2017, 421 – 428

[5] Reaction production + AMS: An alternative method to study low energy reactions. 26Al as a test case. L. Acosta et al. EPJ Web of Conf 165, 01001 (2017)

12. **Jorge Luis Rodríguez Alejandre[1], V. R. Sharma[2] and N. Dasgupta-Schubert[1]**

1. Facultad de Ciencias Físico-Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Michoacán.

2. Instituto Nazionale de Física Nucleare, Laboratori Nazionali de Sud, Catania 95125, Italy.

Title: **Energy-resolution characterization of a Silicon Drift Detector for TXRF spectrometry**

Abstract: Since its invention in 1984, the steady improvement of the performance characteristics of the Silicon Drift Detector (SDD) has revolutionized X-ray and Electron spectrometry. Present-day applications have been extended to the deployment of large area SDDs in the CERN LHC ALICE experiment. Its principle advantages over the conventional Si(Li) or even the HPGe detector are its etter resolution at high countrates and low shaping times, the non-requirement of cryogenic temperatures for its operation and its superior performance in the low photon energy regimes. However, relatively few studies exist of the long-term tracking of its energy resolution, especially in the low energy domain where both electronic noise (EN) and incomplete charge collection (ICC) play significant roles in peak broadening. This work reports the detailed examination of the FWHM of a Bruker SDD over a 5 year time period. The SDD studied possesses the preferred tear-drop design with an integrated FET so that capacitive noise is significantly reduced. It is coupled to a Peltier cooler that maintains its temperature at around -19.8 °C. The detector area is 30 mm2 and its Be window is 8μm thick. We report the FWHM characterization at the 5.9 keV line of Mn as a function of time and its deconvolution into the contributions by the intrinsic, the EN and the ICC FWHMs. The FWHM of the EN peak was separately measured. The FWHM characteristics of the 5.9 keV line was studied in isolation and with the element in other chemical environments to observe possible variations derived from the vicinity of other trace elements. Further, the variation of the FWHM was studied as a function of x-ray energy in the range of 2 - 9 keV and the equation for the observed variation derived in the high energy and low energy regimes where the aforesaid contributions to the overall FWHM have different weightages. The Peak to Background (P/B) ratio of the x-ray lines with respect to energy was also analyzed. This ratio is a measure of the sensitivity of the spectrometer. The analyzed emission lines covered 5 periods of the periodic table of the elements. Additionally, the Bremsstrahlung background was quantified in an attempt to determine the total coherent scattered photon count. All measurements were made on factory supplied standards on quartz discs. The characterization of the SDD detector in this range of energies and chemical environments allows us to expand the diversity of applications of the TXRF technique and the detector based on the results obtained.

13. **Livia Regina Romero Martínez[1], C.J. Ramírez-Martínez[1], C. G. Méndez-García[2], S. Padilla[3] and C. Solís[4].**

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Title: **Optimization of BeO formation parameters for the measurement of ^{10}Be by AMS**

Abstract: ^{10}Be has been widely studied over the last years. Its potential as an environmental tracer and its applications in climate research, geology and astrophysics have generated great interest in multiple fields of science. The increased detection sensitivity offered by AMS has dramatically expanded the utility of ^{10}Be in natural samples by 4-5 orders of magnitude. In the last three decades, numerous ^{10}Be samples have been measured by AMS worldwide with a variety of applications. The chemical species most used in the measurement of ^{10}Be by AMS is beryllium oxide (BeO), which has been shown to offer the best currents and stability in the system. In this work we have studied and optimized several parameters used in the radiochemical procedure of BeO formation (variations in pH, variations in temperature and calcination time, use and proportions of carrier metals) to establish the best measurement conditions in the AMS system of the National Laboratory of Accelerator Mass Spectrometry (LEMA).

14. **Antonio Sebastian Rosado González**

BUAP, Puebla

Title: Relativistic density operators: Dirac dynamics, open quantum systems and non-standard neutrino interactions

Abstract: In the present work we propose the correct covariant density operator formalism for half spin particles as an extension of the standard Dirac equation. We discuss the possibility of extending said formalism to the description of relativistic open quantum systems yet we arrive at the unavoidable conclusion that this is simply unfeasible due to the nature of Lorentz symmetry, even so, we show how a Lindblad-type eq. can be recovered in the non-relativistic limit of our theory. Finally making use of the new formalism presented here we describe the time evolution of a beam of solar neutrinos and obtain certain constraints congruent with experimental measurements, on the intensity of possible non-standard interactions affecting the physics of flavour oscillation.

This work has been partially funded by CONACYT-UNAM 271802, 280760, 299073, 299186, 294537 and DGAPAUNAM IA103218 , IG101016 and IG101120.

15. **Sinhué Sandoval-Hipólito, A. Huerta, J. Mas-Ruiz, E. Andrade and E. Chávez**

Instituto de Física, Universidad Nacional Autónoma de México (UNAM), Av. Universidad 3000. 04510, Cd. de México, México

Title: **Isotopically pure targets of gases nobles for the study of double charge exchange nuclear reactions**

Abstract: Ion implanted targets is a relevant resource in nuclear physics research, specially when dealing with noble gases and the need for mono-isotopic targets. In this work, ^{127}I ions were implanted on a graphite target at an energy of 935 keV using the 1 MV tandem accelerator in the LEMA-IFUNAM ("Laboratorio de Espectrometría de Masas con Aceleradores del Instituto de Física UNAM"). The ^{127}I implantation was characterized using Rutherford Back Scattering (RBS) with beams of ^{1}H, ^{12}C and ^{28}Si at energies of 1635, 4035 and 5035 keV respectively. The idea of using ^{127}I ions, is its similarity with Xenon isotopes, some of which have been identified as strong candidates for the study of the double charge exchange reactions in the NUMEN project (NUclear Matrix Elements for the Neutrinoless double beta decay).

This work has been partially funded by CONACYT-UNAM 271802, 280760, 299073, 299186, 294537 and DGAPAUNAM IA103218 IG101016. Authors are indebted to Sergio Martínez Gonzales for his help preparing the cathodes, Diego Quiterio Vargas for his help preparing the targets, Roberto Gleason for his help in the beam alignment and Juan Carlos Pineda for his help in irradiating the samples.

16. **Omar Valdez, R. Gleason, R. Espejel, C. G. Puigvert-Angulo, C. Valencia, G. Reza, J. Mas-Ruiz, D. Belmont, S. Sandoval-Hipólito, A. B. Zunun-Torres and E. Chávez**

Instituto de Física, Universidad Nacional Autónoma de México (UNAM), Av. Universidad 04510, Cd. de México, México.

Title: **Analysis of surfaces with the new beams of the IFUNAM 5.5 MV Van de Graaff Accelerator**

Abstract: At the Physics Institute of the National Autonomous University of Mexico (IFUNAM) 5 low-energy electrostatic particle accelerators have been installed. One of the most iconic is the 5.5 MV Van de Graaff (VDG) accelerator that operates vertically and is one of 26 manufactured by the High Voltage Engineering Corporation (HVECO). At the end of 2017, the radio frequency (RF) ion source was severely damaged, due to the aging of its components coupled with a large discharge that destroyed several of the accelerator's power supplies. All damaged power supplies were redesigned, built, tested, and mounted on the accelerator. An exhaustive and complex process since several of these components were built at the end of the 60's and are difficult to find today.

This prompted the original ion source design to be modified to accommodate modern components. Between 2019 and 2020, through great teamwork, the ion source has been rebuilt and is in optimal operating condition. However, assembling and disassembling and exchanging so many parts required a series of tests to verify the operation of both the source and the accelerator itself. Align, calibrate, and adjust the necessary parameters to be able to put the accelerator in a position to deliver the necessary beams for the experiments. The first IBA characterization experiment consisted of three different samples: a platinum-coated silicon target (Si+Pt), a gold-coated silicon thin film (Al+Au) and a copper (Cu) sample. The thickness of the coating, as well as its elemental composition, were extracted. The composition of the Si+Pt plate was verified by X-ray energy dispersion spectrometry (EDS) analysis in a scanning electron microscope (SEM).

This work shows the results described above which were also included in an article published on August 11th 2021, in the Journal of Instrumentation, Volume 16. This work has been partially funded by CONACYT-UNAM 271802, 280760, 299073, 299186, 294537 and DGAPAUNAM IA103218, IG101016 and IG101120.

17. **Luis Roberto Valencia[1], G. Reza[1], L.E. Navarro[1], J. Méndez[1], R. Gleason[1], C. Valencia[1], J. Mas-Ruiz[1], R. Espejel[1], D. J. Marín-Lámbarri[2] and E. Chávez[1].**

1. Instituto de Física, UNAM, 04510 Coyoacán, Ciudad de México, México

2. Instituto de Ciencias Nucleares, UNAM, 04510 Coyoacán, Ciudad de México, México

Title: **Refurbishing of one of the largest single-ended electrostatic accelerators in the world**

Abstract: The CN model of the single-ended Van de Graaff accelerators manufactured by High Voltage Engineering Co. in the fifties were the largest accelerators at the time, and still today remain as the largest electrostatic single-ended accelerators ever constructed. In Mexico, at the "Physics Institute of the National Autonomous University" (IFUNAM), we have the second of the 26 accelerators of this model made. It started operation in Rice University in Texas, United States, in 1953. Since then, several upgrades and modifications have been made.

The RF-ion source was upgraded recently and most of what was done at the time was published in 2021 [1]. In this work we report on one last modification made the ion source that now allows the production of heavy ion beams. Of particular interest are beams of Noble Gases since these beams cannot be delivered by Tandem accelerators, as they use negative ions which cannot be produced with Noble Gases.

The preliminary list of beams already identified include: ^{1,2}H, ^{4}H, ^{12}C, ^{14}N, ^{16}O, ^{20,22}Ne and ^{40}Ar.

This work has been partially funded by CONACYT-UNAM 271802, 280760, 299073, 299186, 294537 and DGAPAUNAM IA103218, IG101016, IG101120.

[1] "Restoration of the radio frequency ion source of the 5.5MV CN-Van de Graaff accelerator at IFUNAM" C. G. Puigvert-Angulo et al. JINST 16(2021) T08013

44th Symposium on Nuclear Physics. Cocoyoc, Morelos, Mexico January 9th to 12th 2023

PRELIMINARY PROGRAM

Day	Monday Jan 9	Tuesday Jan 10	Wednesday Jan 11	Thursday Jan 12
	Chair	Session 3. R. Bijker	Session 7. P.O. Hess	Session 9. P. Amador
08:00 - 09:00		Breakfast	Breakfast	Breakfast
09:00 - 09:30		Christian Schubert	Vasilis Soukeras	Patrick O'Malley
09:30 - 10:00		Emmanuel Ortiz	Fabio Risitano	Alessia Di Pietro
10:00 - 10:30	Bus to Cocoyoc departing from Ritz "Centro Histórico"	Tochtli Yepez	Adrian Santana	Daniele Dell'Aquila
10:30 - 11:00		Tobias Beck	Martin Freer	Carlos Bertulani
11:00 - 11:30		Coffee break	Coffee break	Coffee break
	Chair	Session 4. E. Chávez	Session 8. T. Yepez	Session 10. E. Ortiz
11:30 - 12:00		Ani Aprahamian	Nabanita Dasgupta	Grant Mathews
12:00 - 12:30	Registration, Fee Payment, Hacienda Cocoyoc Check-in	Daniele Mengoni	Elí Aguilera	James DeBoer
12:30 - 13:00		Andreas Ekström	Marek Ploszajczak	Gianluca Pizzone
13:00 - 13:30		Gaute Hagen	Javier Valiente	Aurel Bulgac
13:30 - 15:30	LUNCH	LUNCH	LUNCH	LUNCH
Chair	Session 1. L. Acosta	Session 5. N. Dasgupta		
15:30 - 16:00	Homage to Mexican Senior colleagues who are no longer with us. E. Chávez, E. Peinado, M. Torres, L. Barrón-Palos	Efraín Chávez	FREE AFTERNOON	Bus to Mexico City
16:00 - 16:30		Leah Broussard		
16:30 - 17:00	Michael Wiescher	Libertad Barrón		
17:00 - 17:30	Andreas Best	Daniel Marín-Lambarri		
17:30 - 18:00	Coffee break	Coffee break		
Chair	Session 2. E. Aguilera	Session 6		
18:00 - 18:30	Luca Guardo	POSTERS SESSION		
18:30 - 19:00	Philip Adsley			
19:00 - 19:30	Diego Venegas			
19:30 - 20:00	Osvaldo Civitarese			
20:00 - 21:00	DINNER	DINNER	DINNER	
		DFN meeting		