SİVAS CUMHURİYET UNIVERSITY

XVII. INTERNATIONAL Conference on Nuclear Structure Properties

25-27 JUNE 2025

ABSTRACT BOOK

100. Yıl Cultural Center

https://nsp2025.cumhuriyet.edu.tr

17th International Conference on Nuclear Structure Properties

BOOK OF ABSTRACTS

2025

EDITORS

Prof. Dr. Serkan AKKOYUN
Prof. Dr. Mahmut BÖYÜKATA
Prof. Dr. Necla ÇAKMAK
Prof. Dr. Nihal BÜYÜKÇİZMECİ

ISBN: XXX-XXX-XXXX-XX-X

Published by Sivas Cumhuriyet University, July 2025

HONORARY COMMITTEE

Dr. Yılmaz ŞİMŞEK (Governor of Sivas)
Dr. Adem UZUN (Mayor of Sivas)
Prof. Dr. Ahmet ŞENGÖNÜL (Rector, Sivas Cumhuriyet University)
Prof. Dr. Salih Cem İNAN (Dean of Science Faculty, Sivas Cumhuriyet University)
Zeki ÖZDEMİR (Head of Sivas TSO)

ADVISORY COMMITTEE

Ali Ekber Kuliyev (The National Aviation Academy of Azerbaijan, Bakü, Azerbaijan)
Cevad Selam (Independent Researcher – retired from Muş Alparslan University, Muş, Türkiye)
Hasan Gümüş (Independent Researcher – retired from Ondokuz Mayıs University, Samsun, Türkiye)
İhsan Uluer (OSTIM Technical University, Ankara, Türkiye)
Saim Selvi (Independent Researcher – retired from Ege University, İzmir, Türkiye)
Saleh Sultansoy (TOBB University of Economics & Technology, Ankara, Türkiye)

ORGANIZING COMMITTEE

Serkan AKKOYUN - Chair (Sivas Cumhuriyet University, Türkiye)
Abdul MUNEEM (RIKEN, Japan)
Esra YÜKSEL (University of Surrey, UK)
Mahmut BÖYÜKATA (Kırıkkale University, Türkiye)
Necla ÇAKMAK (Karabük University, Türkiye)
Nihal BÜYÜKÇİZMECİ (Selçuk University, Türkiye)
Özge KILIÇOĞLU MEHMETCİK (Marmara University)

LOCAL ORGANIZING COMMITTEE

Derya Betül ÜNSAL ÇELİMLİ (Sivas Cumhuriyet University, Türkiye)
Emre Bahadır AL (Sivas Cumhuriyet University, Türkiye)
Savaş KAYA (Sivas Cumhuriyet University, Türkiye)
Sultan ERKAN (Sivas Cumhuriyet University, Türkiye)

SCIENTIFIC/REFEREE COMMITTEE

Abderrahmane YAKHELEF (Setif, Algeria)
Abdullah AYDIN (Kırıkkale, Türkiye)
Adam MAJ (Kraków, Poland)
Ahmet Hakan YILMAZ (Trabzon, Türkiye)
Aybaba HANÇERLİOĞULLARI (Kastamonu, Türkiye)
Bahadır SAYGI (Ankara, Türkiye)
Bülent YILMAZ (Ankara, Türkiye)
Cafer Mert YEŞİLKANAT (Artvin, Türkiye)
Dennis BONATSOS (Demokritos, Greece)
Dimiter BALABANSKI (ELI-NP, Romania)
Ekber GULIYEV (Baku, Azerbaijan)
Emre TABAR (Sakarya, Türkiye)
Eyyüp TEL (Osmaniye, Türkiye)
Fatima BENRACHI (Constantine, Algeria)
Francesco CAPPUZZELLO (Catania, Italy)
Giacomo de ANGELIS (Padova, Italy)
Goran S RISTIC (Niš, Serbia)
Hakan YAKUT (Sakarya, Türkiye)
Hatice DURAN YILDIZ (Ankara, Türkiye)
Huseyn GULIYEV (Baku, Azerbaijan)
İlkay TÜRK ÇAKIR (Ankara, Türkiye)
İsmail BOZTOSUN (Antalya, Türkiye)
İsmail Hakkı SARPÜN (Antalya, Türkiye)
Jameel-Un NABI (Punjap, Pakistan)
Jose Jaiver VALIENTE-DOBON (Padova, Italy)
Kaan MANİSA (Kütahya, Türkiye)
Khusniddi K OLIMOV (Tashkent, Uzbekistan)
Mahmut BÖYÜKATA (Kirikkale, Türkiye)
Manuela CAVALLARO (Catania, Italy)
Mehmet ERDOĞAN (Konya, Türkiye)
Mohammadreza HADIZADEH (Ohio, USA)
Mustafa TOPAKSU (Adana, Türkiye)
Naima AMRANI (Setif, Algeria)
Necati ÇELİK (Gümüşhane, Türkiye)
Necla ÇAKMAK (Karabük, Türkiye)
Nihal BÜYÜKÇİZMECİ (Konya, Türkiye)
Osman YILMAZ (Ankara, Türkiye)
Ramzi MAALEJ (Sfax, Tunusia)
Recep AKKAYA (Sivas, Türkiye)
Rıdvan BALDIK (Zonguldak Türkiye)
Sefa ERTURK (Niğde, Türkiye)
Selçuk ŞİMŞEK (Sivas, Türkiye)
Serdar ÜNLÜ (Burdur, Türkiye)
Sultan Şahin BAL (Bitlis, Türkiye)
Şeref TURHAN (Kastamonu, Türkiye)
Takehiko SAITO (RIKEN, Japan)
Tuncay BAYRAM (Trabzon, Türkiye)

INVITED SPEAKERS

Abdelhamid BOULDJEDRI (University of Batna 1, Algeria)
Abdul MUNEEM (RIKEN, Japan)
Alberto CAMAIANI (University of Florence, Italy)
Aslı KUŞOĞLU (ELIGANT ELI-NP, Romania)
Dmitry TESTOV (ELIADE ELI-NP, Romania)
Emrah TIRAŞ (Erciyes University, Türkiye)
Haris DAPO (TARLA, Türkiye)
Jameel Un-NABI (University of Wah, Pakistan)
Necati ÇELİK (Gümüşhane University, Türkiye)
Par-Anders SÖDERSTRÖM (ELIGANT ELI-NP, Romania)
Paul STEVENSON (University of Surrey, UK)
Serdar ÜNLÜ (Burdur Mehmet Akif Ersoy University, Türkiye)
Sezgin AYDIN (Tarsus University, Türkiye)

ABOUT THE CONFERENCE

The NSP conference series is a technical event which focuses on advances in nuclear structure, astrophysics, nuclear reactions, nuclear energy, high energy physics, AI in nuclear physics and other related topics. The purpose of this conference series is to provide a platform for researchers, academicians, and practitioners to make them familiar with recent advances in nuclear sciences. The organization committee accepts a wide range of papers to encourage young and experienced researchers to present their work and the possibility of initiating mutual collaboration with internationally renowned researchers and experts of the relevant industries. The conference format comprises of multiple sessions and the selected works in these sessions are based on substantial and novel research. The series of events was initiated in 2004 at Anadolu University, Eskişehir / Türkiye. The following is a list of subsequent meetings in the series:

I. Workshop on Nuclear Structure Properties (NSP2004), Anadolu University, Eskişehir, Türkiye
II. Workshop on Nuclear Structure Properties (NSP2005), Anadolu University, Eskişehir, Türkiye
III. Workshop on Nuclear Structure Properties (NSP2006), Dumlupınar University, Kütahya, Türkiye
IV. Workshop on Nuclear Structure Properties (NSP2007), Gazi University, Ankara, Türkiye
V. Workshop on Nuclear Structure Properties (NSP2011), Muş Alparslan University, Muş, Türkiye
VI. International Workshop on Nuclear Structure Properties (NSP2013), Karabük University, Karabük, Türkiye
VII. International Workshop on Nuclear Structure Properties (NSP2014), Sinop University, Sinop, Türkiye
VIII. International Workshop on Nuclear Structure Properties (NSP2015), Sakarya University, Sakarya, Türkiye
IX. International Conference on Nuclear Structure Properties (NSP2016), Sivas Cumhuriyet University, Sivas, Türkiye
X. International Conference on Nuclear Structure Properties (NSP2017), Karabük University University, Karabük, Türkiye
XI. International Conference on Nuclear Structure Properties (NSP2018), Karadeniz Technical University, Trabzon, Türkiye
XII. International Conference on Nuclear Structure Properties (NSP2019), Bitlis Eren University, Bitlis, Türkiye
XIII. International Conference on Nuclear Structure Properties (NSP2020) it has been attributed to Covid-19.
XIV. International Conference on Nuclear Structure Properties (NSP2021) - online, Selçuk University, Konya, Türkiye
XV. International Conference on Nuclear Structure Properties (NSP2022), Kırıkkale University, Kırıkkale, Türkiye
XVI. International Conference on Nuclear Structure Properties (NSP2023) - online, Karabük University, Karabük, Türkiye

TOPICS

Nuclear Structure
Nuclear Scattering
Nuclear Analytical Methods
High Energy and Particle Physics
Nuclear Astrophysics
Nuclear Reactions
Nuclear Models
Medical and Health Physics
Radiation Measurements and Dosimeters
Nuclear Application in Life Science
Accelerator Physics
Artificial Intelligence in Nuclear Science
Other Related Topics

"The truest guide in life is knowledge and science"

Mustafa Kemal ATATÜRK

DAY 1 25 June 2025 Wednesday		
09:00 – 09:30	**REGISTRATION**	
09:30 – 10:30	**OPENING CEREMONY**	
Chair: Nihal Büyükçizmeci		
10:30 – 10:55	Paul Stevenson	Quantum Computing for Nuclear Structure
10:55 – 11:20	Abdelhamid Bouldjedri	Algebraic description of nuclear clustering in heavy nuclei
11:20 – 11:35	Eyyup Tel	Investigation of Ground State Nuclear Structure Features of ^{238}U nuclei Using Skyrme Hartree-Fock Method
11:35 – 11:50	Orhan Bayrak	Pocket Resonances in Antineutron–Nucleus Systems at Low Energies
12:00 – 13:00 LUNCH		
Chair: Paul Stevenson		
13:00 – 13:25	Haris Dapo	Current and future nuclear physics experimental stations at the Turkish Accelerator and Radiation Laboratory
13:25 – 13:50	Aslı Kuşoğlu	ELIFANT: First Results with a New Tool in Nuclear Spectroscopy
13:50 – 14:05	Serpil Yalçın Kuzu	Shielding Efficiency of Leaded Brass Reinforced Biopolymers Using GEANT4
14:05 – 14:20	Khusniddin Olimov	Energy and centrality dependencies of kinetic freeze-out parameters in high-energy p+Pb, Xe+Xe, and Pb+Pb collisions at the LHC
14:20 – 14:35	Khusniddin Olimov	Study of midrapidity transverse momentum distributions of the charged pions and kaons, protons and antiprotons in high-energy Pb+Pb collisions at the LHC using new combined Tsallis-Hagedorn function with transverse flow
14:35 – 15:00	**COFFEE BREAK**	
Chair: Abdelhamid Bouldjedri		
15:00 – 15:15	Mahmut Böyükata	Systematic Investigation for Nuclear Structure of Polonium Isotopes nearby Z=82 Shell
15:15 – 15:30	Lamia Aissaoui	Monopole interaction and structure evolution of pf shell in the isotopes of ^{48}Ca and ^{56}Ni
15:30 – 15:45	Halil Mutuk	Investigation of Thermal Conductivity and Radiation Shielding Properties of Cement Containing $BaSO_4$ and H_3BO_3
15:45 – 16:00	Halil Mutuk	Bottom-charmed diquarks in constituent quark model
16:00 – 16:30	**POSTER PRESENTATIONS**	
16:30 – 16:45	Sihem Berbache	Describing Bubble Nuclei Using Microscopic Models
16:45 – 17:00	Öznur Çakır	Magnetic Moments Of Triply Heavy Ωccb And Ωbbc Baryons in Quark Model
17:00 – 17:15	Yakup Emül	Optical Properties of a Two-Stage Oppositely Rotated Liquid Crystal Retarder System: A Monte Carlo and Mueller Matrix Study
17:15 – 17:30	Nitin Sharma	Study of odd-even staggering in the alpha decay of $^{207-216}Th$ isotopes
17:30 – 17:45	Cafer Mert Yeşilkanat	Modeling and Predicting Isomeric Yield Ratios in Nuclear Fission through Machine Learning Approaches
19:00 CONFERENCE DINNER		

DAY 2 26 June 2025 Thursday		
Chair: Necla Çakmak		
09:30 – 09:55	Jameel-un Nabi	Competition between neutron capture and β-decay rates for s-process nucleosynthesis
09:55 – 10:20	Serdar Ünlü	Nuclear Matrix Element For Two Neutrıno Double Beta Decay
10:20 – 10:35	Necla Çakmak	Investigation of Allowed GT and U1F Transition Strengths in Selected Cobalt Isotopes by pn-QRPA
10:35 – 10:50	**COFFEE BREAK**	
Chair: Jameel-un Nabi		
10:50 – 11:05	Mehmet DAĞ	Study of allowed F and GT transition strengths for some light nuclei by pn-QRPA
11:05 – 11:20	Elabssaoui Youssra	Nuclear structure studies close to shell closure N = 126 using quasiparticle-phonon plus rotor method
11:20 – 11:35	Şadiye Meral Çakmak	Exploring Spin-Isospin Excitations in Iron Isotopes: Gamow-Teller Transitions and Their Role in Nuclear Structure
11:35 – 11:50	Nadjet Laouet	Neutron rich odd In systems' nuclear structure properties
12:00 – 13:00 LUNCH		
Chair: Aslı Kuşoğlu		
13:00 – 13:25	Dmitry Testov	Implementation of ELIADE spectrometer at ELI-NP
13:25 – 13:50	Emrah Tıraş	Recent Advances in Particle and Neutrino Physics from the Erciyes Neutrino Research Group
13:50 – 14:05	Nihal Büyükçizmeci	Towards strange nucleus production mechanisms
14:05 – 15:00	**TURKISH FOLK DANCE SHOW**	
Chair: Haris Dapo		
15:00 – 15:15	Fatima Benrachi	Z=30 isotopes properties in the vicinity of ^{56}Ni core
15:15 – 15:30	Mohamed Fisli	Higgs Term Contribution to $e^+e^- \rightarrow l^-l$ in lhe Non-commutative Standard model
15:30 – 15:45	Hadjar Rezki	Particles Creation Phenomena in Non-Commutative Space-Time
15:45 – 16:00	Burcu Al	Theoretical Review of Nucleosenthesis and Energy Production Mechanisms in Black Holes
16:00 – 16:15	Murat Dağ	Neutron-induced fission cross section calculation for tungsten, tantalum, bismuth and lead nuclei using CEM03.03 and TALYS
16:15 – 16:30	**COFFEE BREAK**	
16:30 – 16:45	Kevser Hışıroğlu Ayar	Structural and Optoelectronic Characterization of Cu_3SbS_3 Thin Films for Radioluminescent Nuclear Battery Applications
16:45 – 17:00	Saleh Abubakar	Development of a Modular Gadolinium-Doped Water Cheren-kov Detector for Neutron Capture and Reactor Neutrino Studies
17:00 – 17:15	Merve Taş	Enhancing Neutrino Event Reconstruction with AI-based Photon Separation
17:15 – 17:30	Khalid Hadi Mahdi Aal-Shabeeb	Using Argon and Helium Cold Plasma Power in Etching the Nuclear Track Detector CR-39
17:30 – 17:45	Khalid Hadi Mahdi Aal-Shabeeb	Studying the effect of cold plasma on the etching process of the nuclear track detector CR-39
19:00 CONFERENCE DINNER		

DAY 3 27 June 2025 Friday		
Chair: Dmitry Testov		
09:30 – 09:55	Par-Anders Söderström	Nuclear level densities and photon strength functions at ELI-NP/IFIN-HH
09:55 – 10:20	Sezgin Aydın	Portable SPECT prototype for medical imaging
10:20 – 10:35	Omar El Bounagui	Dose deposited during a radiological examinations using Monte Carlo simulation
10:35 – 10:50	COFFEE BREAK	
10:50 – 11:05	Pınar Çölkesen	Aluminum-Free Sintering Strategies for High-Density SiC in Advanced Nuclear Systems
11:05 – 11:20	Halide Köklü	AI-Assisted Multi-Output Eigenvalue Prediction for the Radiative Transfer Equation with Anisotropic Scattering
11:20 – 11:35	Fahrettin Koyuncu	Early Theoretical Results on Electron Shielding Effects in Alpha Decay
11:35 – 11:50	Abir Boubir	Investigating the Ion Range and Stopping Power of Gold Ions in SiO_2 Thin Films under MeV SHI Irradiation
12:00 – 13:00 LUNCH		
Chair: Par-Anders Söderström		
13:00 – 13:25	Alberto Camaiani	Recent highlights from the INDRA and FAZIA experimental campaign at GANIL
13:25 – 13:50	Necati Çelik	Quantum-Enhanced Magnetic Field Sensing via Spin-Dependent Spatial Superpositions and its Possible Applications to Nuclear Physics Studies
13:50 – 14:05	Fatiha Kadem	Measurement of Natural Radioactivity and Dosimetry Assessment of U-238, Th-232, and K-40 in Tea Samples
14:05 – 14:20	Hasan Sansar	Calculating Half-lives of Proton Decays of Nuclei with Different Models
14:20 – 14:35	Sultan Şahin Bal	The Determination of Radon Activity Concentration Levels of Some Medicinal and Aromatic Plants (Bitlis, Turkey)
14:45 – 19:00	CITY TOUR WITH GUIDE	
19:30 GALA DINNER WITH MUSIC AND DANCE		

INDEX

ELIFANT: First Results with a New Tool in Nuclear Spectroscopy

Aslı Kuşoğlu on behalf of ELIFANT collaboration

Extreme Light Infrastructure – Nuclear Physics, Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering, 30 Reactorului Street, 077125 Magurele, Romania

asli.kusoglu@eli-np.ro

The structural effects in the lightest stable nuclei were the first to be studied experimentally by focusing on isospin mixing, properties of isospin multiplets, and α clustering. Recently, the existing experimental data for the γ decay of the stable N = Z doubly-odd nuclei and the β decay of the corresponding isospin multiplets were reviewed [1]. With the advances in ab initio many-body theories, there is renewed interest in the structure of these nuclei. For the first time in ^{10}B, the competing M1 and M3 transitions from the decay of the isobaric analog state have been observed in a γ spectroscopy experiment [2,3,4]. Understanding the radioactive-decay probability of the Hoyle state in ^{12}C is still controversial, and it is strongly desired to solve this puzzle by precise determination of the radiative-decay probability of the Hoyle state [5]. Previous measurements yield controversial results [6-8], therefore we have performed a γ-particle spectroscopy experiment to cross-check the result of Ref. [6] which differs by 3σ from the charged-particle spectroscopy measurements [7,8]. The measurement of the gamma-decay is an important tool to study the Iso-Vector Giant Dipole Resonance (IVGDR) built on excited states and also the low-energy tail of the GDR in stable and unstable nuclei, where structures, named Pygmy Dipole Resonance (PDR), are present at energies around the particle binding energy [9,10]. The GDR, where the maximum E1 strength is concentrated, is an ideal probe for looking for small effects in the isospin symmetric states in ^{72}Kr at low temperature through the γ decay of the GDR populated by fusion reactions [11]. To further understand the microscopic origin of the PDR and possible cancellation effects between isovector matrix elements, which appear to be strongly model-dependent, the neutron 1p-1h structure of the PDR via (d,pγ) reaction was studied at the N = 28, 50 neutron shells, as well as the Z = 28 proton shell nuclei. We have performed four experimental campaigns using, the Eli, IFin, And Tandem (ELIFANT) array, large-volume $LaBr_3$:Ce, and $CeBr_3$ placed in anti-Compton shields and having unprecedented efficiency and Compton suppression for high-energy γ rays [12]. It provided a unique opportunity to address all these open questions. In this talk, I will give an overview of the experiments performed with the ELIFANT array.

Keywords: Nuclear structure, M1 and M3 transitions, ELIFANT, GDR, PDR

[1] A. Kuşoğlu, D.L. Balabanski, Quantum Beam Sci., 7(3), 28 (2023)
[2] A. Kuşoğlu, et al., Nuovo Cim. C, 47, 47 (2024)
[3] A. Kuşoğlu, et al., Phys. Rev. Lett. 133, 072502 (2024)
[4] A. Kuşoğlu, Sci. Bull. 3303-3304 (2024)
[5] K. Sakanashi et al., Phys. Lett. B submitted (2025)
[6] T. Kibédi, et al., Phys. Rev. Lett. 125, 182701 (2020)
[7] M. Tsumura et al., Phys. Lett. B 817, 136238 (2021)
[8] Zifeng Luo et al., Phys. Rev. C 109, 025801 (2024)
[9] A. Zilges, D.L. Balabanski, J. Isaak, N. Pietralla, Prog. Part. Nucl. Phys., 122, 103903 (2022)
[10] A. Bracco et. al. Eur. Phys. J. A 55, 233 (2019)
[11] A. Giaz et al., Phys. Lett. B accepted (2025)
[12] S. Aogaki, et al., Nucl. Instrum. Methods Phys. Res. A, 1056, 168628 (2023)

Acknowledgment: This work was supported by the Romanian Ministry of Research and Innovation under research contract PN 23 21 01 06, and the ELI-RO program funded by the Institute of Atomic Physics, Măgurele, Romania, contract number ELI-RO/RDI/2024-002 CHIPHERS.

Algebraic description of nuclear clustering in heavy nuclei

Abdelhamid Bouldjedri

Batna 1 University, Department of physics, Batna, Algeria

abdelhamid.bouldjedri@univ-batna.dz

Clustering is a well-known phenomenon in light nuclei. Notably, nuclei such as ^{12}C and ^{16}O can be modeled as systems of interacting alpha particles. This behavior is largely attributed to the high binding energy of the helium nucleus. In heavier nuclei, clustering is more subtle, yet it has been experimentally confirmed since 2010. The earliest indications were associated with alpha decay, followed by observations of cluster decay. These findings led to the hypothesis of alpha clustering in heavy nuclei, originally proposed in 1982.

Using an analogy with diatomic molecules, the nuclear vibron U(4)⊗U(6) model was introduced by Daley and Iachello (1983-86). The aim of our group is to extend and develop this model. To that end, we first proposed an IBM-1 extension based on the U(10) algebra to describe systems containing zero and one alpha clusters. We then expanded the framework to include two-cluster configurations by employing the U(7)⊗U(6) and U(14) algebras. In a subsequent step, we introduced the IBM-2 version of these models. For the sake of completeness, we have also studied the effects of octupole and hexadecapole degrees of freedom.

Keywords: Nuclear clustering, heavy nuclei, vibron model, IBM-2

Recent highlights from the INDRA and FAZIA experimental campaign at GANIL

Alberto Camaiani

Department of Physics, Università degli Studi di Firenze and INFN Firenze, Firenze, Italy

alberto.camaiani@fi.infn.it

The FAZIA detector stepped into the scene in 2015 after a long R&D phase. Following an initial experimental campaign at INFN-LNL (IT) in FAZIA stand-alone mode, 12 FAZIA blocks have been installed at GANIL (FR) since 2018, coupled with the multi-detector INDRA. The INDRA+FAZIA setup enables a detailed exploration of reaction dynamics below 100 MeV/u, combining the large angular coverage of INDRA with the isotopic identification capabilities of FAZIA. In this contribution, we will highlight the main scientific cases explored so far during the GANIL phase, mainly dedicated to the investigation of the properties of nuclear matter far from standard conditions: symmetry energy of nuclear equation of state, composition of nuclear matter, and in-medium effects on nuclei properties.

Keywords: FAZIA, nuclear matter, nuclear equation of state

Competition between neutron capture and β-decay rates for s-process nucleosynthesis

Abdul Kabir[1], Abdul Muneem[2] and Jameel-Un Nabi[3]

[1]Department of Space Science, Institute of Space Technology, Islamabad 44000, Pakistan
[2]RIKEN Center for Advanced Photonics, Japan
[3]University of Wah, Quaid Avenue, Wah Cantt 47040, Punjab, Pakistan

jameel@uow.edu.pk

The stellar neutron capture and beta decay rates of Mo isotopes are investigated within the framework of the statistical code TALYS v1.96 and the proton neutron quasi particle random phase approximation (pn-QRPA) model. Both rates are calculated as a function of core temperature and density values. Particular attention is paid to the impact of thermally filled excited states in the decaying nuclei on electron emission and positron capture rates. We later compare the calculated neutron capture and beta decay rates under s-process conditions. It is found that neutron capture rates are bigger than the beta decay rates under s-process conditions. Our findings bear consequences for the s-process nucleosynthesis.

Keywords: Cross-section, TALYS, pn-QRPA, nuclear level density, decay rates, capture rates

Quantum Computing for Nuclear Structure

Paul Stevenson

School of Mathematics and Physics, University of Surrey, Guildford, GU2 7XH, U. K.

p.stevenson@surrey.ac.uk

Quantum computers are a fundamentally new technology which hold the promise of being able to solve some problems that current digital computers will never be able to solve practically due to the computational complexity involved. One such potential application of quantum computers is in the simulation of quantum systems, such as atoms, molecules or atomic nuclei. In this presentation we look at the first steps that have been taken in attacking nuclear physics problems with quantum computation, covering mainly nuclear structure problems. We show results calculated on the basic noisy quantum computers that are available today, as well as simulations of what may be possible in the next generations of fault-tolerant machines.

Keywords: Quantum computer, nuclear structure, fault-tolerant machines

Quantum-Enhanced Magnetic Field Sensing via Spin-Dependent Spatial Superpositions

Necati Çelik

Gümüşhane University, Faculty of Engineering and Natural Sciences, Department of Physics Engineering, Gümüşhane, Türkiye

necati.celik@gumushane.edu.tr

Precise magnetic field sensing is pivotal across quantum technologies, biomedical imaging, and fundamental physics. Classical methods, limited by shot-noise scaling ($\Delta B \propto 1/\sqrt{N}$), are outperformed by quantum protocols exploiting entanglement. However, practical challenges persist in maintaining coherence and mitigating noise. We propose a quantum metrology protocol leveraging spin-position entanglement to achieve sub-shot-noise sensitivity. A unitary coupling between a particle's spin Hamiltonian and momentum induces spin-dependent spatial displacements, encoding the magnetic field B into wavepacket superpositions. Interferometric reconstruction of phase differences between displaced states enables B-estimation with Heisenberg-limited precision. Quantum Fisher information analysis confirms $\Delta B \propto 1/N$ for N-entangled particles, surpassing classical $1/\sqrt{N}$ scaling.

For a spin-1/2 particle, the protocol achieves $\Delta B \geq 4\sigma/(kt\gamma\hbar)$, with k (coupling strength) and γ (gyromagnetic ratio) dictating sensitivity. Entangled N-particle GHZ states enhance this to $\Delta B \propto 1/N$ highlighting entanglement's critical role. Experimental feasibility is analysed for ultracold atoms and NV centres, balancing coherence times, spatial control, and technical constraints like wavepacket dispersion.

This framework bridges quantum theory and practical sensing, enabling nanoscale magnetometry and probing exotic quantum phases. By transducing spin eigenvalues into spatial interference, it offers a versatile pathway toward quantum-enhanced sensors, with extensions to multiparameter sensing and gravitational wave detection envisioned.

Keywords: Quantum metrology, Magnetic field sensing, Spin-position entanglement, Spatial superposition

Nuclear Matrix Element For Two Neutrino Double Beta Decay

Serdar Ünlü

Burdur Mehmet Akif Ersoy University Department of Physics, Burdur, Türkiye

serdarunlu@mehmetakif.edu.tr

The main interest in double beta decay is connected with the neutrinoless decay mode which is important to search a new physics beyond standard model. This decay mode provides a useful information about the fundamental properties of neutrino such as the right-handed leptonic current, the effective mass of neutrino. The investigation of two neutrino decay mode gives us an opportunity to test the nuclear model used to calculate the neutrinoless transitions. Especially, a theoretical description of the nuclear matrix element for two neutrino decay mode plays a key role in checking the validity of theories. The present work gives a theoretical prediction of the nuclear matrix element by using the proton-neutron quasi-particle random phase approximation with the effective interaction potential which is defined so that the broken spin-isospin symmetry is restored.

Keywords: Double beta decay, neutrinoless, standard model, nuclear matrix element

Current and future nuclear physics experimental stations at the Turkish Accelerator and Radiation Laboratory

H. Đapo[1], A. B. Bereketoğlu[1], A. Şahin[1], A. Öztürk[1], A. Hacisalihoğlu[2], B. Yildirimdemir[1], B. Gezer[1], C. Taner[1], C. Doğan[1], E. N. Cansiz[1], F. K. Işik[1], H. Vural[1], H. İ. Nalçak[1], H. Yildiz[1], İ. Tan[1], İ. E. Çolak[1], K. K. Şahbaz[1], M. Tamkaş[1,3], M. B. Gür[1], M. Özdemir[1], M. Z. Şentürk[1], M. Yüksel[1], M. Mutlu[1], N. Ergin[1], O. F. Demirtaş[1], Ö. Karsli[1], R. Tunç[1], R. Kuyrukcu[1], S. Aydinli[1], S. Çakmakoğlu[1], S.Sert[1], T. Olgun[1], Y. Küçük[1,4], Y. E. Yanar[1], Z. R. Öztürk[1]

[1]Turkish Accelerator and Radiation Laboratory, Ankara, TÜRKİYE
[2]Recep Tayyip Erdoğan University, Physics Department, Rize, TÜRKİYE
[3]Marmara University, Science Faculty, Physics Department, İstanbul, TÜRKİYE
[4]Akdeniz University, Department of Physics, Antalya, TÜRKİYE

harisdapo@gmail.com

The Turkish Accelerator and Radiation Laboratory (TARLA) is a user facility based on a superconducting linear accelerator designed to reach 40 MeV and 1.6 mA. Once fully finished TARLA will be equipped with two beamlines: one for bremsstrahlung, and the other for a free-electron laser. Currently, the first accelerating section, providing 20 MeV acceleration, is completed, while the second, for 40 MeV, is under construction. Out of the two beamlines the bremsstrahlung beamline is expected to be available first and start to serve Nuclear resonance fluorescence experiments as soon as available. This future nuclear physics experimental stations its design and intended use will be presented here. In addtion, the current status of the accelerator, project plans and beam application schedule will be presented. In the run-up to the full completion of TARLA a temporary experimental station utilizing the operational 20 MeV section for activation and other radiation physics experiments during a pause in the 40 MeV section's construction, status will also be presented. This is the current nuclear physics experimental stations as all of its compnents are ready and its assembly is set in the very near future. By employing a fast sample transfer system measurements of bremsstrahlung and decay properties of nuclei can be made by activation. Furthermore the station will be used for radiation physics experiments. For bremsstrahlung use a set of of activation measurements using 20 MeV bremsstrahlung is planed. These measurements aim at accelerator characterization by establishing the relationship to the generated bremsstrahlung, as well as for measurements of half-lifes of a few short lived nuclei as demonstrator of the sample transfer system capabilities. For accelerator characterization via bremsstrahlung properties activation of Copper (Cu), gold (Au), and tantalum (Ta) will be used, and for studying short lived nuclei Mg-23, S-31, Si-27 and others will be used. After transfer the irradiated samples will be counted using two pairs of CLOVER and single-crystal HPGe detectors with BGO active Compton suppression. The aim of this research will be to measure the energy transitions and half-lives of these isotopes as a test of the detector and transfer system capabilities. In addition, to presenting the status of the system we will also discus the opportunities for external use of this station.

Keywords: Superconducting linac, bremsstrahlung, activation, gamma-ray spectroscopy, radiation physics

Portable SPECT Prototype for Medical Imaging

Sezgin Aydın[1], Sefa Ertürk[2], Nuray Yavuzkanat[3], Taylan Yetkin[4] and Vakkas Bozkurt[5]

[1]Tarsus University, Engineering Faculty, Department of Natural Science, Tarsus, TURKEY
[2]Nigde Ömer Halisdemir University, Faculty of Medicine, Department of Biophysics, Nigde, TURKEY
[3]Bitlis Eren University, Science and Art Faculty, Department of Physics, Bitlis, TURKEY
[4]Istinye University, Faculty of Engineering and Natural Sciences, İstanbul, TURKEY
[5]Nigde Ömer Halisdemir University, Science and Art Faculty, Department of Physics, Nigde, TURKEY

sezginaydin@tarsus.edu.tr

Single-Photon Emission Computed Tomography (SPECT) is a widely used diagnostic tool in medical imaging. This study focuses on the design and performance evaluation of a novel portable SPECT device utilizing new scintillator materials, specifically GAGG(Ce) and BGO, coupled with Silicon Photomultipliers (SiPMs). We present imaging results obtained from phantoms injected with Technetium-99m (Tc-99m), a commonly used radioisotope in medical imaging. The study also investigates the enhancement of image sensitivity through the use of different collimators, including hexagonal and pinhole types. This presentation will detail the methodologies employed and the developmental stages of the prototype system, along with key findings from simulation and experimental measurements.

Keywords: SPECT, Portable imaging, GAGG(Ce), SiPM, Tc-99m, Collimator, Image processing

We acknowledge TUBITAK (121F264 project number) for their support.

Nuclear level densities and photon strength functions at ELI-NP/IFIN-HH

P.-A. Söderström

Extreme Light Infrastructure (ELI-NP), Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH), Str. Reactorului No. 30, 077125 Bucharest–Măgurele, Romania

par.anders@eli-np.ro

In this contribution we will discuss the possibilities to measure statistical properties of nuclei, nuclear level densities and photon strength functions, using the large volume LaBr3:Ce and CeBr3 scintillator detectors available at ELI-NP together with the light charged-particle beams available at the 9MV Tandem accelerator facility at IFIN-HH [1].

The nuclear level densities and the photon strength functions are two critical components for calculating nuclear reaction rates, especially neutron capture reactions. After the capture of a neutron on a nucleus with mass, the probability of the compound nucleus to remain depends directly of the probability to populate states below the neutron separation threshold via gamma decay and the number of the possible final states in this region. These reaction rates are, in turn, needed for our understanding of nuclear processes ranging from stellar nucleosynthesis to nuclear reactors.

These measurements have been undertaken at ELI-NP/IFIN-HH using a variety of methods involving inelastic proton scattering, and compared with complementary data from other facilities. In a first experiment in 2023, we measured photon-ray strength functions and nuclear level densities

of ^{112,114}Sn [2], and in a second (p, p'γ) scattering experiment in 2024, we have extracted the nuclear level density of ^{128}Te [3] where we compared the results to photonuclear data, resulting in nuclear level densities without intrinsic model dependencies from the constant temperature or Fermi gas models. Here we will give an overview of these measurements, the results, and future potential.

Keywords: Nuclear level densities, photon strength functions, pygmy dipole resonances

[1] S. Aogaki, et al. Nucl. Instrum. Methods Phys. Res. A 1056 (2023) 168628

[2] P.-A. Söderström, et al. Phys. Rev. C, in print

[3] P.-A. Söderström, et al. Phys. Scr. 100 (2025) 075301

This work was supported by the ELI-RO program funded by the Institute of Atomic Physics, Măgurele, Romania, contract number ELI-RO/RDI/2024-002 (CIPHERS) and the Romanian Ministry of Research and Innovation under research contract PN 23 21 01 06.

Implementation and status of ELIADE γ-ray spectrometer at ELI-NP

D.A. Testov[1], V. Lelasseux[1], A. Dhal[1], S. Aogaki[1], D.L. Balabanski[1], R. Donthi[1], P. Pârlea[1], T. Sebe[1,2,3]

[1] *Extreme Light Infrastructure - Nuclear Physics, IFIN-HH, Bucharest-Magurele, 077125, Romania*
[2] *Faculty of Physics, University of Bucharest, 405 Atomistilor Str., 077125, Bucharest-Magurele, Romania*
[3]*Doctoral School in Engineering and Applications of Lasers and Accelerators (SDIALA), National University for Science and Technology Politehnica Bucharest, 060042 Bucharest, Romania*

dmitry.testov@eli-np.ru

The ELIADE (ELI-NP Array of Detectors) gamma-ray spectrometer is installed at the Extreme Light Infrastructure - Nuclear Physics (ELI-NP) facility, part of IFIN-HH, Romania [1]. Designed for nuclear resonance fluorescence (NRF) studies [2], ELIADE will exploit high-brilliance γ-ray beams from the forthcoming VEGA (Variable Energy Gamma) system [3].

The spectrometer consists of 32 High-Purity Germanium (HPGe) crystals arranged into eight Clover-type segmented detectors, placed at 90° and 135° relative to the beam direction, and supplemented by four $CeBr_3$ scintillator detectors. All detectors are equipped with active anti-Compton shields to enhance spectral quality. A trigerless data acquisition is based on commercially available CAEN digitizes and is controlled by the in-house developed DELILA (Digital ELI-NP List-mode Acquisition) distributed data acquisition system.

The presentation will cover the status of ELIADE and will report on the performance of the Clover detectors across a broad energy range. Characterization has been carried out using standard gamma-ray calibration sources (121–3548 keV) and extended to higher energies (up to 9 MeV) via neutron capture reactions using in-house fabricated PuBeNi sources [4]. Advanced data processing techniques, including cross-talk correction, addback algorithms, and Compton suppression, have been implemented. Their impact on performance of ELIADE was investigated through both experimental data and comparison with full realistic GEANT4 simulations.

Keywords: Gamma-ray spectrometer, segmented clover detectors, HPGe detectors

[1] C.A. Ur et al., *Rom. Rep. Phys.* **68** (2016) S483
[2] A. Zilges et al., *Prog. Part. Nucl. Phys.* **122** (2022) 103903
[3] Variable Energy Gamma System at ELI-NP 2021; https://www.eli- np.ro/rd2_second.php/
[4] P.-A. Söderström et al., *Appl. Radiat. Isot.* **191** (2023) 110559

The authors would like to acknowledge the support of the Romanian Ministry of Research and Innovation under research contract PN 23 21 01 06.

Gamma Attenuation Properties Of $Li_2B_4O_7$ Doped With Gd

Hakan Eroğlu[1*], Sümeyye Gümüş Uzun[1], Mustafa Çağatay Tufan[1], Bayram Bilmez[2], Mevlüt Gürbüz[3], Bilgehan Cem Turhan[3]

[1]Ondokuz Mayis University, Graduate School, Department of Radiological Sciences, 55139 Atakum, Samsun
[2]Ondokuz Mayis University, Faculty of Sciences, Department of Physics, 55139 Atakum, Samsun
[3]Ondokuz Mayis University, Faculty of Engineering, Department of Mechanical Engineering, 55139 Atakum, Samsun

hakaneroglu55@gmail.com

In this study gamma attenuation properties of pure $Li_2B_4O_7$ and 1 % mol Gd doped $Li_2B_4O_7$ were investigated by using gamma spectrometry system with narrow beam geometry. Samples sere synthesized by solid state reaction method. In experimental studies; linear and mass attenuation coefficients were determined for 0.1218 MeV, 0.2447 MeV, 0.3443 MeV, 0.7789 MeV, 0.964 MeV and 1.408 MeV energy peaks of Eu-152. The atomic and electronic cross sections, effective atomic number and electron density, half value thickness (HVL), tenth value thickness (TVL) and mean free path (MFP) values were also calculated from these values. The obtained values were compared with XCOM values for theoretical data. It was found that Gd doping increased the attenuation coefficients in the low energy region, but its effects were limited at higher photon energies.

Keywords: Gamma attenuation coefficient, scintilation detector, NaI(Tl), lithium tetra borate, rare earth elements

Investigation of Ground State Nuclear Structure Features of ^{238}U By Using Skyrme Hartree-Fock Method

E. Tel[1], M.T. Amanvermez[1], M. Harputoğlu[1], A.Bülbül[2]

[1]Osmaniye Korkut Ata Uni., Fac. of Engineering and Natural Sciences, Dept. of Physics, Osmaniye, Turkiye
[2]Osmaniye Korkut Ata Uni., Osmaiye Vocational High School, Dept. of Electric and Energy Osmaniye, Turkiye

eyuptel@osmaniye.edu.tr

In this study, total binding energies per particle, root mean square (rms) nuclear charge radii, rms nuclear mass radii, rms nuclear proton and neutron radii and neutron skin thickness for ^{238}U nuclei were investigated by using Skyrme-Hartree-Fock (SHF) and Skyrme-Hartree-Fock-Bogolyubov with the relativistic mean field theory. We have investigated the best fitting Skyrme force parameters for total binding energies, total binding per particle energies and root mean square (rms) nuclear charge radii for experimental values. The calculated ground state features have compared with available experimental data and results. In this study, the obtained findings show that SHF and SHFB methods have very successful to explain the ground state features of ^{238}U nuclei. Also, these obtained results can be used for better understanding the nuclear structure of uranium isotopes and transuranium elements.

Keywords: ^{238}U, Skyrme Force, Hartree-Fock, RMS radii, Ground State, Binding Energie

Investigating the Ion Range and Stopping Power of Gold Ions in SiO2 Thin Films under MeV SHI Irradiation

Abir Boubir[1*], Sihem Berbache[1] and Rahma Belaabed[1]

[1]*Department of Physics, LRPRIM Laboratory, Batna 1 University, Batna, Algeria*

abir.boubir@univ-batna.dz

When a fast-moving charged particle, such as a gold (Au) ion, enters matter, it interacts with the target atoms and loses energy as it penetrates the material until it comes to rest. This energy loss is governed by two primary processes: electronic inelastic collisions, where energy is transferred to the target electrons, and nuclear elastic collisions, where energy is transferred to the atomic nuclei of the material. Both processes play significant roles in determining the ion range (how deep the ion penetrates) and the stopping power (the rate at which energy is lost during this process)[1]. In this study, we investigate the ion range and stopping power of gold ions in SiO2 thin films under MeV SHI irradiation using two established simulation tools: SRIM (Stopping and Range of Ions in Matter) [2] and TREKIS-3 (Transport of Reactive Ions in Solids) [2]. SRIM provides rapid and efficient predictions, making it ideal for identifying general trends, while TREKIS-3 offers a more detailed and adaptable framework, accommodating complex variables such as crystal structure and irradiation conditions. The results highlight the differences in the approaches of these tools and their respective suitability for various levels of analysis. This study contributes to a deeper understanding of ion-solid interactions, particularly in the context of material modifications and applications involving high-energy ion irradiation.

Keywords: Swift heavy ions, Ion range, Stopping power, Ion irradiation

[1]. Ziegler, J. F., Biersack, J. P., & Littmark, U. (2008). The Stopping and Range of Ions in Matter (SRIM). Pergamon Press.
[2]. Ziegler J.F., Biersack J.P., Littmark U., The stopping and range of ions in solids, Pergamon, New York, 1985; SRIM computer code, available at http://www.srim.org
[3]. N. A. Medvedev, R. A. Rymzhanov, A. E. Volkov, J. Phys. D. Appl. Phys. 48 (2015) 355303

Nuclear structure studies close to shell closure N = 126 using quasiparticle-phonon plus rotor method

Y.Elabssaoui[1], A. Khouaja[1], J. Inchaouh[1], M.K. Jammari[2], Z. Housni[1], O.Jdair[3], A. Morsad[1], H.Chakir[1], A.Kartouni[1], M.Fiak[1] and J.Dudek[4]

[1]*Department of Physics, LPMC-ERSA, Faculty of Sciences Ben M'Sik, Hassan II Casablanca University, Casablanca, Morocco
[2]*Department of Physics, Faculty of Sciences Ain chock, Hassan II Casablanca Ain chock University, Casablanca, Morocco
[3]* Department of Physics, Polydisciplinary Faculty, University Abdelmalek Essaadi, Larache, Morocco
[4]*Department of Physics and Ingenierie, University of Strasbourg, and the Institut Pluridisciplinaire Hubert Curien/IN2P3/CNRS, Strasbourg, France

yoelabssaoui@gmail.com

The analysis of the heavy and very heavy nuclei with, particularly, an extension into the domain of exotic and superheavy nuclei is in the center of the contemporary research in low energy subatomic physics. This research program, currently going on the biggest laboratories in the world, is motivated from the theoretical calculations which predict the existence of an island of stability for superheavy nuclei beyond Z = 82 for protons and N = 126 for neutrons. To study the structure of heavy and superheavy nuclei, we need to produce a handful of events and therefore provide a detailed spectroscopic data. Owing to the Key words extreme limit of current capabilities and weak production cross sections close to 1 nb, the structure of heavy and very heavy nuclei could help us to understand the structure and stability of superheavy nuclei since such shell properties may be a consequence of nuclear deformation.

Keywords: Nuclear Structure, Nuclear deformation, Exotic nuclei, QPRM method

Analyzing the Quantum phase transition of Te nuclear isotopes in the interacting boson model by using entanglement entropy

Amiri Narjes[1], Ghalehasadi Aydin[1], Ghapanvari Maryam[2]

[1]*University of Tabriz, Faculty of Physics, Tabriz, Iran*
[2]*Plasma and Nuclear Fusion Research School, Nuclear Science and Technology Research Institute, Tehran, Iran*

aidin.asadi@gmail.com

The quantum shape phase transition between spherical nuclei and the even and uniform gamma-unstable (U(5) - (O(6)) deformation has been studied in the framework of the Interaction Boson Model (IBM) for low-energy states, using the "entanglement entropy". Theoretical results showed that the minimum and maximum values of entanglement between bosons exist at the U(5) and O(6) limits, respectively. In order to confirm the theoretical results, we have calculated and analyzed the entanglement entropy of proton-neutron bosons in the tellurium isotopes (118-128Te). The results show that the entanglement entropy correctly describes the transition from U(5) to O(6) for the ground state.

Keywords: Quantum phase transition, Interaction Boson Model, Entanglement entropy, Tellurium isotope

Structural and Optoelectronic Characterization of Cu_3SbS_3 Thin Films for Radioluminescent Nuclear Battery Applications

Kevser Hışıroğlu Ayar[1], Orhan İçelli[1] and Özlem Yağcı[1]

[1]*Department of Physics, Faculty of Arts and Sciences, Yildiz Technical University, Istanbul, Turkey*

k.hisiroglu@gmail.com

Radioluminescent nuclear batteries rely on the conversion of ionizing radiation into visible light, which is subsequently converted into electrical energy by appropriate semiconductors. The development of radiation-tolerant semiconductors is essential for improving device efficiency and durability in such systems. In this study, Cu_3SbS_3 thin films were investigated for their potential use in radioluminescent nuclear battery systems. The samples were subjected to a total dose of 100Gy beta irradiation using a $^{90}Sr/^{90}Y$ source. The structural, morphological, and optoelectronic properties of the films were assessed through X-ray diffraction (XRD) measurements, scanning electron microscopy (SEM) imaging, current–voltage (I–V) measurements, and Raman spectroscopy measurements. After irradiation, observable modifications in crystallinity, surface morphology, and electrical response were detected. These findings support its potential suitability for use in radioluminescent systems, particularly in low-power nuclear energy applications.

Keywords: Cu_3SbS_3 thin films, beta irradiation, radioluminescent nuclear batteries, radiation effects, structural characterization, optoelectronic properties

AI-Assisted Multi-Output Eigenvalue Prediction for the Radiative Transfer Equation with Anisotropic Scattering

Halide Köklü

Igdir University, Vocational School of Health Services, Department of Medical Services and Techniques Iğdır, Turkey

halide.koklu@igdir.edu.tr

The discrete eigenvalues of the Radiative Transfer Equation (RTE) under anisotropic scattering conditions play a critical role in modelling neutron and photon transport in nuclear systems. Traditional spectral approaches such as the Legendre polynomial method (PN) provide highly accurate solutions but require substantial computational resources, particularly for high-order expansions and complex scattering phase functions like the Henyey-Greenstein (HG) model.

In this study, we present a novel artificial intelligence (AI)-based framework designed to predict multiple discrete eigenvalues of the RTE for a given set of physical parameters. Our approach focuses on the P_N method with order N=9, under HG scattering, where each input pair of single scattering albedo (ω) and asymmetry parameter (g) corresponds to five dominant eigenvalues. A comprehensive dataset is generated using Mathematica-based spectral solvers for systematically varied (ω,g) combinations. The resulting data is used to train and evaluate a multi-output regression model using machine learning techniques such as Random Forest Regressors and deep neural networks implemented in PyTorch.

The model demonstrates high predictive accuracy with minimal computational time, achieving a coefficient of determination (R^2) above 0.98 across all eigenvalue outputs. This performance indicates the model's capability to reproduce spectral results without iterative numerical procedures. Furthermore, the AI model retains physical consistency among eigenvalue sequences due to its multi-output structure.

The proposed framework not only accelerates eigenvalue-based RTE analyses but also enables efficient parametric studies, uncertainty quantification, and fast benchmarking in neutron transport applications. This study contributes an original AI-integrated predictive tool to the nuclear science domain, particularly suited for forward modelling tasks in shielding design, criticality safety, and nuclear diagnostics.

Keywords: Radiative Transfer Equation, Henyey-Greenstein Scattering, Multi-Output Regression, Artificial Intelligence in Nuclear Physics, Spectral Methods

Dose deposited during a radiological examinations using Monte Carlo simulation

O. El Basraoui, O. Qassimi, O. El Bounagui

LaMCScI, Faculty of Sciences, Mohammed V University in Rabat, Morocco

o.elbounagui@um5r.ac.ma

In this study, we have developed a program based on the Monte Carlo method to simulate the propagation of photons through living matter and subsequently calculate the absorbed dose taking into account the types of interactions of the photons with matter at lo energy. To complete this study, we adopted a cylindrical geometry to simulate the thorax of a child as a target organ by considering water as a material equivalent to biological tissues, and make a comparative study using the material composed of HCNO atoms. However, the results obtained by our program are in close agreement with the results given by the MCNP code.

Keywords: Absorbed dose, Photons, H_2O, Mote Carlo, MCNP code

Monopole interaction and structure evolution of pf shell in the isotopes of ^{48}Ca and ^{56}Ni

Lamia Aissaoui[1], Asma Ziri[1], Soumia Benchia[1]

[1] *Physics of Radiation and their Interactions with Matter laboratory (PRIMLAB), University of Batna 1, Allées de 19 mai, Route de Biskra 05000 Batna, Algeria*

aissaouilamia@yahoo.fr

The nuclear structure of the nuclei with model space pf has been well studied experimentally near the stability line. In this study, we highlight the monopole interaction resulting from the interaction of the magic core with valence neutrons, emphasizing its importance in understanding the nuclear structure evolution of neutron-rich calcium isotopes ^{48}Ca and nickel isotopes ^{56}Ni. We conducted spectroscopic calculations, including excitation energies and reduced probabilities of electric transitions, using the nuclear structure code NuShell [1]. We introduce some modifications using the monopole neutron-neutron interaction in the interaction, ho [2], for the ^{48}Ca region, and in the interaction, jj44pna [3], for the ^{56}Ni region. These adjustments resulted in two new interactions called hom and jj44am. The results obtained from spectroscopic calculations show significant improvements in the accuracy of theoretical predictions compared to the available experimental data. This study enhances our understanding of shell structure evolution within the *pf* model space and helps predict new sub-closure shells.

Keywords: pf Shell, monopole interaction, code NuShell

[1] Brown, B. A., & Rae, W. D. M. The shell-model code NuShellX@ MSU, *Nuclear data sheets*. 2014;120:115-118. doi: 10.1016/j.nds.2014.07.022
[2] Horie, H., & Ogawa, K. Effective Proton-Neutron Interaction and Spectroscopy of the Nuclei with *N*=29. *Progress of theoretical physics*. 1971;46:439-461. doi.org/10.1143/PTP.46.439
[3] Lisetskiy, A. F., Brown, B. A., Horoi, M., & Grawe, H. New *T*=1 effective interactions for the $f_{5/2}\,p_{3/2}\,p_{1/2}\,g_{9/2}$ model space: Implications for valence-mirror symmetry and seniority isomers, *Physical revie*. 2004;C70:044314-044318. doi: 10.1103/PhysRevC.70.044314

Neutron rich odd In systems' nuclear structure properties

N. Laouet[1] and F. Benrachi[1]

[1]*Laboratoire de Physique Mathématique et de Physique Subatomique (LPMPS), Physics Department, Constantine-1 Frères Mentouri University, 25017 Constantine-Algeria*

.

nadjet.laouet@umc.edu.dz

Due to instability nearby nucleon drip lines, study of systems therein is a challenging topic that have received great interest along the history of theoretical and experimental progress of nuclear structure [1]. The nuclear shell theory is one of the most promising theories that helps to understand nucleon-nucleon interaction and nuclear properties in such instable regions. Besides, interactions between nucleons in various orbits alter the shell structure, which may result in the emergence of new magic numbers. The consideration of this effect may offer the opportunity to predict some missed nuclear structure properties, in non-investigated systems. In order to reproduce the nuclear structure properties of odd-even neutron rich Z=49 isobars; we have performed some spectroscopic calculations, by means of NuShellX@MSU [2] nuclear structure code, using recent experimental single particle energies [3]. The two-body matrix elements (TBMEs) of the used effective interaction in ^{78}Ni core were deduced from those of *mkh* one in ^{132}*Sn* mass region [4]. Basing on the original interaction, the TBMEs are then modified taking into account the similarity effect and the monopole interaction [5] in ^{78}Ni to introduce *mkh78* new interaction [6]. The obtained results are then compared to the available experimental data.

Keywords: Z=49 neutron rich isotopes, Neutron drip line, Nuclear Structure Spectroscopy, NuShellX@MSU nuclear structure code, Gamma Decay

[1] Bohr, A., Mottelson, B., Nuclear Structure Volume I, 1998.
[2] B. A. Brown, B. A., Rae, W. D. M., Nucl. Data Sheets. 120 (2014), 115-118.
[3] https://www.nndc.bnl.gov
[4] B. A. Brown et al., Phys. Rev. C 71 (2005), 044317 1-5.
[5] T. Otsuka, A. Gade, O. Sorlin et al., Rev. Mod. Phys.92 (2020), 015002 1-52.
[6] N. Laouet and F. Benrachi, Unpublished work

Pocket Resonances in Antineutron–Nucleus Systems at Low Energies

Teck-Ghee Lee[1], Orhan Bayrak[2] and Cheuk-Yin Wong[3]

[1]*Department of Physics, Auburn University, Auburn, AL36849, USA*
[2]*Department of Physics, Akdeniz University, Antalya, 07070, Türkiye*
[3]*Physics Division, Oak Ridge National Laboratory, Oak Ridge, TN37831, USA*

bayrak@akdeniz.edu.tr

Experimental observations of oscillatory structures in both the elastic and annihilation cross-sections of the antineutron + nucleus reactions at low energies can be interpreted in terms of semiclassical analyses of the S-matrix. These oscillations are identified as *pocket resonances*, which originate from quasi-bound states localized within the potential pocket of the antineutron–nucleus optical potential. This behavior arises due to the interference between partial waves reflected from the interior of the potential pocket and those propagating beyond the barrier region, in close analogy to the nuclear Ramsauer effect. Furthermore, our analysis reveals that anomalous large-angle scattering (ALAS) is highly sensitive to the strength of the imaginary component of the optical potential, highlighting the critical role of absorption in shaping the angular distributions.

Keywords: Pocket resonances, S-matrix, ALAS

Machine learning for the prediction of recurrence after radiotherapy and immunotherapy in thyroid cancer: Identification of clinical and biological signatures

Fouzia Bouchelaghem[1], Badria Bouchelaghem[2], Samra Neheoua[3] and Syham Lias[4]

[1,3]Physics Department, Science Faculty, Mohamed Boudiaf University, Msila, 28000, Algeria
[2]Freelance Consultant in Software Development and Machine Learning, Paris, France
[4]University of Science and Technology Houari Boumediene BP 32 Bab Ezzouar, 16111. Algeria

fouzia.bouchelaghem@univ-msila.dz

Thyroid cancer recurrence remains a significant clinical concern despite standard treatments such as surgery followed by radiotherapy. This study aims to compare recurrence rates between patients treated with radiotherapy versus immunotherapy, with a focus on sex differences and biological hypotheses that may explain variability in treatment response. A cohort of over 5,000 thyroid cancer patients was analyzed, stratified by treatment type (radiotherapy or immunotherapy). Recurrence rates were calculated and cross-tabulated with sex. Further analysis explored treatment timing, potential biological influences such as hormone interactions, and adherence patterns. Recurrence after radiotherapy was notably higher than after immunotherapy, particularly among male patients (7.5% vs. 0%). The absence of recurrence in the immunotherapy group raises questions about selection bias, treatment indication severity, or a genuinely higher therapeutic efficacy. Additionally, sex-based differences in immune response and hormonal regulation may underlie this divergence. Immunotherapy shows promise as a potentially more favorable treatment option for select patients with thyroid cancer, possibly due to enhanced immune responsiveness or fewer systemic disruptions. Further investigations are warranted to validate these findings, explore sex-specific treatment strategies, and integrate biological markers into future clinical decision-making.

Keywords: Thyroid cancer recurrence, Machine learning, prediction of recurrence

Particles Creation Phenomena in Non-Commutative Space-Time

Hadjar Rezki, Slimane Zaim and Rahma Belaabed

University of Batna 1, Algeria

h.rezki94@gmail.com, hadjar.rezki@univ-batna1.dz

In this work, we explore particle creation phenomena within the framework of non-commutative space-time, where the structure of space-time itself deviates from classical commutativity. We examine how non-commutativity influences quantum field behavior and leads to novel effects in particle production. Using the Bogoliubov transformation method, we derive expressions for the number density of created particles. Our calculations highlight key deviations from standard commutative scenarios. The results offer deeper insight into quantum processes in early-universe cosmology and potential implications for quantum gravity. This study opens new avenues for understanding fundamental physics in non-commutative geometries.

Keywords: Particles creation, Bogoliubov transformation, Non-commutative space-time

Calculating Half-lives of Proton Decays of Nuclei with Different Models

H. Sansar, A. Soylu

Department of Physics, Niğde Ömer Halisdemir University, 51240, Niğde, Türkiye

hsansar@ohu.edu.tr

In this study, we have investigated the half-lives of proton decays for different nuclei with available experimental data. Modified Universal Decay Law (modified-UDL), including the isospin and shell effects, has been applied to estimate the experimental half-lives proton decays, as well as using various semi-empirical mass formulas. The parameters of semi-empirical formulas have been fitted using 44 experimental available data points. We have reduced root-mean-square (rms) deviation value for the modified-UDL in calculating proton decay half-lives. To better understand data and formulas, we have also used machine learning algorithms such as Random Forest as well. For future studies, we plan to focus on the theoretical background of the results and on using deep learning techniques for finding a pattern in proton decay half-lives.

Keywords: Proton radioactivity, half-lives, semi-empirical mass formulas

Pairing model and neural networks in nuclear structures

A. Jalili, Z. Saleki, A. X. Chen

Zhejiang Key Laboratory of Quantum State Control and Optical Field Manipulation, Department of Physics, Zhejiang Sci-Tech University, Hangzhou 310018, China

jalili@zstu.edu.cn

In this lecture, we present an integrative approach that combines the traditional nuclear pairing model with modern neural network methodologies to explore nuclear structures. The nuclear pairing interaction, a cornerstone of nuclear many-body theory, plays a critical role in describing collective phenomena such as superfluidity and even-odd mass staggering in finite nuclei. Recent advancements in artificial intelligence (AI), particularly in neural networks, provide a powerful framework for capturing nonlinear correlations and extrapolating physical observables with high accuracy.

We first revisit the foundational aspects of the pairing model and its analytical solvability in specific cases. Building upon this theoretical framework, we introduce data-driven techniques, focusing on the use of neural networks to enhance and complement the predictive capabilities of the nuclear models. Emphasis is placed on recent developments in machine learning (ML) applied to nuclear mass predictions, charge radii, and decay properties, highlighting the synergistic potential between physics-based models and learning algorithms.

Key references include the physically interpretable ML framework for nuclear masses [3], charge radius prediction using support vector regression [4], and beta-decay half-life estimations relevant to r-process nucleosynthesis [5]. These studies demonstrate how neural networks, when guided by physical insight, can significantly improve our understanding of complex nuclear systems. The lecture concludes by discussing ongoing efforts to embed nuclear symmetries and nuclear models directly into neural network architectures, aiming for interpretable and physically consistent AI models in nuclear theory.

Keywords: Nuclear pairing model, nuclear structure, neural network

[1] V. Vapnik, The Nature of Statistical Learning Theory (Springer Science and Business Media, 1999).
[2] Boehnlein, A. et al. Colloquium: Machine learning in nuclear physics. Reviews of Modern Physics 94, 031003 (2022).
[3] Mumpower, M., Sprouse, T., Lovell, A. and Mohan, A. Physically interpretable machine learning for nuclear masses. Physical Review C 106, L021301 (2022).
[4] Jalili, A. and Chen, A.-X. Prediction of ground state charge radius using support vector regression. New Journal of Physics 26, 103017 (2024).
[5] Jalili, A., Pan, F., Luo, Y. and Draayer, J. P. Nuclear beta-decay half-life predictions and r-process nucleosynthesis using machine learning models. Physical Review C 111, 034321 (2025).

Description of backbending in deformed Pt and Hg isotopic chains by using the SU(3) dynamical symmetry approach

Z. Jahangiri, H. Sabri

Department of Physics, University of Tabriz, Iran

z.jahangiri@tabrizu.ac.ir

The sudden changes in the variation of moment of inertia for different angular momentums are related to backbending phenomena. We considered the even –even nuclei of Pt and Hg isotopic chains as the candidates for deformed nuclei and describe the variations of their moments of inertia by using the experimental energy values of different levels up to $J^{\pi}>20^{+}$. We also, used the SU(3) dynamical symmetry of interacting boson model in order to calculate some high-spin levels which their experimental counterparts are not reported. Our results suggest the backbending for the moment of inertia of different levels in the ground band of energy for different nuclei of the considered isotopic chain. Also an obvious relation are observed between the half-lives of considered nuclei and also the experimental quadrupole deformation values of the ground states and the value of $E/J(J+1)$ ratios.

Keywords: Backbending, deformed nuclei, interacting boson model, ground band of energy, half-lives

Deformation studies in odd-A nuclei near A ~ 180 via lifetime measurements

S.K. Chamoli

Department of Physics and Astrophysics, University of Delhi, New Delhi-110007, India

skchamoli@physics.du.ac.in

The nuclei with Z < 82 and A < 190 have variety of deformed structures at high spins. The nuclei with Z~75 (e.g., Re, Ir, etc.) of this mass region have transitional character between the strongly deformed rare earth and the spherical lead nuclei. These nuclei have softness in their nuclear potential towards gamma degree of deformation, so classified as 'gamma-soft nuclei'. For these nuclei, the proton Fermi level lie close to the highly down sloping low Ω, high-j orbitals like πh9/2 and πi13/2 orbitals, intruding from above the Z = 82 shell closure and high-K orbitals like πh11/2 (K = 9/2) and πd5/2 (K = 5/2). The intruding orbitals have a tendency of drive the equilibrium nuclear shapes to high deformation values, whereas, the high-K orbitals are upsloping as a function of deformation in the Nilsson diagram (have positive slope) and therefore have a tendency to drive the nucleus to smaller deformations The presence of these different shape driving orbitals, along with softness of nuclear potential collectively makes the nuclear structure studies in this mass region more interesting. For nuclei with Z ~ 82 (e.g. Tl, Hg, Au, etc.), on the other hand, nuclear shape coexistence/ transition/ mixing is a well-known phenomenon. The evidences of shape coexistence are being reported in Au, Hg, Tl, Pb, Po nuclei of this mass regions [1, 2]. Understanding these multiple deformed structures and their existence at low excitation in the nuclei of this mass region has always engaged researchers
over the years.

Understanding the deformed structures essentially require, deformation measurements in the nuclei. In this respect the Coulomb excitation studies and lifetime measurements are important experimental tools as they provide a fair estimate of deformation values of various populated energy bands in a given nucleus. The Coulomb excitation, though provides the magnitude and sign of the reduced E2 matrix elements between the low-lying excited states in a unique way, but essentially needs prior and precise knowledge of lifetimes, branching and mixing ratios for the nucleus of interest. This information may not always available, so almost no credible spectroscopic quadrupole moments could be obtained via Coulomb excitation to firmly establish deformation systematics in this mass region [3,4]. Due to this reason, the nuclei of this mass region have mostly been targeted by lifetime measurements to established deformation. Looking at the importance of such measurements, here in India, we have initiated a program to study odd-A nuclei of this mass region via lifetime measurements. In the last 2-decades, a number of such measurements have been done by our group using the experimental facilities available at the IUAC, Delhi and interesting results have been obtained. My talk would not only focus on the major outcomes from these experiments, but would also help drawing an emerging systematics of deformed nuclear structure in this mass region.

Keywords: Deformed nuclei, gamma-soft nuclei, Coulomb excitation, lifetime measurement

1. J. Bonn, et al., Physics Letter B 38(5), 308 (1972).
2. I. Angeli, et al., Atomic and Nuclear Data Table 99, 69 (2013).
3. N. Bree, et al., Physical Review Letter 112, 162701 (2014)
4. Wrzosek-Lipska, et al., European Physics Journal A 55(8), 130 (2019).

Aluminum-Free Sintering Strategies for High-Density SiC in Advanced Nuclear Systems

Pınar Çölkesen

Nuclear Energy Research Institute, Turkish Energy, Nuclear and Mineral Research Agency

pinar.colkesen@tenmak.gov.tr

This study investigates the densification of silicon carbide (SiC) using aluminum-free sintering additives. Recognizing that alkaline earth and rare earth elements offer improved stability under neutron irradiation compared to conventional aluminum-based additives, various systems were evaluated. Thermodynamic simulations, based on Gibbs free energy calculations, predicted the compatibility of these additives with β-SiC, which was subsequently validated through hot-pressing experiments at 1750 °C and 20 MPa in an Ar atmosphere.

The findings indicate that while alkaline earth elements do not cause SiC decomposition, they remain ineffective as sintering additives due to limited densification (maximum ~77%). In contrast, rare earth additives facilitated substantial densification, with densities ranging from 70.6% to 99.2%, depending on the specific oxide system. The highest density (99.2%) was achieved with a combination of 2.5 wt.% Sc_2O_3 and 2.5 wt.% Y_2O_3, outperforming conventional Al_2O_3-based systems. The key factors for successful densification were identified as the uniform distribution of a low-viscosity liquid phase and the suppression of its vaporization during sintering.

Given the exceptional thermal stability, high strength, corrosion resistance, and low neutron activation of SiC, it is considered a strong candidate for next-generation nuclear reactor structural components. Enhancing SiC densification without aluminum-based additives is crucial for maintaining its radiation tolerance and ensuring the long-term performance of reactor materials under extreme operating conditions. This study provides important insights into developing high-density SiC materials tailored for advanced nuclear applications

Keywords: SiC, densification, Al-free sinterin additives, alkaline earth oxides, rare earth oxides

Theoretical Review Of Nucleosenthesis And Energy Production Mechanisms In Black Holes

Burcu Al

Tokat Gaziosmanpaşa University, Department of Physics, Tokat, Türkiye

burcu.al1219@gop.edu.tr

Nucleosynthesis in black holes, especially in accretion disks, has received considerable attention in the astrophysics community because of its implications for our understanding of element formation in the universe. For example, smaller black holes have been found to enhance the nucleosynthesis of lighter elements, especially those with atomic numbers less than Z = 40. The efficiency and type of nucleosynthesis that occurs in these accretion disks is strongly influenced by several physical parameters, including the mass of the black hole and the viscosity of the accretion disk itself. Mukhopadhyay and Chakrabarti (2000) investigated three different accretion flows and concluded that nucleosynthesis of certain chemical elements is possible depending on certain conditions outlined in their model. Moreover, research conducted by Chakrabarti et al. (1987) highlighted that in thick accretion disks, fundamental nucleosynthesis processes such as the proton-proton (PP) chain, the carbon-nitrogen-oxygen (CNO) cycle and the fast proton (rp) process can produce various elementary products in the core of the disk. This underscores the potential for significant nucleosynthesis activity in black hole environments. Other studies, such as Hu and Peng (2008), have provided more focused insights into transport-dominated accretion flows (ADAFs), revealing that in the vicinity of a black hole of about 10 M⨀ in size, a significant amount of isotopes such as 26Al, 51Cr, 53Mn and 55Fe can be synthesized with certain heating factors. All these findings suggest that black hole accretion disks are not only places of intense gravitational forces, but also dynamical environments capable of producing a variety of essential elements, thus contributing to our understanding of cosmic nucleosynthesis processes. One of the biggest questions now is whether energy can be produced from a black hole, which has incredible power. Black holes tear apart objects that enter their gravitational field with incredible force, right down to their atoms. So much so that the remaining atoms also disintegrate, releasing an incredible amount of energy. Some of this energy is absorbed by the black hole, while the rest is blown out into space. So, with so much energy being released from the black hole, the question arises as to why this energy is not being harnessed. In fact, it seems that the only thing that needs to be done is to collect this energy. However, this is not as possible as one might think. Because even the closest known black hole is 1,500 light years away from us. In other words, it is not possible to reach the nearest black hole with any source or method. 'So why is it still so mysterious despite all these studies and research? Besides all these; could a black hole be the key to an infinite energy for the universe?' In this study, answers to these questions will be sought.

Keywords: Black Hole, Nucleosynthesis, Energy Production, Infinite Energy, Energy Harvesting

Neutron-induced fission cross section calculation for tungsten, tantalum, bismuth and lead nuclei using CEM03.03 and TALYS

Murat Dağ

Vocational School of Health Services, Kırşehir Ahi Evran University, Kırşehir, TURKEY

muratdag@ahievran.edu.tr

Nuclear reaction data serve as essential inputs for improving theoretical models of nuclear interactions, understanding nuclear structure, and investigating the properties of nuclear matter. They support the development of accelerator-driven power generation and radioactive-waste transmutation systems, guide the design of shielding for both accelerators and spacecraft, and enable applications such as medical isotope production. In particular, accurate neutron-induced fission cross-section data over a wide range of neutron energies are essential not only for developing a new generation of nuclear reactors that reduce the challenges associated with nuclear waste storage but also for deepening our understanding of the fission process. Therefore, this work primarily focuses on neutron-induced fission cross sections in tungsten, tantalum, bismuth, and lead over the intermediate-to high-energy regime (20–1000 MeV).

Neutron-induced fission cross sections have been calculated using CEM03.03, the latest Cascade-Exciton Model, and TALYS 2.0, which integrates optical-model calculations with Hauser-Feshbach formalism and preequilibrium effects. Model-based calculations are then compared with one another as well as with experimental data from the literature and evaluated data libraries. This paper will guide future theoretical and experimental efforts in nuclear fission research, highlight the energy ranges where additional experimental measurements are needed, and identify areas where computational modeling of nuclear reactions needs improvement, thereby validating model accuracy.

Keywords: Neutron-induced fission, tungsten, tantalum, bismuth, lead, CEM03.03, TALYS

Development of a Modular Gadolinium-Doped Water Cherenkov Detector for Neutron Capture and Reactor Neutrino Studies

Saleh Abubakar[1*], Emrah Tiras[1,2], Burcu Kirezli[1], Mustafa Kandemir[3], Murat Akar[4] and Furkan Bilgin[5]

[1]Department of Physics, Erciyes University, Kayseri, Türkiye, 38030
[2]Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa, USA, 52241
[3]Department of Physics, Recep Tayyip Erdogan University, Rize, Türkiye, 53100
[4] Department of Mechatronics Engineering, Erciyes University, Kayseri, Türkiye, 38030
[5] Department of Computer Engineering, Erciyes University, Kayseri, Türkiye, 38030

salehbinabubakar@gmail.com

Despite being one of the most prevalent subatomic particles, second only to photons, relatively little is understood about the behavior and physical characteristics of neutrinos. These particles have weak interactions with matter, but because of the very limited nature of these interactions, they continue on their course, which is one of their puzzling characteristics. Nonetheless, neutrinos are extremely significant for the information they convey about their sources. Neutrino oscillations, or phase transitions, between neutrino types have been confirmed experimentally, indicating that these particles are not massless as the Standard Model predicts. As a result of this finding, neutrino physics is now being studied in greater detail and with greater interest. Particles like neutrons, protons, and muons that arise as byproducts of neutrino-nucleus interactions must be closely studied in order to replicate the energy of neutrinos and gather further data. While neutrino interactions frequently produce events containing a mixture of both charged and neutral particles, charged particle reproduction is typically a simpler process. This scenario emphasizes how crucial it is to precisely identify the neutron component that results from the contact in order to determine the neutrino energy. Thus, reliable neutron detection and experimental model development are essential for a better understanding of neutrino interactions. By using accurate measurements, our initiative seeks to remedy these inadequacies. This project's primary goal is to establish a controlled experimental setting that will improve our understanding of neutrino interactions and allow for more accurate measurements of them. In this regard, an AmBe point neutron source and a water Cherenkov detector loaded with gadolinium will be used for investigations. Fundamental information for a deeper comprehension of neutrino interactions with matter will be provided by the data gathered from these investigations. This project aims to be a pioneering study to capture neutrinos from the Akkuyu nuclear power plant, which is active in Türkiye. The development and testing of a water-based liquid scintillator (WbLS) is another aspect of the project. International neutrino investigations are intended to use this water-based scintillator. The initiative will be a valuable reference for neutrino physicists and seek to advance a more thorough and precise knowledge of neutrino interactions. A crucial basis for future studies in neutrino physics will be established by this effort.

Keywords: Gadolinium-Doped Water Cherenkov Detector, Neutron Capture, Reactor Neutrino Interaction, Water-based Liquid Scintillator (WbLS)

Early Theoretical Results on Electron Shielding Effects in Alpha Decay

F. Koyuncu[1*], A. Soylu[2], S. A. Alavi [3] and V. Dehghani[3]

[1]Burdur Mehmet Akif Ersoy University, Türkiye
[2]Niğde Ömer Halisdemir University, Türkiye
[3]University of Sistan & Baluchestan, Iran

fahrettinkoyuncu85@gmail.com

In this study, we investigated alpha decay of Californium isotopes using the Coulomb proximity potential model (CPPM) incorporating electron screening effects. We found that the lowest root-mean-square (rms) deviation corresponds to a relatively small screening radius, resulting in an electron density significantly higher than typical metallic values. Conversely, larger screening radii yielded electron densities that are more physically reasonable. As a future work we will focus on exploring a range of screening radii as well as other physical mechanisms influencing alpha decay, such as nuclear deformation, pairing effects, and preformation probability.

Keywords: Californium isotopes, alpha decay, electron shielding

Gamma attenuation properties of $SrTiO_3$ doped with Rb and Y

Sümeyye Gümüş Uzun[1], Hakan Eroğlu[1], Bayram Bilmez[2], Mustafa Çağatay Tufan[1], Mevlüt Gürbüz[3], Bilgehan Cem Turhan[3]

[1]*Ondokuz Mayis University, Graduate School, Department of Radiological Sciences, Samsun, Türkiye*
[2]*Ondokuz Mayis University, Faculty of Sciences, Department of Physics, Samsun, Türkiye*
[3]*Ondokuz Mayis University, Faculty of Engineering, Department of Mechanical Engineering, Samsun, Türkiye*

sumeyye-gumus@hotmail.com

In this study, an experimental and theoretical study was carried out to investigate the radiation shielding properties of Strontium Titanate ($SrTiO_3$) perovskite ceramic with 1% Rb and Y added. For this purpose, nanocrystal samples of $SrTiO_3$:Rb and Y were synthesized by solid state reaction method. The gamma attenuation properties of Rb and Y doped $SrTiO_3$ were investigated by using narrow beam geometry gamma spectrometry system. In this study, linear and mass attenuation coefficients were determined for 0.1218 MeV, 0.2447 MeV, 0.3443 MeV, 0.7789 MeV, 0.964 MeV, and 1.408 MeV energy peaks of Eu-152 and from these values, atomic and electronic cross sections, half value thickness (HVL), tenth value thickness (TVL) and mean free path (MFP) values were also calculated. The results were compared with WinXCOM values. It was found that Rb and Y doping increased the attenuation coefficients in the low energy region, but its effects were limited at higher photon energies. The same trend was observed for other calculated parameters such as HVL, TVL and MFP. It was found that SrTiO3 perovskite samples with 1% Rb and Y doping had high attenuation properties and had good potential for shielding and other dosimetric uses. In this study, effective atomic number (Zeff) and effective electron density (Neff), which are important parameters in gamma absorption, were also calculated and compared with experimental results.

Keywords: Gamma attenuation coefficient, Scintilation detector, NaI(Tl), Strontium Titanate, Rare earth elements

Measurement of Natural Radioactivity and Dosimetry Assessment of U-238, Th-232, and K-40 in Tea Samples

Fatiha Kadem, Duha Alfara, Romaissa Bensedira

USTHB, Faculté de Physique, Laboratoire SNIRM, B.P. 32, El-Alia, 16111, Bab Ezzouar, Algiers, Algeria

kademassiae@gmail.com

Tea is among the most widely consumed beverages globally, with major production in countries like China, India, and Kenya. This study focuses on the measurement of natural radioactivity levels in commercial tea samples using high-resolution gamma spectrometry. Specifically, the activity concentrations of Uranium-238 (^{238}U), Thorium-232 (^{232}Th), and Potassium-40 (^{40}K) were determined. Commercial tea samples of various types and origins were analyzed. Each 125 g tea box was dried, ground, and sieved to ensure uniform particle size before analysis. Measurements were conducted using a high-purity germanium (HPGe) detector with an energy resolution of 1.8 keV at 1332.5 keV (Co-60), and spectra were processed using Genie 2000 software. Detector efficiency was established through experimental calibration.

The results indicated that 40K exhibited the highest activity concentrations, ranging from (568.11 ± 45.66) to (822.73 ± 44.19) Bq·kg^{-1}, while 232Th ranged from (15.35 ± 6.65) to (37.88 ± 15.51) Bq·kg^{-1}. Lower levels of 238U were also observed. The elevated 40K levels are attributed to its significant uptake in plants due to physiological potassium pathways. Trace levels of 137Cs were detected in two samples.

Additionally, the study calculated the annual effective dose from ingestion, ranging from 0.23 to 0.34 mSv/year, indicating no significant radiological health risk to consumers. Radium equivalent activity values were within internationally accepted safety limits.

Keywords: Tea, Gamma spectrometry, Natural radioactivity, HPGe detector, Dosimetry

[1] Roberto Cruz da Silva et al., Radiological evaluation of Ra-226, Ra-228 and K-40 in tea samples: A comparative study of effective dose and cancer risk, Applied Radiation and Isotopes 165 (2020) 109326
[2] Gökmen, I. G., Birgül, O., Kence, A., & Gökmen, A. Chernobyl radioactivity in Turkish tea and its possible health consequences. Journal of Radioanalytical and Nuclear Chemistry, 198, 1995,p487.

Using Argon and Helium Cold Plasma Power in Etching the Nuclear Track Detector CR-39

Ferhat Bozduman[1], Wisam M. Abboosh[2], and Khalid Hadi Mahdi Aal-Shabeeb[2]

[1]Karabük University Faculty of Medicine Biophysics Department, Karabük 78050, Türkiye
[2]Karabük University Faculty of Science Physics Department, Karabük 78050, Türkiye

khalidaal-shabeeb@karabuk.edu.tr

In this study, we investigated the effect of cold plasma power on the number of tracks in the nuclear track detector CR-39 when it was etched. The CR-39 detectors were exposed to alpha particles emitted from a 241Am source with an activity of 1µci for 5 min. and then etched in a cold plasma etching system. The plasma power was 7W, voltage: 10kV, frequency: 10kHz, gas flow rate:4lt/min, working distance: 1- 2 cm. Parameters given above are the same for both gases (Argon and Helium). The number of tracks analysed using an optical microscope. Our results showed that the plasma power significantly affected the number of tracks for both gases. The number of tracks increased with increasing plasma power. We also found that the optimal conditions for Argon gas are obtaining a high track density (3944.773 tracks/mm2) at time 40 min for a distance of 3mm. Optimal conditions for Argon gas obtaining a high track density (5681.525 tracks/mm2) at time 40 min. for a distance of 3mm. The results show that the track density increases by increasing exposure time to the plasma until we get the maximum, then decreases, and track density increases with decreasing distance between the plasma and the detector. Results are important for optimising the cold plasma etching process of CR-39 detectors for various nuclear applications.

Keywords: CR-39, cold plasma, etching, detector

Studying the effect of cold plasma on the etching process of the nuclear track detector CR-39

Ferhat Bozduman[1], Mohammed K. Hussein [2], and Khalid Hadi Mahdi Aal-Shabeeb[2]

[1]*Karabük University Faculty of Medicine Biophysics Department, Karabük 78050, Türkiye*
[2]*Karabük University Faculty of Science Physics Department, Karabük 78050, Türkiye*

khalidaal-shabeeb@karabuk.edu.tr

In this work, cold plasma was used in the process of etching the polymeric detector CR-39. This detector is considered one of the important nuclear solid state detectors because it is used in many applications to measure the concentration of uranium, radon, and thoron in homes, soil, and food, in addition to many practical applications, such as its use to measure radiation doses. The detector used for detecting charged particles such as alpha particles, protons, and fission products, where the radiation works to disintegrate the polymer entanglement and break the bonds between the monomer, it passes to leave a track that is detected by using chemicals or using physical techniques such as electrochemical etching or using cold plasma. Therefore, the results recorded for using Argon plasma in etched the detectors. Radioactive source Americium-241 as the first group and Radium-226 as the second group, which emits alpha particles with different energy 5.485 and 4.485 MeV respectively. The results showed almost the same behavior, and this is confirmed by calculation the correlation coefficient, which showed that most of the etching cases are subject to a fifth-degree polynomial equation, also shown by the correlation coefficient of the results Plasma etching with chemical etching results were high, ranged 0.63 to 0.70. This means that we can rely on the plasma etching results and use the correlation process by choosing the most appropriate etching conditions, which showed a decrease in the number of tracks with increasing distance and reaching the maximum value of the curve at time of 40 and 30 minutes for the first and second groups respectively.

Keywords: CR-39, cold plasma, etching, detector

Higgs Term Contribution to e $^{+}$e^{-} −→ $l\bar{l}$ in The Non-commutative Standard Model

Mohamed Fisli

ENSET SKIKDA, Algeria

m.fisli@enset-skikda.dz

Non-commutative scale parameter Λ_{NC} is a fundamental constant, which characterizes the threshold where non-commutative effects become relevent, its role can be compared to that of ~ in conventional quantum mechanics. This work aims to obtain a constraints on this parameter based on the effects du to space-time non-commutativity occurring in leptons pair production in the process e $^{+}$e^{-} −→ $l\bar{l}$ (l= τ, μ) where the electron and positron beams are polarized. This work is an extension of the previous one [1]. This time we take into account the pair production resulting from Higgs boson exchange, which we considered negligible in the previous work. The total crossection and the angular distrubition of the final state are presented at tree level QED calculation and up to the second order in non-commutative parametters $\theta_{\mu\nu}$. Finally we get a new constraint on Λ_{NC}. The center of mass energy ($\sqrt{s}$) is considered to be in the range 300 − 500 GeV and we take into account the case of fully polarised $e^{+}e^{-}$ beams because these condition will take place at the future International linear collider (ILC), So our resiltus my be tested.

Keywords: Standard Model, Non-commtativity, Λ_{NC}, International Linear Collider

[1] M.FISLI, “lepton pair production in the noncommutative standard model with polarized e+e−beams”, Phys. Part. Nuclei Lett. 20, 1342(2023).

Study of allowed F and GT transition strengths for some light nuclei by pn-QRPA

Mehmet Dağ[1,2], Necla Çakmak[2]

[1]Karabük University, Department of Medical Services and Techniques, Vocational School of Health Services, Karabük, Türkiye
[2]Karabük University, Faculty of Sciences, Department of Physics, Karabük, Türkiye

mehmetdag@karabuk.edu.tr

In this study, the allowed Fermi (F) and Gamow-Teller (GT) transition properties of selected Si and Al isotopes were investigated by Pyatov Method (PM) and Schematic Model (SM) within the scope of proton-neutron Quasiparticle Random Phase Approximation (pn-QRPA). For the calculation of the beta (β) decay log*ft* values, both allowed F and GT transitions were considered in both the particle-hole (ph) and the particle-particle (pp) channels. Our calculations were based on the Woods-Saxon (WS) potential. The obtained log*ft* value was compared with the data in the literature and discussed.

Keywords: Fermi and Gamow-Teller transitions, pn-QRPA, Pyatov method, schematic model, Woods-Saxon potential

Investigation of Allowed GT and U1F Transition Strengths in Selected Cobalt Isotopes by pn-QRPA

Necla Çakmak[1], Mehmet Dağ[1,2]

[1]*Karabük University, Faculty of Sciences, Department of Physics, Karabük, Türkiye*
[2]*Karabük University, Department of Medical Services and Techniques, Vocational School of Health Services, Karabük, Türkiye*

neclac@karabuk.edu.tr

In this work, the beta (β)-decay rates of the ^{64,66,68}Co isotopes have been investigated using the proton-neutron quasi-particle random phase approximation (pn-QRPA). The calculations were performed within the framework of the Schematic Model (SM), employing a Woods-Saxon potential basis. For the calculation of the β-decay half-lives, both allowed Gamow-Teller (GT) and unique first-forbidden (U1F) transitions were considered in the particle-hole (ph) and the particle-particle (pp) channels. Comparison of the half-lives and log*ft* values is made with available experimental data and other theoretical calculations.

Keywords: Gamow-Teller, unique first forbidden, pn-QRPA, schematic model, Woods-Saxon potential

Enhancing Neutrino Event Reconstruction with AI-based Photon Separation

Merve Tas[1*], Emrah Tiras[2,3], Dilara Kizilkaya[4], M. Anil Yagiz[5], Mustafa Kandemir[6]

[1] *Artificial Intelligence and Big Data Application and Research Center, Erciyes University, Kayseri, 38030 Türkiye*
[2] *Department of Physics, Erciyes University, Kayseri, 38030 Türkiye*
[3] *Department of Physics and Astronomy, The University of Iowa, Iowa City, IA, 52242 USA*
[4] *Department of Computer Science, University of Iowa, Iowa City, Iowa, 52241 USA*
[5] *Department of Engineering and Natural Sciences, Kırıkkale University, Kırıkkale, 71450 Türkiye*
[6] *Department of Physics, Recep Tayyip Erdogan University, Rize, 53100 Türkiye*

mervetas@erciyes.edu.tr

In neutrino physics, the classification of Cherenkov and scintillation photons in water-based liquid scintillators (WbLS) plays a critical role. Accurate separation of these photon types is essential for reliable energy reconstruction, particle identification, and the effective discrimination of signal from background noise in neutrino interactions. While traditional approaches relying on predefined kinematic thresholds offer a basic means of photon discrimination, recent advancements in machine learning (ML) techniques have demonstrated significantly superior classification performance.
In this study, we conducted a comprehensive evaluation of multiple ML-based classification algorithms and benchmarked them against conventional rule-based methods. The analysis utilized a range of input features, including photon arrival times, energy levels, and the spatial coordinates of photomultiplier tubes (PMTs) within the detector geometry. Thirteen high-performing machine learning algorithms, chosen for their relevance and demonstrated effectiveness in related fields, were trained and evaluated. Among these, Random Forest, XGBoost, and LightGBM emerged as the most accurate models. These top-performing models were subsequently fine-tuned through hyperparameter optimization to further improve classification accuracy. Additionally, a stacked ensemble strategy combining the outputs of the three models yielded the highest overall performance, highlighting the potential of ensemble learning in photon-type discrimination tasks in neutrino experiments.

Keywords: Neutrino physics, Water-based liquid scintillator (WbLS), Photon classification, Machine learning, Ensemble learning, Cherenkov photons, Sintillation photons

Magnetic Moments Of Triply Heavy Ω_{ccb} AND Ω_{bbc} Baryons in quark model

Öznur Çakır, Halil Mutuk

[1] *Ondokuz Mayıs University, Faculty of Science, Department of Physics, Samsun, Türkiye*

22282852@stu.omu.edu.tr

Triply heavy baryons such as Ω_{ccb} and Ω_{bbc} serve as a crucial testing ground for understanding the dynamics of Quantum Chromodynamics (QCD) in the heavy quark sector. In this work, we calculate the magnetic moments of Ω_{ccb} and Ω_{bbc} baryons of spin-1/2 and spin-3/2 states using a nonrelativistic quark model framework. The model parameters are determined through a detailed fit procedure to the known mass spectrum of B_c mesons, ensuring consistency with heavy quark dynamics. This fitting approach enhances the predictive power of the model and enables more realistic estimates of the magnetic moments. The calculated values are compared with results from alternative theoretical models. Our findings highlight the sensitivity of electromagnetic observables to underlying quark dynamics and offer valuable theoretical input for potential future experimental investigations into triply heavy baryon systems.

Keywords: Triply heavy baryons, Ω_{ccb}, Ω_{bbc}, magnetic moment, quark model

Investigation of Thermal Conductivity and Radiation Shielding Properties of Cement Containing $BaSO_4$ and H_3BO_3

Tuğba Mutuk[1], Umutcan Yıldız[1], Halil Mutuk[2*]

[1]*Ondokuz Mayıs University, Faculty of Engineering, Department of Metallurgical and Materials Science, Samsun, Türkiye*
[2]*Ondokuz Mayıs University, Faculty of Science, Department of Physics, Samsun, Türkiye*

hmutuk@omu.edu.tr, tugba.isitan@omu.edu.tr

In this study, both thermal conductivity and radiation shieding properties of cement composites were investigated by adding barium sulfate ($BaSO_4$) and boric acid (H_3BO_3) to cement mixtures. Barium sulfate is quite effective in absorbing ionizing radiation types such as gamma and X-rays due to its high atomic number and density. Boric acid is particularly effective on neutron radiation. The combined use of these two substances can provide versatile protection against both photon and neutron radiation. In the study, boric acid reinforcement ratio of 5 w.t% was kept constant and $BaSO_4$ ratios were determined as 5 wt%, 10%, 15% and 20%. When the composites with additives were compared to the reference samples without additives, a decrease was observed in thermal conductivity values. Thus, it was seen that the low thermal conductivities of the additives affected the structure. Elemental mapping analyses were performed on the microstructure with scanning electron microscope (SEM-EDX). In addition, the radiation protection properties of the samples were examined with NaI detector.

Keywords: Cement mortar, Thermal conducticity, Radiation shielding

Study of odd-even staggering in the alpha decay of $^{207-216}$Th isotopes

Nitin Sharma and Manoj K. Sharma

Department of Physics and Materials Science, Thapar Institute of Engineering and Technology, Patiala-147004, India

nitin.sharma@thapar.edu

Alpha decay serves as a powerful tool for investigating the structural properties of atomic nuclei, providing crucial insights into nuclear shell effects, magic numbers, and nucleon correlations. By examining decay energies (Q-value) and half-lives, researchers can unravel fundamental aspects of nuclear stability and clustering phenomena. Recently, Yang et al. [1] experimentally identified new thorium isotopes, 207,208Th, and analyzed their alpha decay energies (Qα) in comparison with other Th isotopes. Their study revealed a distinct odd-even staggering (OES) pattern in nuclei with Z > 82 and N < 126, deviating from the traditionally assumed smooth trend in the decay energies. Beyond decay energy, alpha emission is governed by multiple factors, including preformation probability (P0), penetration probability (P) and assault frequency (υ0). In the present work, we have performed a systematic alpha decay analysis of 207-216Th isotopes using the preformed cluster model (PCM) [2, 3]. Our findings demonstrate that the observed odd-even effects in alpha decay energies are evident in the preformation and penetration probabilities as a function of neutron number of the daughter fragment. We have compared the calculated preformation probabilities with other theoretical approaches. The results provide deeper insights into nuclear pairing correlations, clustering effects, and their implications for alpha decay dynamics in medium-to-heavy nuclei, further contributing to the understanding of nuclear structure and stability aspects.

Keywords: Alpha Decay, Radioactivity, Preformation Probability, Half-lives, Preformed cluster model

1) H. B. Yang et al., Phys. Rev C 105, L051302 (2022).
2) N. Sharma and M. K Sharma, Phys. Rev C 106, 034608 (2022).
3) C. Jindal, N. Sharma and M. K Sharma, Chin. Phys. C 47, 104108 (2023).

Towards strange nucleus production mechanisms

Nihal Buyukcizmeci

1Department of Physics, Selcuk University, TR-42079 Konya, Türkiye

nihal@selcuk.edu.tr

Formation mechanisms of strange and egzotic nuclei are important to understand borders of three dimensional nuclear chart as theoretically and experimentally. In this study, it is proposed a new hybrid method by comparing of different nuclei/hypernuclei yields in same reactions to obtain new information about strange and egzotic nuclei in central nucleus-nucleus collisions at relativistic energies as theoretically. After the central collision of two nuclei, produced initial nucleons are produced with Ultra-relativistic Quantum Molecular Dynamic Model (UrQMD), hot primary clusters estimated via the method of clusterization of baryons (CB) afterwards processes are applied for de-excitation to final nuclei. The correlations of nuclei are investigated by comparing existing experimental data.

Keywords: Central nucleus-nucleus collisions, clusterization, strange nuclei

This research is supported by the TÜBİTAK 124N105 project.

A Novel Ponceau S-Based Chelating Hydrogel for Efficient Uranium Removal from Aqueous Media

Selçuk Şimşek[1], Zeynep Mine Şenol[2]

[1]*Sivas Cumhuriyet University, Faculty of Sciences, Department of Chemistry, 58140 Sivas, Türkiye*
[2]*Sivas Cumhuriyet University, Faculty of Health Sciences, Department of Nutrition and Diet, 58140 Sivas, Türkiye*

msenol@cumhuriyet.edu.tr

Over the past century, the rise in metal pollutants in the environment and wastewater has emerged as a critical concern due to their adverse impacts on human health and ecosystems [1]. Colored pollutants, which are extensively utilized across various industrial sectors, have increasingly posed serious health risks owing to their toxicity, initially accumulating in wastewater and subsequently propagating through aquatic ecosystems and the food chain [2]. Among the various treatment techniques, adsorption stands out as one of the most practical and cost-effective methods for the removal of metal contaminants. "In this study, a novel polymeric material incorporating a functional dye group was developed for the efficient removal of uranium from aqueous media. The polymer was synthesized by introducing Ponceau S (PS) dye into a hydrogel matrix via solution polymerization. The structural and morphological characteristics of the synthesized material were comprehensively examined using Fourier-transform infrared spectroscopy (FT-IR), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDX). The adsorption performance of the polymer was systematically evaluated under varying conditions, including pH, contact time, initial uranium concentration, and temperature. According to the Langmuir isotherm model, the maximum adsorption capacity was determined to be 0.0976 mol kg^{-1}, while the pseudo-second-order (PSO) kinetic model yielded a rate constant of 6.372 mol kg^{-1} min^{-}1. Thermodynamic analysis revealed an enthalpy change (ΔH°) of 4.02 kJ mol^{-1}, indicating an endothermic adsorption process accompanied by increases in entropy and enthalpy. These findings suggest that the PS-functionalized hydrogel presents a promising, sustainable, and effective adsorbent for environmental remediation applications, particularly in the treatment of uranium-contaminated wastewater.

Keywords: Uranyl, adsorption, ponceau S, wastewater treatment

Acknowledgements
The Sivas Cumhuriyet University Scientific Research Projects Commission partly supported the present study.

[1] L. Chen, J. Liu, W. Zhang, J. Zhou, D. Luo, Z. Li, Uranium (U) source, speciation, uptake, toxicity and bioremediation strategies in soil-plant system: A review, J. Hazard. Mater. 413 (2021). https://doi.org/10.1016/j.jhazmat.2021.125319.
[2] N. Rani, P. Singh, S. Kumar, P. Kumar, V. Bhankar, N. Kamra, K. Kumar, Recent advancement in nanomaterials for the detection and removal of uranium: A review, Environ. Res. 234 (2023). https://doi.org/10.1016/j.envres.2023.116536.

Shielding Efficiency of Leaded Brass Reinforced Biopolymers Using GEANT4

Mustafa Kaya[1], Serpil Yalçın Kuzu[1], Mustafa Ersin Pekdemir[2], Sibel Selçuk Pekdemir[2] and Hüseyin Bozdemir[1]

[1]*Department of Physics, Faculty of Science, Firat University, Elazig, Turkey*
[2]*Polymer and Biomaterials Research Laboratory, Department of Chemistry, Faculty of Science, Firat University, Elazig, Turkey*

skuzu@firat.edu.tr

This study presents a detailed investigation into the gamma radiation attenuation performance of biocomposite materials reinforced with leaded brass. Polylactic acid (PLA) and polyethylene glycol (PEG) were blended and doped with varying concentrations of leaded brass, an alloy primarily composed of copper (Cu), zinc (Zn), and lead (Pb), to evaluate their radiation shielding capabilities. Key attenuation parameters, including the mass attenuation coefficient (MAC), linear attenuation coefficient (LAC), half value layer (HVL), tenth value layer (TVL), and mean free path (MFP), were calculated using the GEANT4 Monte Carlo simulation framework across a wide range of photon energies. The findings support the potential use of leaded brass reinforced biopolymers as sustainable and effective alternatives to conventional radiation shielding materials. The study contributes to the advancement of eco-friendly shielding technologies suitable for applications in medical, industrial, and nuclear environments.

Keywords: Brass, biopolymers, radiation protection, polylactic acid (PLA), polyethylene glycol (PEG)

Systematic Investigation for Nuclear Structure of Polonium Isotopes nearby Z=82 Shell

Mahmut Böyükata[1] and Aysun Erduran[2]

[1]*Kırıkkale University, Faculty of Engineering and Natural Sciences, Physics Department, Kırıkkale, Türkiye*
[2]*Kırıkkale University, Graduate School of Natural and Applied Sciences, Physics Department, Kırıkkale, Türkiye*

boyukata@kku.edu.tr

We study on the some even-even Polonium (Po) isotopes nearby the Z=82 proton shell within the Interacting Boson Model-1 (IBM-1) in this study. The IBM-1 calculations have been systematically performed for the energy bands and electromagnetic properties along isotopic chain. The energy ratios of given isotopes were analyzed to see their dynamical symmetry behavior then the analysis were expanded for R_L ratios in the ground state band. The calculated low-lying energy levels and B(E) values are compared with the recent available experimental data. Moreover, the unknown data were also predicted for the given isotopes.

Keywords: Po isotopes, energy levels, B(E2) values, IBM-1 model, dynamical symmetry

Optical Properties of a Two-Stage Oppositely Rotated Liquid Crystal Retarder System: A Monte Carlo and Mueller Matrix Study

Yakup Emül

Sivas Cumhuriyet Üniversitesi, Sivas Turkiye

yakupemul@cumhuriyet.edu.tr

We present a computational study of a two-stage liquid crystal (LC) retarder system composed of oppositely rotated planar-aligned LC layers placed between three linear polarizers. The molecular orientations of the LC molecules (LCMs) are modeled using Monte Carlo (MC) simulations based on the Lebwohl–Lasher and Rapini–Papoular potentials. The resulting director configurations are used as input for Mueller matrix-based optical analysis to compute polarization-dependent transmittance across the visible spectrum. We systematically explore the effects of rotation angle, cell thickness, and wavelength on the system’s transmission characteristics. Particular attention is given to red (700 nm), green (546.1 nm), and blue (435.8 nm) light components, demonstrating polarization-sensitive spectral filtering and angular tunability. Our findings highlight the system’s potential for use in compact optical filters, RGB channel isolation, and polarization-sensitive imaging applications.

Keywords: Monte Carlo simulation, liquid crystal retarder, polarization optics, Mueller matrix, tunable optical filter, birefringence

Improved semi-empirical formula for (n, ^3He) reaction cross section at 14.6 MeV

Asma Ghezal[1], Samra Nehaoua[1] and Nouri Benaidja[2]

[1]Laboratory of Materials and Renewable Energy, Faculty of Science, Department of Physics, University of Msila, University Pole, Bordj Bou Arreridj, M'sila 28000, Algeria
[2]Common trunk, Faculty of technology, University of Msila, University pole, Bordj Bou Arreridj, M'sila 28000, Algeria

ghezal.asma@univ-msila.dz

A new semi-empirical formula has been developed to calculate the (n, ^3He) reaction cross-section at a neutron energy of 14.6 MeV, with the aim of improving prediction accuracy by incorporating the Q-value and asymmetry parameters. The formula is based on the exciton model, which describes the pre-equilibrium reaction mechanism. Experimental data from the literature were used to validate the formula and optimize its free parameters. The results show that the proposed formula provides a better fit to experimental data compared to previous models, especially at incident energies above 15 MeV. The model has also been extended to cover a wider energy range and validated using additional experimental data.

Keywords: (n, ^3He) function excitaion;; fusion reaction; ^3He reaction emission

Novel systematic for (n,d) reaction cross section at 14-15 MeV

Samra Nehaoua[1], Fouzia Bouchelaghem[1], Asma Ghezal[1] and Nouri Benaidja[2]

[1]*L aboratory of Materials and Renewable Energy, Faculty of Science, Department of Physics, University of Msila, University Pole, Bordj Bou Arreridj, M'sila 28000, Algeria*
[2]*Common trunk, Faculty of technology, University of Msila, University pole, Bordj Bou Arreridj, M'sila 28000, Algeria*

samra.nehaoua@univ-msila.dz

Few (n,d) measured cross section exists with heigh uncertainties for 20 elements 7 ≤ A ≤ 96. The difficulty of measure in nuclear reactor is the reason of this poor data. Therefore, the systematic (n,d) reaction cross section at 14–15 MeV neutron energy is used to reproduce measured data and predict unmeasured one. A new semi empirical formula for (n, d) nuclear reaction is proposed to calculate function excitation at 14-15 MeV, with three adjustable parameters this systematic proofs the contribution of pre-equilibrium deuterium particle emission. To check the formula's quality we compare obtained cross section with measured one. The formula obtained has a good fitting with lower values of Σ and χ^2.

Keywords: (n,d) cross section, (n, d) systematic, fusion reaction

Bottom-charmed diquarks in constituent quark model

Sinem Küçükyılmaz[1], Halil Mutuk[2]

[1]*Department of Physics, Ondokuz Mayıs University, Samsun, Türkiye*
[2]*Department of Physics, Ondokuz Mayıs University, Samsun, Türkiye*

24280455@stu.omu.edu.tr

Double-heavy quark systems, particularly those composed of a charm and a bottom quark (bc), are essential for deepening our understanding of exotic hadron structures and the non-perturbative dynamics of Quantum Chromodynamics (QCD). This work explores the mass spectra of bottom-charmed diquarks using a phenomenological model based on the Cornell potential. The interaction includes a linear confining term, a spin-spin coupling component, and a Coulomb-like term that accounts for short-range gluon exchange. The energy eigenvalues for spin-0 (S=0) and spin-1 (S=1) diquark configurations are computed by numerically solving Schrödinger equation in a non-relativistic framework. Model parameters are calibrated to reproduce known meson properties, enabling reliable predictions of both ground and excited states of the bc system. The results form a theoretical foundation for studying hadrons containing heavy diquark constituents. These predictions may provide valuable guidance for identifying bc-based states in precision experiments such as those at LHCb and Belle II.

Keywords: Exotic hadrons, bottom-charmed diquark, constituent quark model, mass spectrum, heavy quark dynamics

Comparıson Of Sbrt Virtual Treatment Plans Obtained With Different Collimators In The Cyberknife System In Partial Breast Irradiatıon: A Retrospective Study

Öznur Sarıbaş[1], Sibel Kahraman Çetintaş[2]

[1]Kocaeli Üniversitesi Fen Edebiyat Fakültesi Fizik Anabilim Dalı, Kocaeli.
[2]Bursa Uludağ Üniversitesi Tıp Fakültesi Radyasyon Onkolojisi Anabilim Dalı, Bursa

oznursaribass@gmail.com

It was aimed to compare target volume and critical organ doses using three different collimators in the Cyberknife system in accelerated partial breast irradiation in patients with early stage breast cancer. Three different virtual plans were made with Iris, multi-leaf collimator and fixed collimator for the Cyberknife system from the computed tomography sections of 5 patients who received radiotherapy with the diagnosis of early-stage breast cancer. Virtual plans were made by defining target volumes CTV and GTV in the tumor cavity, with a daily 6 Gy total of 30 Gy. NSABP-39 / RTOG 0413 protocol restrictions were taken into account in the plans to protect critical organs and ensure that the target volume receives 95% of the prescribed dose. The prescribed dose was defined on a minimum 80% isodose curve, and the homogeneity index, conformity index, treatment time, monitor unit and doses received by critical organs were compared. Monitor unit (7161,3) and treatment time (25 min) were found in the lowest multi-leaf collimator. It was determined that the multi-leaf collimator was superior to the other collimators. (Monitor unit for iris (19736.2), treatment time (47.6 min), monitor unit for fixed collimator (20267.3), treatment time (52.2 min)) V_{30Gy} (10.9 Gy) and V_{15Gy} (21.95 Gy) values were found in the lowest multi-leaf collimator. There was no significant difference between the maximum dose values for lung and heart ($p > 0.05$).The defined CTV received the desired dose in each collimator. Although there was no significance value, it was determined that the contralateral breast and contralateral lung doses were the lowest in the Iris collimator, and the heart doses were the lowest in the fixed collimator. Since the use of fixed collimator, treatment time (52.2 min) and monitor unit (20267.3) value is high, it would be more appropriate to evaluate on a patient basis when planning breast radiotherapy. The same dose of volume wrapping is obtained with multi-leaf collimator in patients who do not maintain its stability for a long time. If patient stability can be achieved in patients who require high-risk heart and lung protection, Iris collimator can be tried.

Keywords: APBI, Breast cancer, Collimator, CyberKnife

A Retrospective Dosımetric Comparison Of Volumetric Arc Therapy (VMAT) And Intensity Adjustable Radiotherapy (IMRT) Plans Of Patients Receiving Whole-Brain Radiotherapy With Hıpocampus Sparing

Öznur Sarıbaş[1], Sibel Kahraman Çetintaş[2]

[1]Kocaeli Üniversitesi Fen Edebiyat Fakültesi Fizik Anabilim Dalı, Kocaeli
[2]Bursa Uludağ Üniversitesi Tıp Fakültesi Radyasyon Onkolojisi Anabilim Dalı, Bursa

oznursaribass@gmail.com

Whole brain radiotherapy (WBRT) has been the treatment of choice for patients with brain metastases. However, changes/decreases in neurocognitive functions (NCFs) resulting from impaired hippocampal neurogenesis may occur after WBRT. The hippocampus is responsible for memory and cognitive function. It is thought that conformally sparing the hippocampus during whole-brain radiation therapy will protect NCFs. Hippocampus-sparing WBRT (HS-WBRT) is a strategy that aims to reduce the neuro-cognitive side effects of whole-brain radiotherapy treatment by sparing the hippocampus while delivering the prescribed dose to the rest of the brain. In this study, dosimetric comparisons were made by making virtual treatment plans with VMAT and IMRT treatment planning systems, with hippocampus-sparing whole-brain radiotherapy technique in 10 patients with brain metastases who received radiation therapy. Archival data of 10 patients with brain metastases who were treated in Uludağ University Faculty of Medicine, Department of Radiation Oncology were obtained retrospectively. In the plans made, a dose of 30 Gy was determined to be given in 10 fractions. Contours of the whole brain, hippocampus, lens, orbit, optic nerve, cochlea, parotid, lacrimal, optic chiasm, pituitary, hypothalamus, mandible, and brain stem were made for virtual plans. PTV was created by subtracting the target brain volume from the whole brain volume by giving a 5 mm margin to the hippocampus. In the plans, attention was paid to ensure that the isodose covers 95% of the target volume and that the critical organs receive doses within the specified limits. Statistical analysis was performed using SPSS program, Mann Whitney U test and Independent Simples T test. As a result, there was a significant difference in dosimetric comparisons of PTV, hippocampus, lens, optic nerve, optic chiasm, while no significant difference was found for brainstem. Although the brain stem was found to be lower in the VMAT technique, no statistical significance was found between the two different treatment techniques

Keywords: Hippocampus sparing whole brain radiotherapy, IMRT, VMAT

Investigations Of The Ground-State Magnetic Moments Of The Odd-Mass $^{153-179}$Yb Isotopes

Öznur Sarıbaş

Kocaeli Üniversitesi Fen Edebiyat Fakültesi Fizik Anabilim Dalı, Kocaeli, Türkiye

oznursaribass@gmail.com

In this thesis, the ground state magnetic properties and magnetic dipole excitations of the single A 153-179Yb deformed nuclei located in the rare earth region of the periodic table were theoretically investigated for this first time in tha framework of QPNM (Quasiparticle Phonon Nuclear Model). K=1/2 is calculated in a core by the QPNM method. The theoretical values of the ground state magnetic properties such as intrinsic magnetic moment (gK), effective spin gyromagnetic factor (gs eff.) and magwntic moment (μ) were compared with the available experimental data and the spin-spin interaction parameter was determined for each nuclei under investigation. The results of QPNM calculations were also compared with the results of KPM (Kuliev-Pyatov Method) and QTDA (Quasiparticle Tamm-Dancoff Approximation).

Keywords: Odd-Mass, Deformed Nucleus, Spin-Flip, QPNM

Quantum Simulation of Light Nuclei Using Pionless Effective Field Theory and the Variational Quantum Eigensolver Algorithm

Pınar Çifci, Serkan Akkoyun

Department of Physics, Faculty of Sciences, Sivas Cumhuriyet University, Sivas, Türkiye

pinar.ciftci@outlook.com

Quantum computing has recently gained attention as a promising tool for simulating few-body nuclear systems, especially in the context of fusion energy studies. In this work, we focus on light nuclei — deuteron (^{2}H), triton (^{3}H), and helium-3 (^{3}He) and simulate their ground states using the Variational Quantum Eigensolver (VQE) algorithm combined with pionless effective field theory at leading order. The nuclear Hamiltonians are constructed to include both two-body and three-body interactions, and are mapped onto symmetry-adapted qubit systems that reflect the spin and isospin properties of the nuclei. The low-energy constants (LECs) in the interaction terms are calibrated using experimental data. To encode the fermionic degrees of freedom, we apply both Jordan-Wigner and Bravyi-Kitaev transformations. Ground-state energies are extracted from expectation value measurements performed on estimator-based simulations of VQE circuits. The computed energies show good agreement with experimental and literature-reported values, indicating that this hybrid quantum-classical approach can reliably capture essential features of nuclear structure. Overall, the results illustrate the potential of quantum computing as a new computational framework for studying light nuclear systems and provide a foundation for future simulations of fusion reactions.

Keywords: quantum computing, light nuclei, pionless EFT, fusion energy, binding energy, VQE

This paper has been developed as part of my ongoing Ph.D. dissertation titled “Quantum Computational Modeling of Nuclear Fusion Reactions,” supervised by Prof. Dr. Serkan Akkoyun at Sivas Cumhuriyet University.

From MCFM to Machine Learning: A Modern Approach to Higgs Cross-Section Predictions

Ibrahim Koca[1], Merve Tas[2], Emrah Tiras[3,4], Kamuran Dilsiz[5], Berker Utku[1]

[1]Graduate School of Natural and Applied Sciences, Department of Physics, Erciyes University, Kayseri, Türkiye, 38030
[2]Artificial Intelligence and Big Data Application and Research Center, Erciyes University, Kayseri, Türkiye, 38030
[3]Department of Physics, Erciyes University, Kayseri, Türkiye, 38030
[4]Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa, USA, 52241
[5]Department of Electrical and Electronics Engineering, Faculty of Engineering, Bingol University, Bingöl, Türkiye, 12000

kocaibrahim52@gmail.com

This study introduces a hybrid computational framework for predicting the cross-sections of Higgs boson production in association with vector bosons (W and Z) at current and future high-energy colliders. In the first phase, quantum chromodynamics (QCD) cross-section calculations were conducted at leading order (LO), next-to-leading order (NLO), and next-to-next-to-leading order (NNLO) using the MCFM (Monte Carlo for FeMtobarn processes) tool and a variety of parton distribution functions (PDFs) via the LHAPDF interface, covering center-of-mass energies from 7 TeV to 27 TeV. These theoretical results served as training data for machine learning models designed to extrapolate cross-sectionpredictions to unexplored energy regimes, including the 100 TeV scale foreseen for future colliders. The machine learning models aim to provide accurate and efficient cross-section estimates in intermediate or previously untested energy domains, thereby reducing computational demands and enhancing predictive capabilities. This work establishes a foundation for integrating AI-driven methods into precision theoretical predictions for Higgs-related processes in next-generation high-energy physics experiments.

Keywords: Higgs boson, QCD cross-sections, machine learning, high-energy colliders, MCFM

Gamow-Teller Strength in Iron Isotopes: A Detailed Study Using QRPA Modeling

Şadiye Meral Çakmak

Program of Medical Monitoring Techniques, Osmangazi University, Eskisehir, Türkiye

scakmak@ogu.edu.tr

Gamow-Teller (GT) transitions play a crucial role in understanding the nuclear structure and decay processes, particularly in the context of spin-isospin excitations. In this study, we investigate the Gamow-Teller strength distributions in iron isotopes using the Quasi-Particle Random Phase Approximation (QRPA) framework, alongside the schematic model and the Pyatov method. Our approach includes both particle-hole (ph) and particle-particle (pp) channels, providing a comprehensive analysis of the GT transitions across a range of iron isotopes. The iron isotopes, due to their unique nuclear structure and role in astrophysical processes, offer a valuable platform for studying the underlying mechanisms of GT transitions. The theoretical results obtained are compared with available experimental data to assess the accuracy and reliability of our models. Additionally, this work provides essential insights for future investigations into the nuclear structure of iron and its isotopes, laying the groundwork for further studies on spin-isospin excitations and their implications in nuclear physics.

Keywords: Gamow-Teller (GT) transitions, nuclear structure, QRPA

Describing Bubble Nuclei Using Microscopic Models

Sihem Berbache, Abdelhamid Bouldjedri and Abir Boubir

PRIMALAB, Department of physics, Batna1 University, Route de Biskra, Batna, Algeria

sihemberbacher@gmail.com

Bubble nuclei are a unique nuclear phenomenon characterized by a central depletion in proton or neutron density, which significantly impacts their structure and interaction properties. In this study, we make use of microscopic models, such as the Shell Model, along with other frameworks to describe the properties of these nuclei (density profile, form factor, energy levels, magic numbers, etc.). Furthermore, we construct a map showing the global distribution of density depletion over the periodic table, by analyzing proton and neutron density profiles across a wide range of nuclei. This map allows us to determine the most probable candidates exhibiting bubble-like structures. Moreover, we provide a detailed analysis of the role of pairing interaction in the formation of density depletion within the nucleus, shedding light on the underlying physical mechanisms driving this phenomenon. This theoretical investigation led us to derive a criterion, based on experimental electron scattering data, for experimentally identifying the occurrence of a bubble structure using the form factor.

Keywords: Bubble nuclei, depletion, pairing interaction

SSLG4: A Scintillator Simulation Library for Geant4 Optical Applications

Burcu Kirezli Ozdemir[1], İbrahim Koca[1], Mustafa Kandemir[2], Emrah Tiras[3,4]

[1]*Graduate School of Natural and Applied Sciences, Department of Physics, Erciyes University, Kayseri, Türkiye*
[2]*Department of Physics, Recep Tayyip Erdogan University, Rize, Türkiye*
[3]*Department of Physics, Erciyes University, Kayseri, Türkiye*
[4]*Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa, USA*

burcukirezli@erciyes.edu.tr

This study presents a novel Scintillator Simulation Library, SSLG4, developed for the Geant4 Monte Carlo simulation framework. SSLG4 is made to make optical simulations faster and easier by simplifying how scintillators are added and providing a complete collection of materials. The library allows users to effortlessly incorporate predefined scintillator materials into their simulations, eliminating the need for manual configuration. The initial release of SSLG4 includes 68 scintillators, comprising 58 organic and 10 inorganic types. These materials were primarily selected from the catalogues of leading scintillator manufacturers, particularly Eljen and Luxium, while additional scintillators were chosen based on their widespread application across various physics disciplines. New scintillators being used in the field are planned to be added to the new version of the library in the near future. Optical properties for each scintillator are stored in ASCII-format files (.mac and .txt), enabling users to add, remove, or modify material parameters at runtime. Furthermore, all scintillator data included in the library is made freely accessible via a dedicated webpage, ensuring broad and convenient usability for the research community.

Keywords: SSLG4, Scintillator library, Geant4, Predefined scintillator, Optical photon simulation, Material optical properties, Eljen scintillators

The Determination of Radon Activity Concentration Levels of Some Medicinal and Aromatic Plants (Bitlis, Turkey)

Sultan Şahin Bal[1*], Önder Kılıç[1], Fikriye Gönültaş[1] and Murat Kurşat[2]

[1] Bitlis Eren University, Faculty of Sciences and Arts, Physics Department, Bitlis, Türkiye
[2] Bitlis Eren University, Faculty of Sciences and Arts, Biology Department, Bitlis, Türkiye

ssahin@beu.edu.tr

In this study, 13 medicinal and aromatic plant samples grown in Bitlis center and districts were collected. ^{222}Rn radioisotope activity concentration levels of the collected samples were determined using passive radon measurement system. It was observed that radon activity concentration levels varied between 272.42 ± 15.10 Bq/m^3 and 3460.25 ± 53.81 Bq/m^3. The obtained data were compared with literature data and interpreted.

Keywords: Medicinal and aromatic plant, radon, Bitlis

Electric quadruple reduced transition probability & triaxiality for even $^{122-130}$Te nuclei in IBM- I & IBM-II

Ramesh Kumar[1], Indu Bala[2]

[1]*NIILM University, Kaithal-136027, Haryana, India*
[2]*Govt. college, Bherian-136030, Haryana, India*

rkgupta1701@gmail.com

The IBM is explained in detail, with a focus on the variant of the model that involves higher order interactions between the bosons. A full account of the IBM is given by Iachello and Arima (1974). The nucleus is represented in the IBM in terms of interacting s and d bosons. The vibrational U (5) limit, the rotational SU (3) limit, and the γ-unstable SO (6) limit are three separate types of analytical solutions or limits for such a device. While the vibrational and rotational limits were well-known aspects of the nuclear environment at the time of the IBM introduction in 1974, the third limit was not. Its predictions were found to match the empirical structure of some Pt nuclei very closely. Supersymmetry is the IBM second major contribution to nuclear physics. Its starting point is the IBM expansion to odd-mass nuclei, which was accomplished by using a single fermion in addition to the bosons. The interacting boson–fermion model (IBFM) that results lend itself just as well as the IBM to a study focused on symmetry considerations that allows some groups of model Hamiltonians to be solved analytically. The conceptual similarity in the definition of even– even and odd-mass nuclei is an especially appealing feature. While the IBM spectrum generating algebra is UB(6), the IBFM is UB(6) * UF(Ω), where Ω is the size of the single-particle space accessible to the fermion and the superscripts B and F indicate whether the Lie algebra is realized by a boson or fermion. The Lie algebra UB(6) * UF(Ω) distinguishes between even–even and odd–odd mass nuclei. Despite the fact that the treatment is identical in both cases, there is no operator that links the even–even and odd–odd mass states. Iachello proposes an extension that takes into account operators that convert a boson into a fermion or vice versa. The resulting set of operators no longer resembles a traditional Lie algebra defined in terms of commutation relations. The prediction of neutron–proton non-symmetric states is the IBM third major contribution. Given the microscopic understanding of bosons as correlated pairs of nucleons, a natural extension of the IBM-1 (the most basic version of the IBM) is to assume two separate forms of bosons, neutron and proton, resulting in the neutron– proton interacting boson model, or IBM-2. IBM-2 algebraic structure is made up of U (6) algebras, Uν (6) * Uπ (6), which are made up of neutron (ν) and proton (π) generators, respectively. The most significant feature of IBM-2 is that it predicts states that are not present in IBM-1. The lowest-energy states in U (6) are symmetric and analogues of those in IBM-1. The next set of states in U (6) is no longer symmetric; they have been found experimentally and appear to be a long-term characteristic of nuclei. Non-symmetric states, according to a geometric analysis, refer to linear or angular displacement oscillations in which the neutrons and protons are out of phase, as opposed to symmetric IBM-2 states, where those oscillations are in phase. The existence of such states in vibrational and deformed nuclei was first predicted in the context of geometric two-fluid models, where they appear as neutron–proton counter oscillations.The IBM-2 confirms these geometric distinctions while also broadening them to include all nuclei, not only spherical and deformed ones, but also γ- unstable and transitional ones. This model was introduced in which seems to be relevant for the explanation of deformed nuclei showing triaxial features. Also describing the many nuclear properties like spins, energies of lower level, emission of gamma rays and multiple moments. The shell model reveals that the low-lying states of the even-even nuclei are made up predominantly by nucleon pairs with total spin 0 and 2. The spins of such pairs of even number nucleons shows the antisymmetric state. The basic assumption of IBM is that the nucleon pairs are represented by bosons with angular momenta l=0 or 2. When the number of bosons depends on the number of active nucleon pairs it builds a closed shell. S-and d-boson has its own binding energy within the closed shell. The IBM describes the even-even nuclei as an inert core combined with bosons which represent pairs of identical nucleons. Each boson has a wave function but two bosons not represent the wave function because they are interchanged. The interacting boson-fermion model which deals with odd number of identical nucleons, bosons are coupled to nucleons. The total spin of boson is identical, even parity and also angular momenta of the bosons are even (l = 0, 2). The model where the proton and neutron bosons are explicitly introduced is referred as the interacting boson model-2 and no distinction is made between proton and neutron pairs, called interacting boson model-1. The models IBM1 and IBM2 are restricted to nuclei with even number of protons and neutrons. In this model 2,8,20,28,50,82 and 126 magic numbers are shown by the number of bosons. Electric Quadrupole reduced transition probability are in good agreement with the experimental result for even $^{122-130}$Te. Triaxiality is not found in $^{122-130}$Te isotopes with the electric reduced transition probabilities.

Keywords: Electric quadruple reduced transition probability, triaxiality, IBM

Z=30 isotopes properties in the vicinity of ^{56}Ni core

Fatima Benrachi and Nadjet Laouet

Laboratoire de Physique Mathématique et Physique Subatomique, University Constantine-1 Frères Mentouri, Route Ain El Bey 25017 Constantine, Algeria

fatima.benrachi@umc.edu.dz

Analysing the excitation energies of individual states and the nucleon-nucleon interaction in each region of the nuclear chart provides a basis for testing the fundamental components of nuclear shell model predictions. Furthermore, the nuclear structure of nuclei in the nickel region exhibits shape coexistence. This phenomenon refers to a nucleus's ability to adopt different shape configurations at relatively close energies, which makes their theoretical and experimental study particularly interesting. Such behavior in other isotopes challenges our simplistic view of spherical nuclei. Improving our understanding of this phenomenon will contribute to a better comprehension of the fundamental properties of nuclear matter.

This study aims to examine the influence of the monopole effect within the context of the nuclear shell model. The focus is on Z=30 isotopes surrounding the 56Ni doubly magic core. Investigations into certain nuclear spectroscopic properties of these nuclei are conducted. Calculations are performed within the nuclear shell model framework using the NuShellX@MSU nuclear structure code. The jj44pn valence space forms the basis of this investigation, incorporating recent experimental values of single-particle energies. Various effective interactions have been adopted. This work provides a detailed description of the nuclear structure and shape evolution of these isotopes. The results obtained showed a reasonable correlation with the available experimental data for the low-lying yrast and yrare first states of these nuclei.

Keywords: ^{56}Ni mass region, NuShellX@MSU code, Low-lying yrare states, Shape coexistence, monopole effect

Application of Genetic Algorithm on Nuclear Structure Properties of even-even Si isotopes

Sinan Anılan[1] and Mahmut Böyükata[2]

[1]Kirikkale University, Graduate School of Natural and Applied Sciences, Physics Department, Kirikkale, Türkiye
[2]Kirikkale University, Faculty of Engineering and Natural Sciences, Physics Department, Kirikkale, Türkiye

sinananilan@gmail.com

In this work, some nuclear structure properties of even-even Si isotopes were investigated A~30 mass region. This investigation was performed by applying the genetic algorithm (GA) based on artificial intelligent (AI) in python 3 on colab. The aim of this study is to obtain the essential Hamiltonian parameters of the consistent – Q formalism (CQF) within the AI application. For this process, the experimental energy levels were loaded to AI platform in which compiling ibar code of interacting boson model-1 (IBM-1). Later, the energy levels of give Si isotopes and their B(E2) values were calculated and compared with recent experimental data. This AI application will be expanded to other neighbor isotopes in the same region such as Ne, Mg, S, Ar isotopes in the same region.

Keywords: Genetic algorithm, Artificial intelligent, IBM-1 model, Nuclear structure, Si isotopes

Energy and centrality dependencies of kinetic freeze-out parameters in high-energy *p*+Pb, Xe+Xe, and Pb+Pb collisions at the LHC

Khusniddin K. Olimov[1,2,3,a], Anastasiya Fedosimova[4,5], Fu-Hu Liu[6,b], Aziza N. Kakhorova[1,7], Igor A. Lebedev[4], Azizjon Tokhirov[1], Sayora Ibraimova[4], Ekaterina Bondar[4]

[1]Physical-Technical Institute of Uzbekistan Academy of Sciences, Chingiz Aytmatov str. 2[b], 100084 Tashkent, Uzbekistan
[2]New Uzbekistan University, Tashkent, Uzbekistan
[3]National University of Science and Technology MISIS (NUST MISIS), Almalyk branch, Almalyk, Uzbekistan
[4]Institute of Physics and Technology, Satbayev University, Almaty, Kazakhstan
[5]Institute of Nuclear Physics, Almaty, Kazakhstan
[6]Institute of Theoretical Physics, Shanxi University, Taiyuan 030006, China
[7]Samarkand State University named after Sh. Rashidov, Samarkand, Uzbekistan

khkolimov@gmail.com; kh.olimov@uzsci.net, fuhuliu@163.com; fuhuliu@sxu.edu.cn

Evolution of kinetic freeze-out properties of the system with changing collision centrality and energy has been studied analyzing the midrapidity experimental transverse momentum distributions of identified particle species, measured by the ALICE Collaboration in Pb+Pb collisions at $(s_{\rm nn})^{1/2}$=2.76 and 5.02 TeV, Xe+Xe collisions at $(s_{\rm nn})^{1/2}$=5.44 TeV, and in *p*+Pb collisions at $(s_{\rm nn})^{1/2}$=5.02 TeV in the low $p_T \leq$ 2 GeV/*c* range with the help of thermodynamic Maxwell-Boltzmann distribution function with (embedded) transverse flow. The simultaneous minimum χ^2 fits by the Maxwell-Boltzmann distribution with transverse flow of the experimental midrapidity transverse momentum spectra of the charged pions and kaons, protons and antiprotons have been conducted in four p_T ranges up to $p_{T\max}$ = 1.0 GeV/*c*, p_{Tmax} = 1.3 GeV/*c*, p_{Tmax} = 1.5 GeV/*c*, and p_{Tmax} = 2.0 GeV/*c* in various centralities of Pb+Pb collisions at $(s_{\rm nn})^{1/2}$=2.76 and 5.02 TeV, Xe+Xe collisions at $(s_{\rm nn})^{1/2}$=5.44 TeV, and *p*+Pb collisions at $(s_{\rm nn})^{1/2}$=5.02 TeV.

Qualities of the simultaneous fits by the Maxwell-Boltzmann distribution with transverse flow for the studied four collision types have proved to be quite good with $\chi^2/n.d.f.$ values being of the order of 1 in case of the fitting p_T ranges up to p_{Tmax} = 1.0 GeV/*c* and 1.3 GeV/*c*. On the other hand, the quality of the fits has been unsatisfactory with $\chi^2/n.d.f.$ values being in the range from ~ 2 up to around 10 in case of the fitting p_T ranges up to p_{Tmax} = 1.5 GeV/*c* and 2.0 GeV/*c*. Therefore, we have analyzed and compared the kinetic freeze-out temperatures (T_0) and average transverse flow velocities ($\langle\beta_T\rangle$), extracted from simultaneous minimum χ^2 fits by the Maxwell-Boltzmann distribution with transverse flow (Eq. (3)) of the experimental midrapidity transverse momentum spectra of the charged pions and kaons, protons and antiprotons in various centralities of the studied collision types in fitting p_T ranges up to 1.0 GeV/*c* to 1.3 GeV/*c* only, for which $\chi^2/n.d.f.$ values are of the order of 1 or smaller.

The average transverse flow velocity, $\langle\beta_T\rangle$, demonstrates the similar dependencies on the average number of participant nucleons, $\langle N_{part}\rangle$, in Pb+Pb collisions at $(s_{\rm nn})^{1/2}$=2.76 and 5.02 TeV, Xe+Xe collisions at $(s_{\rm nn})^{1/2}$=5.44 TeV: firstly $\langle\beta_T\rangle$ increases at a high rate in the lower $\langle N_{part}\rangle$ range, then the degree of increase of $\langle\beta_T\rangle$ decreases significantly with an increase in $\langle N_{part}\rangle$, showing an almost plateau-like behavior in the region of the largest $\langle N_{part}\rangle$. In case of *p*+Pb collisions at $(s_{\rm nn})^{1/2}$=5.02 TeV, $\langle\beta_T\rangle$ also increases with an increase in $\langle N_{part}\rangle$. However, no plateau-like region of $\langle\beta_T\rangle$ is observed for *p*+Pb collisions, which is likely due to the narrow $\langle N_{part}\rangle$ range as compared to much larger $\langle N_{part}\rangle$ ranges for Pb+Pb collisions at $(s_{\rm nn})^{1/2}$=2.76 and 5.02 TeV, and Xe+Xe collisions at $(s_{\rm nn})^{1/2}$=5.44 TeV.

The central Pb+Pb, Xe+Xe, and *p*+Pb collisions (large <N_{part}> values) at the LHC have been characterized by the significantly smaller values of the kinetic freeze-out temperature, T_0, as compared to the significantly larger values of T_0 in peripheral collisions (small <N_{part}> values). The values of the kinetic freeze-out temperature, T_0, in most peripheral collisions have proved to be very close to the chemical freeze-out temperature, T_{ch}, of about 150-160 MeV, calculated for these heavy-ion collisions at the LHC. On the other hand, the T_0 values have been significantly smaller than T_{ch} in central Pb+Pb, Xe+Xe, and *p*+Pb collisions at the LHC. Therefore, we can conclude that the fireball produced in central heavy-ion collisions at the LHC lives significantly longer time and decays at significantly lower temperature, T_0, as compared to the significantly shorter lifetime (and, hence, significantly larger T_0) of the fireball produced in more peripheral collisions. The values of the kinetic freeze-out temperature extracted for the most peripheral (the lowest <N_{part}>) Pb+Pb collisions at $(s_{\mathrm{nn}})^{1/2}$=2.76 and 5.02 TeV, Xe+Xe collisions at $(s_{\mathrm{nn}})^{1/2}$=5.44 TeV, and p+Pb collisions at $(s_{\mathrm{nn}})^{1/2}$=5.02 TeV have coincided within uncertainties with the chemical freeze-out temperature of around 150-160 MeV.

Keywords: Kinetic freeze-out parameters, *p*+Pb, Xe+Xe, Pb+Pb, LHC

Acknowledgements
The research has been supported by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP23487706). The work of PTI (Tashkent) group has been supported by the Agency of Innovative Development of the Ministry of Higher Education, Science and Innovations of Uzbekistan within the fundamental research Grant № F3-20200929146 on analysis of open data on heavy-ion collisions at the LHC. The work of F.-H.L. has been supported by the National Natural Science Foundation of China (Grant № 12147215) and Shanxi Provincial Basic Research Program (Natural Science Foundation) under Grant № 202103021224036.

Study of midrapidity transverse momentum distributions of the charged pions and kaons, protons and antiprotons in high-energy Pb+Pb collisions at the LHC using new combined Tsallis-Hagedorn function with transverse flow

Khusniddin K. Olimov[1,2,3,a], Anastasiya Fedosimova[4,5], Fu-Hu Liu[6,b], Aziza N. Kakhorova[1,7], Sayora Ibraimova[4], Ekaterina Bondar[4]

[1]*Physical-Technical Institute of Uzbekistan Academy of Sciences, Chingiz Aytmatov str. 2[b], 100084 Tashkent, Uzbekistan*
[2]*New Uzbekistan University, Tashkent, Uzbekistan*
[3]*National University of Science and Technology MISIS (NUST MISIS), Almalyk branch, Almalyk, Uzbekistan*
[4]*Institute of Physics and Technology, Satbayev University, Almaty, Kazakhstan*
[5]*Institute of Nuclear Physics, Almaty, Kazakhstan*
[6]*Institute of Theoretical Physics, Shanxi University, Taiyuan 030006, China*
[7]*Samarkand State University named after Sh. Rashidov, Samarkand, Uzbekistan*

khkolimov@gmail.com; kh.olimov@uzsci.net, fuhuliu@163.com; fuhuliu@sxu.edu.cn

In this work, we introduce the new combined Tsallis-Hagedorn function with transverse flow, which combines thermodynamically consistent Tsallis distribution function with embedded transverse flow, which can describe quite well the low and intermediate parts of p_T spectra, and the QCD inspired Hagedorn function, which is known to reproduce well the high p_T part of hadron spectra in high-energy nucleon-nucleon collisions:

$$\frac{d^2N}{N_{ev}dp_T dy} = 2\pi p_T \cdot A_q \cdot \langle\gamma_T\rangle(m_T - p_T\langle\beta_T\rangle) \cdot \left(1 + \langle\gamma_T\rangle\frac{(q-1)(m_T - p_T\langle\beta_T\rangle)}{T_0}\right)^{-q/(q-1)} \cdot \left(1 + \frac{p_T}{p_0}\right)^{-n}, \quad (1)$$

which we call combined Tsallis-Hagedorn function with transverse flow in present work. In this work, we analyze the transverse momentum (p_T) distributions of the charged pions and kaons, protons and antiprotons, measured at ten centrality groups in Pb+Pb collisions at $\sqrt{s_{nn}}$=5.02 TeV by ALICE Collaboration [1] at the LHC.

We have presented the new combined Tsallis-Hagedorn function with transverse flow, which is obtained by combining the thermodynamically consistent Tsallis distribution function with embedded transverse flow, which describes quite well the low and intermediate parts of p_T spectra, and the QCD inspired Hagedorn function, which is known to reproduce well the high p_T part of hadron spectra in high-energy nucleon-nucleon collisions. The combined Tsallis-Hagedorn function with transverse flow has been obtained applying the multiplication rule for probability of independent events under assumption that the soft and hard processes, which contribute to the lower and higher parts of p_T spectra, are independent.

In case of p_T fit range up to 5 GeV/c, the quality of fits performed by combined Tsallis-Hagedorn function with transverse flow proved to be slightly better than those by thermodynamically consistent Tsallis distribution function with embedded transverse flow. On the whole, combined Tsallis-Hagedorn function with transverse flow has resulted in slightly larger values of the average transverse flow velocity,
$\langle\beta_t\rangle$, and slightly lower values of the kinetic freeze-out temperature, T_0, as compared to those obtained using thermodynamically consistent Tsallis function with embedded transverse flow, while the

dependencies of the average transverse flow velocity and freeze-out temperature on collision centrality have been similar in both cases.

In case of model analysis using thermodynamically consistent Tsallis function with embedded transverse flow, non-extensivity parameter q decreases systematically for all particle species with an increase in Pb+Pb collision centrality at $\sqrt{s_{nn}}$ = 5.02 TeV, in agreement with the similar decreasing trend of parameter q observed earlier in Xe+Xe collisions at $\sqrt{s_{nn}}$=5.44 TeV and Pb+Pb collisions at $\sqrt{s_{nn}}$=2.76 TeV [28] at the LHC. This result implies that the degree of system thermalization increases with an increase in centrality of high-energy heavy-ion collisions. However, in case of combined Tsallis-Hagedorn function with transverse flow, parameter q values fluctuate significantly and generally do not follow the systematically decreasing trend of q with an increase in $\langle N_{part} \rangle$. While q values for protons and antiprotons on the whole show approximately decreasing tendency with increasing Pb+Pb collision centrality, parameter q for the charged kaons demonstrates quite large fluctuations with large fitting uncertainties, not following decreasing behavior with increasing collision centrality. For the charged kaons, magnitude of fluctuations decreases significantly with an increase in the maximum of fitting border from p_T = 5 GeV/c to 8 GeV/c. While the maximum of fitting border increases from p_T = 5 GeV/c to 8 GeV/c, nonextensivity parameter q for the charged pions, extracted using function in Eq. (6), starts approaching an approximately decreasing trend with an increase in centrality of Pb+Pb collisions. The observed significantly fluctuating behavior of parameter q is likely due to significant correlations between parameters q and n in the combined Tsallis-Hagedorn function with transverse flow.

Keywords: Pb+pb, LHC, QCD, Tsallis-Hagedorn function

[1] ALICE Collaboration (S. Acharya *et al.*), Production of charged pions, kaons and (anti-)protons in Pb-Pb and inelastic pp collisions at $\sqrt{s_{nn}}$=5.02 TeV. Phys. Rev. C 101, 044907 (2020). arXiv:1910.07678v1

Acknowledgements The research work of Almaty group was funded by the Ministry of Education and Science of the Republic of Kazakhstan (grant No. AP22785312). The work of Tashkent group was supported by the Agency of Innovative Development of the Ministry of Higher Education, Science and Innovations of Uzbekistan within the fundamental research Grant № F3-20200929146 on analysis of open data on heavy-ion collisions at the LHC. The work of Shanxi group was supported by the National Natural Science Foundation of China under Grant No. 12147215, the Shanxi Provincial Basic Research Program (Natural Science Foundation) under Grant No. 202103021224036, and the Fund for Shanxi “1331 Project” Key Subjects Construction.

Investigations Of The Relationship Between Eartquakes And The Radon Relases In Fault Lines

N. T. Koç[1], M. Koç[2] and S. Akkoyun[3]

[1]Sivas Cumhuriyet University, Graudate School of Natural and Applied Sciences, Sivas, Türkiye
[2]Sivas Cumhuriyet University, Vocational School of Health Services, Sivas, Türkiye
[3]Sivas Cumhuriyet University, Department of Physics, Sivas, Türkiye

nurcantrn88@gmail.com

Earthquakes are sudden movements of the Earth's crust that can cause severe loss of life and property. In recent studies, changes in physical and chemical properties within the crust are being explored as possible precursors to such events. Radon (222Rn), a radioactive noble gas generated from the natural decay of uranium underground, can migrate to the surface through increased permeability and microfractures in fault zones. This poster investigates the relationship between radon emissions and seismic activity through field observations, monitoring station designs, graphical analysis, and a case study from Turkey. Notable events such as the Kobe and Izu-Oshima earthquakes in Japan, and anomalies along the North Anatolian Fault in Turkey, have shown significant radon increases before seismic events. However, environmental factors like temperature, pressure, and humidity affect radon release, limiting its standalone predictive value. When integrated into artificial intelligence-based time-series models and multi-parameter frameworks, radon data can meaningfully contribute to seismic risk forecasting. Accordingly, the establishment of radon monitoring stations, AI-supported data analysis, and the development of a multi-sensor early warning system are being considered within the scope of a project aiming to enhance earthquake forecasting capability in Turkey’s active fault zones.

Keywords: Earthquake, Radon, Fault Line, Artificial Intelligence, Early Warning, North Anatolian Fault, Radon Monitoring, Seismic Activity

Modeling and Predicting Isomeric Yield Ratios in Nuclear Fission through Machine Learning Approaches

Cafer Mert Yeşilkanat[1] and Serkan Akkoyun[2]

[1]Department of Mathematics and Science Education, Artvin Coruh University, Artvin, Türkiye
[2]Department of Physics, Sivas Cumhuriyet University, Sivas, Türkiye

cmyesilkanat@artvin.edu.tr

The prediction of isomeric fission yield ratios is important for understanding nuclear fission dynamics, particularly regarding the angular momentum distribution of fission fragments. In this study, we applied four machine learning algorithms—Bayesian Regularized Neural Network, Support Vector Regression, XGBoost, and Random Forest—to predict the isomeric yield ratios based on experimentally measured fission data. The input variables for the models included projectile energy, ground and metastable state spins, spin differences, spin energy squared differences, fragment proton and neutron numbers, target nucleus mass numbers, and fissility parameters. Model performances were evaluated using determination coefficient, root mean square error, and concordance correlation coefficient. Among the models, Bayesian Regularized Neural Network demonstrated the highest predictive performance on test data (determination coefficient of 0.417, root mean square error of 0.1671, concordance correlation coefficient of 0.617). Support Vector Regression (determination coefficient of 0.373, root mean square error of 0.1719, concordance correlation coefficient of 0.535) and XGBoost (determination coefficient of 0.376, root mean square error of 0.1746, concordance correlation coefficient of 0.592) showed moderate predictive abilities, whereas the Random Forest model yielded the lowest performance (determination coefficient of 0.347, root mean square error of 0.1773, concordance correlation coefficient of 0.559). The results suggest that while machine learning methods, especially Bayesian Regularized Neural Network, can effectively approximate isomeric yield trends, overall prediction accuracies remain limited due to inherent complexities in the underlying nuclear mechanisms. Further improvements are expected with expanded data sets and the incorporation of additional physical parameters to enhance the reliability and applicability of these predictive models for nuclear physics applications.

Keywords: Isomeric yield ratios, Machine learning, Nuclear fission, Bayesian neural network, Predictive modeling

SPONSORS

We would like to thank the Sivas Governorship, Sivas Municipality, Sivas Chamber of Commerce and Industry, Boğaziçi Defense, BG Grup and Moledro Software that supported our congress.