NSP2021

XIV. International Conference on Nuclear Structure Properties

2-4 June 2021

Selcuk University, Konya, Turkey

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SCIENTIFIC PROGRAMME

June 02 2021 Wednesday

Morning session 10:00 – 12:30 **Time Zone Istanbul (GM+3)**

Chair: Nihal Buyukcizmeci (Selcuk Un., Konya, Turkey)

10:00- 10:30 Opening Remarks

10:30-11:00 **Marcus Bleicher** (ITP, Goethe Un., HFHF, Frankfurt, and GSI, Germany)
Cluster production in high-energy collisions

11:00-11:30 **Wolfgang Trautmann** (GSI, Darmstadt, Germany)
The nuclear symmetry energy: New directions from new results?

11:30-12:00 **Igor Mishustin** (FIAS, Frankfurt, Germany)
Alpha-clustering and alpha condensation in nuclear matter

12:00-12:15 **Manpreet Kaur** (Institute of Physics, Bhubaneswar, India)
Effect of microscopic temperature-dependent binding energies in the decay of $^{32}Si^*$ nuclear system

12:15-12:30 **Anagha Chakraborty** (Visva-Bharati Un., Visva-Bharati, India)
Onset of different excitation modes in the neutron rich ^{78}As

12:30 -13:30 LUNCH BREAK

Afternoon session 13:30 -15:30

Chair: Bulent Yilmaz (Ankara Un., Ankara, Turkey)

13:30-14:00 **Mitko Gaidarov** (INRNE-BAS, Sofia, Bulgaria)
Evolution of the symmetry energy and skins of mirror nuclei

14:00-14:15 **Koh Meng Hock** (University Teknologi Malaysia, Malaysia)
Role of nuclear tensor within Skyrme mean-field approach on deformed magic numbers in rare earth region

14:15-14:30 **Ugur Ilter** (Nigde Omer Halisdemir Un., Nigde, Turkey)
Results from the EMPIRE code for reaction cross-section calculations

14:30-14:45 **Ferhan Akdeniz** (Akdeniz Un., Antalya, Turkey)
Nucleon densities of Lanthanum isotopes calculated by Skyrme and Gogny models

14:45-15:00 **Magdalena Skurzok** (Jagiellonian Un., Krakow, Poland)
Search for eta-mesic nuclei with WASA at COSY facility

15:00-15:15 **Deepika Pathak** (Guru Nanak Dev Un., India)
Prediction of cluster radioactivity of Z=118 isotopes

15:15-16:00 COFFEE BREAK

Afternoon session 16:00-18:15

Chair: Serkan Akkoyun (Sivas Cumhuriyet Un., Sivas, Turkey)

16:00-16:30 **Chhanda Samanta** (Virginia Military Institute, Virginia, USA)
Binding and bonding of cascade hyperons in nuclei

16:30- 16:45 **Hasan Bircan** (Kutahya Dumlupinar Un., Kutahya, Turkey)
A new parameter set for extended Thomas-Fermi model

16:45- 17:00 **Rajeev Singh** (Institute of Nuclear Physics Polish Academy of Sciences, Krakow, Poland)
Quantum fluctuations in energy for hot relativistic fermionic gas

17:00-17:15 **Sevki Senturk** (Karadeniz Technical Un., Trabzon, Turkey)
Production cross-section and reaction yield of ^{82}Sr for ^{82}Sr/^{82}Rb generator

17:15-17:30 **Abderrahmane Yakhelef** (Ferhat Abbas Setif 1 Un., Algeria)
Neutron single particle states in ^{101}Sn by polynomial fits and SM calculations

17:30-17:45 **Fatima Benrachi** (Frères Mentouri Constantine 1 Un., Algeria)
Gamma radiation analysis and radiological hazards assessment in granite samples commonly used in Algerian building constructions

17:45-18:00 **Bouchra Imene Chibane** (Frères Mentouri Constantine 1 Un., Algeria)
A dosimetric comparison of 3D conformal therapy and volumetric intensity modulated arc therapy for the treatment of nasopharyngeal carcinoma

18:00-18:15 **Fatima Zohra Chemingui** (Frères Mentouri Constantine-1 Un., Algeria)
Monte Carlo simulation on human heterogeneous organs

June 3 2021 Thursday

Morning session 10:00 - 12:30 **Time Zone Istanbul (GM+3)**

Chair: Mahmut Boyukata (Kirikkale Un., Kirikkale, Turkey)

10:00-10:30 **Jameel-Un Nabi** (University of Wah, Punjab, Pakistan)
Spectroscopic study of ^{9}Be (p, γ) ^{10}B at astrophysical energy

10:30-11:00 **Valentin O. Nesterenko** (JINR, Dubna, Russia)
Vortical excitations in nuclei: Recent progress

11:00-11:15 **Tuncay Bayram** (Karadeniz Technical Un., Trabzon, Turkey)
Ground-state properties and decay rates of isotopic chain of Molybdenum

11:15-11:30 **BirBikram Singh** (Akal Un., Talwandi Sabo, Bathinda, India)
Clustering phenomenon in the decay of light mass composite nuclei

11:30-11:45 **Nuray Yavuzkanat** (Bitlis Eren Un., Bitlis, Turkey)
Geant4 investigation of the alpha-beta-gamma detector system

11:45-12:00 **Mehana Parameswaran** (Avinashilingam Deemed Un., India)
Spin-orbit splitting of protons and neutrons

12:00-12:15 **Aybaba Hancerliogullari** (Kastomunu Un., Kastamonu, Turkey)
Advanced generation hybrid type pusher D-T fusion plasma fueled rocket modelling

12:15-12:30 **Hanane Mebrek** (Batna-1 Un., Algeria)
Study of the astrophysical ^{25}Al(p,γ)^{26}Si nuclear reaction

12:30-13:30 LUNCH BREAK

Afternoon session 13:30-15:30

Chair: Vakkas Bozkurt (Nigde Omer Halisdemir Un., Nigde, Turkey)

13:30-14:00 **Juergen Gerl** (GSI, Darmstadt, Germany)
Exotic nuclei studied with NUSTAR at FAIR/GSI

14:00-14:15 **Nihal Buyukcizmeci** (Selcuk Un., Konya, Turkey)
Coalescence theory in heavy ion collisions

14:15-14:30 **Ghulam Bary** (Yibin Un., Yibin, China)
Analyses of multi-pion Bose-Einstein correlations for granular sources with coherent droplets

14:30-14:45 **Ercan Yildiz** (Kahramanmaras Sutcu Imam Un., Kahramanmaras, Turkey)
Cross-sections and thermonuclear reaction rates for $^{181}Ta(\alpha,n)^{184}Re$ reaction

14:45-15:00 **Iftikhar Benchikh Lehocine** (University Tahri Mohammed Bechar, Algeria) Shell closure at N, Z = 40 in the vicinity of ^{56}Ni region

15:00- 15:15 **Samiha Benarous** (Nuclear Research Center of Algiers, Algieria)
Spatial distribution of major, minor and trace element in semiarid land of western Algeria

15:15-15:30 **Nazrin Babayeva** (Selcuk Un., Konya, Turkey)
Dosimetric properties of opagis drug: An EPR study

15:30 – 16:00 COFFEE BREAK

Afternoon session 16:00 – 18:15

Chair: Tuncay Bayram (Karadeniz Technical Un., Trabzon, Turkey)

16:00-16:30 **Ali Ihsan Kilic** (Szczecin Un., Husinec, Czechia)
A new approach to nuclear reaction mechanism in dense matter. Thermonuclear and pycnonuclear reactions

16:30-16:45 **Aydin Ghalehasadi** (Tabriz Un., Iran)
Calculation of the photon pair production cross section by artificial neural network

16:45-17:00 **Abderrahim Ait Ben Hammou** (Cadi Ayyad Un., Morocco)
Coriolis contribution to excited states of odd-mass nuclei with deformation-dependent mass formalism

17:00-17:15 **Nadjet Laouet** (Frères Mentouri Un., Constantine-1 Algerie)
Proton drip line neighbouring nuclei and nuclear structure

17:15-17:30 **Naila Bouchera Bouchelit** (National Polytechnic School of Algiers, Algeria)
Study of column of flow-rig using technical radiotracer

17:30-17:45 **Mounia Benchabane** (Ferhat Abbas Setif 1 Un., Algeria)
Minors and trace elements distribution in phosphate deposits using X-ray fluorescence

17:45-18:00 **Harjeet Kaur** (Guru Nanak Dev Un., Amritsar, India)
Analysis of two proton radioactivity half-lives of nuclei

June 4 2021 Friday

Morning session 10:00-12:30 **Time Zone Istanbul (GM+3)**

Chair: Necla Cakmak (Karabuk Un., Karabuk, Turkey)

10:00-10:30 **Bahadır Saygi** (Ege Un., Izmir, Turkey)
Chasing $B(E2)_{4_1^+/2_1^+}$ anomaly

10:30-11:00 **Alberto Camaiani** (Institute for Nuclear and Radiation Physics, Leuven, Belgium)
Exploring heavy-ion collisions with the FAZIA multi-telescope array

11:00-11:15 **Birgul Eren** (Nigde Omer Halisdemir Un., Nigde, Turkey)
Results from the PACE4 Code for fusion evaporation reaction cross-section calculations

11:15-11:30 **Mohamed El Adri** (Cadi Ayyad Un., Morocco)
Tensor force effect on the neutron shell closure in Z=114 super-heavy element

11:30-11:45 **Esra Yuksel** (Yildiz Technical Un., Istanbul, Turkey)
Gamow-Teller resonances and beta decay half-lives of nuclei at finite temperature

11:45-12:00 **Vasanthi Loganathan** (Avinashilingam Institute, India)
Preformation probability of complete binary fragments of ^{294}Og

12:00-12:15 **Aleeddine Lahbas** (ESMaR, Mohammed V Un., In Rabat, Morocco)
Davydov-Chaban Hamiltonian within the formalism of deformation-dependent effective mass for Kratzer potential

12:15-12:30 **Imad El-Ilali** (Cadi Ayyad Un., Morocco)
Excited states of the odd-mass nucleus ^{173}Yb with different deformation-dependent mass coefficients

12:30-13:30 LUNCH BREAK

Afternoon session 13:30-15:30

Chair: Sefa Erturk (Nigde Omer Halisdemir Un., Nigde, Turkey)

13:30-14:00 **Takehiko Saito** (RIKEN/GSI/Lanzhou Un., Japan/Germany/China)
Puzzles of hypernuclei

14:00-14:15 **Sonja Orrigo** (IFIC (CSIC-UV), Spain)
Beta decay of the neutron-deficient ^{60}Ge and ^{62}Ge isotopes at RIKEN

14:15-14:30 **Menekse Senyigit** (Ankara Un., Ankara, Turkey)
Comparison of NaI detector efficiency via measurement and Monte Carlo, modelling new scintillators

14:30-14:45 **Serpil Yalcin Kuzu** (Fırat Un., Elazıg, Turkey)
Machine learning approach in particle pair investigation

14:45-15:00 **Ayben Karasu Uysal** (KTO Karatay Un., Konya, Turkey)
Diffraction cross-section measurements at the LHC

15:00-15:15 **Esra Uyar** (Gazi Un., Ankara, Turkey)
Investigation of the effect of copper cooling rod on detector efficiency with monte carlo method in HPGe detectors

15:15-15:30 **Adem Pehlivanli** (Gazi Un. and Kirikkale Un., Turkey)
Investigation of secondary neutrons produced by proton and helium ion beams in water

15:30-16:00 COFFEE BREAK

Afternoon session 16:00-18:00

Chair: Ismail Hakki Sarpun (Akdeniz Un., Antalya, Turkey)

16:00-16:30 **Serkan Akkoyun** (Sivas Cumhuriyet Un., Sivas, Turkey)
Artificial intelligence: A laboratory for nuclear physics studies

16:30-16:45 **Hatice Duran Yildiz** (Ankara Un., Ankara, Turkey)
Superconducting cavity design for linear accelerator systems and Cern-Atlas experiment adcos studies

16:45-17:00 **Imad Tagdamte** (Cadi Ayyad Un., Morocco)
The sextic potential within Bohr Hamiltonian for rigid nuclei in the presence of minimal length

17:00-17:15 **Kuminder Kaur** (Guru Kashi Uni., Talwandi Sabo, India)
Comparative study of gamma treatment on fruit (Kinnow) and vegetable (Tomato) as an application of nuclear physics

17:15-17:30 **Huseyin Bahtiyar** (Mimar Sinan Fine Arts Un., Istanbul, Turkey)
Neural network application to the nuclear binding energies and charge radii

17:30-17:45 **Sarbjeet Kaur** (Sri Guru Granth Sahib World Un., Fatehgarh Sahib, India)
Role of pairing coefficient in the dynamics of compound nuclei $^{24,25}Mg^*$

17:45-18:15 Closing Remarks

ABSTRACTS

The nuclear symmetry energy: New directions from new results?

W. Trautmann

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The investigation of the nuclear equation of state has entered a new era when the first gravitational waves from a neutron-star merger were recorded and when the first radii of millisecond pulsars were measured by time-resolved pulse shape analysis. Long-awaited new results from laboratory experiments on nuclear structure and reactions have very recently been released as well. As it appears at present, the majority of these new data is favouring stiffer solutions for nuclear symmetry energy than expected on the basis of general trends established earlier. It will be interesting to see how apparent tensions may be resolved in the near future.

Alpha-clustering and alpha condensation in nuclear matter

Igor Mishustin

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Ground- and excited states of light- and medium-size nuclei exhibit clear alpha-clustering features. Also, alpha-particles are abundantly produced in intermediate-energy heavy-ion collisions, as demonstrated by several experimental groups (Texas, GSI, Dubna). These features can be explained by assuming that alpha particles preserve their identity even in the close packing arrangements. We have developed a mean-field approach to describe these features in terms of Bose condensation of alpha-particles. Parameters of the mean-field are extracted from the microscopic calculations of alpha matter performed previously by several authors, e.g. Clark@Wang. More specifically, we consider a Skyrme-like effective potential containing quartic (attraction) and sixtic (repulsion) terms. We have calculated the phase diagram of alpha-matter on the temperature-baryon density plane, which is similar to the well-known phase diagram of atomic He-4. It contains both a liquid-gas phase transition at temperatures below 14 MeV and Bose condensation of alpha-particles at lower temperatures.

Effect of microscopic temperature-dependent binding energies in the decay of $^{32}Si^*$ nuclear system

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The investigation of fusion reactions involving light neutron-rich exotic nuclei is of paramount significance to understand nucleosynthesis in astrophysical scenarios. Recently, the fusion of neutron-rich ^{20}O with ^{12}C target has been studied with the measurement of fusion cross-section (σ_{fus}). Bass model under predicts the σ_{fus} and time-dependent Hartree-Fock model also fails to explain the experimental data. To explicate the same, the investigation of $^{20}O+^{12}C$ reaction at near barrier energies has been made within the quantum mechanical fragmentation-based dynamical cluster- decay model (DCM) [M. Kaur et al., Phys. Rev. C 95, 014611 (2017)]. Within DCM, the fragmentation potential comprises temperature-dependent Coulomb, nuclear and centrifugal potentials, along with temperature-dependent binding energies (T.B.E.) calculated within the macroscopic approach of the Davidson mass formula. Recently, we have explored the temperature dependence of different nuclear properties and nuclear symmetry energy within microscopic relativistic mean-field (RMF) theory [M. Kaur et al., Nucl. Phys. A 1000, 121871 (2020)]. In the present work, we inculcate the microscopic T.B.E. from RMF theory within DCM and investigate the structure of fragmentation potential for $^{32}Si*$ formed in $^{20}O+^{12}C$ reaction, comparatively for macroscopic (mac) and microscopic (mic) T.B.E. obtained from Davidson mass formula and RMF theory, respectively. The structure and magnitude of fragmentation potential are found to change drastically/notably along with a change in energetically favoured/minimized fragments for both choices of T.B.E. The α particles (4He, 5He) are favoured at lower angular momenta in fragmentation profile for mic T.B.E. case only, which is in the agreement with predictions of statistical model results. This change in the nuclear structure embodied via fragmentation potential energy carries its imprints in the preformation probability P0 of different fragments and affects the contribution of individual light-charged particle (LCP) channel in the σfus. A comparison of the relative cross-section of different LCP channels toward σfus is quite different for both cases of T.B.E. The cross-section of ^{2}H and ^{4}He LCP channels is relatively enhanced for mic T.B.E. compared to mac T.B.E. Among different LCP channels, the ^{5}He channel is the major contributor in σfus, which is in line with the results of the statistical EVAPOR model. The DCM- calculated σ_{fus} is in agreement with the experimental data.

Onset of different excitation modes in the neutron-rich ^{78}As

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The level structure of the neutron-rich nucleus, ^{78}As has been investigated at the low- and medium-spin regime through the alpha-induced fusion evaporation reaction, ^{76}Ge(α,pn). The de-excited gamma rays were detected using the INGA spectrometer stationed at VECC, Kolkata. The level scheme of ^{78}As has been constructed using the standard gamma-ray spectroscopic techniques. The observed low-lying, low-spin level structure is found to be highly irregular suggesting the dominance of single-particle excitations. The onset of regular positive- and negative-parity band-like structures are developed at the medium-spin excitation regime. Based on the theoretical calculations, these band-like structures are interpreted to origin from the novel excitation mode known as "stapler"-like shears mechanism. The results will be presented in detail during the conference.

Evolution of the symmetry energy and skins of mirror nuclei

[1]M. K. Gaidarov, [2]I. Moumene, [1]A. N. Antonov, [1]D. N. Kadrev, [3]P. Sarriguren,

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The knowledge of the neutron skin is important for nuclear physics and astrophysics, but its experimental determination faces many challenges. We calculate the neutron skin of a nucleus [1] by using the possibility to relate it with the difference between the proton radii of the corresponding mirror nuclei as an alternative way [2,3]. The calculations are based on the Hartree-Fock-Bogoliubov method by using the cylindrical transformed deformed harmonic-oscillator basis [4]. Predictions for proton skins are also made for several mirror pairs in the middle mass range. The correlation between the thickness of the neutron skin and the characteristics related to the density dependence of the nuclear symmetry energy [5,6] is investigated for Ni isotopic chain with mass number A = 48 − 60 and the respective mirror nuclei. These quantities are calculated within the coherent density fluctuation model [7,8] using Brueckner and Skyrme energy-density functionals for isospin asymmetric nuclear matter with two Skyrme-type effective interactions, SkM* and SLy4. Results are also presented for the symmetry energy as a function of A for a family of mirror pairs from selected chains of nuclei with Z = 20, N = 14, and N = 50. The evolution curves show a similar behavior crossing at the double-magic nucleus in each chain and a smooth growing deviation when N 6= Z starts. Comparison of our results for the radii and skins with those from the calculations based on high- precision chiral forces [2] is made.

References:

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[5] M.K. Gaidarov, A.N. Antonov, P. Sarriguren, and E. Moya de Guerra, Phys. Rev. C 84 (2011) 034316; Phys. Rev. C 85, 064319 (2012).

[6] M.K. Gaidarov, P. Sarriguren, A.N. Antonov, and E. Moya de Guerra, Phys. Rev. C 89 (2014) 064301.

[7] A.N. Antonov, V.A. Nikolaev, and I.Zh. Petkov, Bulg. J. Phys. 6 (1979) 151; Z. Phys. A 297 (1980) 257; ibid 304 (1982) 239; Nuovo Cimento A 86 (1985) 23; A.N. Antonov et al., ibid 102 (1989) 1701; A.N. Antonov, D.N. Kadrev, and P.E. Hodgson, Phys. Rev. C 50 (1994) 164.

[8] A.N. Antonov, P.E. Hodgson, and I.Zh. Petkov, Nucleon Momentum and Density Distributions in Nuclei, Clarendon Press, Oxford (1988); Nucleon Correlations in Nuclei, Springer-Verlag, Berlin-Heidelberg-New York (1993).

Role of nuclear tensor within Skyrme mean-field approach on deformed magic numbers in rare-earth region

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A small peak in the solar abundances around the mass number, A = 160 in the rare-earth region due to the rapid neutron capture process has been associated with maximum nuclear deformation which stabilizes the nucleus similar to the role of shell closure. This leads to the idea of a deformed magic number associated with neutrons. From the experimental side, the actual neutron deformed magic numbers in this region are still far from certain. There has been a suggestion that N = 100 is a deformed magic number but this was challenged just 3 years after. Other neutron magic numbers were also proposed for e.g., N= 98 around Z = 64, N = 104 in mid rare-earth element, and N = 108 for Z = 72, 74 and 76. On the theoretical side, attention was paid mostly to lighter rare-earth with Z = 62, 64 and 66. The studies performed without including nuclear tensor force supported the magicity of N = 100 for these elements. In our work, we explore the impact of nuclear tensor using the fully fitted Skyrme TIJ forces on two-neutron separation energy differential for elements with Z = 62 up to Z = 70. We will present these findings as well as highlighting the role of tensor coupling in determining the neutron magicity in this region.

Results from the EMPIRE code for reaction cross-section calculations

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The EMPIRE code is a modular system of nuclear reaction codes for advanced modelling of nuclear reactions using various theoretical models, designed as a general, flexible and easy-to-use tool for basic research and evaluation of nuclear data, operated through the Graphical User Interface (GUI). It consists of a set of FORTRAN codes, an input parameter library, and an experimental data library (EXFOR/CSISRS). It offers the possibility to combine various theoretical approaches in a single study, to choose among alternative input parameters, and to calculate an expanded set of observables. Nuclear data evaluation is facilitated by ENDF-6 formatting, file validation, and graphical comparison with experimental data. Experimental cross-section results of some exotic nuclei will be compared with the calculation performed using EMPIRE and results of this comparison will be presented.

Nucleon densities of Lanthanum isotopes calculated by Skyrme and Gogny models

Ferhan Akdeniz[1,a], Ismail Hakki Sarpun[1,2], Eyyup Tel[3], Abdullah Aydin[4]

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Proton and neutron densities of the Lanthanum isotopes, namely $^{135, 137, 138, 139}$La were calculated with both Hartree-Fock (HF) and Hartree-Fock-Bogolyubov (HFB) approximation. The ground-state properties of the nuclei are generally calculated using two different methods, namely Skyrme and Gogny interactions. Skyrme interactions use with Hartree-Fock (SHF) and Hartree-Fock-Bogolyubov (HFB-S) approximation, which uses Woods-Saxon (WS) and Harmonic Oscillator (HO) potentials. Gogny forces use with Hartree-Fock-Bogolyubov (HFB-G) approximation methods. In this study, the densities and the rms radii for both proton and neutron of La isotopes were calculated using four different approximation methods, namely SHF-HO, SHF-WS, HFB-S and HFB-G. In SHF methods different Skyrme interaction parameter sets have been used for best conformity between theoretically calculated charge radius and experimental data of Angeli and Marinova. Then, nucleon densities, obtained with four theoretical calculations, compared in each other. For all Lanthanum iso topes, all methods give similar results.

Search for eta-mesic nuclei with WASA at COSY facility

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The existence of eta-mesic nuclei in which the eta meson is bound in a nucleus by means of the strong interaction was postulated more than 30 years ago, however, it has not been yet confirmed experimentally. The discovery of this new kind of exotic nuclear matter would be very important as it might allow for a better understanding of the eta meson structure and its interaction with nucleons. The search for eta-mesic helium is carried out with high statistics and high acceptance with the WASA detector, installed at the COSY accelerator in the Research Center Juelich. The search is performed via the measurement of the excitation function for selected decay channels of the 4He-eta and 3He- eta systems. The talk will include a description of the experimental method used at WASA and the status of the data analysis.

Prediction of cluster radioactivity of Z=118 isotopes

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The cluster decay process in unknown even-even superheavy nuclei (SHN) for Z=118 (A=298-312) isotopes has been investigated using a semi-classical approach. Minima obtained in the values of Gibbs free energy for the various combinations of daughter nuclei produced via cluster decay process (Zc=6 to Zc=42) has been chosen as the criteria for the most probable decay mode in superheavy nuclei. Utilizing periodic-orbit theory within microscopic-macroscopic formalism, we have calculated the binding energies and thereafter, cluster disintegration energies (Qc-values) of superheavy nuclei. The logarithmic values for cluster decay half-lives are determined using the empirical methods: the Universal Decay Law (UDL), the Universal formula for cluster decay (UNIV) and the scaling law of Horoi. The dominant decay mode is predicted by calculating the branching ratios relative to alpha decay and spontaneous fission, respectively. These predictions may guide for further experimental investigation on cluster radioactivity in the identification of exotic nuclei.

Binding and bonding of cascade hyperons in nuclei

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The production of hypernuclei beyond the normal neutron-dripline is an outstanding challenge. Previously, we developed a theoretical model to calculate hypernuclear binding energies which led to the first suggestion that bound Lambda-hypernuclei may exist beyond the neutron-dripline. We now show that Cascade-hypernuclei may also exist in this regime. Importantly, Cascade-hyperons that are negatively charged reduce the Coulomb repulsion arising from the positively charged protons in the hypernuclei and thereby have increased separation energies compared to uncharged Lambda-hyperons. Consequently, we predict the existence of a "valley" containing multiple bound Cascade-hypernuclei beyond the neutron-drip line. In this talk, I will describe the binding and bonding characteristics of Cascade hyperons and discuss how these results may be utilized to guide the production of exotic strange hypernuclei which have remained elusive to date.

A new parameter set for extended Thomas-Fermi model

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A Variational Monte Carlo (VMC) method is employed to determine the new parameter set for the Extended Thomas–Fermi Model (ETFM). The realistic Urbana V14 two nucleon interaction potential of Lagaris and Pandharipande was used in the VMC calculations. Also, using the new three-nucleon interaction (TNI) potential term. The properties of nuclear matter were calculated with the new parameter set.

Quantum fluctuations in energy for hot relativistic fermionic gas

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Explicit expressions for quantum fluctuations of energy in subsystems of a hot relativistic gas of spin-1/2 1/2 particles are derived. The results depend on the form of the energy-momentum tensor used in the calculations, which is a feature described as pseudo-gauge dependence. However, for sufficiently large subsystems the results obtained in different pseudo-gauges converge and agree with the canonical-ensemble formula known from statistical physics. As different forms of the energy-momentum tensor of gas are a priori equivalent, our finding suggests that the concept of quantum fluctuations of energy in very small thermodynamic systems is pseudo-gauge dependent. On the practical side, the results of our calculations determine a scale of coarse-graining for which the choice of the pseudo-gauge becomes irrelevant.

Production cross-section and reaction yield of ^{82}Sr for $^{82}Sr/^{82}Rb$ generator

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There are many radioisotopes used for diagnostic and therapeutic purposes in nuclear medicine. One of the radioisotopes used for diagnostic purposes is ^{82}Sr. It is used in positron emission tomography (PET) as to be positron emitter and commonly obtained from $^{82}Sr/^{82}Rb$ generator. In this study, we have investigated some possible production mechanisms of ^{82}Sr by regarding $^{82}Sr/^{82}Rb$ generator. $^{85,87}Rb(p,xn)^{82}Sr$ and $^{80,82,83,84,86}Kr(^{3}He,xn)^{82}Sr$ reaction channels have been investigated using the CTFGM, BSFGM, and GSM models within the framework of TALYS nuclear reaction code. It has been seen that the production cross-sections, reaction yields and total activation values calculated up to 60 MeV beam energy value are in good agreement with the available data in the literature.

Neutron single-particle states in ^{101}Sn by polynomial fits and SM calculations

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The region around the doubly magic nuclide sn100 is very interesting for nuclear studies in terms of structure, reaction and nuclear astrophysics. The main ingredients in nuclear structure studies using the shell model are the single-particle energies and the two-body matrix elements. To obtain the former, experimental data of ^{101}Sn isotope spectrum are necessary. Since there is not enough experimental data, different approaches are used in the literature to obtain single-particle energies. Brown et al used the hole excitation spectrum in ^{131}Sn to determine neutron single-particle energies in sn100pn interaction. The other approach is the use of the lightest isotope, ^{107}Sn, which figures the model space orbitals. In this work, we do second-order polynomial fits of the tree single-particle states $2s_{1/2}$, $d_{3/2}$ and $h_{11/2}$ in the light tin isotopes up to ^{113}Sn and ^{115}Sn which are not determined yet experimentally. By an extrapolation toward light tin isotopes, we can obtain the excitation energies of all the single-particle states in ^{101}Sn. Subsequently, neutron SPEs of the model space orbitals are defined. Shell model calculations for even and odd Sn isotopes are carried out using NushellX@MSU code for the two sets and compared with the experimental data and results obtained using the widely used interaction in the region, sn100pn. Results are faire and some perfection is needed especially for some high spin states.

Gamma radiation analysis and radiological hazards assessment in granite samples commonly used in Algerian building constructions

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Granite is widely used as finishing materials in Algerian building constructions, they are classified as a source of hazardous contamination because of their naturally occurring radionuclides content, mainly Uranium and Thorium families and the radioactive isotope of Potassium. The presence of such primordial radionuclides in granites is due to their natural composition of soil and rocks. To estimate the harmful effects of ionizing radiations emitted by these materials, broad investigations of natural radioactivity levels must be established. In this study, twenty samples of granite materials used in Algerian dwellings were collected from dealers. The samples measurements were undertaken by gamma spectrometry, using a high-resolution HPGe semiconductor detector with (1.8 keV for ^{60}Co keV line). The spectra were analyzed using the Genie 2000 software dedicated to the processing of gamma spectra. Activity concentrations of radionuclides of interest ^{232}Th, ^{226}Ra and ^{40}K were determined, they were found within the worldwide average values. The presence of anthropogenic radionuclide ^{137}Cs was found in some samples with low activity concentrations. Radiation hazard parameters and received doses were calculated and compared to worldwide average values. Further, statistical analyses were performed and discussed for the resulted data.

A dosimetric comparison of 3D conformal therapy and volumetric intensity modulated arc therapy for the treatment of nasopharyngeal carcinoma

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Currently, with the evolution of radiotherapy treatment techniques, the VMAT (Volumetric Modulated Arc Therapy) became a tool of choice in the treatment of complex shapes tumours of head and neck cancers. On another side, three-dimensional conformal radiotherapy (3D- CRT) using the five-field method, is a conventional technique that has been long used as a standard in the treatment of head and neck cancers. In this study, the potential benefits and limitations of each technique have been assessed using the comparative treatment planning method. For this study, 3D- CRT and VMAT treatment plans were calculated for ten consecutive patients with nasopharyngeal cancer. The plans were compared in terms of dose coverage and toxicity, dose homogeneity index (HI), dose compliance index (CI) and quality index (QI). Our Results show that VMAT assures better preservation of parotid glands, total optic and brainstem and good coverage of target volumes. Also, VMAT and 3D-CRT have different values for all the indices analysed (TC, CI, HI and IQ). To conclude, the study confirms that VMAT is superior to 3D-CRT in the treatment of nasopharyngeal carcinoma.

Keywords: *VMAT, 3D-CRT, planning comparison, Nasopharyngeal cancer.*

Monte Carlo simulation on human heterogeneous organs

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Cancer is a major public health problem. Treatment can be done in a systemic or locoregional way. In this case, the treatment technique is important to specify the right localisation of the tumour. The Monte Carlo GEANT4/GATE was applied in different simulations on homogenous and heterogeneous phantoms to visualize the proton beam dose distribution in all the tissues and to reproduce the pulmonary heterogeneity with a small tumour represented by a target size of 2mm. **Keywords:** Monte Carlo simulation, Geant 4/GaATE, radiotherapy.

Spectroscopic study of ^{9}Be (*p, γ*) ^{10}B at astrophysical energy

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Nuclear reaction rates are quantities of crucial importance in nuclear astrophysics. A considerable attempt has been devoted in the last decades to measuring or calculating them. The reactions ^{9}Be (p, γ) ^{10}B have been studied at energies inside the astrophysically relevant energy window in terms of the potential model. The total cross-section is taken as the sum of both direct and partial resonance transitions. Based on the computed cross-section we calculate the nuclear reaction rates within the selected range of temperatures. Our calculated model-based nuclear rates and cross-section at zero energy shows a satisfactory agreement with the previously published results.

Vortical excitations in nuclei: Recent progress

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During the last decades, the vortical properties of nuclear excitations attract high attention. These excitations are, to a large extent, beyond the continuity equation and represent an important but yet poorly explored kind of nuclear dynamics. I briefly review some recent topics in this activity: toroidal vortical dipole resonance and its relation to the pygmy dipole resonance [1-3], individual low-energy E1 toroidal states (TS) in light deformed nuclei (^{24}Mg [4], ^{20}Ne [5], ^{10}Be [6]), the interplay of vortical states with cluster modes in light nuclei [7], possible ways for identification of individual toroidal states in the experiment [8], some open problems and prospects.

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Ground-state properties and decay rates of isotopic chain of Molybdenum

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Beta-minus and electron capture decays are important processes for the late phases of the evolution of heavy stars. The relative abundance coupled with the stellar weak rates on Mo isotopes may affect the lepton-to-baryon content of the core material. In the present study, we have calculated nuclear ground-state properties of Mo isotopes (N=82−138) such as binding energy per nucleon, neutron and proton separation energies, charge radii, total electric quadrupole moments and deformation parameter of electric quadrupole moments by using a density-dependent version of the RMF model. Later we have calculated the weak decay rates of the considered isotopes by using the pn-QRPA model. The calculated electric quadrupole deformation parameters have been used in a deformed pn-QRPA calculation to calculate half-lives and weak decay rates for these Mo isotopes in the stellar matter. We have calculated the electron capture and β-decay rates over an extensive range of temperature (0.01 × 10E9 K to 30 × 10E9 K) and density (10 to 10E11) g/cm^3. The results of the study can be useful for the simulation of presupernova evolution

Clustering phenomenon in the decay of light mass composite nuclei

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The dynamical cluster decay model (DCM), has been successfully employed for the study of a range of compound nuclei in different mass regions including that of the very light mass region i.e. A~20-40, to explore the dynamics of clustering effects for the same [Phys. Rev. C 95, 014611 (2017), Nucl. Phys. A 969, 14 (2018)]. It is pertinent to this dynamical approach that the fragment/cluster emission from the composite nuclei has to follow the two-step process. The DCM calculated results for the composite nuclei have been compared, quite successfully, with the experimental data. While doing so, the different mechanisms like that of fusion-fission and deep inelastic orbiting have also been addressed in these studies.

Geant4 investigation of the alpha-beta-gamma detector system used in medical imaging, environmental and nuclear site monitoring

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No commercially available detector system can measure alpha, beta and gamma-rays at the same time and separately with good efficiency while being cost-effective, portable and offering real-time monitoring. The main purpose of an alpha-beta-gamma detector would be for safety management and nuclear decommissioning in the nuclear industry. This idea for a detector system became more valuable, after Fukushima in Japan, because nuclear waste can contain fission products and transactinide materials which not only emit gamma-rays but also emit alpha and beta particles and in some cases, neutrons. In this research, we investigated the best available alpha-beta-gamma radiation detector materials and their optimum thickness by using Geant4 based GATE simulation. The work revealed a better efficiency result for each radiation type than in previous work. In the simulation, 0.05mm ZnS(Ag), 3.2mm plastic scintillator and 1.75mm BGO was found to be best for the detection and identification of alpha, beta and gamma-rays respectively. In nuclear medicine, this type of detector system could also modify to become a miniaturized radio-guided surgery beta- gamma probe besides the modification into robotic surgery. This research result will influence three different areas in imaging technology, homeland security and the nuclear industry.

Spin-orbit splitting of protons and neutrons

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The nuclear shell structure was based on the assumption of the spherical symmetric potential governing the motion of the individual nucleons in the nuclei. The single-particle energy levels have been calculated using the potential having the intermediate shape between the square well and the harmonic oscillator well potential. The introduction of the spin-orbit coupling with shell model potential reproduced the magic number correctly, by shifting the highest j states downwards and the energy levels of the lowest j state were shifted upwards. In the present study, the single-particle energies for both protons and neutrons are calculated using the difference between the experimental binding energies of the core nucleus and the corresponding adjacent nuclei [1]. The difference between these single-particle energies yields the spin-orbit splitting of protons and neutrons. The results pertaining to the spin-orbit splitting of protons and neutrons and associated nuclear phenomena will be presented.

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Advanced generation hybrid type pusher D-T fusion plasma fueled rocket modelling

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Developed states, scientists, and great entrepreneurs have constantly accelerated their advanced research projects agency into nuclear-powered spacecraft and rockets to gain the upper hand for future generations. A fusion D-T rocket is a simulation design for a fusion-powered rocket capable of providing efficient and long-range acceleration in space without the need for a large fuel source. However, this system is a larger and more complex model. Also, a potentially advantageous option is possible. The instant availability of the system hybrid type (fission + fusion) energy, the scope of this study, as part of a subcritical working spacecraft to be replaced traditional electric drive arrangement that can contain high power plasma. It is possible to transform it into a production/acceleration structure.

In this study, this system with D-T fuel is a magnetically printed controlled design with smaller lighter magnetic restraint that is more effective with the MCNP-5X nuclear modelling. In addition, it may be possible to develop continuously in the future with new mathematical theory and simulation to prevent plasma imbalances. The system can provide a lighter and more compact alternative based on fusion energy, just as the field can be analyzed like a fusion engine based on an inverted configuration.

Study of the astrophysical $^{25}Al(p,\gamma)^{26}Si$ nuclear reaction

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The major challenge in nuclear astrophysics is to find ways to determine reaction rates at excitation energies relevant for burning in the stellar environment. These rates depend upon the spectroscopic properties of states in the produced nucleus. The *rp*-process reaction rates are crucial nuclear physics input to astrophysical models of nucleosynthesis in novae, supernovae, and explosive hydrogen burning conditions. Silicon burning is a very brief sequence of nuclear fusion reactions that occur in massive stars with a minimum of about 8-11 solar masses. It is the final stage of fusion for the massive star. It follows the previous stages of hydrogen, helium, carbon, neon, and Oxygen burning processes. Some silicon isotopes are one of the elements produced in space through the *rp*-process. As an example, we quote the $^{25}Al(p,\gamma)^{26}Si$ reaction, which attracted our attention. In our work, we determined the spin/parity assignments in ^{26}Si, especially, those of astrophysical interest above the proton threshold, 5513.8 keV based on the comparison to the shell model using the PSDPF interaction and the analogue assignments of the T=1 states in ^{26}Mg and ^{26}Al. These levels are essential to calculate the $^{25}Al(p,\gamma)^{26}Si$ reaction rate which will be presented in this contribution.

Exotic nuclei studied with NUSTAR at FAIR/GSI

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Exotic nuclei studied with NUSTAR at FAIR/GSI J. Gerl GSI/FAIR Darmstadt, Germany Recently the DESPEC nuclear spectroscopy campaign started at the SIS/FRS facility at GSI as part of the FAIR/NUSTAR Phase-0 program. It aims at the investigation of exotic heavy nuclei produced in fragmentation reactions employing detectors and instrumentation developed for the FAIR facility. An important aspect of the program is the training of students and young researchers in the field. Despite the Covid-19 pandemic, a novel fast-timing spectroscopy set-up has been commissioned and the first experiments have successfully been performed. Physics topics include the evolution of the shell structure around ^{100}Sn, basic decay information of n-rich isotopes at N=126 below ^{208}Pb and octupole correlations of n-rich actinide isotopes. Novel experimental techniques and first results will be presented.

Coalescence theory in heavy-ion collisions

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Many new baryons and nuclear clusters can be obtained in the peripheral or central nucleus-nucleus collisions. In the literature, the phenomenological coalescence models were used extensively for the description of light nuclei from these baryons in a very broad range of collision energies. We propose that the coalescence nucleation process can be effectively considered as the formation of low-density baryon matter which can be subdivided into primary diluted clusters with limited excitation energy, and the following statistical decay of such clusters leading to the final cold nuclei production. We reproduce the experimental fragment yields (FOPI data) including the important collision energy dependence of He isotope production in relativistic ion reactions. We investigate the regularities of this new kind of fragment production, especially their yield, isospin, and kinetic energy characteristics.

Analyses of multi-pion Bose-Einstein correlations for granular sources with coherent droplets

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The ALICE Collaboration measured the three and four pions Bose-Einstein correlations for Lead-Lead collisions at the Large Hadron Collider. It is speculated that the observed significant suppression of multi pions correlations is owing to a considerable degree of coherent pion emission in these collisions. Here, we investigate the multi-pion Bose-Einstein correlation functions for granular sources with coherent pion-emission droplets. We find that the intercepts of the correlation functions at the relative momenta near zero are sensitive to the number of droplets in the granular source. They decrease with the number of droplets. The three-pion correlation functions for evolving granular sources with momentum-dependent partially coherent pion-emission droplets agree with the experimental data for Pb-Pb collisions at TeV at the LHC. Investigations into normalized multi- pion correlation functions of granular sources suggest an interesting enhancement of the normalized four-pion correlation function in the moderate relative-momentum region.

Cross-sections and thermonuclear reaction rates for $^{181}Ta(\alpha,n)^{184}Re$ reaction

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Since the models used in stellar evolution and nucleosynthesis studies are highly dependent on these data, cross-section experimental data are of great importance for thermonuclear reaction rate determinations. Especially cross-sections in the low energy region are important in the design of reactors. Tantalum (Ta) is a promising building material, so studying its interaction with alpha is extremely important.

Shell closure at N, Z = 40 in the vicinity of ^{56}Ni region

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Spectroscopic properties of even-even ^{58,70}Ni isotopes and N=28 isotones with 30 ≤ Z ≤ 42 around Ni-56 were studied by performing shell model calculations using Nushell code [1] with different effective interactions JUN45 [2], jj44b [3] and jj44pna [4] for f5pg9 model space. We aim ito predict the eventual existence of new magic number in these nuclei. The calculated energies $E(2_1^+)$ of the first excited state, the reduced electric transition probabilities $B(E2;\ 2_1^+ \rightarrow 0_1^+)$, the ratio $R_{4/2}$ of the excitation energies and the ratios $B_{4/2}$ of reduced transition probabilities are compared with the available experimental data [5]. Our present investigation forecasts that N,Z=40 is a new magic numbers for Ni-56 region.

Keywords: Nushell code, JUN45, jj44b and jj44pna interactions, $E(2_1^+)$energies, reduced transition probabilities $B(E2)$, $R_{4/2}$and $B_{4/2}$ratios.

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Spatial distribution of major, minor and trace element in semiarid land of western Algeria

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The characterization of the content and source of Major, Minor and trace element in soils are necessary to establish quality standards on a regional level that allow the detection of sampling sites affected by pollution. The objective of this work is to set a baseline of the elements composition of agricultural soil in a small watershed located approximately 40 km east of the city of Tlemcen in the NorthWest of Algeria. A total of 25 soil samples were collected manually at 04 points, for each sampling point, paedological pits of dimensions 30 × 30 × 30 cm were dug and 6 samples at the depths 0–5, 5–10, 10–15, 15–20, 20–25 and 25–30 cm were taken. The distribution of major and trace elements was systematically investigated using a combination between the Energy Dispersive Xray Fluorescence technique (ED-XRF) and the Wave Dispersive X-ray Fluorescence (WDXRF). The obtained results indicate that the concentrations of major, minor and trace elements in the soils were mainly controlled by natural sources, and do not present any ecological risk. Further research in other areas of the region would improve the basis for proposing such soil quality standards.

Keywords: Soil Characterization, ED-XRF, WD-XRF, Major and Trace Element distribution Pollution sources.

Dosimetric properties of opagis drug: An EPR study

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Nowadays, it has become of vital importance to determine the radiation dose that living beings are exposed to by using dosimeters, due to a large number of applications of radiation. Especially in radiation accidents, measuring accurately and quickly the doses exposed by the victims can enable immediate and appropriate medical treatment. Thus, it is very important to investigate the dosimetric properties of materials located near and/or on persons. Electron Paramagnetic Resonance (EPR), the unique spectroscopic technique used for the direct determination of paramagnetic centres with unpaired electrons, is widely used in dosimetric studies. In this study, the dosimetric properties of the drug Opagis (30mg), whose active ingredient is Lansoprazole, were investigated using the EPR technique. Firstly, the sample was heated up to 200^{o}C in an ashing furnace and it was observed that due to its organic nature it was not resistant to temperature and therefore it cannot be a Thermoluminescence (TL) dosimeter. Then for EPR studies; a dose-response study was performed in the dose range of 10-900 Gy after irradiating the sample with a ^{60}Co gamma source, and the dose sensitivity of the radiation-induced radical was determined. To determine the stability of radiation-sensitive radical, room temperature kinetic study and also isochronal-isothermal annealing experiments were performed. This drug, which is frequently used in the treatment of gastroenterological diseases, can be used as a potential ESR dosimeter in nuclear accidents because it can be on or near many people because of its cheapness and easy availability.

Keywords: Opagis, Lansoprazole, Radiation dosimeter, Electron Paramagnetic Resonance (EPR)

A new approach to nuclear reaction mechanism in dense matter. Thermonuclear and pycnonuclear reactions

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Pycnonuclear reactions take place in the high-density matter during nuclei are frozen in metallic lattices and it is very crucial to understanding the mechanism for cold cores of White dwarfs and in crusts of accreting neutron stars. The zero-temperature pycnonuclear reactions are possible because of the reduction of the Coulomb barrier by the Screening potential and overlap of nuclear wave functions. However, Thermonuclear fusion occurs in relatively hot and dilute plasmas inside stars. In this work, a new theoretical approach will be presented for the reaction rates which is temperature independent but increases exponentially with increasing density and enhancement factors for different fusion reactions.

Calculation of the photon pair production cross-section by artificial neural network

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Photon pair production is the most likely photon interaction at high energies. Many efforts have been performed in pair production cross-section calculation. Artificial neural networks have emerged with successful applications in nuclear physics as well as in many fields of science in recent years. In this paper, the artificial neural network was used to calculate photon pair production cross-section. Multilayer perceptron feedforward artificial neural network model was used to fitting the reference values for pair production cross-section. Results show a good agreement with the experimental values. Also, other statistical tests were examined to show the accuracy of the proposed method.

Coriolis contribution to excited states of odd-mass nuclei with deformation-dependent mass formalism

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For heavy deformed odd mass nuclei, we investigate the effect of Deformation-Dependent Mass Formalism (DDMF), when Coriolis interaction between the rotational and single-particle motions is included in the Bohr Hamiltonian, on the structure of nuclear excited states and the moments of inertia.

Proton drip line neighbouring nuclei and nuclei structure

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Nuclei lie near nucleon drip-lines provide the opportunity to improve our theoretical nuclear model, to develop our knowledge about the nuclear structure and to predict spectroscopic properties of such instable systems. In the aim of studying nuclei close to the proton drip-line, some spectroscopic calculations are realised using NuShellX@MSU nuclear structure code. The calculation is carried out using ni56pn modified effective interaction in ^{100}Sn mass region near the rp-process path. The obtained results are compared to the available experimental data.

Keywords: Proton Drip-Line, Spectroscopic Properties, NuShellX@MSU Nuclear Structure Code, 100Sn Mass Region

Study of column of flow-rig using technical radiotracer

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Reactors represent the heart of industrial installations and their operating characteristics condition the installations located upstream and downstream. Therefore, the precise knowledge of the flow dynamics of the material flows in industrial reactors remains necessary to evaluate their performance but also the performance of the whole process. Several parameters used for the hydrodynamic characterization of reactors can be obtained directly by measurements of the residence time distribution (RTD): mean residence time, variance, Peclet number, axial dispersion coefficient. The flow rate, being indirectly related to these parameters can have significant effects on these RTD measurements and consequently on the hydrodynamics of industrial reactors. In the present study, evaluations of the RTD, at different feed rates, were performed in a laboratory-scale flow rig column -assimilated to an industrial reactor-, using Technetium-99m as a radiotracer. Technetium-99m was injected instantaneously at the inlet of the system, four NaI(TI) scintillation detectors were placed at different positions to follow the evolution of the radioactive material and to verify by the transit time method the flow rate. The spectra obtained have been analyzed to get the maximum information about the system study at different values of the flow, and consequently to evaluate its effect on the installation studied which is the main objective of this work.

Keywords: Residence time distribution, hydrodynamic characterization, radiotracer, Technétium- 99m.

Minors and trace elements distribution in phosphate deposits using X-ray fluorescence

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The determination of minors and traces elements in Kef Es-Senoun deposit in Tebessa province (Eastern Algeria) is highly important for the characterization of Algerian phosphate in order to assess the pollution level of this site. The objective of this work is to study the distribution of minor and trace elements in different geological layers of the phosphate mine using ED−XRF technique. A total of three samples were collected from different layers. The preparation of phosphate samples required drying, crushing and sieving. After that, the phosphate samples were irradiated using X-ray fluorescence beam generated by Silver anode, with 40 KV and 20 micro-Ampere currents. The X-ray spectra were detected by means of SDD (Silicon Draft Detector) with high resolution 135 eV at 5.9 gamma energy of Fe-55, during 300 seconds. The X-ray spectra were treated using the Axil software dedicated to the processing of X-ray spectra. The elements' concentration was determined using the external standards method.
Keywords: Phosphates, X−ray fluorescence, Axil software, major and minor elements distribution.

Analysis of two-proton radioactivity half-lives of nuclei

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A new form of nuclear potential between two protons and the daughter nucleus comprising of deformation dependent proximity and Coulomb potentials is used to determine the two-proton radioactivity half-lives of nuclei. A comparison with the experimental data and the other theoretical results of ground and isomer states of nuclei undergoing such radioactivity demonstrate that our model can reproduce the half-lives of the order of magnitude possessed by experimental ones. We believe that such a study would find its way to the corridors of the superheavy regime as well where alpha-decay and spontaneous fission are established as the dominant modes of disintegration.

Chasing $\mathrm{B(E2)}_{4_1^+/2_1^+}$ anomaly

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An atomic nucleus is a quantum-many body problem, and its geometry differs from a spherical one by increasing neutron number in the isotopic chain. These geometries are determined with three paradigms, which are vibration, symmetric rotation and γ −soft or axially asymmetric rotation. Each of these limits has its specific experimental footprints. One of the footprints is the reduced transitional probability values; $B(\mu\lambda;\ L \rightarrow L - \lambda)$. Reduced transition probability for an electric quadrupole transition is given as $B(E2;\ L \rightarrow L - 2)$ and this quantity is one of the direct measurements of the deformation in the atomic nucleus, the higher B(E2) means the higher deformation. $\mathrm{B(E2)}_{4_1^+/2_1^+}$ is equal to 2, 1.42 and 1.34 for a vibrator, symmetric rotor and γ −soft nuclei, respectively. Recent lifetime measurements revealed that the $\mathrm{B(E2)}_{4_1^+/2_1^+}$ ratio is far less than unity in several nuclei [1-4]. From the theoretical point of view, the origin and the underlying structure giving rise to this anomalous behaviour remains unexplained up to date. On the other hand, a quantum phase transition from seniority-conserving structure to a collective regime as a function of neutron number around $\approx$ 90-94 has been proposed for these nuclei from the phenomenological point of view [3]. In the present talk, we are aiming to discuss our ongoing experimental [5-6] and theoretical programs [7-8] to investigate and understand the underlying structure of the anomalous behaviour as a function of neutron, proton and NpNn number.

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Exploring heavy-ion collisions with the FAZIA multi-telescope array

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Heavy-ion collisions are a key tool to investigate the properties of the nuclear Equation of State (nEoS) above and below the nuclear saturation density. Indeed, interesting signals have been observed in peripheral and semi-peripheral collisions within the so-called Fermi energy domain (25- 50 MeV/u), where two main exciting fragments arise after the collision, but preserving the memory of the entrance channel: the so-called quasi-projectile and quasi-target. During the projectile-target interaction, the system is expected to experience densities far from the normal one and the nucleon exchanges are driven by the nEoS. To this end, the FAZIA collaboration has developed a telescope array, which represents the state of art of solid-state detectors. Such a device combines the granularity of the array detectors and the isotopic identification of mass spectrometers up to Z~25. For the first time, this has allowed us to isotopically identify the emerging quasi-projectile remnant and also the accompanying fragments, thus extracting information about the nucleon exchange that occurs during the projectile-target interaction. In this contribution the experimental campaigns of the FAZIA collaboration at the INFN Laboratori Nazionali del Sud will be presented (2015-2019), showing both experimental results and comparisons with available theoretical models.

Results from the PACE4 code for fusion evaporation reaction cross-section calculations

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The fusion-evaporation code PACE4 [1] is a modified version of PACE (Projection Angular Momentum Coupled Evaporation) that was originally written by A. Gavron [2]. The code work in the framework of LISE ++ [3]. PACE is a very commonly used code for fusion-evaporation measurements. The code PACE4 based on Hauser-Feshbach theory for CN (Compound Nucleus) decay and uses the Monte Carlo approach for the De-excitation of the compound nucleus. The code uses the BASS Model to determine compound nuclear fusion cross-section. The performance of this code will be tested using experimental cross-section results of some exotic nuclei and results of this comparison will be presented.

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Tensor force effect on the neutron shell closure in Z=114 super-heavy element

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A systematic study of the effect of tensor force on the evolution of shell structure in the even-even super-heavy nucleus with proton number Z=114 in the region of neutron numbers 178 ≤ N ≤ 188 is presented. We use, in this investigation, the Hartree-Fock framework by means of different types of Skyrme functionals in two cases with and without tensor force. The Bardeen-Cooper-Schriefer (BCS) approximation has been used to treat the pairing correlations. By investigating structural and decay properties of the nucleus under consideration, it is found that N=184 shell gap is more enhanced by the tensor interaction which depends on the isoscalar tensor coupling constant C0J of the used Skyrme interactions. In the case without tensor interaction, this gap is significant only for T22, T24, T42 and SLy5. So, it disappears with T46, T64 and T66, and is too weak for T26, T44 and T62. Without exception, the shell gap at N=184 becomes more pronounced when the tensor part is taken into account.

Gamow-Teller resonances and beta decay half-lives of nuclei at finite temperature

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Presently, understanding the behavior and properties of nuclei under extreme conditions of isospin and temperature is a major area of interest within the field of nuclear physics because of its relevance to better understand the behavior of nuclei and some astrophysical processes. In this framework, the nuclear energy density functional theory is known as a reliable and powerful tool to study the ground-state and excited-state properties of nuclei all over the nuclear chart. In this talk, I will present our results for the Gamow-Teller excitations in nuclei using the finite temperature proton-neutron QRPA based on the relativistic nuclear energy density functional theory. The effect of the temperature on the excitation energies and strength functions of the Gamow-Teller excitations will be investigated for the selected open and closed-shell nuclei. I will also discuss the interplay between the temperature and pairing effects at low temperatures, where both effects are relevant. Finally, the impact of temperature on beta decay half-lives of nuclei will be presented.

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Preformation probability of complete binary fragments of ^{294}Og

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Preformation probability for the complete binary decay of ^{294}Og formed in the heavy-ion fusion reaction is studied in the framework of Yukawa-plus-exponential (YEM) potential with a third-order polynomial potential [1,2] for the overlapping region, incorporating temperature through the surface energy constant of liquid drop model. Poenaru et al [3], considered the penetration probability corresponding to the overlapping potential as the preformation probability of the alpha or cluster and this idea is used to calculate the preformation probability of complete charge minimized binary fragments of ^{294}Og formed in the heavy-ion fusion reaction. Temperature is incorporated through the surface energy constant of the liquid drop model from which YEM stems. Preformation probability has been calculated for the use of both reduced mass and hydrodynamical mass. Results pertaining to the study will be presented.

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Davydov-Chaban Hamiltonian within the formalism of deformation-dependent effective mass for Kratzer potential

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In this work, we modify the Davydov-Chaban Hamiltonian describing the collective motion of a gamma-rigid atomic nucleus by allowing the mass to depend on nuclear deformation. Exact analytical expressions are derived for energy spectra as well as normalized wave functions for Davidson potential. The model called Z(4)-DDMD (Deformation Dependent Mass with Davidsonpotential), is achieved by using the Asymptotic Iteration Method (AIM). The numerical calculations for energy spectra and B(E2) transition probabilities are compared to the experimental data of $^{192-196}$Pt isotopes. The obtained results show an overall agreement with the experiment and an important improvement in respect to other models.

Excited states of the odd-mass nucleus ^{173}Yb with different deformation-dependent mass coefficients

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In this work, our purpose is to investigate the properties of low-lying collective states of the odd nucleus ^{173}Yb by using a new generalized version of the collective quadrupole Bohr Hamiltonian with deformation-dependent mass coefficients. The proposed new version of the Bohr Hamiltonian is solved for Davidson potential in β shape variable, while the γ potential is taken to be equal to the harmonic oscillator. The obtained results of the excitation energies and B(E2) reduced transition probabilities show an overall agreement with the experimental data. Moreover, we investigate the effect of the deformation-dependent mass parameter on energy spectra and transition rates in both cases, namely when the mass coefficients are different and when they are equal.

Puzzles of hypernuclei

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Experimental hypernuclear physics entered a new era in recent years by experiments employing heavy ion beams, i.e., the HypHI, STAR and ALICE experiments. These experiments have revealed a puzzle of the lightest know three-body hypernucleus, the so-called hypertriton on its lifetime and binding energy, though it is regarded as the benchmark of hypernuclear physics for seven decades. Furthermore, the HypHI experiment observed signals indicating the existence of the unprecedented Lambda-nn bound state but the theoretical calculations show negative results on its existence. These puzzles have become hot topics in hypernuclear and few-body physics, and they must be urgently clarified. We'll discuss our on-going unique approaches for solving the puzzles with the heavy ion beams, nuclear emulsion and machine learning. We'll also present our perspective beyond the puzzles.

Beta-decay of the neutron-deficient ^{60}Ge and ^{62}Ge isotopes at RIKEN

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Beta-decay has direct access to the absolute values of the Fermi and Gamow-Teller transition strengths. We obtained remarkable results in decay spectroscopy experiments, among which the discovery of the exotic beta-delayed gamma-proton decay in ^{56}Zn [1] and the first observation of the 2^+ isomer in ^{52}Co [2]. These studies are extended to higher masses and more extreme nuclear conditions thanks to the high-intensity radioactive ion beams available at RIKEN. New results concerning the beta decay of the neutron-deficient ^{60}Ge and ^{62}Ge isotopes [3] will be presented.

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Comparison of NaI(Tl) detector efficiency via measurements and Monte Carlo simulations and modelling new scintillations detector system

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The calibrations of the full energy peak efficiency, energy, and energy resolution are the main factors for successful quantitative gamma-ray analysis. In this research, these calibration factors of the NaI(Tl) scintillation detector system investigated in the experiment, and also the detector efficiency evaluated using Geant4 based GATE simulation. The experiment performed in Ankara University, Department of Physics using a 2"x 2" NaI(Tl) detector and radioactive point and cylinder-shaped sources that emit photons at different energies from 59 keV to 1408 keV. The analytical equations for efficiency calibration found out. Since the results obtained from the experimental and simulation are compatible with each other, the novel scintillation detectors (LaBr3, GAGG(Ce), and SrI) also modelled in the simulation.

Machine learning approach in particle pair investigation

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In high-energy physics experiments, to investigate the properties of a particle resulting from a collision, its decay products can be identified by using sophisticated techniques including a high level of computational and physics knowledge. Therefore identification of pairs is a challenging process requiring a long time to accomplish. Implementation of machine learning (ML) techniques in various fields become more and more popular to enhance human efforts with high efficiency. For this reason, the usage of ML approach in particle pair investigation is a necessity to overcome the mother particle determination puzzle. In this study, ML approach is used to understand electron-positron pairs from different sources as an example of pair identification in particle and nuclear physics experiments.

Diffraction cross-section measurements at the LHC

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The Large Hadron Collider gives a possibility to study the properties of diffractive physics in a new kinematic domain. Diffractive events can be identified in all major LHC experiments using the rapidity gap recognition method. ALICE is one of the large experiments at the LHC. It focuses on the study of heavy-ion collisions at ultra-relativistic energies. Its main goal is to study in great detail the properties of matter under extreme energy densities. The cross-sections of inelastic and diffractive processes in proton-proton (pp) collisions are among the basic observables used to characterize the global properties of interactions, and thus are always a subject of interest at a new centre-of-mass energy. In this conference contribution, the measurement of inelastic, single, and double diffraction cross-sections in pp collisions by the ALICE Collaboration at $\sqrt{s}$ = 0.9, 2.76, and 7 TeV will be presented. The relevance of diffraction to the understanding of inelastic pp interactions will be discussed.

Investigation of the effect of copper cooling rod on detector efficiency with monte carlo method in HPGe detectors

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PGe detectors are widely used in gamma spectrometry for the identification and quantification of samples due to their high energy resolution. The full energy peak efficiency (FEPE) determined by experimental or Monte Carlo (MC) simulation methods is a very important parameter in HPGe detectors. Instead of the experimental method, which has many disadvantages such as being time-consuming and costly, the use of the MC method is increasingly common. FEPE depends on detector parameters, source-detector geometry and energy. Therefore, the detector parameters provided by the manufacturer are of great importance in modelling the detector with the MC method. However, no information is given by the detector manufacturers about the thickness of the copper cooling rod, which is located in the middle of the detector hole and provides thermal conductivity.

In this study, the effect of copper cooling rod thickness on detector efficiency was investigated using PHITS MC simulation program. According to the radiological imaging results in the literature, its diameter was measured between 4-7 mm. The efficiency values were obtained by increasing the radius of the copper rod by 0.5 mm intervals from 1 mm to 3.5 mm for photons in the energy range of 59.5 keV-1408 keV. According to the results, it has been observed that the copper rod thickness causes a change up to 2% in the detector efficiency, especially in the high energy region.

Keywords: HPGe detector, PHITS, Monte Carlo, copper cooling rod, FEPE.

Investigation of secondary neutrons produced by proton and helium ion beams in water

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Hadron therapy uses particles with therapeutic energy to treat tumours and protect healthy tissues as much as possible. Proton and helium ions with energy ranging from 50 to 250 MeV per nucleon (MeV/A) depending on the depth of the tumour are successfully used in radiation therapy. Secondary neutrons the interaction of the particles with the patient's body is produced. Secondary neutrons cause undesirable dose contribution in healthy tissues close to the target volume and are important for the long-term health of cancer patients. Because of the high biological activity of secondary neutrons for cancer induction, it is very important to calculate even small neutron doses. This study aims to calculate and compare neutrons produced by protons and helium ions with therapeutic energy in a (20 cm)3 water cube with the PHITS Monte Carlo simulation code. The number of secondary neutrons in the total volume and dose distributions were obtained at certain depths. The number of neutrons produced 100 MeV per nucleon in the water phantom is 0.05 for proton and 0.38 for helium, respectively. As a result, it was seen that the number of neutrons produced by helium ions and the dose stored by neutrons increased compared to the proton.

Keywords: Hadrontherapy, Secondary neutrons, Monte Carlo

Artificial İntelligence: A laboratory for nuclear physics studies

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Artificial intelligence, which has become widespread in every field of science and technology in recent years, has taken its place as an alternative method in nuclear physics studies. With the use of existing data, the machines that are subject to learning can make predictions based on what they have learned, and complete future data or the deficiencies in the data set they belong to. From this point of view, it seems possible to carry out a nuclear physics experiment without the need for any experimental setup. For example, by using the binding energies of approximately 3000 isotopes whose experimental data are available in the literature, computers can be well trained about the binding energies of atomic nuclei. This training will open the door for us to correctly request information about any isotope whose experimental binding energy data is not available in the literature. Before artificial intelligence, computers could give us what we gave. However, with artificial intelligence, we can now get more than we give. They perform this training with the artificial neural networks (ANN) method, which models the work of the brain functionality and nervous system. The units of the ANN, which are named neurons, are connected by adjustable weighted connections. The main task in the method is to find the appropriate values for the connections. The more accurately we can find these values, the more valid our alternative nuclear physics laboratory will be. In this talk, how ANN is used as a nuclear physics laboratory will be discussed with examples.

Superconducting cavity design for linear accelerator systems and Cern-Atlas experiment adcos studies

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We study SRF photocathode gun cavity design and beam dynamics for various gun cavities at the linear accelerators. In addition, detailed studies have been made on the solenoid design and the location of the solenoid along the beam path. A design with the most optimized cavity geometry and RF fields for the gun cavity was posed. The injector system was designed for the Turkish SASE-FEL Project with cavities of many different geometrical sizes. The most efficient high energy cavity system is determined as 1.6-cell cavity. The emittance value of the beam was achieved as $1.76 \pm 0.42\ \pi\ mm\ mrad$and the beam energy reached at the end of the cavity was obtained as $3.5\ MeV$. I also study at the CERN-ATLAS Experiment participating in the Class1 and Class2 shifts, which is to take part in data distribution to the world. The ATLAS (A Toroidal LHC ApparatuS) detector represents the large collaboration work including many physicists, engineers, technician, and etc. After experiment started at CERN, especially the last ten years, I contributed the shift duties on Class1 and Class2-ADCoS (*ATLAS* Distributed Computing Operations Shifts) shifts at CERN-ATLAS experiment. Class2 shift includes data transferring all over the world depending on Tier Centers while Class1 focuses on run control. I summarize simulation studies and shift duties by using DDM Dashboard, transfer and deletion issues.

Keywords: Gun cavity, photocathode, CERN-ATLAS Experiment, ADCoS, DDM Dashboard

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The sextic potential within Bohr Hamiltonian for rigid nuclei in the presence of minimal length

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In the present paper, we study the collective states of even-even nuclei in gamma rigid mode within the sextic potential and the Minimal Length (ML) formalism in Bohr–Mottelson model. The eigenvalues problem for this latter is solved by means conjointly of Quasi-Exact Solvability (QES) and a Quantum Perturbation Method (QPM). Numerical calculations are performed for 35 nuclei: ($^{98-108}$)Ru, ($^{100-102}$)Mo, ($^{116-130}$)Xe, ($^{180-196}$)Pt, ^{172}Os, ($^{146-150}$)Nd, ($^{132-134}$)Ce, ^{154}Gd, ^{156}Dy and ($^{150-152}$)Sm.

Through this study, it appears that our elaborated model leads to an improved agreement of the theoretical results with the corresponding experimental data by reducing the rms with a rate going up to 63% for some nuclei. This comes out from the fact that we have combined the sextic potential, which is a very useful phenomenological potential, with the formalism of the ML which is based on the generalized uncertainty principle and which is, in turn, a quantum concept widely used in quantum physics. Besides, we investigate the effect of ML on energy ratios, transition rates, moments of inertia and a shape phase transition for the most numerous isotopic chains, namely Ru, Xe, Nd and Pt.

Comparative study of gamma treatment on fruit (Kinnow) and vegetable (Tomato) as an application of nuclear physics

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The present study was conducted to access the effect of different doses of gamma radiation on the storage performance of Kinnow and Tomato under room temperature (28±1)°C and refrigerator temperature 4°C conditions. Fruits were irradiated to gamma irradiation at different doses (0.6 kGy, 0.8 kGy, 1 kGy). Shelf life of unirradiated and irradiated Kinnow and Tomatoes was evaluated at room temperature (28±1)°C and refrigerator temperature 4°C. The control fruits were kept at room temperature (28±1)°C and refrigerator temperature 4°C for 15 and 30days respectively. The observations on various physico-chemical quality attributes of fruits were recorded at different storage intervals. The results revealed that for kinnow under room temperature (28±1)°C and refrigerator temperature 4°C. TSS, Total sugars and Physiological weight loss were increased with storage intervals. However, other parameters like TA and Vitamin C were decreased. For Tomato under room temperature (28±1)°C and refrigerator temperature 4°C. TSS, Vitamin C, Total sugars, Physiological weight loss were increased with storage intervals but other parameters like TA were decreased. It is concluded that for kinnow gamma irradiation dose @ 1 kGy was very effective in improving the overall quality and extending the shelf life of Kinnow fruits under room temperature(28±1)°C and refrigerator temperature 4°C storage conditions and for tomatoes gamma irradiation dose @ 0.6 kGy was very effective in improving the overall quality and extending the shelf life of Kinnow fruits under room temperature(28±1)°C and gamma irradiation dose @ 0.6 kGy was very effective in improving the overall quality and extending the shelf life of Kinnow fruits under refrigerator temperature 4°C storage conditions.

Neural network application to the nuclear binding energies and charge radii

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Recently, there has been a significant interest in artificial neural networks and their applications in scientific research. In this work, the Multilayer Perceptron (MLP), a class of feed-forward neural networks, is constructed and applied to predict ground-state binding energies and charge radii of atomic nuclei. To this end, we implement various MLP architectures, both deep and shallow, and study their effects on the predictions. Besides, we change the input size to study the impact of different inputs on predictions. It is seen that using appropriate MLP architectures with relevant physical information in the input channels, MLP predictions are comparable to the well-known microscopic models.

Role of pairing coefficient in the dynamics of compound nuclei ^{24,25}Mg*

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In the present work, the effect of pairing coefficient on the reaction dynamics of compound systems ^{24,25}Mg∗ formed via respective entrance channels namely ^{12}C+^{12}C and ^{13}C+^{12}C is studied within the collective clusterization approach using dynamical cluster decay model (DCM) [Manpreet Kaur, BirBikram Singh et.al, Phys. Rev. C 99, 014614 (2019)]. In a previous study the decay of ^{25,24}Mg∗ compound nuclei (CN) for the experimentally observed intermediate mass fragments (IMFs) that are ^{6,7}Li and ^{7,8,9}Be have been explored [Rupinder Kaur, Sarbjeet Kaur et al., Phys. Rev. C 101, 034614 (2020)] within DCM. The role of the α-cluster structure of the complementary fragments was explored, which results in the enhanced preformation probability (P_0) with respect to other fragments. These enhanced P_0 values accordingly affect the yields of the respective IMF. In the present study, we have extended this work to study the effect of the pairing coefficient. The fragmentation and preformation profiles with the inclusion of pairing coefficient have been compared with the previous work at critical value and for both the spherical and deformed configurations.

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