International Conference on Recent Issues in Nuclear and Particle Physics (RINP2)

Report of Contributions

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Contribution ID: **2** Type: **not specified**

Enhanced nuclear dipole polarizability and continuity of shell effects in the quasi-continuum of medium-mass nuclei

The nuclear dipole polarizability - a second-order effect in Coulomb-excitation perturbation theory competing with the reorientation effect that varies with the shape of a nucleus and splitting of magnetic substates –governed by the dynamics of the giant dipole resonances has been investigated along with the effects of recently observed enhancement of photon strength functions at low energies for nuclides in the A ≈ 50, 90 mass region. Empirical drops observed in ground-state nuclear polarizabilities indicate deviations from the effect of giant dipole resonances and reveal the presence of shell effects in semi-magic nuclei with neutron magic numbers N = 50, 82 and 126. Similar drops of polarizability in the quasi-continuum of nuclei with, or close to, magic numbers N = 28, 50 and 82, reflect the continuing influence of shell closures up to the nucleon separation energy. These findings are presented for the first time in this conference and strongly support recent large-scale shell-model calculations in the quasi-continuum region describing the origin of the low-energy enhancement of the radiative or photon strength function as induced paramagnetism, and assert the Brink-Axel hypothesis as more universal than originally expected.

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Session Classification: Parallel Session Nuclear Physics

Contribution ID: **3** Type: **not specified**

Excitation function of the proton induced natSn reactions below 22 MeV for reactor applications

Excitation function of the proton induced natSn reactions below 22 MeV for reactor applications

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ABSTRACT
Tin (Sn) has a wide range of applications in the present and modern fusion/fission reactor technologies. Zircaloy-2 and zircaloy-4 materials with 1.5% Sn are the commonly used structural alloys in present nuclear reactors. Tin offers a great resistance to corrosion and can hold high temperatures as well. Tin also possesses superconducting properties which makes it useful in the International Thermonuclear Experimental Reactor (ITER) [1], which is one of the most advanced fusion reactors, produces efficient green energy by utilizing the D-T fusion reaction. In ITER, Nb3Sn conductor is selected for making the toroidal field coils [2], which are able to carry higher current and produce a stronger magnetic field that initiates, confine shape and control the ITER plasma. As these field coils are located just after the blanket holding the plasma, thus, get exposed to high energy secondary particles produced from the fusion reaction. A nuclear reaction of 14 MeV neutrons with the ITER's surrounding materials can produce high energy γ, n, p, and α particles. Since high energy protons can be produced in the surrounding materials, therefore, proton-induced reaction cross-section data becomes vital for all possible reaction channels around 14 MeV on different isotopes of this carefully selected magnetic material (Sn). In the present work, we have measured the production cross-sections of the 113In, 117Sb, 118mSb, 120mSb, 122Sb, and 124Sb radioisotopes using the natSn(p, x) reaction. The experiment was performed at 14UD BARC-TIFR Pelletron at Mumbai, India. A stack of five Sn foils together with the Al degraders was irradiated with 22 MeV protons. The results were measured with the literature data [3], TALYS-1.9 [4] and the ALICE-2014 [5,6] nuclear model codes. As the data for the natSn(p, x) reactions are scarce, therefore, present results becomes important from the perspective of modern reactor technology.

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Contribution ID: **4** Type: **not specified**

Model-independent Astrophysical Constraints on Leptophilic Dark Matter in the Framework of Tsallis Statistics

We derive model-independent astrophysical constraints on leptophilic dark matter (DM), considering its thermal production in a supernova core and taking into account core temperature fluctuations within the framework of q-deformed Tsallis statistics. In an effective field theory approach, where the DM fermions interact with the Standard Model via dimension-six operators of either scalar-pseudoscalar, vector-axial vector, or tensor-axial tensor type, we obtain lower bounds on the effective cut-off scale Λ from supernova cooling and free-streaming of DM from supernova core, and upper bounds on Λ from thermal relic density considerations, depending on the DM mass and the q-deformation parameter. Using Raffelt's criterion on the energy loss rate from SN1987A, we obtain a lower bound on $\Lambda >= 3$ (12) TeV corresponding to $q = 1.0$ (1.1) and an average supernova core temperature of $T_{\rm SN} = 30$ MeV. From the optical depth criterion on the free-streaming of DM fermions from the outer 10\% of the SN1987A core, we obtain a weaker lower bound on $\Lambda >= 1$ TeV. Both cooling and free-streaming bounds are insensitive to the DM mass m_χ for $m_\chi <= T_{\rm SN}$, whereas for $m_\chi \gg T_{\rm SN}$, the bounds weaken significantly due to the Boltzmann-suppression of the DM number density. We also calculate the thermal relic density of the DM particles in this setup and find that it imposes an upper bound on Λ^4/m_χ^2, which is in conflict with the supernova cooling/free-streaming bounds for a wide range of DM mass. From this, we obtain a model-independent lower bound of $m_\chi >= 200$ MeV-1 GeV on the leptophilic DM, which only depends on the operator type and q-deformation parameter.
Keywords: Dark Matter, Supernova, Effective Field Theory, Tsallis Statistics.

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Session Classification: Parallel Session Paticle Physics

Contribution ID: **5** Type: **not specified**

Study of neutron induced reaction cross sections of 93Nb and 92Mo with 14.78 MeV neutron energy and covariance analysis

Abstract
The cross sections for the 93Nb(n,2n)92mNb and 93Nb(n,α)90mY reactions and first time for the 92Mo(n,p)92mNb reaction have been measured relative to 197Au(n,2n)196Au monitor reaction at the incident neutron energy of 14.78 MeV from the 3H(d,n)4He fusion reaction by using activation and off-line γ-ray spectrometric technique. The experiment was carried out by making use of the neutron generator constructed based on the Cockcroft-Walton voltage multiplier accelerator of Purnima at Bhabha atomic research center (BARC), Mumbai. The efficiency calibration of the HPGe detector system was done by using a 152Eu point source from their known characteristic γ-ray energies with covariance analysis. The reaction cross sections were calculated with covariance analysis by taking into consideration of partial uncertainties in various attributes and correlation between those attributes. The present data have been compared with the literature data available in EXFOR, evaluated data of different libraries and theoretical values based on TALYS-1.8 code.

Keywords: 93Nb(n,2n)92mNb, 93Nb(n,α)90mY and 92Mo(n,p)92mNb reaction cross section, 3H(d,n)4Hereaction neutron, Activation and off line γ-ray spectrometry, Covariance, TALYS-1.8

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Contribution ID: **6** Type: **not specified**

EMMA- the recoil mass spectrometer at TRIUMF

Monday, 4 February 2019 12:10 (25 minutes)

The ElectroMagnetic Mass Analyser (EMMA) is a new experimental facility at TRIUMF. Located after the ISAC-II accelerator, EMMA is a symmetric QQEDEQQ-type mass spectrometer capable of separating recoiling nuclear reaction products from the beam. With the low emittance radioactive beams delivered from ISAC-II at energies up to at least 6.5 A MeV, EMMA is designed for fusion evaporation and transfer reactions of interest in nuclear structure and astrophysics studies. A vacuum mode separator, EMMA disperses ions according to mass/charge in the focal plane. During successful commissioning runs over the last year, the angular, energy, and mass acceptances as well as the dispersion were characterized. EMMA is currently being coupled with the TIGRESS γ-ray detector array, to perform detailed in-beam spectroscopy. Today, we present the current status of the EMMA mass spectrometer as it begins its experimental life.

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Session Classification: Plenary Session V

Contribution ID: **7** Type: **not specified**

Radii measurements of exotic nuclei

Tuesday, 5 February 2019 11:00 (30 minutes)

With large neutron-to-proton ratios far from the line of stability, nuclei develop exotic structures. Systematic studies of nuclear radii closer to the drip line have demonstrated the change of nuclear properties, such as the emergence of nuclear halo, development of neutron skin and the nuclear deformation. Halo nuclei show unexpected behavior, such as, large interaction cross section which in turn, points to large matter radius [1] and narrow momentum distribution of the valence neutrons. In this context, nuclei with two neutron halo are intriguing systems to understand the correlation between the two halo neutrons and the core. Borromean nuclei are such systems where the nucleus is bound with two halo nucleons but the combination of core and one halo nucleon is unbound. Two-neutron halos in Borromean nuclei have been identified along the dripline in the p-sd shell in 6He, 11Li, 14Be, 17,19B and 22C but its occurrence beyond the sd-shell, has not been fully investigated. Beyond sd-shell, in the $N = 20$ island of inversion region, one neutron halo configuration was found in 31Ne [2, 3] and 37Mg [4, 5].

An important question is how unusually the large extension of the neutron wave function influences the protons. This can be investigated by measuring the root mean square (rms) radii of the proton distribution. Charge radius which is a fundamental nuclear ground-state property, seems to be changing with the increase of valence neutrons. The proton radius is also necessary to understand the spatial correlation between the halo and the core. Furthermore, it is also crucial to determine the neutron-skin thickness if the matter radius is known. Complimentary to the traditional methods for determining the charge radius (or proton radius) which are isotope shift measurements and electron scattering measurements, charge-changing cross section measurement is a new tool which can be applied very well for stable nuclei and as well as for exotic nuclei far from the beta-stability line [6-8]. The radii are obtained from the cross sections through finite range Glauber model analysis of the reaction.

The rare isotope facility at GSI is unique in having energies up to 1 A.GeV. Experiments for precise radii measurements are best suitable at this energy as a wide variety of isotopes of interest could be fully ionized. It is also possible to perform such studies for light nuclei at beam energies around 200-300 MeV/u that are available at RIKEN.

In this presentation, I will discuss how the proton and matter distribution radii measurements of nuclei far from the line of stability can unfold the exotic structures.

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Session Classification: Plenary Session VII

Contribution ID: **8** Type: **not specified**

Limiting mass of a white dwarf to retain stability with different remnant core composition

Limiting mass of a white dwarf to retain stability with different remnant core composition.
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ABSTRACT
White dwarfs are remnant of sun like stars which now a day is used as an astrophysical observatory. When nuclear fuel undergoing hydrogen fusion in the stellar core gets exhausted, the remnant of the core is supported with pressure provided by a gas of degenerate electrons. This degenerate pressure balances the self gravitation of the star and stops further collapsing. There may be a mixture of non relativistic and relativistic electrons. In this work we have attempted to find a transition density of the remnant core by merging the non relativistic and relativistic limit. Here we have employed an empirical relation showing variation of star density with corresponding radius. Using hydrostatic equilibrium equation of star along with our empirical relation and transition density as mentioned before, limiting mass of a white dwarf to retain permanently is calculated with different composition of the white dwarf. If the white dwarf is composed with helium core only, transition density comes out to be 2.556× 〖10〗 ˆ9 Kg/mˆ3 and the corresponding limiting mass of the white dwarf comes out to be 1.558 solar mass with radius being 8979.4 Km. Almost 90 years back S.Chandrasekhar established a mass limit of white dwarf as 1.4 solar mass to retain its stability. But he had not mentioned the actual composition of a white dwarf in his work. This mass limit is expected to be changed with different composition of the core remnant of white dwarf. This limit should also depends on whether degenerate electrons are relativistic or non relativistic. We have also calculated the same for a white dwarf to be composed with carbon and other heavy elements. If the temperature of the core is sufficiently high then further fusion reaction like triple alpha may produce carbon and oxygen. For a white dwarf composed with carbon and other heavy elements the limiting mass of the white dwarf is calculated as 0.693 solar mass. This approximates the result obtained by Oppenheimer and Volkov to find the maximum mass of a neutron star as 0.7 solar mass to retain permanently. Actually neutron star might be formed only when the core remnant contains heavy element above carbon. The result obtained by Oppenheimer and Volkov might be the lowest mass limit of a neutron star. So, the result of this work can be correlated easily both with Chandrasekhar and Oppenheimer prediction of mass limit of white dwarf and neutron star respectively.

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Contribution ID: **9** Type: **not specified**

Resolution of R_D-R_{Dˆ*} puzzle

One of the exciting results in flavor physics in recent times is the R_D/R_{D^*} puzzle. The measurements of these flavor ratios performed by the B-factory experiments, BaBar and Belle, and the LHCb experiment are about 4σ away from the Standard Model expectation. These measurements indicate that the mechanism of $b \to c\tau\bar{\nu}$ decay is not identical to that of $b \to c(\mu/e)\bar{\nu}$. This charge lepton universality violation is particularly intriguing because these decays occur at tree level in the Standard Model. In particular, we expect a moderately large new physics contribution to $b \to c\tau\bar{\nu}$. The different types new physics amplitudes, which can explain the R_D/R_{D^*} puzzle, have been identified previously. In this letter, we show that the polarization fractions of τ and D^* and the angular asymmetries A_{FB} and A_{LT} in $B \to D^*\tau\bar{\nu}$ decay have the capability to uniquely identify the Lorentz structure of the new physics. A measurement of these four observables will lead to such an identification.

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Contribution ID: **10** Type: **not specified**

Nuclear structure study across N=114

Nuclear structure study across N=114

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Nuclei in the mass region A ˜ 180-200, show various nuclear shapes. The active proton and neutron orbitals in this mass region are pih9/2, pih11/2, nui13/2, etc. where nui13/2 is a unique parity orbital. The uniqueness in parity of nui13/2 prevents mixing and allows one to study uniquely, the effect of this high-j orbital on the high spin structure of nuclei. The nui13/2 orbital is completely filled at neutron number N = 114 for spherical nuclei. Nuclear deformation breaks the spherical symmetry and the orbitals split into (2j+1)/2 number of levels based on different omega(projection of nucleonic angular momentum on the symmetry axis of the nucleus) quantum numbers. The high and low omega components of the high-j nui13/2 orbital come down in energy drastically for both oblate and prolate deformations. Thus the effect of different components of the valance nui13/2 orbital on the nuclear shape can be investigated from the study of the excited states in nuclei in this mass region with different neutron numbers.Recently, in 195Tl (N=114), two chiral band structures have been reported based on 3-qp and 5-qp configurations [1]. These configurations involve 2 and 4 particles in nui13/2 orbitals. The fact that the chiral rotation of a nucleus arises due to the triaxial core, it indicates that neutrons in i13/2 orbitals generates triaxiality in this nucleus. On the other hand the lighter Os and Pt nuclei, for which the neutron Fermi level lies below N = 114, are reported to be gamma-soft [2].Therefore, it is interesting to study the nuclear structure as a function of number of neutrons in nui13/2 orbital.
In this conference, the details of the experimental investigation of the high spin spectroscopy of 197Tl (N=116), and 187Os (N=111) nuclei will be presented. These were studied by-ray spectroscopic technique at VECC using alpha beams from the K-130 cyclotron.The VENUS (VECC Nuclear Spectroscopy array) and INGA (Indian National Gamma Array) were used to detect the discrete gamma rays. These two nuclei with neutron number above and below N=114, would provide a better understanding on nuclear shape across N=114. The band structures in both the nuclei have been extended considerably and band crossings have been identified for the first time. Several non-yrast band structures have also been found in these nuclei.
References:
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Contribution ID: **11** Type: **not specified**

Nuclear structure studies at VECC using INGA

Tuesday, 5 February 2019 14:00 (25 minutes)

The study of the excited states in nuclei is the key to understand not only the structure of nuclei but also the modes of generation of angular momentum in nuclei and different quantum mechanical symmetries in nuclei. In order to predominantly excite a particular set of states in a nucleus, one has to choose a suitable reaction. For example, the heavy-ion induced fusion reaction mostly populates the high-spin yrast states while the lower spin and non-yrast states are populated mostly by light-ion induced reactions. Moreover, the higher spin states of heavy nuclei near the stability line can only be populated by light-ion induced reactions. At VECC, the K-130 cyclotron can provide both heavy ion and light ion beams at higher energies which gives the opportunity to access a wide range of nuclei in the nuclear chart. Therefore, a variety of structural phenomena can be experimentally addressed. Recently, an experimental campaign using the INGA (Indian National Gamma Array) setup with up to 10 Compton suppressed clover HPGe Detectors has been completed at VECC with an aim to exploit the advantages of the unique beams available at VECC in the study of the excited states in nuclei by \gamma-ray spectroscopy technique. A PIXIE-16 based digital data acquisition system, setup by the UGC-DAE-CSR, Kolkata Centre, was used in this campaign. A total of 23 experiments were carried out by different users from Universities and Institutions in India and abroad. The highlights of some of the experiments and the results will be presented.

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Session Classification: Parallel Session Nuclear Physics

Contribution ID: **12** Type: **not specified**

Stability in the Minimal Type-III Seesaw Model

Tuesday, 5 February 2019 14:00 (25 minutes)

We study the minimal type-III seesaw model to explain the origin of the non-zero neutrino masses and mixing. We show that the naturalness arguments and the bounds from lepton flavor violating decay ($\mu \longrightarrow e\gamma$) provide very stringent bounds on the model along with the constraints on the stability of the electroweak vacuum up to High energy scale. We perform a detailed analysis of the model parameter space including all the constraints for both normal as well as inverted hierarchies of the light neutrino masses. We find that most of the region that are allowed by lepton flavor violating decay fall into the metastable region.

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Session Classification: Parallel Session Paticle Physics

Contribution ID: **13** Type: **not specified**

Isomers and the evolution of structure in Hg, Tl and Pb isotopes

Monday, 4 February 2019 15:15 (25 minutes)

The structure of nuclei around the line of stability with A˜200 exhibits diverse excitation modes ranging from collective rotation, including decoupled and semi-decoupled bands, and isomeric states whose decay rates span a large range from enhanced to hindered in comparison with single-particle estimates. The evolution of collectivity and the gradual predominance of intrinsic excitations with increasing Z from Hg (Z=80) to Pb (Z=82), as well as along an isotopic chain approaching the neutron shell closure at N=126, is evident. Isotopes of Hg, Tl and Pb which lie in this transitional region offer insight into the complex underlying nuclear interactions.

The excited level structure of a number of isotopes, $viz.$ $^{197-202}$Hg, $^{199-203}$Tl and $^{202-204}$Pb, have been studied using fusion-evaporation and multi-nucleon transfer reactions. The experiments have been performed at the Inter-University Accelerator Centre and the Argonne National Laboratory with γ-ray coincidence data being recorded using the Indian National Gamma Array (INGA) and Gammasphere spectrometers. An extensive analysis of the data obtained in these experiments has been performed [1] resulting in considerable extension of the known level structure and identification of new isomeric states.

While the data have revealed a number of facets of the structure of these nuclei, a common theme is the observation of isomers with half-lives ranging from a few nanoseconds to hundreds of microseconds. The gamut of responsible excitation mechanisms is exemplified by the disparate configurations and decay modes of the isomers. A total of 12 isomers have been newly identified in Hg, Tl and Pb isotopes [2,3,4] and several previously established ones have been confirmed. These results allow for a systematic and thorough examination of nuclear structure in this region. An understanding of these results, particularly those for isomers, has been obtained in the context of empirical calculations using single-particle and pair-gap energies, and residual interactions obtained from experimental data and shell model calculations performed with the Oxbash code using the KHH7B interaction. The detailed results will be presented at the conference.

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Session Classification: Parallel Session Nuclear Physics

Contribution ID: **14** Type: **not specified**

Thin isotopic Nickel target preparation and characterization for nuclear reaction studies

Thin and pure ^{61,62}Ni targets of uniform thickness are required to perform nuclear reaction experiments at HIRA, IUAC, New Delhi. Although self-supporting targets are preferable for such case but, instead, carbon-backed isotopic targets are prepared using physical vapour deposition technique as the target that will be obtained using this method will be comparatively more stable, intact and consistent. More than 20 numbers of thin targets of both ^{61}Ni and ^{62}Ni isotopes are prepared using the limited amount of available enriched target material (less than 100 mg). The carbon-backed slides along with the parting reagent (potassium chloride) are prepared using a diffusion pump based coating unit and the target material is deposited over these carbon-backed slides in the turbopump based coating unit. KCl is chosen to be the parting agent in this case because the potassium mass and Nickel mass differs by substantial amount which will make analysis easier after experiment, if there is any impurity due to KCl within the target element. To obtain consistent and intact targets, some trials were done with deposited slides and were found that the material degrades in any of the slides when kept idle for a few days. The thicknesses of the targets are verified using profilometer, α –energy loss technique, and RBS technique. They were found to be in good agreement with each other using these techniques. The purity and the uniformity of the fabricated targets are further verified using RBS and EDS techniques, both of which confirmed their purity and uniformity.

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Contribution ID: **15** Type: **not specified**

A theoretical study of shape shifters on forth generation flavour - sterile neutrino

Tuesday, 5 February 2019 15:10 (20 minutes)

Interpretation of data from MiniBooNE experiment at Fermilab and liquid scintillator neutrino detector (LSND) with a two-neutrino oscillation model, i.e, muon neutrino to electron neutrino, shows that, MiniBooNE experiment confirms the fourth neutrino flavour. These flavour's properties and behaviours raise a lot of opportunities and challenges to understand the universe. In this present work, during oscillation, i.e, shape shifting, neutrino's mass and chirality and their velocity are to be considered. Experimentally, one of the dependent parameter on this muon neutrino oscillation is mass and zenith angle during the interaction. Similarly finding the other required parameters for this oscillation is another task. In this proposed model, nature of the shape shifter for the four flavours is discussed, in that idea fourth sterile neutrino is also in the part of oscillation. We believe that outcome of this trial model will pave the way to the clarity in the shape shifters within the four flavours.

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Session Classification: Parallel Session Paticle Physics

Contribution ID: **16** Type: **not specified**

Lifetimes, Level Energies and Light Shifts in a single trapped Baˆ{+} ion

A precise measurement of Atomic Parity Violation (APV) in atomic systems aims at the determination of electroweak mixing Weinberg angle ($\sin^2\theta_W$) at low momentum transfer. The precision to which $\sin^2\theta_W$ can be determined depends on the accuracy of the knowledge of the atomic structure of the trapped and laser cooled simple alkaline earth ionic systems like Ba^+ and its intrinsic sensitivity to high precision measurements. Available information on the atomic system Ba^+ and experimental inputs for verification of recent improved calculations for Ba^+ wavefunctions is a part of this research work. The information on the lifetime of the long lived $5d^2D_{5/2}$ state, level energies and light shifts in the presence of the additional laser field in single Ba^+ ion is provided with a focus on the experimental conditions and their influence on the measurements. This information will be further implemented towards APV. A single ion localized to better than one optical wavelength is a necessary prerequisite for such a precise APV measurement. A single Ba^+ ion experiment has been constructed and the frequency stabilization techniques for the employed laser systems have been implemented. The lifetime $D_{5/2}$ of the metastable $5d^2D_{5/2}$ state is extensively studied both in single and multiple ions in this setup. These measurements provide for detailed and precise understanding of the intrinsic atomic structure and enables extraction of atomic wavefunctions of the involved states. High resolution frequency spectroscopy of the laser cooling transitions $6s^2S_{1/2}$-$6p^2P_{1/2}$ and $5d^2D_{3/2}$-$6p^2P_{1/2}$ in Ba^+ with single and multiple trapped and laser cooled ions permits the determination of absolute frequencies of the relevant transitions to 100 kHz accuracy which is more than 100 times better than earlier measurements. This gives an excellent understanding of the complex spectra of Ba^+ with an Optical Bloch Equation (OBE) 8-level system. The spectra are exploited towards observation of light shifts in the $6p^2P_{1/2}$-$5d^2D_{3/2}$ transition in a single Ba^+ ion for the first time and the systematic effects have been investigated.

The vector and tensor light shifts of the individual Zeeman components for different $6s^2S_{1/2}$-$5d^2D_{3/2}$ transitions in Ba^+ are observed. Further, extensive studies of these vector and tensor light shifts have been initiated and are currently in progress. This is an excellent step towards light shift determinations in the Zeeman sublevels of the ground state of a single ion which is crucial for the precise determination of APV.

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Contribution ID: **17** Type: **not specified**

Investigation on single particle excitation in 63Zn

Introduction
Detail study on nuclear structure in mass region A~60 reveals various interesting phenomena. Both single particle and collective excitations with various shapes, namely, prolate, oblate and triaxial have been observed in this region in many Cu, Zn and Ni nuclei [1,2,3,4,5]. Here the lower excitations are due to the negative parity 2p3/2 , 1f5/2 and 2p1/2 orbitals but most of the high spin states are mainly due to the presence of the high j 1f7/2 and 1g9/2 intruder orbitals. Strongly coupled rotational band was first observed in 64Zn [6] in this mass region and this band showed similar characteristics of those smoothly terminating rotational bands in the Sn-Sb nuclei of the A~110 region. Normal and super deformed bands have been identified in 61,65Zn isotopes . But evidence of such extreme situation as in 61,65Zn is yet to be explored in 63Zn.The most recent study with 16O beam [7] used 12 Compton suppressed HPGe detectors along with 14 BGO detectors which predicted rotational like states at lower excitation energy rather than at higher excitation energy. To get more insight into the nuclear structure of 63Zn, an experiment was performed using more efficient array of 14 Compton suppressed HPGe clover detectors at IUAC, New Delhi.

Experiment and Analysis
Investigation on excited states in 63Zn were done through in-beam γ-ray spectroscopic techniques using the 52Cr(18O, 3n) fusion-evaporation reaction at a beam energy of 72.5 MeV [8]. Detection of emitted γ-rays of excited nuclei were performed in the coincidence mode using fourteen Compton suppressed Ge clover detectors of the Indian National Gamma-ray Array (INGA). Based on the γ-γ coincidence data, thirteen new transitions have been placed in the level scheme according to the coincidence relationship and intensity balance. Spin and parity assignments have been done by extracting the DCO and Polarization asymmetry values of the γ-rays.

Acknowledgement
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Contribution ID: **18** Type: **not specified**

HALF-LIVES AND CLUSTER RADIOACTIVITY

HALF-LIVES AND CLUSTER RADIOACTIVITY
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Abstract:

George Gamow provided the first model to explain alpha-decay, which can be used to formulate the relationship between energy of alpha particle and the tunnelling probability. In the present work we have employed Gamow's theory for evaluating the decay rates of cluster emitters. The pre-formations of cluster radioactivity have been analysed in the framework of the preformed cluster model for heavy nuclei. The penetration probability mainly determines the half-life of the cluster radioactivity. This work is theoretical where a simple square well potential is assumed for quantum mechanical tunnelling.
Using the modified formula, the penetration probability and thereby the half lives of the element has been calculated. In recent years we have access to a large amount of experimental data available on the newly synthesised alpha emitters. We have calculated half lives for 21 elements where Half lives varied from 1.0×10ˆ11 sec to 1.5×10ˆ32 sec. The graph has been plotted between the experimental log T1/2 to calculated log T1/2 and was found to be linear. This shows that the calculated half-lives are in good agreement with the experimental half-lives within one order of magnitude.
Gamow's theory has been experimentally verified using Geiger-Nuttal law. This law is valid for the radioactivity of all clusters (including α particles), by considering the clusterization and subsequent decay of nucleons within the nucleus. The law has been verified by plotting several graphs between calculated log T1/2 and the energy Q (MeV). It shows a linear relation between the half-lives of the decaying clusters and their corresponding Q-values. We have divided the α-decaying nuclei into four regions:
(I) N≤126, Z≤82;
(II) N≤126, Z>82;
(III) N>126, Z>82;
(IV) N>126, Z≤82.
Our work is concentrated on the elements from III region.
The Barrier height, Barrier width and Barrier area have been calculated for the above elements. Graphs have been also plotted between experimental log T1/2 and Barrier area. It was found to be linear which is in agreement with the theory. The model reproduces cluster decay half-lives using the same radius constant as 1.2 fm.

Keywords: Gamow's theory, cluster decay, Pre-formation factor, half life, G.N.Law,

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Contribution ID: **19** Type: **not specified**

Fermionic Dark Matter in the light of AMS-02 Positron-fraction excess

We consider the existence of a fermionic dark matter along with the extension of the Standard Model (SM) of particle physics by the two Higgs doublet model. The Yukawa interaction of the Higgs doublets with the SM fermions, in the Lepton Specific configuration, is responsible for the generation of the latter's mass. The two doublets couple to the dark matter (fermionic singlet) through a non-renormalisable coupling which provides a new physics scale. We investigate
whether the electron-positron pair produced as a result of the annihilation of such a dark matter can explain the excess in the positron-fraction in the primary cosmic rays observed by the Alpha Magnetic Spectrometer (AMS-02) on board the International Space Station (ISS) beyond 10 GeV, peaks around 350 GeV. Since no such excess has been reported in the anti-proton fraction, it can be concluded that such a dark matter would not couple to the SM quarks in the tree-level. We calculate the positron flux from such annihilating dark matter and compare with those reported by the AMS-02 experiment.

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Contribution ID: **20** Type: **not specified**

Measurement of fusion excitation functions around the Coulomb Barrier for 18O + 116Sn system

ABSTRACT:
Around the coulomb barrier, in low energy region, enhancement of the sub-barrier fusion cross-section for some systems could be seen as compared to its corresponding theoretical predictions. Among the various degrees of freedom that influence the sub-barrier fusion cross-section enhancement, the role of static deformation and quantal zero point motion is well established but there are still ambiguities in the quantitative effects of positive Q –value neutron transfer channels. To investigate the transfer reaction and the sub-barrier fusion cross-section of the system 18O + 116Sn, having positive Q –values for the two neutron stripping channels, the experiment to measure the fusion excitation functions of this system was carried out at HIRA, IUAC, New Delhi. The preliminary result of the data analysis along with the theoretical calculations carried out for the fusion cross section and barrier distribution measurements will be presented in the conference.
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Contribution ID: **21** Type: **not specified**

Signatures of parton saturation at small-x

Monday, 4 February 2019 15:18 (22 minutes)

The parton saturation behaviour at small-x is shown in a semi-analytical solution of the nonlinear GLR-MQ equation with parton recombination corrections, which resembles the widely discussed BK saturation of gluons. The effect of gluon shadowing on the small-x and moderate-Q^2 behaviour of gluon and singlet quark distribution function is examined. The computed results are compared with different experimental data as well as global parametrizations. It is very fascinating to observe that the strong growth of parton density corresponding to the linear QCD evolution equations at small-x can be tamed by gluon shadowing. Our predictions for nonlinear parton density are also compared with the results for the integrated gluon density obtained from the BK equation. The resulting analytic expression for nonlinear gluon density further allows us to predict the logarithmic derivative of the singlet structure function *dF_2^S(x,Q^2)/dlnQ^2* which also shows a tamed behavior in the small-x region due to shadowing corrections. The present calculation suggests that the saturation of parton density towards small-x can be interpreted as a dynamical balance between the splitting and the recombination processes of partons, without incorporating any other mechanism.

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Session Classification: Parallel Session Particle Physics

Contribution ID: **22** Type: **not specified**

Gated MCA technique for demonstration of coincidence phenomena with a set of indigenously developed gamma spectrometers

We present the design of an indigenously developed coincidence gamma spectrometry setup with a custom built 1K Multi-channel Analyzer with an external trigger input. In addition to its own discriminator input signal generated from the shaped pulse fed to a comparator with an adjustable threshold setting, it also interprets a secondary trigger of configurable width supplied from another spectrometer's discriminator via a cable.

The setup records spectra only if both signals are true within a predefined time window, thereby enabling time coincidence measurements. This check occurs prior to the digitisation of the signal, so recorded spectra contain only events involving gamma rays incident on both spectrometers simultaneously.

The MCA processor operates with a 64 Mhz clock, and the associated step size for adjusting this window is 15ns. But, a minimum window of 500nS has been set in order to account for time jitter arising from the shaper signal variations as characterised by a 2GS/s oscilloscope.

The setup has been tested to verify the electron-positron annihilation peak from a 22-Sodium source where conservation of momentum dictates that the resultant two gamma rays must be emitted in opposite directions.

A 22-Na point source was centrally placed between two spectrometers with their detectors facing each other over a 15cm gap. One of the spectrometers' discriminator output is shared with the other via a short cable, and spectra were acquired from both spectrometers for 40 minutes. While the ratio of the events triggered by the 1275 keV gamma ray to the the 511 keV annihilation gamma was observed to be 27781:137636(0.2) in the ungated spectrometer, the second spectrometer that had used the secondary trigger with a width of 600ns had recorded 137:9200(0.015) events in the same energy regions under coincidence conditions, thereby validating this approach. The 137 stray counts can be attributed to chance coincidence events. These were distributed across 600 channels, spanning more than 1 MeV, with no definite energy peaks that could be observed.

Preliminary tests for angular correlation showed coincidence events rapidly declining when the angle subtended by the spectrometers and the gamma source is changed by a few degrees from its optimal 180 degree arrangement.

The designed spectrometers are highly compact, and occupy a 112mm$60mm$31mm enclosure containing all electronics inclusive of the scintillator and detector, with USB connectivity. We have also designed an open-source software capable of handling two different spectrometers simultaneously, and configuring the secondary trigger on either, or both of them. The absence of expensive and bulky equipment makes this ideal for undergraduate labs where coincidence spectra can be quickly demonstrated.

Near future goals involve the design of a dual channel MCA with list-mode capability, and 15nS time resolution, to prepare a dedicated coincidence measurement unit.

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Contribution ID: **23** Type: **not specified**

Application of new reduction methodology for reaction cross sections induced by tightly bound nuclei

The investigation is made to extract the total reaction cross section from a previous work where the elastic scattering of the tightly bound 10B on the 58Ni target was measured, at energies close to the Coulomb barrier. Total reaction cross sections were extracted from the elastic scattering analysis using the Optical Model with double-folding type potentials. We have also taken the total reaction cross section of the systems with the same mass targets 58Ni and different projectiles from the literature and tried to compare with our system by reducing the cross sections, for the elimination of trivial effects due to different sizes and different Coulomb barriers. In addition to that, for all the systems considered, one-channel calculations that account only for fusion have been performed to study the quantitative effect of the direct reaction channels on the total reaction cross section.

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Contribution ID: **24** Type: **not specified**

Signatures of Synchrotron Radiation from the Annihilation of Dark Matter at the Galactic Centre

Monday, 4 February 2019 14:00 (30 minutes)

We propose a fermionic dark matter model by extending Standard Model with a Dirac fermion and a real pseudoscalar. The fermion dark matter particle interacts with the Standard Model sector via the Higgs portal through a dimension five interaction term as also through a pseudoscalar interaction term. The parameter space of the model is then constrained by using the vacuum stability and perturbativity condition as also with the LHC constraints. They are finally constrained by the PLANCK results for dark matter relic densities. The direct detection limits are then ensured to have satisfied by the model. We then explore within the framework of the model, the possible signatures of synchrotron radiation from the annihilations of dark matter in the Galactic Centre region when the end product is e^+e^-. We consider the observational data from the radio telescopes namely SKA, GMRT and Jodrell Bank telescopes and compare our calculated synchrotron flux density with them and also with the results predicted by these experiments. We predict that the low frequency radio telescopes like GMRT, SKA, if operate at the peak frequencies obtained from our calculations should get a better r.m.s sensitivity.

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Session Classification: Parallel Session Particle Physics

Contribution ID: **25** Type: **not specified**

Lepton polarization asymmetry in excited b-mesons

Tuesday, 5 February 2019 14:50 (20 minutes)

Recently, some unexpected phenomena in various B meson decays are being observed in several experiments. Few of the observables are branching ratio of $B_s \to ^{+-}$ decay, angular observable P_5‘ in $B \to K^{*+-}$ decay, lepton flavour non-universality parameters $R_{K^{(*)}}$,$R_{D^{(*)}}$ etc. The fact that these observables show significant deviation around 3σ from their standard model (SM) values declares them as anomalies in recent time. To find the possible solutions scientists extend their ideas beyond the SM which points towards the presence of new physics (NP). There are various NP models like leptoquark, 2HDM, non-universal Z', fermion fourth generation etc which are being examined to see whether they could explain the recent anomalies. Here, we are interested to study the heavy-light systems like the $(b\bar{q})$ mesons which have a rich spectrum of excited states. We are mainly concerned about the decay $B^*_{(s,d)} \to l^+l^-(l = e, ,)$ which includes $b \to sll$ flavor-changing neutral-current (FCNC) transition. The excited mesons $B^*_{(s,d)}$ are unstable under electromagnetic and strong interactions and possess narrow width with corresponding lifetime of the order of 10^{-17} s. The $B^*_{(s,d)} \to l^+l^-$ decays are sensitive to short-distance structure of $B = 1$ transitions. Some theoretical studies are being done in ref. [1, 2] regarding these decay channels. The authors of ref. [1] have proposed a novel method to study FCNCs in the $B^*_{(s,d)} \to e^+e^-$ transition and predicted the branching ratio [1] $BR(B^*_{(s,d)} \to e^+e^-) = 0.98 \times 10^{-11}$. In ref. [2] $B^*_{(s.d)} \to l^+l^-$ decay modes have been studied in the SM and the branching ratio has been predicted as $BR^{SM}(B_{(s,d)})^* \to l^+l^-) = (0.7 - 2.2) \times 10^{-11}$ for decay width $= 0.10(5)$ keV, irrespective of the lepton flavor. We have recently studied [3] $B^*_{(s,d)} \to l^+l^-(l = , e)$ decay in Z' model and predicted the branching ratio as $BR(B^*_s \to l^+l^-) = (1.5 - 2.2) \times 10^{-11}$ and $BR(B^*_d \to l^+l^-) = (1.7 - 2.2) \times 10^{-13}$.
Theoretical investigation of longitudinal lepton polarization asymmetry (A_{P_L}) is found to be more clean compared to the branching ratio of this decay channel as the observable A_{P_L} is independent of the total width of B^* meson which is not confirmed theoretically or experimentally. In this work, we first calculate the SM prediction of A_{P_L} and then analyse its sensitivity to the non-universal Z' model [4] which is an extension of SM with an extra U(1)' symmetry. The main attraction of this NP model is that FCNC transitions could occur at tree level due to the off-diagonal couplings of non-universal Z' with fermions, which is not allowed under SM consideration. The relation between the electroweak interaction eigenstates and mass eigenstates induces GIM mechanism within SM due to which flavor changing neutral interaction (FCNI) becomes forbidden at tree level. However, the relation between the electroweak interaction eigenstates of NP and the mass eigenstates is not same as of the SM. In such a situation, Z' model could allow the tree level FCNC $b \to sll$ transitions. As, $B^*_{(s,d)} \to l^+l^-$ decay modes are not observed experimentally till now, so these decays are expected to be used to test the flavour sector of the SM and search for NP.

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Session Classification: Parallel Session Paticle Physics

Contribution ID: **26** Type: **not specified**

New Physics search with $B_d^0 \to l^+l^-$

The rare leptonic decays $B_{s,d} \to l^+l^-(l = e, ,)$ present vital base to analyse the flavour structure of the standard model (SM) and also become potential source to dig out possible signatures of new physics (NP) beyond the SM [1]. The muonic decay $B_s \to \mu^+\mu^-$ has been observed at the LHC as well as the upper limits of branching ratios for other $B_{s,d} \to l^+l^-$ have been updated recently. In this work, we have studied the decay $B_d \to \mu^+\mu^-$ with NP effect [2]. NP models involve the tree level exchange of a leptoquark or a $Z^{'}$ boson. If new non-SM particles present in the loop process or non-SM coupling mechanisms occur in the process, the rate of these decays can significantly change. Here, we have studied the decays with the contribution of heavy $Z^{'}$ boson. This model introduces additional couplings to this new heavy mediator at both tree and loop level and these couplings could modify the values of branching ratios. We have allowed the $Z^{'}$ boson to couple with the flavour changing part $b\bar{d}$ as well as with $\mu\bar{\mu}$. Including the NP couplings we have calculated the branching ratio expression for μ channel. The current experimental status of the branching ratio values for several channels of B_d^0 meson are given as [3, 4]: $B(B_d \to \mu^+\mu^-) < (3.4 \times 10^{-10})$,$B(B_d \to e^+e^-) < (8.3 \times 10^{-8})$, $B(B_d \to \tau^+\tau^-) < (2.1 \times 10^{-3})$. The branching ratio expression consists of $b\bar{d}Z^{'}$ coupling term B_{db}^L and right-handed and left-handed $\mu\bar{\mu}Z^{'}$ coupling terms $B_{\mu\mu}^L$ and $B_{\mu\mu}^R$ respectively [5]. We have performed χ^2 fit to find these NP couplings using various constraints. From the best fit values we have calculated the branching ratio for the μ channel and got the same order as the experimental one. Here, we can say that as the fitting is useful for $B_d \to \mu^+\mu^-$, it has predicted the branching ratio value correctly. We know that $Z^{'}$ boson does not behave in similar manner with all the generations of leptons and that infers the non-universality nature of $Z^{'}$ model. Due to non-universality we have to change $\mu\bar{\mu}Z^{'}$ couplings for the other two channels and then we can predict their branching ratios. So we can expect that the strategy used in this work is very fruitful in the investigation of NP as well as it will provide an interesting probe of lepton flavour violation. \linebreak

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Contribution ID: **28** Type: **not specified**

Isomers and intrinsic excitations at high spin in ^{200,201}Tl and ^{202}Pb

Nuclei just below the doubly magic 208Pb (Z=82, N=126) are near-spherical and isomers are realized due to the hindered decays from states with predominantly high-j contributions to those with relatively lower-j values. The high-j orbitals in this region are $h_{11/2}$ for protons and $i_{13/2}$ for neutrons. Tl (Z=81) isotopes correspond to one proton hole and a few neutron holes with respect to ^{208}Pb and the coupling of the odd proton to different neutron configurations can be explored. Tl isotopes with A ≥ 200 are characterized by weakly-deformed oblate to near-spherical shapes and are expected to exhibit the presence of isomers. With increase in neutron number approaching the closed shell at N=126, intrinsic excitations arising from the coupling of a few to several valence neutrons in the unique-parity $i_{13/2}$ subshell and a proton in the $h_{11/2}$ orbital dominate the yrast line. In a few cases, contributions from some low-j orbitals are also evident. The isotopes of specific interest are ^{200,201}Tl which are odd-odd and odd-even respectively, in terms of nucleon numbers. They allow the opportunity to explore intrinsic states embedded along with weakly collective, oblate deformed levels. The study of these contrasting excitation mechanisms up to high spin can provide considerable nuclear structure insights.

The present work encompasses the analysis of data from two experiments, one with the Gammasphere detector array at Argonne National Laboratory, USA, and the other with INGA (Indian National Gamma Array) at the Inter-University Accelerator Centre, New Delhi. High-fold coincidence data were analyzed and a number of histograms were created, up to three dimensions, involving energy and time parameters for verifying the placement of known transitions, identifying new ones and their location in the level scheme, and exploring the data for the presence of high-spin isomers. The analysis was performed primarily using the Radware suite of programs. The decay scheme of ^{201}Tl was extended up to spin I ≈ 25 $\hbar$ and an excitation energy Ex ≈ 8.5 MeV with the inclusion of many newly identified transitions. A total of four isomeric states (three of them being newly identified along with confirmation of one which was previously established) with half-lives ranging from a few nanoseconds to the sub-microsecond region were established using the centroid-shift method or by fitting exponential decay. At high spin, intrinsic configurations with dominant contributions from high-j orbitals are found to be favored. An isomeric state at high spin in ^{200}Tl is newly identified and is attributed to a possible 4-quasiparticle configuration involving high-j nucleons. Additionally, half-lives of a few previously established isomeric states in ^{202}Pb, an isotone of ^{201}Tl, were also revisited.

A number of calculations have been performed to understand the experimental results. Single-particle energies were calculated using a Woods-Saxon potential with universal parameters. Empirical calculations were also performed using experimental data for 1-quasiparticle states and residual interactions obtained from isomers in neighboring nuclei. Further, shell model calculations using the Oxbash code with the KHH7B interaction have also been performed. Detailed results will be presented at the conference.

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Contribution ID: **29** Type: **not specified**

Theoretical study of semileptonic decay $B^+ \to K^+\mu^+\mu^-$ in non-universal Z model

In recent years, semileptonic decays of bottom hadrons are in the focus of many theoretical as well as experimental studies due to increasing experimental evidences of new physics (NP). One of the most important ways for searching NP is to analyse rare B meson decays which are induced by flavour changing neutral current (FCNC) transition. Generally FCNC processes are forbidden at the tree level in standard model (SM) and will arise from loop diagrams which are supressed in comparison to tree diagrams. This provides an excellent testing ground for NP. Recently the hadronic semileptonic rare B meson decay modes which are induced by the quark level transition $b \to s$ achieve a great attention in both experimentally and theoretically.Here, we would like to study such a type of semileptonic rare B decay mode $B^+ \to K^+\mu^+\mu^-$ involving the quark level transition $b \to sl^+l^-(l = \mu)$. FCNC coupling of Z boson can be generated at the tree level in various scenarios [1, 2]. We analyse the effect of non-universal Z boson in the differential decay rate of the decay mode $B^+ \to K^+\mu^+\mu^-$ and predict the value of branching ratio in the SM and in non-universal Z model. To evaluate the branching ratio in non-universal Z model we have fixed the numerical value of the coupling parameter U_{sb} which is strictly constrained from $B_s^0 - \bar{B}_s^0$ mixing. Considering $|U_{sb}| \leq 0.0015$ [3] and the whole range of U_{sb} as 02Π we can predict the value of branching ratio in SM and in non-universal Z model as $(Br(B^+ \to K^+\mu^+\mu^-))_{SM} = 1.92^{+0.33}_{-0.3} \times 10^{-7}$ and $(Br(B^+ \to K^+\mu^+\mu^-))_Z = 5.58^{+0.29}_{-0.27} \times 10^{-7}$ respectively whereas from LHCb data it is found that the branching ratio of this decay is $(Br(B^+ \to K^+\mu^+\mu^-))_{exp} = 4.37 \pm 0.15 \pm 0.23 \times 10^{-7}$ [4]. From this we can conclude (i) the experimental value of branching ratio is found to be higher than the corresponding SM prediction. This deviation of branching ratio can be considered as an smoking gun signal for NP and (ii) our predicted value of the differential decay rate as well as the branching ratio for this decay in FCNC mediated Z model is larger than the SM value and also than from the experimental value. This indicates that the non-universal Z model is very sensitive to this decay $B^+ \to K^+\mu^+\mu^-$. \linebreak

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THEORETICAL STUDY OF MAGNETIC CORONAL ROTATION DEPENDENCE ON SOLAR ROTATION

This paper deals with the possibility of magnetic coronal rotation and its dependence on solar rotation. A study of green coronal rotation confirms that differential rotation degree varies symmetrically through a solar cycle 1. The coronal fields shows much less differential rotation than photosphere 2. The coronal magnetic fields shows similar features as coronal green lines. The differential rotation is highly symmetric with the coronal magnetic fields during sunspot minimum.

The complex structure of coronal magnetic fields shows some correlation to the solar rotation. But only in the innermost region of coronal magnetic fields shows full symmetry with solar cycles. There are three regions in coronal magnetic fields. The second and outermost region are not symmetric to solar cycles. Second region however shows very complex behavior due to its magnetic loop properties. Outermost being the least symmetric in all three.

These variations are due to various vectors involved in coronal magnetic fields such as energy densities, dipole moment etc. Apparently these layers shows a pattern of variation of densities. Least dense layer being least symmetric and vice-versa.

Anomalous middle layer shows its peculiar behavior due to magnetic loop formation in it.

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Contribution ID: **31** Type: **not specified**

Confinement and de-confinement aspects of fermion in lower dimensional field theoretical model and its symmetry, e.g. BRST and field dependent BRST

Monday, 4 February 2019 14:55 (23 minutes)

Lower dimensional field theoretical models, e.g. Schwinger model, Chiral Schwinger model, Non-Confining Schwinger model, Thirring-Wess model and its Chiral generation known as Chiral Thirring-Wess model are of great interest because the models can explain the mass generation via dynamical symmetry breaking. It was known that the Schwinger can explain the confinement of fermions. However, in the Non-confining Schwinger model fermions are found to get liberated. The usual Chiral Schwinger model also fails to describe the confinement aspect of fermions. But Chiral Schwinger model with a particular counter term can explain the confinement aspect of fermions too. All these models are exactly solvable and exact bosonization of these models are possible. The Schwinger model is the eldest of all. Only Schwinger is gauge invariant at the quantum mechanical level. Other models are not so. But Gauge invariant, as well as BRST invariant reformulation, of all these models is found possible. Extension of phase space is needed to make these models gauge symmetric. Since extension of phase space is needed to make these models invariant under gauge and BRST transformations. It is important to ensure that physical contents must remain unchanged in presence of the extension of phase space required to make these models Gauge as well as BRST symmetric. There are different approaches to show it. Field dependent BRST (FF-BRST) transformation is a current development in this direction. These systematic developments related to these lower dimensional models will be the subject of my presentatio

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Session Classification: Parallel Session Particle Physics

Contribution ID: **32** Type: **not specified**

Effect of magnetic fields on $B^{-}\to l^{-}\bar{\nu}_{l}$ in two-Higgs doublet model

In this paper, we have studied $B^{-}\to l^{-}\bar{\nu}_{l}$ decay in the presence of magnetic field in two-Higgs doublet model (2HDM). The decay rate of the process is calculated both in the presence of magnetic field and in the absence of magnetic field in standard model (SM) and 2HDM. In the SM, the leptonic decay of charged B meson $B^{-}(p)\to l^{-}(k)\bar{}_{l}(q)$ [1,2] originate from charged-current interactions due to W^{-} exchange between quark and lepton currents. Whereas, in the 2HDM, this is due to H^{-} exchange between quark and lepton currents. Here, l^{-} is charged lepton $(l = e, ,)$ and$\bar{}_{l}$ is the corresponding neutrino. The p,k and q denote the momenta to the B meson, the lepton and the antineutrino respectively. We have found that the ratio of muonic and tau leptonic decay rate is independent of the magnetic field in both the SM and 2HDM, for $eB\ m^{2}$, $(B)_{B\to\bar{}}/(B)_{B\to\bar{}} = (m^{2})/(m^{2})$ 3.6×10^{-3}. In the absence of magnetic fields, $(0)_{B\to\bar{}}/(0)_{B\to\bar{}}$ 4.5×10^{-3}. The ratio of decay rates of the decays $B\to\bar{}$ and $B\to\bar{}$ in the presence of magnetic fields is reduced by 20% than that in the absence of magnetic fields both in SM and 2HDM. The tau leptonic decay becomes more dominant than muonic decay at B both in SM and 2HDM. Further, it is found that ${}_{2HDM}(B = 0) > {}_{SM}(B = 0)$ and ${}_{2HDM}(B)/{}_{2HDM}(0) < {}_{SM}(B)/{}_{SM}(0)$.

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Contribution ID: **33** Type: **not specified**

Two component WIMP–FImP dark matter model with singlet fermion, scalar and pseudo scalar

Tuesday, 5 February 2019 14:25 (25 minutes)

We explore a two component dark matter model with a fermion and a scalar. In this scenario the Standard Model (SM) is extended by a fermion, a scalar and an additional pseudo scalar. The fermionic component is assumed to have a global $U(1)_{DM}$ and interacts with the pseudo scalar via Yukawa interaction while a $_2$ symmetry is imposed on the other component –the scalar. These ensure the stability of both dark matter components. Although the Lagrangian of the present model is CP conserving, the CP symmetry breaks spontaneously when the pseudo scalar acquires a vacuum expectation value (VEV). The scalar component of the dark matter in the present model also develops a VEV on spontaneous breaking of the $_2$ symmetry. Thus the various interactions of the dark sector and the SM sector occur through the mixing of the SM like Higgs boson, the pseudo scalar Higgs like boson and the singlet scalar boson. We show that the observed gamma ray excess from the Galactic Centre as well as the 3.55 keV X-ray line from Perseus, Andromeda etc. can be simultaneously explained in the present two component dark matter model and the dark matter self interaction is found to be an order of magnitude smaller than the upper limit estimated from the observational results.

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Session Classification: Parallel Session Paticle Physics

Contribution ID: **34** Type: **not specified**

Signature of supersymmetry and L_mu - L_tau gauge boson at Belle-II

Tuesday, 5 February 2019 10:30 (30 minutes)

In this talk we will discuss a proposal that the γ + missing energy signal at the Belle-II detector will be a smoking gun for supersymmetry (SUSY) in the presence of a gauged $L_\mu - L_\tau$ symmetry. A striking consequence of breaking the enhanced symmetry appearing in the limit of degenerate (s)leptons is the non-decoupling of the radiative contribution of heavy charged sleptons to the $\gamma - Z'$ kinetic mixing. The signal process, $e^+e^- \to \gamma Z' \to \gamma$ + missing energy, is an outcome of this ubiquitous feature. We take into account the severe constraints laid down on gauged $L_\mu - L_\tau$ models by several low-energy observables and show that any significant excess in all but the highest photon energy bin would be an undeniable signature of such heavy scalar fields in SUSY coupling to Z'. The number of signal events depends crucially on the logarithm of the ratio of stau to smuon mass in the presence of SUSY. In addition, the number is also inversely proportional to the $e^+ - e^-$ collision energy, making a low-energy, high-luminosity collider like Belle-II an ideal testing ground for this channel. This process can probe large swathes of the slepton mass ratio vs the additional gauge coupling (g_X) parameter space. More importantly, it can explore the narrow slice of $M_{Z'} - g_X$ parameter space still allowed in gauged $L_\mu - L_\tau$ models for superheavy sparticles.

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Session Classification: Plenary Session VII

Contribution ID: **35** Type: **not specified**

Stellar β– Decay: The Case of Bare Atoms

In a stellar plasma where atoms get partially or fully ionized, the well known continuum β– decay is not the only option. Nuclear β– decay to the bound states of the ionized atom is another probable channel. The β– decay half-life of an atom can even fall drastically due to the opening of this new channel which in tern may affect the nucleosynthesis process.
In our recent study we have studied the β– decay rates to the continuum as well as bound state of some fully ionized atoms of astrophysical interest, in the mass range (A ≈ 60 - 240), where information for neutral atom experimental half-life and β– decay branchings are terrestrially available. Most importantly the study of effective half-lives for bare atoms will be helpful to set a limit for the maximum enhancement in β– decay rate due to the effect of bound state decay channels. Moreover, we have also observed the effect of different nuclear structure and decay inputs (Q value, radius etc.) over the bound to continuum decay rate ratio. Our study indicates the decay rate to bound state of daughter atom becomes larger as the neutral atom Q value becomes lower. Also we found that there must be an increment of decay rate in case of bare atom in comparison with neutral atom.
Most importantly, an interesting phenomenon of changes in β– decay branching for a number of bare atoms has been observed, for the first time. We have found that, for β– decay from a parent level to daughter levels, the ratio of β– decay rate in fully ionized (bare) to neutral atom increases with decreasing Q value and that effects the β– decay branching from the parent level to the daughter levels. Even, sometime the branching scenario may flip in bare atom in comparison with neutral atom due to this phenomenon. Our calculations suggest this branching flip phenomenon can occur in bare 134Cs and 228Ra atoms. Verification of this branching change phenomenon in bare atom decay might be of interest for future experiments.

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Contribution ID: **36** Type: **not specified**

High spin study of even Hg isotopes

The study of Hg isotopes (Z=80), close to doubly magic ^{208}Pb (Z=82), provides an opportunity to study the interplay between collective and intrinsic excitation mechanisms. High-spin data in neutron-rich Hg nuclei are not as well established as in the proton-rich region. The neutron-rich region can be reached through projectile fragmentation and multi-nucleon transfer reactions. Previous work includes the study of excited states populated in (α, xn) reactions for ^{196,198,200}Hg and (n, γ) and (d, pn) reactions for ^{202,204}Hg. In this work, multi-nucleon transfer products ^{198,200,202}Hg are studied upto high spin.

Data have been obtained for even Hg isotopes from two experiments performed at the Argonne National Laboratory using the ATLAS superconducting linear accelerator and Gammasphere detector array. Excited states in Hg isotopes were populated through multi-nucleon transfer between ^{209}Bi and ^{197}Au followed by neutron evaporation, with a 1450-MeV ^{209}Bi beam incident on a thick (50 mg/cm^2) Au target. Further, using a 1430-MeV ^{207}Pb beam incident on another ^{197}Au target, similar reaction channels also produced a number of Hg isotopes. High-fold coincidence data with different timing conditions were analyzed. The data have also been explored for the presence of high-spin isomers with lifetimes in the ns or higher range. $\gamma - \gamma$ directional correlation measurements were done for spin assignments.

The level scheme for ^{198}Hg has been expanded with the inclusion of 11 new transitions at high spin upto $E_x \approx 6$ MeV. Two high spin coupled rotational sequences built on a four-quasiparticle configuration have been identified. These are observed to decay to positive- and negative-parity bands with two-quasiparticle character. The excitation energy and moment of inertia of the newly observed band structure support the four-quasiparticle assignment. The lifetimes of isomeric states in ^{198}Hg have also been determined and are in agreement with previously reported values. The decay scheme for ^{202}Hg has been expanded with the inclusion of 15 new transitions placed above the 5^- state. The time difference analysis leads to a halflife of $10.4(18)$ ns for the 7^- state and $1.2(10)$ ns for the 9^- state. Similar analysis suggested half-life of 1.2(5) ns for the 12^+ state in ^{200}Hg.

Hg isotopes are characterized by moderate oblate deformation near their ground states. A pronounced alignment similar to Pt isotopes has also been observed in the yrast positive parity sequences in ^{196,198,200}Hg at $\hbar\omega \approx 0.2$ MeV in all three isotopes. It is attributed to the decoupling of an $i_{13/2}$ neutron pair occupying low-Ω orbitals. The close lying 5^-, 7^- and 9^- negative-parity states are built from a configuration of aligned $i_{13/2}$ and $p_{3/2}/f_{5/2}$ neutrons. Effective g-factor measurements for the 12^+ state in ^{198}Hg suggest a rotation-aligned $(\nu i_{\frac{13}{2}}^{-2})$ configuration. Cranked shell model calculations also indicate rotation alignment of $i_{13/2}$ neutrons around $\hbar\omega \approx 0.2$ MeV and suggest moderate oblate deformation for the observed bands. A systematic study of the excitation energy of the positive and negative parity sequences in Hg isotopes is done to illustrate that with the increase in neutron number towards N=126, reduction in collectivity is evident along with an abrupt increase in the excitation energy of the 12^+ state due to N=120 sub-shell gap.

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Contribution ID: **37** Type: **not specified**

Wavelet analysis of Unusual spiky Events at SPS Energy

Angular spectra of the unusual spiky events produced in 32S-Ag/Br interactions at ultrarelativistic high energy are analysed by the method of continuous wavelet transform in different scale for the ring-like structures which could indicate either the production of Cherenkov gluons or the occurrence of Mach shock waves in excited nuclear matter. The analysis is based on the assumption that the presence of above mention effects would be manifested by excess of particles at some characteristic pseudorapidities. The irregularities are revealed in the wavelet pseudorapidity spectra in the scale pseudoradity region up to 0.6. These irregularities are interpreted as the preferred pseudorapidities of groups of emitted particles. As an example to illustrate the irregularities more vividly in the paper, we have chosen the event of 32S-Ag/Br interactions at 200A GeV/c with 229 charged tracks(pions).The experimental results are compared with the MC simulated and randomly generated data sets.

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Contribution ID: **38** Type: **not specified**

Nuclear Data Evaluation and Applications

The compilation and evaluation of nuclear structure and decay data is being carried out by the network of Nuclear Structure and Decay Data (NSDD) Evaluators- an international network established under the auspice of International Atomic Energy Agency (IAEA), Austria. India became a member of this network in 2005 with the establishment of Nuclear Data Center at Indian Institute of Technology, Roorkee and further these NSDD evaluation activities in India have received a boost with the formation of Nuclear Data Physics Centre of India (NDPCI).
Experimentally measured nuclear structure and decay data for all known nuclei are presented in the ENSDF database [1] after due evaluation by trained and experienced evaluators in this field. This database a primary source for many specialized data bases such as Nubase, MIRD, RIPL, JAINS, RADWARE and for some important publications such as Nuclear Data Sheets, Table of Isotopes, Nuclear Wallet Cards etc.
There are many situations where the evaluation process has led to removal of contradictions in data and also led to new studies and measurements [2-5]. It is gratuitous to emphasize that the planning of any new experiment in nuclear physics invariably uses the ENSDF database.
Indian nuclear data centre is responsible for evaluation and updation of total 15 mass chains pertaining to A=215-229 mass region. In this presentation, I will discuss about organization of Evaluated Nuclear Structure Data Files (ENSDFs), NSDD evaluation activities being executed in India along with our contributions towards horizontal evaluations [6] and development of ENSDF analysis and utility codes [7] for NSDD evaluation.

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Session Classification: Parallel Session Nuclear Physics

Contribution ID: **39** Type: **not specified**

Investigation of the medium-spin level structure of 78Se with alpha beam

The excited states of 78Se have been investigated using alpha beam through the 76Ge(α, 2n) fusion evaporation reaction. The 30 MeV alpha beam was delivered by the K-130 Cyclotron at VECC, Kolkata. The target was prepared through centrifuge process of enriched metallic 76Ge powder on mylar backing. The target used in this experiment was 2mg/cm2 thick and two such targets staged together to increase the yield of the residual nuclei. The excited gamma rays emitted from the residual nuclei were detected by Indian National Gamma Array (INGA) at the Variable Energy Cyclotron Centre (VECC), Kolkata, India. The INGA array used in this experiment composed of seven Compton-suppressed HPGe Clover detectors and one Low Energy Photon Spectrometer (LEPS). Four Clover detectors were placed at 90°, two at 125° , and one Clover and the LEPS at 40° relative to the beam axis. The γ-γ symmetric and asymmetric matrices were sorted using the code "IUCPIX". DCO matrix have used to assigned the multipolarity of the gamma transitions and it's constructed by sorting the data from 90° detectors and 125° detectors along x and y axes correspondingly. Few newly observed transitions have been placed based on the coincidence relationship and intensity measurement in the decay scheme. The ongoing analysis of the data help us to extend the level scheme up to Ex ˜ 6.5 MeV and J ˜ 15ħ. The spins and parities of the excited levels have been assigned based on the results from the DCO and polarization measurements. Detail analysis of the in-beam data is in progress to understand the complex coupling mechanism between the octupole correlations and the gamma modes of vibration.

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Contribution ID: **40** Type: **not specified**

Gamma-ray spectroscopy in 70As

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Introduction

The structures of the odd-odd nuclei in mass region ≈70 attract more attention because both single particle and collective excitations with different shapes, namely prolate, oblate and tri-axial have been observed in this region. At low spins, properties of the nuclei are governed by 1f5/2, 2p3/2 and 2p1/2 spherical shell model orbitals. However , the high spin states and excitation energies are due to the particle-hole excitation from the 1f7/2 to 1g9/2 high-j intruder orbitals. In the odd-odd nucleus 70As, the low lying states were experimentally well investigated by the works of Brink et al. [1] and Filevich et al.[2] using proton, alpha and light-ions as projectile. The study of the high spin states of 70As, using 16O beam was done by Badika et al. [3] and they could populate up to 11+ and tentatively up to the 13+ state at 4.076 MeV. The lifetime measurements of 11+ and 13+ levels, by Garcia Bermudez et al. [4] indicated an enhancement in B(E2) values of the 981 keV and 1343 keV transitions. The work by B. Mukherjee et al[14], using HIRA+GDA at IUAC extended level scheme up to 8.9 MeV with tentative spin parity 19+. Authors have reported three rotational bands, with two positive parity bands which are the signature partners of each other. However the signature partner of the negative parity band could not be established in this work. To get more information about the nuclear structure of 70As, an experiment was performed using INGA array of 16 Compton suppressed HPGe clover detectors at IUAC, New Delhi.

Experiment and Analysis

Excited states in 70As were populated through in-beam γ-ray spectroscopic techniques using the 48Ti(28Si, αpn) fusion-evaporation reaction at a beam energy of 100 MeV. Emitted γ-rays of excited nuclei were detected in the γ-γ coincidence mode using 16 Compton suppressed Ge clover detectors of the Indian National Gamma Array (INGA). Few new transitions have been observed and are being placed in the level scheme. Spin and parity assignments are also in progress by extracting the DCO and Polarization asymmetry values of the γ-rays.

Acknowledgement

We would like to acknowledge Mr. S. R. Abhilash (IUAC) for target preparation and pelletron staff of IUAC for providing excellent beam.

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Contribution ID: **41** Type: **not specified**

Exploration of magnetic rotational band structure and new isomeric level in doubly odd 204At.

Investigation of high spin states of trans-lead nuclei attracted much attention in recent years. But nuclear structure of such nuclei largely remains unexplored mainly because of the difficulty in production via fusion-evaporation reactions along with large background due to much stronger and competing fission channel. Also the difficulty in extracting the targeted information and corroborating the results from the theoretical shell model calculations, that are virtually impossible for these nuclei, makes the job much more challenging.
Proton-rich Astatine (Z = 85) isotopes have not been explored in detail. The isotopes in the proximity of N = 120, with both the odd proton and odd neutron occupying high-j orbitals, have been found to exhibit magnetic rotational band structure at high angular momenta. The experiment was done using Indian National Gamma Array (INGA) of 16 Compton suppressed Clover detectors to produce 204-206At isotopes via 12C+197Au fusion reaction at 65 MeV and 75 MeV beam energy. Coincidence data with time stamps were collected using a fast DSP data acquisition system. Data sorting into coincidence matrices, cubes, angle dependent DCO and crystal orientation dependent polarization matrices were done using MARCOS sorting program, followed by projected spectral analysis using RADWARE and INGASORT softwares. A significant number of new transitions are found. DCO ratios and polarization asymmetry results were used to establish spin and electric-or-magnetic nature. New cross-over weak E2 transitions and B(M1)/B(E2) ratios confirms the ΔI = 1 MR band. A couple of transitions are identified as possible isomeric levels by fitting on the gated ΔT-spectra. A tentative level scheme of 204At is proposed.

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Contribution ID: **42** Type: **not specified**

Correlation as a measure of Information Entropy

Information theory studies the quantification, storage, and communication of information. It was originally proposed by Claude E. Shannon in 1948 to find fundamental limits on signal processing and communication operations such as data compression, in a landmark paper entitled “A Mathematical Theory of Communication”.
A key measure in information theory is “entropy”. Entropy quantifies the amount of uncertainty involved in the value of a random variable or the outcome of a random process. Simply, Entropy is the amount of information contained in a system. This is a term that reveals about the amount of disorderliness in the system.
In a plain hypothetical system with no disorder or in perfect order has no information, only when the disorder sets into the system it starts having information which is proportional to the disorder in the system. Any random variable has an expectation/mean probability which is an inverse measure of its information or Entropy. Higher the probability lower is the information.
In the independent –electron model the effect of electronic repulsion, globally referred to as correlation is disregarded. The correlation effect can, however, have major influence on measureable quantities in atomic systems. The ‘Hartree and Ingman 1933’type wave function has been used to derive an analytical model to calculate single-particle wave functions in coordinate-space and its momentum-analog using the Fourier Transform of the wave functions to quantify the correlation of two-electron systems. Subsequently, its response to the correlation effect of bare or uncorrelated single-particle charge densities of two-electron systems both in position - and momentum –space has been observed and examined its momentum-space analog that could serve as candidates for the correlation measure of two-electron systems. On the one hand the charge densities obtained by our method can be used to compute numbers for position-space information entropy (s_ρ) and momentum-space information entropy (s_γ). It has been suggested that such numbers for s_ρand s_ɣ can be used as an electron –correlation tool. On the other hand, our single particle wave functions will be useful to study the effect of correlation on position-space Fisher information (I_ρ) and momentum-space Fisher information (I_γ).

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Contribution ID: **43** Type: **not specified**

Constant and variable matter density effects in Long Baseline Neutrino Experiments

In this paper, the appearance and survival probabilities ($P(\nu_\mu \rightarrow \nu_e)$ and $P(\nu_\mu \rightarrow \nu_\mu)$) have been studied for neutrinos travelling through matter of constant density to explore the oscillation behaviours among the three known active neutrinos. The **Deep Underground Neutrino Experiment (DUNE)** with a baseline of $1284.9km$ (from **FermiLab**, Illinois to **Sanford Laboratory**, South Dakota) with constant matter density of $2.957gcc^{-1}$ has been considered in the analysis. Additionally, using Byron Roe's method, neutrino oscillations for a beam of muon neutrinos traversing the variable densities of the earth interior have been explored. Oscillations measured using variable density profile are, then, compared to that of constant density calculations and a qualitative assessment is performed. For the calculations, the three-neutrino fit from the **NuFIT 4.0.**, based on the data available in November, 2018, are considered for the oscillation parameters. Furthermore, the oscillations have been studied considering muon anti-neutrinos ($\bar{\nu}_\mu \rightarrow \bar{\nu}_e$ and $\bar{\nu}_\mu \rightarrow \bar{\nu}_\mu$) and the asymmetry in neutrino-antineutrino oscillations is measured for both constant and variable density profiles.

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Contribution ID: **44** Type: **not specified**

Fission dynamics in the Super Heavy Nuclei

Tuesday, 5 February 2019 15:15 (25 minutes)

Search for the new elements has been one of the major area of research activity in physics and chemistry over last few decades. Elements up to 294Og (atomic number Z = 118) have been synthesized
successfully using fusion evaporation route, where either double magic nuclei 208Pb (in the synthesis
of Z = 104 -113) or 48Ca (Z = 114 - 118) were extensively used due to extra stability achieved from their
spherical shell structure. But for the synthesis of elements beyond Z = 118, 48Ca beam can no longer
be used as in that case the other reaction partner required would be highly radioactive and currently
impossible to produce in sufficient quantities.
So it is extremely important to understand the reaction dynamics and its dependence on entrance channel parameters like shell structure, isospin asymmetry and ground state deformation of the reaction partners. A systematic study has been performed at the Australian National University using
other possible beams 50Ti, 54Cr along with 48Ca to understand the reaction dynamics which will be
presented during the talk.

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Session Classification: Parallel Session Nuclear Physics

Contribution ID: **45** Type: **not specified**

How atomic nuclei polarize

Monday, 4 February 2019 11:10 (30 minutes)

Empirical drops in ground-state nuclear polarizabilities indicate deviations from the effect of giant dipole resonances and may reveal the presence of shell effects in semi-magic nuclei with neutron magic numbers N = 50, 82 and 126. Similar drops of polarizability in the quasi-continuum of nuclei with, or close to, magic numbers N = 28, 50 and 82, could reflect the continuing influence of shell closures up to the nucleon separation energy. These findings strongly support recent large-scale shell-model calculations in the quasi-continuum region, which describe the origin of the low-energy enhancement of the photon strength function as induced paramagnetism, and assert the generalized Brink-Axel hypothesis as more universal than originally expected.

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Session Classification: Plenary Session V

Contribution ID: **46** Type: **not specified**

Nuclear Reactions using VEC: (1977 –2017), A Journey over 4 decades

Sunday, 3 February 2019 16:45 (25 minutes)

The Variable Energy Cyclotron (VEC), at Kolkata, recently completed its 40 years of operation in 2017. Several milestones have been achieved in experimental nuclear physics, using the light and heavy ions beams from this cyclotron during the last four decades. In this talk, an overview of the intense research activities carried out in nuclear reaction studies, using beams from cyclotron during the last four decades will be presented.

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Session Classification: Plenary Session III

Contribution ID: **47** Type: **not specified**

Who is game changer in heavy-ion fusion reaction dynamics?

Tuesday, 5 February 2019 14:50 (25 minutes)

In heavy-ion fusion reactions, the energy of the projectile couples with the intrinsic degrees of freedom of the target during the collision process and this leads to a dissipative phenomenon. Consequently, the dissipation in the system causes the angular momentum hindrance during the fusion process. Here we have focused on the dissipative behavior of the fusing nuclei and its dependency on the incident energy. The dissipative evolution of the system depends not only on the entrance channel mass asymmetry but also on the incident energy, which was not mentioned in earlier studies. Moreover, the dissipative behavior of the fusing nuclei is also compared with respect to the entrance channel parameters like mass asymmetry α and the Coulomb interaction term ZPZT. The dissipation phenomenon decreases when the mass asymmetry increases and it increases when the Coulomb interaction term ZPZT increases.

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Session Classification: Parallel Session Nuclear Physics

Contribution ID: **48** Type: **not specified**

Present and Future Developmental Activities of Modern Ion Accelerators and associated Research Facilities

Sunday, 3 February 2019 12:05 (35 minutes)

Developments of various modern ion accelerators in India for delivering ion beams in a wide range of the energy have created new opportunities in carrying out innovative research and developmental activities. Focused research in the areas of nuclear physics, atomic and molecular physics, materials science and radiation biology using these state of the art accelerators are being carried out in the Country by a large number of researchers from all over India and abroad. Some of the innovative and interesting research and developmental activities undertaken by different accelerator centres in the country will be discussed systematically.

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Session Classification: Plenary

Contribution ID: **49** Type: **not specified**

Nuclear Halos and Efimov Effect: A three-body approach

Tuesday, 5 February 2019 09:30 (30 minutes)

The advent of Radioactive Ion Beam facilities and subsequent explosive growth in the studies of neutron rich nuclei near the drip line has opened up new vistas in modern nuclear physics. The discovery of halo structures, both 1-neutron and 2-neutron halos, in neutron-rich, light nuclei has been a significant development in nuclear structure studies. The 2-neutron halo nuclei can have both Borromean or non-Borromean properties and can be ideally modeled as three-body systems. A variety of theoretical techniques have been applied over the years to investigate the structural properties of 2-neutron halo nuclei. Of all these techniques, three-body approaches appear to be very successful and effective. In this talk we will summarise our efforts, over the years, to calculate different structural properties of 2-n halo nuclei, like, 11Li, 14Be, 20C etc. We will also talk about our search for the elusive Efimov effect in such nuclei. We will show the possible presence of Efimov states in certain non-Borromean 2n halo nuclei, their evolution to resonances with increasing neutron-core (2-body) interaction and emergence as an asymmetric Fano resonance.

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Session Classification: Plenary Session VII

Contribution ID: **50** Type: **not specified**

Nuclear Structure properties significant to neutrinoless double beta decay of 124Sn

Monday, 4 February 2019 14:00 (25 minutes)

The decay rate of neutrinoless double beta process is expected to give the first direct measure of the neutrino mass, if the corresponding nuclear matrix element can be reliably calculated [1]. A major complication in extracting the neutrino mass from the half-life of this decay is the uncertainty in the nuclear matrix element. There are certain experimental observable that may be placed to constrain the calculations of the matrix element [2]. One of the main ingredients in calculating the nuclear matrix element is the wave functions of the initial and final states, which are usually calculated based on different nuclear models [1, 2]. Single-nucleon transfer reactions can be used to probe the occupancy and vacancy of valence orbitals which can help to characterize the ground-state wave functions. The precise measurement of both neutron addition and removal cross-sections can be used to determine the occupation of valence orbits relevant to 0ν2β-decay, following the Macfarlane and French sum rules [3]. The method consists of requiring a normalization such that for a given orbit characterized by total angular momentum j, the sum of the measured occupancy and vacancy on the same target add up to the degeneracy of the orbit 2j+1. It has been shown that such measurements allowed for a detailed description of the energy and vacancy of the valence orbitals of 76Ge and 76Se, where 76Ge is a candidate for 0ν2β-decay. The results indicated that the Fermi surface is much more diffuse than in theoretical calculations [4]. Similar measurements have been recently performed on 130Te and 130Xe [5]. Both 76Ge and 130Te are subject of research for 0ν2β-decay programs known as GERDA, Majorana (for 76Ge) and CUORE (for 130Te).

In the present talk a brief review of the research activities in this direction along with the results from our recent measurements to study neutron pickup and stripping transfer cross- sections on one of the 0ν2β-decay candidate 124Sn and its daughter 124Te will be presented. This nucleus is the focus of neutrino-less double beta decay study, at the upcoming underground India based Neutrino Observatory (INO). This information will be useful for constraining calculations of the nuclear matrix element for the 0ν2β-decay of 124Sn. References [1] H. Ejiri, and F. Simkovic, Rep. Prog. Phys. 75, 106301 (2012). [2] S. J. Freeman and J. P. Schiffer, J. Phys. G: Nucl. Part. Phys. 39, 124004 (2012). [3] M. H. Macfarlane and J. B. French, Rev. Mod. Phys. 32, 567 (1960). [4] J. P. Schifferet al., Phys. Rev. Lett. 100, 112501 (2008). [5] T. Bloxhamet al, Phys. Rev. C 82, 027308 (2010).

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Session Classification: Parallel Session Nuclear Physics

Contribution ID: **51** Type: **not specified**

A Pictorial History of Nuclear Instrumentation

Sunday, 3 February 2019 16:00 (30 minutes)

The progress of nuclear instrumentation in the last hundred years is described. Some of the landmark discoveries, which became possible due to the development of new instrumentation, are explained. A connection between the early developments and the state of the art instrumentation is made.

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Session Classification: Plenary Session II

Contribution ID: **52** Type: **not specified**

Expanding Horizons of the Seniority Isomers

Monday, 4 February 2019 16:50 (30 minutes)

Nuclear isomers are beginning to play an ever important role in unravelling the nuclear structure changes at higher spins and excitations. The seniority isomers constitute a separate class of isomers which are not exactly spin isomers. Very recently, we have shown the emergence of a new class of seniority isomers for the first time, which decay by odd-multipole transitions. This finding has led to many additional findings and explanations of some of the longstanding puzzles in nuclear structure physics. For example, we could address one of the long standing puzzles in nuclear structure physics, that of a asymmetric and double hump behavior of the B(E2; 2+⟶0+) values across the chain of Sn isotopes. Using the simple Generalized Seniority approach, we are able to show that a change of dominating orbitals from g7/2 to h11/2 after the mid-shell is responsible for the observed behavior. This simple yet robust interpretation is supported by the shell model calculations. We further strengthen this interpretation by expanding the Generalized seniority approach to magnetic moments and quadrupole moments, which is also able to explain the observed features in other isotopic chains.
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Generalized Seniority Schmidt Model and g-factors in semi-magic nuclei
Under Review.

Invited talk at the International Conference on "Recent Issues in Nuclear & Particle Physics", February 3-5, 2019, Visva Bharti (Central University), Santi Niketan –731235, West Bengal

Primary author: Prof. A.K. JAIN (Amity Inst. Of Nucl. Sc. & Tech., Amity University, NOIDA *Department of Physics, University of Malaya, Kuala Lumpur, Malaysia)

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Session Classification: Plenary Session VI

Contribution ID: **53** Type: **not specified**

Nuclear reactions and astrophysical s-process

Tuesday, 5 February 2019 12:10 (25 minutes)

Astrophysical s-process is among the principla processes which are responsible for creation of heavy elements beyond the iron peak nuclei. Radiative neutron capture reactions in the vicinity of nuclear shell closures are important to understand the abundance of various heavy elements. Semi-microscpic calculation has been carried out in isotopes near magic numbers for neutron capture reactions. Results of some of these calculations will be presented and their implications for elemental abundance will be discussed.

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Presenter: Prof. GAUTAM GANGOPADHYAY (Department of Physics University of Calcutta)

Session Classification: Plenary Session VIII

Contribution ID: **54** Type: **not specified**

Investigation of nuclear overlaps near the neutron dripline

Monday, 4 February 2019 10:30 (30 minutes)

Direct reactions are known to provide access to crucial nuclear structure information e.g. the quantum overlap between the ground state wave function of an initial nucleus and the states populated by the reaction. The case of light nuclei is of particular interest as direct reaction experiments involving isotopes at the dripline can be implemented, providing access to the nuclear overlaps at the extreme of the chart. Moreover, the possibility to perform full ab initio calculation of overlaps and use those as nuclear structure inputs in reaction calculations may provide a stringent test of these models. I will present results focusing on the <Li|Be> overlaps through the study of proton transfer reaction on neutron-rich Lithium isotopes. I will also introduce present investigations of clustering properties of light nuclei close to the neutron dripline using cluster knockout reactions. An experimental programme on the topic has just started at RIKEN/RIBF facility in Japan, accompanied by theoretical developments in reaction calculations [1]. In such experiments, multi-neutron systems, which represent a subject of interest in nowadays Nuclear Physics can also be investigated. Recent studies and outlooks on the topic will be briefly discussed.
[1] M.Lyu et al., Phys. Rev. C 97, 044612 (2018)

Primary author: Prof. D.BEAUMEL (Institut de Physique Nucléaire, CNRS/IN2P3, Université de Paris Sud, Université de Paris-Saclay, 91406 Orsay, France)

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Session Classification: Plenary Session IV

Contribution ID: **56** Type: **not specified**

Spectroscopy of nuclei at the N˜Z line at GANIL

Monday, 4 February 2019 11:40 (30 minutes)

Nuclei in the vicinity of the N˜Z line form a unique laboratory for studying many different phenomena among which the interplay of T=0 and 1 states at low energy, the role of neutron–proton pairing correlations, the shape coexistence along the N=Z line, the role of isospin symmetry and to which extent it is violated. A special emphasis is put on the heaviest N=Z nuclei located to the doubly magic N=Z=50, 100Sn nucleus, a key element in the Segré chart to adjust the interaction used in shell-model calculations as well as to delineate precisely the proton dripline. In addition, and connected to this latter point, these nuclei lie along the explosive rp-process nuclear synthesis pathway and, hence, their low-lying structure may be of interest in determining reaction rates.
For these numerous motivations, nuclei lying at or close to the N=Z line have been extensively studied at GANIL and in particular in the last months using a complex experimental setup consisting of the AGATA tracking array, the NEDA neutron detector and the DIAMANT charged particle detector. This powerful coupling of efficient detectors, made it possible to address several of the key questions mentioned above. This experimental campaign, as well as earlier results obtained along the N=Z line, will be presented and some of the main topics which, have been addressed, will be reviewed in a more detailed way.

Primary author: Prof. G DE FRANCE (GANIL, for the AGATA-NEDA-DIAMANT collaborations)

Presenter: Prof. G DE FRANCE (GANIL, for the AGATA-NEDA-DIAMANT collaborations)

Session Classification: Plenary Session V

Contribution ID: **57** Type: **not specified**

Is neutrino its own antiparticle?

Monday, 4 February 2019 17:50 (30 minutes)

The mass and nature of neutrinos play an important role in theories beyond the standard model. It is now well established that neutrinos have a non-zero mass, but whether the neutrino and anti-neutrino are the same (Majorana particle) or distinct (Dirac particle) is still an open question. At present, neutrinoless double beta decay (NDBD or 0□□□), is perhaps the only experiment which can provide an answer to this key question. The normal double beta decay (2□□□) process has been experimentally observed in 13 nuclei so far with a half-life in the range - □1/2˜1018 □□ 1024□. The 0□□□ decay violates conservation of lepton number and has implication in understanding the matter-antimatter asymmetry in the universe. Further, the nuclear β decay and double beta decay can provide the information on absolute effective mass of the neutrinos. Given the significance of the NDBD, there is a widespread interest worldwide employing a variety of novel techniques. This talk will give a brief overview of ongoing as well as proposed NDBD experiments, with an emphasis on challenges involved in these experiments. This talk will highlight various R&D aspects of the TIN.TIN (The India-based Tin Detector) to search for 0□□□ in 124□□.

Primary author: Prof. VANDANA NANAL (TIFR)

Presenter: Prof. VANDANA NANAL (TIFR)

Session Classification: Plenary Session VI

Contribution ID: **58** Type: **not specified**

Opportunities for Nuclear and Particle Physics in India

Sunday, 3 February 2019 10:20 (35 minutes)

Research in Nuclear and Particle Physics has been pursued in India over the past eight decades. It has gone through ups and downs in the past and currently many opportunities exist for pursuing research in these fields both in the country and abroad. I shall discuss some of these possibilities in this talk.

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Presenter: Prof. AMIT ROY (Ex-IUAC)

Session Classification: INAUGURAL SESSION

Contribution ID: **59** Type: **not specified**

Isomers for nuclear structure and future tools

Nuclear metastable states with half-lives longer than a few nanoseconds may be found in many nuclides in the nuclear landscape. With the increasing sensitivity of different measuring techniques, a number of new isomers are being discovered with various spectrometers at new accelerator facilities. These isomers provide a tool to study the different nuclear structure models. Furthermore, a wide range of applications of nuclear isomers remain a topic of current interest. In particular, nuclear isomers have the potential to provide material with high energy storage capacity with controlled release of its energy on demand. The tools required to probe the isomers will be presented [1]. Some of our recent results on nuclear isomers will be highlighted [2-6].
Acknowledgements:
Author is thankful to all the members of the INGA collaboration for the various inputs and discussion. The help of the staff at TIFR-BARC Pelletron Linac Facility and TIFR central workshop for successful completion of the INGA campaign is acknowledged. Support from S. V. Jadhav, R. Donthi, B. S. Naidu and A. Thomas during the experiment is deeply acknowledged. This work was supported in part by the Department of Science and Technology, Government of India (No. IR/S2/PF-03/2003-II).
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Session Classification: Parallel Session Nuclear Physics

Contribution ID: **60** Type: **not specified**

Building up for the next decade @ GANIL

Sunday, 3 February 2019 14:30 (30 minutes)

The GANIL facility has a wide range beams ranging from intense stable and short-lived unstable beams (ISOL and fragmentation) including a variety of unique and state of art equipments. These are used to study the evolution of the properties of the quantum many body system, the nucleus, as a function of the three axis of nuclear physics namely excitation energy, angular momentum and the asymmetry of neutrons and protons.
In this talk we will introduce the facility and give an overview of the arsenal of tools and their upgrades at GANIL that provide new vistas for searching and understanding the simple and regular patterns that are found in the structure of complex nuclei and also to understand the dynamics of colliding nuclei. Highlights of recent results will be presented. The talk will also highlight among others the recent experiments done using the AGATA gamma array especially with the VAMOS spectrometer. The potential of the production of new isotopes around and beyond the neutron shell N=126 for nuclei below Pb by multinucleon transfer will also be shown. The current status of the of LINAC along with the associated equipment (SPIRAL2 phase 1) and future plans will also be discussed.

Primary author: Prof. A. NAVIN (Grand Accélérateur National d'Ions Lourds, Caen, France)

Presenter: Prof. A. NAVIN (Grand Accélérateur National d'Ions Lourds, Caen, France)

Session Classification: Plenary Session II

Contribution ID: **61** Type: **not specified**

Weakly Bound Neutron-Rich Nuclei and Cosmic Phenomena

Sunday, 3 February 2019 17:35 (25 minutes)

The study of single particle and bulk properties of the neutron-rich nuclei constrains fundamental issues of Nuclear physics like limits of existence of the quantum many body system (atomic nucleus) and equation of state of neutron-rich matter etc [1-7]. This information has also important impact in understanding cosmic phenomena, like neutron star, nucleosynthesis, evolution of star etc...[1,6,7]. The state of art of Coulomb breakup of the neutron-rich nuclei has been used to explore those properties [1-9]. The unambiguous information on detailed components of the ground-state wave-function along with quantum numbers of the valence neutron of the nuclei obtained from the measurement of threshold strength along with the g-ray spectra following Coulomb breakup [1,3-5,9]. The shape of this threshold strength is a finger-print of the quantum numbers of the valence neutron. We investigated the ground-state properties of neutron-rich Na, Mg, Al nuclei around, island of inversion, N ˜20 using this method at GSI, Darmstadt. Very clear evidences have been observed for melting and merging of long cherished magic shell gaps at N = 20,28 [4,9]. The evanescent neutron-rich nuclei imprint their existence in stellar explosive scenarios (r-process etc.). The indirect measurements are the only possible access to the information which is a valuable input to the model for star evolution process [6]. Some valuable bulk properties of the neutron-rich nuclei like density dependent symmetry energy, neutron skins etc. [7] play a key role in understanding densest object in the universe, the neutron star. I shall discuss our experimental investigation to obtain those information.

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Session Classification: Plenary Session III

Contribution ID: **62** Type: **not specified**

Study of QCD Using Event Shape Variables in pp Collisions at /s = 13TeV

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Quantum Chrmodynamics is an important subject of study at the colliding beam experiments. Event-Shape Variables (ESVs) are functions of the four-momenta of particles in hadronic final states and are theoretically robust. They are sensitive to both perturbative and non-perturbative aspects of QCD and help us understand the flow of energy in an event. They may also be used in search of new phenomena. Here we present results on the measurement of four ESVs in events with multiple jets using proton-proton collision data collected by the CMS at the Large Hadron Collider at the centre of mass energy of 13TeV. Data are compared with general-purpose Monte Carlo event generators: Pythia8, HERWIG++, and MadGraph5 MC@NLO which use different theoretical models of QCD. The parton shower and hadronization have been studied in details for future tuning of the parameter set of Pythia8. We also study Pythia8 extensively to figure out the dependence of the ESVs on strong coupling constant(αS) through the initial-state (ISR) and final-state (FSR) radiations. Finally, we use RIVET and Professor framework to estimate some optimum values for αS corresponding to these shower kernels so that Pythia8 describe the data better.

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Session Classification: Parallel Session Particle Physics

Contribution ID: **63** Type: **not specified**

Nuclear Structure study of 183Ir

Investigation of the structure of atomic nuclei in the vicinity of Z=82 shell closure become important due to co-existance of single particle and collective excitations. Three high-j obitals viz. d5/2 , h11/2 and h9/2 lie near proton Fermi surface along with low-j s1/2 and d3/2 orbitals, resulting in number of K-isomers in this mass region.

The iridium isotopes (Z = 77) are located in the transitional region between the rare-earth isotopic chains of well-deformed nuclei and lead (Z = 82) chain of near-spherical isotopes. The structure of these nuclei are mainly influenced by the low-Ω intruder 1/2[541]h9/2 proton orbital. Interestingly, a signature partner of πh9/2 band was reported in 181Ir. In heavier 185Ir, a band built on 11/2- state was also reported. But such kind of band structure on 11/2- state is hitherto unreported in 183Ir. Hence it is interesting to search for the band structure above 11/2- state in the structure of Iridium isotopes.

High spin states of 183Ir were populated via 169Tm(18O,4n) fusion evaporation reaction at beam energy 94MeV, delivered by 15UD Pelletron acceletrator of Inter- University Accelerator Centre [IUAC], New Delhi. Indian National Gamma Array [INGA] is used for detecting the emitted gammas in the reaction. A self-supporting 169Tm foil of 6.5mg/cm2 thickness was used as the target. Typical beam current was 4 nA. Offline analysis is being done using CANDLE, INGASORT and RADWARE computer codes. Results will be reported in the conference.

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Contribution ID: **64** Type: **not specified**

Low- and medium-spin level structures of neutron-rich 98Zr nucleus: Competition between single particle and collective modes of excitations

Neutron-rich nuclei in the mass region A˜100 exhibit large variety of interesting nuclear structure phenomena. The nuclei having neutron number N ≤ 58 has a nearly spherical ground state, but they undergo a rapid shape transition from nearly spherical to well-deformed prolate deformation as N = 60 is approached. This abrupt shape change was correctly described by largescale Monte Carlo shell model (MCSM) calculations which pointed out the proton-neutron interaction between π(1/) and ν(1/) orbitals. Lying in the intermediate position between the spherical 96Zr and the deformed 100Zr, it is expected that the level structure of 98Zr should exhibit the multifaceted excitation features arising out due to the strong competition between single particle and collective behaviors.

As these neutron rich nuclei are difficult to populate through conventional fusion evaporation reaction, the previous investigations on these nuclei were mostly carried out using the spontaneous fission (SF) data from 252Cf and 248Cm radioactive sources. The present study attempts an investigation of nuclear structure phenomena associated with the 98Zr nucleus, in the low- and medium spin regimes, incorporating the new spectroscopic results obtained from an experiment employing thermal neutron induced fission of 235U. The experiment was performed at the PF1B line of the high-flux reactor facility at the Institut Laue-Langevin (ILL), Grenoble, France. The γ- rays from the 98Zr nucleus and its complimentary fragment nuclei were detected by an array consisting of eight EXOGAM large clovers, six large single-cryatal coaxial detectors and two unsuppressed clovers from ILL. Evidence of shape-coexistence phenomenon with all its complexities and consequences, and possibilities of other exotic modes of excitations in this nucleus will be presented.

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Contribution ID: **65** Type: **not specified**

Evolution of Collectivity in 66Zn

Excited high spin states in 66Zn, populated in the fusion evaporation reaction 52Cr(18O, 2p2n), have been studied using in-beam γ-spectroscopic methods. The Indian National Gamma-ray Array (INGA) equipped with fourteen Compton suppressed Hp-Ge clover detectors was used to detect the gamma-rays emitted by the de-exciting nucleus. The 18O beam at 72.5 MeV was supplied by the 15UD Pelletron Accelerator of the Inter University Accelerator Center (IUAC), New Delhi. The level scheme of the 66Zn nucleus, previously studied long back with modest detection systems, has been extended in this work significantly by the addition of eighteen new transitions and ten new levels. The ground state band has been found to crossed by the two quasiparticle band based on νg9/2 orbital at a spin value of 6ħ. The evolution of collectivity in this nucleus has been discussed in the framework of Total Routhian Surface Calculation(TRS) and in comparison with the neighbouring 68Ge(N=36) and 70,72Ge.

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Contribution ID: **66** Type: **not specified**

A new approach to understand the Concept of 4D-Space in Universe

Abstract
Human eye is limited to observe any thing under a short range of EMR (400nm-700nm) in 3D space and even by using various instruments (SEM, TEM, XRD, XPS, NMR, LHC etc) the scientist were succeeded in broadening the range of observation in EMR but still, could not unlock the 4D space concept. For 4D-space Universe, We must understand the conceptual mechanism that how the constituents of 4th dimension of 4D space are interacting with the combined constituents of 3D space, but the problem is, the modern mathematics and quantum physics is not enough to elaborate the above concept due to its limitations*, result into a reason that scientist possibly will not invent any instrument that can be able to detect/observe the activated action of the constituents of 4th dimension of 4D space. Now, a new subject "Incothematics"based on the concept that the velocity of expansion of time is more than the velocity of expansion of combined 3D space is used as a new approach to understand the Concept of 4D-Space in Universe .

key points
Newton's third law of equilibrium , Probability waves, Maxwell equations, Theory of general relativity, Gravitational waves, mass-time relation, Incothematics

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Contribution ID: **67** Type: **not specified**

Systematics of β- and γ-bands in the A = 160 region

Sunday, 3 February 2019 15:30 (30 minutes)

By considering the nucleus as a vibrating liquid drop, and assuming the potential to be a function of the elongation β, and triaxiality γ, of the nucleus, the Bohr Hamiltonian can be solved to give the so-called K=0+, β-vibrational and K=2+ γ-vibrational bands. However, as summarized in the review by Garrett[1], very few of the observed 0+2 bands in deformed nuclei possess the properties expected of a β vibration. It is likely that the nature of the 0+2 levels in deformed regions differ according to the precise location of the Fermi level, and contain admixtures of β-vibrational, two-phonon, pairing, and shape-coexisting states.

At iThemba LABS, a systematic investigation of low-lying levels in the mass 160 region has been made. An extensive set of data on the low-lying, positive-parity bands in the nuclides between N = 88 and 92 and Sm to Yb has been obtained from γ-γ coincidence measurements following fusion-evaporation reactions optimized of the population of low-spin states. Some these results point to the role of quadrupole pairing in forming 0+2 bands[2].

In this work, the energies and electromagnetic properties of the so-called β- and γ-bands of nuclei in this region are compared with the solutions of a five dimensional collective Hamiltonian for quadrupole vibrational and rotational degrees of freedom, with moments-of-inertia and mass parameters determined by constrained self-consistent relativistic mean-field calculations using the PC-F1 relativistic functional[3,4]. This model is able to account for features such as vibrations and shpe-coexistence on al equal footing.

A good qualitative agreement is found between the measured energies and of the in-band/out-of-band branching ratios across the entire region.

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Session Classification: Plenary Session II

Contribution ID: **68** Type: **not specified**

The India based Neutrino Observatory, mini-ICAL and a shallow ICAL

Monday, 4 February 2019 09:30 (30 minutes)

The genesis of the India based Neutrino Observatory project is described briefly. The flagship experiment is based on a 51,000 ton magnetised iron calorimeter (ICAL) which aims to determine the mass ordering of the 3 tiny neutrino masses through a measurement of atmospheric muon neutrinos and muon anti-neutrinos. An 85 ton 4mx4mx10 layer mini- ICAL detector with 10 glass RPCs has been built and is presently taking data at the rented premises of INO at Madurai. The delay in starting construction at the preferred site in the Theni district in Tamil Nadu has encouraged us to look at other options for locating the ICAL detector including the possibility of a shallow depth ICAL together with an efficient cosmic veto shield. The first steps towards examining this possibility are outlined.

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Presenter: Prof. V.M. DATAR (INO Cell, TIFR)

Session Classification: Plenary Session IV

Contribution ID: **69** Type: **not specified**

Nuclear Structure and Decay Data Evaluation

Monday, 4 February 2019 14:25 (25 minutes)

Nuclear Data evaluation is a very essential part of Experimental nuclear research. The Nuclear Structure and Decay Data Evaluation evaluation is a source to many new experiments and new ideas, besides the standardization of experimental data.

Mass A=139 data evaluation led to a new experiment for measuring the half life of 139Ba which had several past measurements not in agreement. The same mass chain evaluation also dealt with several discrepancies, which were settled amicably. Similarly data evaluation

of many other mass chains has led to new questions. One important question is the quantum of measurement of half-life

values in all the experimentally known nuclei. The analysis throws up interesting numbers on these measurements, indicating large

number of nuclei have very small number of half life values measured.

Same is the story on the quantum of measurement of values of spins and parity values of these nuclei. In the talk

I will present some of these numbers.

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Session Classification: Parallel Session Nuclear Physics

Contribution ID: **70** Type: **not specified**

MSSM with Non-Standard Soft Interactions

Sunday, 3 February 2019 17:10 (25 minutes)

Non-holomorphic soft supersymmetry breaking interactions will be discussed in relation to MSSM. Unlike MSSM, it is possible to have a higgsino as a single component type of dark matter candidate while having a low electroweak fine-tuning. Muon g-2 may also be enhanced. We will also explore the bottom squark sector by studying the 2b plus missing transverse energy signal at the LHC. We will probe parameter space that may potentially have an enhanced event rate than MSSM.

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Session Classification: Plenary Session III

Contribution ID: **71** Type: **not specified**

Recent trends in the neutron and proton induced reaction cross section data for advanced reactor applications

Tuesday, 5 February 2019 14:25 (25 minutes)

The light particle induced reaction cross-section data are of prime interest for the different areas like radiation dose estimation, radiation damage, fuel cycle assessments, transmutation of long lived nuclei and many more. The future nuclear reactors like Accelerator Driven Subcritical systems (ADSs), International Experimental Thermonuclear Reactor (ITER) and fast breeder reactors demand the neutron and proton induced reaction cross-sections data at high incident energies. The data will also be helpful for the advancement of medical accelerators and for the medical isotope production. We have made an attempt to understand the nature of the cross-section data for reactor fuel materials (238U, 232Th) [1, 2] and structural materials (Sn, Tb, W, Gd, Ni, Al, In) [3,4,5] within the neutron energies from threshold to 22 MeV. The proton induced reaction cross-sections were also measured for the reactor structural materials (Ag, Ti, Nb, and Sn) [6, 7] within 10-22 MeV energies. In addition to this, we have also measured the cross-sections for the most demanding medical isotope 99mTc using two production routes 100Mo(n, 2n)99mMo [8] and 100Mo(p, 2n)99mTc.The experiments were carried out at the 14UD BARC-TIFR Pelletron accelerator utilizing the activation and off-line ɣ-ray measurement technique for both neutron and proton irradiations. The quasi-monoenergetic neutrons of desired energies were generated using the 7Li(p, n) (Eth = 1.88 MeV) reaction. The nuclear model codes like, TALYS-1.9 [9], ALICE-2014 [10] and EMPIRE-3.2.3 [11] were used for the theoretical predictions. The uncertainty in each measured data was calculated using the error propagation method [1]. The uncertainties together with the correlation coefficients were calculated for each case and were found to be within the range of 10-20%. The recent work emphasis the vitality of the reaction cross-section data for the reactor based applications. The work also highlights that the precise reaction cross-section data is achievable within 20% uncertainty by using the 7Li(p, n) reaction as the neutron generator.

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Session Classification: Parallel Session Nuclear Physics

Contribution ID: **72** Type: **not specified**

The applications of MCNP in nuclear data measurement and analysis

The nuclear transport calculations are crucial for the optimization of the reactor design parameters. The nuclear data from the different nuclear data libraries are used for such transport calculations. There are several nuclear transport codes are available such as MCNP, FLUKA, GEANT4, etc. The Monte Carlo based N Particle code i.e., MCNP code is a worldwide used for such particle transportation. It can transport neutron, photon, electron, proton, and many other particles. Its application in shielding design is remarkable and International Thermonuclear Experimental Reactor (ITER) shielding has been designed using MCNP code.

The code is useful for the various parameter estimation and optimization in the experiment. The detector efficiency is one of the sensitive parameter for the experiments based on activation analysis. In such experiment the source used for efficiency calibration is most probably a point source where the actual samples are volume sample. For such case MCNP modeling is useful to calculate the exact efficiency of the sample geometry. A sample detector geometry effect in cross section estimation will be discussed. The neutron spectra from the accelerator based neutron source is also a key parameter for the accurate calculation of the cross section of a nuclear reaction. In pelletron facilities the 7Li(p,n) reaction is most commonly used for the neutron production. The neutron energy spectra can be measured using the Time of Flight set up. The alternative is to produce it using particle transport which is done using MCNP. The generation of such neutron spectra will be discussed. These two work shows the importance of MCNP in nuclear experiments. Further, the different shielding materials are used for neutrons and gamma shielding. Concrete is a common reactor shielding material for neutron and high energy gamma. The amount of concrete used for the shielding requires high amount, which need more space and cost effective. In present work we have used different composition of concrete to increase its shielding capacity. We mainly changed the amount of WC and B4C to enhance the shielding of gamma and neutrons respectively. So the application of MCNP in different area of experiment and radiation protection simulation will be discussed.

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Contribution ID: **73** Type: **not specified**

Redefining the edge of the island of inversion for Na nuclei

The magic numbers of the nuclei, proposed by Mayer and Jensen are a benchmark of nuclear structure. The underlying shell gap is a characteristic of the mean nuclear field which takes into account of many ingredients of the nucleon-nucleon interactions. Recently, it has been noted that these magic numbers are no longer valid in the exotic nuclei which are far away from the β-stable line and close to the drip line. The modification in the shell gaps through effects such as the tensor component of the N-N force become pronounced with large neutron–proton asymmetries in the exotic nuclei. These lead to the disappearance of established magic numbers and the appearance of new ones. Large deformation was reported in nuclei for N˜20, e.g. 31Na, 32Mg etc. The large deformation in those nuclei was explained by considering the intruder effects which suggests a clear vanishing of the shell gap between sd and pf shell around N = 20. The N = 20 isotones for Z =10–12 are considered to belong to the "island of inversion" where intruder configurations dominate the ground state wave function. Though it is established that the valence neutron(s) in the ground state of the neutron-rich Na, Mg, Ne isotopes at N=20, occupies pf intruder orbitals, but this is not well established for the neighboring nuclei. Recently nuclei with N˜20 have been studied and valence nucleon occupancy in the pf orbital is reported by our group. An experimental program GSI-S306 was initiated to explore ground state configurations of neutron-rich nuclei around N=20 through Coulomb breakup of secondary beams at intermediate energy (400–500) MeV/nucleon. Coulomb breakup is a direct method to probe the quantum numbers of the valence nucleons of loosely bound nuclei [1]. The invariant mass spectra of 29,30Na have been obtained through measurement of the four-momenta of all decay products after Coulomb excitation of those nuclei on a 208Pb target at energies of 400–430 MeV/nucleon [2, 3]. The major part of one neutron removal, CD cross-sections of those nuclei populate the core, in its ground state. A comparison with the direct breakup model, suggests the predominant occupation of the valence neutron in the ground state of 29Na (3/2+) and 30Na (2+) is the d-orbital with a small contribution from the s-orbital, which are coupled with the ground state of the core. The ground state spin and parity of these nuclei obtained from this experiment

are in
agreement with earlier reported values. The spectroscopic factors for the valence neutron occupying the s
and d orbitals for these nuclei in the ground state have been extracted and reported for the first time.
Interestingly it has been found that the spectroscopic factor for the valence neutron in the d-orbital for
29Na is in close agreement with USD-B calculation; however it is less by 1/3 for 30Na. Hence in contrary
to the previous works, we can conclude that 29Na is probably not a member of the island of inversion and
we propose 30Na as the new boundary [4]. A comparison of our experimental findings with shell model
calculation using the MCSM suggests a lower limit of around 4.3 MeV of the sd–pf shell gap in 30Na.
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Contribution ID: **74** Type: **not specified**

Ground-state configuration of neutron-rich 35 Al via Coulomb breakup

The ground-state configuration of 35Al has been studied via Coulomb dissociation (CD) [1] using the LAND-FRS setup (GSI, Darmstadt) at a relativistic energy of ~403 MeV/nucleon. The measured inclusive differential CD cross section for 35Al, integrated up to 5.0 MeV relative energy between the 34Al core and the neutron using a Pb target, is 78(13) mb [2].The exclusive measured CD cross section that populates various excited states of 34Al is 29(7) mb. The differential CD cross section of 35Al ⟶ 34Al + n has been interpreted in the light of a direct breakup model, and it suggests that the possible ground-state spin and parity of 35Al could be, tentatively, 1/2+ or 3/2+ or 5/2+. The valence neutrons, in the ground state of 35Al, may occupy a combination of either l = 3,0 or l = 1,2 orbitals coupled with the 34Al core in the ground and isomeric state(s), respectively. This hints of a particle-hole configuration of the neutron across the magic shell gaps at N = 20,28 which suggests narrowing the magic shell gap. If the 5/2+ is the ground-state spin-parity of 35 Al as suggested in the literature, then the major ground-state configuration of 35Al is a combination of 34Al(g.s.; 4−) ⊗ νp3/2 and 34Al(isomer; 1+) ⊗ νd3/2 states. The result from this experiment [2] has been compared with that from a previous knockout measurement [3] and a calculation using the SDPF-M interaction.

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Contribution ID: **75** Type: **not specified**

Singlet Fission: H2 dimer model system

Singlet fission (SF), a process whereby one high energy singlet exciton is converted into two lower energy triplet excitons, is an excited state phenomenon with a potential impact on the efficiency of inexpensive organic solar cells [1,2]. In this process high energy singlet exciton, resultant from the absorption of a high energy photon, is converted into two triplet exciton which increase the efficiency of single junction solar cell. In principle, we can increase the efficiency limit to 42%, which is about a quarter more than conventional (Shockley–Queisser limit on efficiency, 33%) solar cell. It is observed to occur spontaneously in some organic materials where the energy of the singlet exciton, Es, is approximately twice the energy of the triplet exciton, ET. However, the dynamical mechanism of this phenomenon is not fully understood and a complete microscopic theory of singlet fission is lacking. A four-electron four-orbital model is a simple model to understand the mechanism of singlet fission for the transition from an initially excited intramolecular singlet state, S1, to the multiexciton triplet-triplet state, TT. In this work we considered H2 dimer as a model and try to comprehend the SF mechanism.

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Contribution ID: **76** Type: **not specified**

The knowns and unknowns of Neutrinos

Sunday, 3 February 2019 18:30 (50 minutes)

In this talk the goal is to bring out why neutrinos hold a prominent place in today's physics. The neutrino is uncharged and interacts very weakly. As a consequence, over long distances it is a faithful messenger for information about its source, e.g., the sun. But the weakness of its interaction also makes neutrinos quite difficult to detect. The story of the neutrino is exciting and is yet to reach its completion. In this introductory talk, meant for non-experts, we discuss how we arrived at the present state of our knowledge about neutrinos and indicate the open issues which are being actively pursued.

Primary author: Prof. AMITAVA RAYCHAUDHURI (University of Calcutta)

Presenter: Prof. AMITAVA RAYCHAUDHURI (University of Calcutta)

Session Classification: Evening Lecture

Contribution ID: **77** Type: **not specified**

Flavourful axion phenomenology

Sunday, 3 February 2019 15:00 (30 minutes)

We provide a comprehensive discussion of the phenomenology of flavourful axions, including both standard Peccei-Quinn (PQ) axions, associated with the solution to the strong CP problem, and non-standard axion-like particles (ALPs). Presenting the general flavourful axion-fermion and axion-photon coupling, we calculate flavour-violating decays of mesons and leptons involving a flavourful axion. We also derive the mixing between axions and mesons which affects the meson oscillation probability and mass difference, and also contributes to meson decays into axions and axion decays into two photons. These effects may be relevant for ALPs. Finally we describe the phenomenology of a particular "A to Z" Pati-Salam model, in which PQ symmetry arises accidentally due to discrete flavour symmetry. Here all axion couplings are fixed by a fit to flavour data, leading to sharp predictions and correlations between flavour-dependent observables.

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Session Classification: Plenary Session II

Contribution ID: **78** Type: **not specified**

Dynamical System Study of Steep Exponential Potential

A large number of cosmological observations suggest that the present universe is undergoing an accelerated expansion. The driving force responsible for this expansion is called dark energy (DE). A number of cosmological models have been proposed to account for this unknown DE component and a scalar field quintessence model is one of the main candidates for Dark Energy. The quintessence scalar field models are usually characterized by the associated potential and a large variety of potentials have been explored in this context.

Recently scalar field models with very steep potentials have been considered as candidate for DE [1]. In this paper we have analysed the dynamics of such steeper potential models using the centre manifold theory [2]. We have solved the system of autonomous differential equations for steep exponential potential models and have shown that in most of the cases a steep exponential model does not provide a very stable solution.

References:
1. M. Shahalam et al., arXiv:1802.00326 [gr-qc]
2. S. Bahamonde et al., arXiv:1712.03107 [gr-qc]

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Contribution ID: **79** Type: **not specified**

Signature of phase transition in finite strongly interacting matter

Phase structure of QCD is interesting in its own and existence of a possible Critical End Point (CEP) in QCD phase diagram is under active investigation, both in theoretical and experimental fronts. The system created in heavy ion collisions has a finite size and motivates us to work on possible finite size effects on QCD phase transition on the theoretical side. In this work, we have used a QCD inspired effective model, namely Polyakov loop extended version of Nambu-Jona-Lasinio model. Finite size effects are incorporated using Multiple Reflection Expansion formalism. We investigate the finite size effects on the fluctuation of conserved charges and its possible implication on CEP search.

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Contribution ID: **80** Type: **not specified**

Experimental and theoretical correlation of relative yield distribution of neutron-rich fragments produced in α induced fission of 232Th

The data for the work has been obtained from the experiment performed at Variable Energy Cyclotron Centre, Kolkata using the INGA facility. A self-supporting 232Th target of thickness ˜25 mg/cm2 was bombarded with 30 MeV α particles. A total of six compton suppressed clover Ge detectors and one LEPS detector were used in the array.
By analyzing the two-fold coincidence data, a complete relative isotopic yield distribution of the fission fragments has been extracted. Detail experimental results followed by the necessary theoretical interpretation would be presented.
A.D. would like to acknowledge the financial support from BRNS, BARC, Mumbai (Sanction no. 37(3)/14/17/2016-BRNS).

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Session Classification: Parallel Session Nuclear Physics

Contribution ID: **81** Type: **not specified**

An overview of recent experimental results in nuclear cluster physics over the whole nuclear chart

Tuesday, 5 February 2019 11:40 (30 minutes)

This presentation will highlight some of most recent results concerning experiments devoted to the understanding of cluster structures in atomic nuclei. Selected topics will cover results from experimental studies on 12 C, self-conjugated and non-self-conjugated nuclei, clustering effects in nuclear reactions with light partners, including those of interest in nuclear astrophysics, and in the region of heavier mass nuclei. Effects attributable to clustering will be further discussed in processes such as fission and quasifission, in the heavy and superheavy mass region, where shell closures definitively play a role.

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Session Classification: Plenary Session VIII

Contribution ID: **82** Type: **not specified**

Ab initio Methods in Nuclear Physics

(to be introduced soon)

Primary author: Prof. JAVID SHEIKH (Cluster University)

Presenter: Prof. JAVID SHEIKH (Cluster University)

Contribution ID: **83** Type: **not specified**

Beyond the Standard Model with Flavour

Tuesday, 5 February 2019 10:00 (30 minutes)

Flavour Physics is perhaps the only way to look beyond the Standard Model if the new particles are beyond the direct production reach of the LHC. While the three-generation CKM picture works very well, there are enough reasons to believe that this is only an effective theory. In this talk, I will discuss about the way flavour data can act as a window to the unexplored land of new physics, about some of the interesting anomalies and the possible patterns of new physics they point to.

Primary author: Prof. KUNDU, Anirban (University of Calcutta)

Presenter: Prof. KUNDU, Anirban (University of Calcutta)

Session Classification: Plenary Session VII

Contribution ID: **84** Type: **not specified**

Astroparticle physics of neutrinos

Monday, 4 February 2019 10:00 (30 minutes)

Neutrinos with energies ranging from meV to EeV pervade the universe, and play crucial roles in astrophysics and cosmology. This talk will describe the rich phenomenology of these astrophysical neutrinos, and how their future observations will enrich our knowledge of particle physics, astrophysics, and cosmology.

Primary author: Prof. DIGHE, Amol

Presenter: Prof. DIGHE, Amol

Session Classification: Plenary Session IV

Contribution ID: **85** Type: **not specified**

Looking for Extra Dimensions at the Large Hadron Collider

A model of elementary particles defined in $4 + 1$ space time dimensions
naturally provides a candidate for the dark Matter. The hall mark of such a model is the presence of Kaluza Klein excitations of our known Standard Model fields. We will discuss a possible search strategy of such a model at the Large Hadron Collider.

Primary author: DATTA, Anindya (University of Calcutta)

Presenter: DATTA, Anindya (University of Calcutta)

Session Classification: Plenary Session III

Contribution ID: **86** Type: **not specified**

Supersymmetry: Present and Future

Monday, 4 February 2019 16:20 (30 minutes)

Discovery of Higgs boson confirms once again the stupendous success of the Standard Model (SM) of particle physics. Nevethless, there are many experimental and theoretical issues which SM fails to address convincingly, leading us to think about more bigger description of the SM, i.e. beyond the standard model physics. Among several beyond standard models, the supersymmetry is the most popular candidate. In Large Hadron Collider experiment(LHC), at CERN, Geneva, after the discovery of Higgs boson, the major thrust area is to look for the signature of supersymmetry. Unfortunately, so far no signal is found in data, resulting exclusions of masses of various sparticles. However, the experiments still will continue to look for it in future experiments with more energy and data. In this talk we will discuss the various issues explaining the present status of Supersymmetry and the future prospect of finding of it.

Primary author: Prof. GUCHAIT, Monoranjan (Tata Institute of Fundamental Research (TIFR))

Presenter: Prof. GUCHAIT, Monoranjan (Tata Institute of Fundamental Research (TIFR))

Session Classification: Plenary Session VI

Contribution ID: **87** Type: **not specified**

Non-equilibrium statistical mechanics, Fermion dark matter and SN1987A cooling

Monday, 4 February 2019 14:30 (25 minutes)

Light dark matter(1 – 30 MeV) particles which can be pair
produced in electron-positron annihilation e – e + ⟶ χ χ inside the
supernova SN1987A core, take away the energy released in the supernova
SN1987A explosion. Working within the framework of q-deformed scenario
(non-equilibrium statistics) and using the Raffelt's criteria on the
energy loss rate and the optical depth criteria on the free streaming
of the dark matter fermion, we find that the lower bound on the scale
Λ of the dark matter effective theory to be Λ ~1.0E+07 TeV for m χ =
30 MeV. We will briefly address our recent work on the supernova and relic density constraints on
leptophillic operators.

Primary author: Dr DAS, PRASANTA (B)

Presenter: Dr DAS, PRASANTA (B)

Session Classification: Parallel Session Particle Physics

Contribution ID: **89** Type: **not specified**

Measurement of the composition and film thickness of the Ge/Si quantum dot hetero-junction samples by the Rutherford Backscattering technique

Rutherford Backscattering (RBS) technique is one of the most useful techniques to measure the hetero-structure film thickness and the composition of the sample. In this technique, sample is irradiated with light ions (usually 2-3 MeV α-particles or protons) and the elastically backscattered projectiles at large angles are detected. The mass of the target atoms could be identified from the energy of the backscattered projectile. We have employed the RBS technique to measure of the thickness and composition of Ge/Si quantum dot (islands) hetero-junction as-deposited sample and for a series of annealed samples. The simulated result of the as-deposited sample has been used to extract the equivalent Ge layer thickness, which is found to be 14 monolayers (ML) thick. A successive decrease of the intensity of Ge peak for different duration of annealing indicates the consumption of metastably thick Ge wetting layer during prolong annealing. The metastable Ge wetting layer greater than 3ML beneath alloyed islands is feeding them during annealing to increase the island volume. The broadening of Ge peak RBS spectra is due to the decrease of Ge mole fraction in the resultant Si1-xGex alloys, with the increase of annealing time. Rutherford back scattering spectroscopy (RBS) was carried out with 2 MeV He+ incident normally on the samples, with the detector fixed at a scattering angle 165°. All measured data were simulated and analyzed using SIMNRA version 6 developed by Max-Planck-Institute for Plasma physics, Garching, Germany.

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Contribution ID: **90** Type: **not specified**

Looking for dark matter: usual and unusual ways

Sunday, 3 February 2019 11:30 (35 minutes)

Presenter: Prof. MUKHOPADHYAYA, Biswarup (Harish-Chandra Research Institute, Allahabad, India)

Session Classification: Plenary

Contribution ID: **91** Type: **not specified**

Composite Higgs Phenology

Sunday, 3 February 2019 14:00 (30 minutes)

Presenter: Prof. BHATTACHARYYA, Gautam (Saha Institute of Nuclear Physics)

Session Classification: Plenary Session II

Contribution ID: **92** Type: **not specified**

Particle Physics implications of neutrinoless double beta decay

Monday, 4 February 2019 15:50 (30 minutes)

Presenter: Prof. PAL, Palash (University of Calcutta)

Session Classification: Plenary Session VI

Contribution ID: **93** Type: **not specified**

Lighting Lamp etc

Sunday, 3 February 2019 10:00 (5 minutes)

Session Classification: INAUGURAL SESSION

Contribution ID: **94** Type: **not specified**

Welcome speech by Anagha Chakraborty

Sunday, 3 February 2019 10:05 (5 minutes)

Session Classification: INAUGURAL SESSION

Contribution ID: **95** Type: **not specified**

Opening Remark: By Departmental Head and other Dignitaries

Sunday, 3 February 2019 10:10 (10 minutes)

Session Classification: INAUGURAL SESSION

Contribution ID: **96** Type: **not specified**

The Digital Way to the Heart of the Nucleus : Free Knowledge & Deep Truths

Monday, 4 February 2019 17:20 (30 minutes)

Presenter: Prof. GHUGRE, S.S. (UGC-DAE-Consortium for Scientific Research, Kolkata 700 098, India)

Session Classification: Plenary Session VI

Contribution ID: **97** Type: **not specified**

Looking for Extra Dimensions at the Large Hadron Collider

Monday, 4 February 2019 12:35 (25 minutes)

Presenter: Prof. DATTA, Anindya (University of Calcutta)

Session Classification: Plenary Session V

Contribution ID: **98** Type: **not specified**

Nuclear Data Evaluation and Applications

Tuesday, 5 February 2019 12:35 (25 minutes)

Presenter: Dr DHINDSA, sukhjeet

Session Classification: Plenary Session VIII

Contribution ID: **99** Type: **not specified**

Vote of Thanks of Swarup Kumar Majee

Sunday, 3 February 2019 10:55 (5 minutes)

Session Classification: INAUGURAL SESSION

Contribution ID: **100** Type: **not specified**

Particle Physics implications of neutrinoless double beta decay

It will be a pedagogical talk on neutrinoless double beta decay. I will discuss the importance of lepton number violation, Majorana masses of neutrinos, and other processes related to neutrinoless double beta decay.

Primary author: Prof. PAL, Palash (University of Calcutta)

Presenter: Prof. PAL, Palash (University of Calcutta)

Contribution ID: **101** Type: **not specified**

The Digital Way to the Heart of the Nucleus : Free Knowledge & Deep Truths

The pursuit of experimental nuclear physics at both the teaching as well as research level is, at times, prohibitively difficult owing to the required resources and allied expenses. In addition to the expenditures, the burden of maintaining the setups through massive and prolonged usage is often a bottleneck in upholding the quality of training that the laboratory course aspires to impart. As of today little can be done to circumvent the requirement to use commercially available radiation detectors, however, it is possible to dispense with, the conventional pulse processing systems, atleast for the basic laboratory level courses, by taking recourse to the contemporary digital signal processing methodology, as would be detailed during the presentation. The methodology utilizes the open source resources for pulse processing as well as the data acquisition. With this approach, the basic representations of nuclear phenomena, such as spectrum of a radioactive source, can be efficiently accomplished for an illustrative training of the students.

The experience in dabbling with the DSP algorithms has paved way for the Nuclear Physics Group at the Kolkata Centre of the Consortium in the developmental endeavours associated with the digital signal processing and data acquisition, in the vibrant domain of in-beam gamma ray spectroscopy, being actively pursued using the Indian National Gamma Array. One of the recent implementations of such a system has been in a campaign of the Indian National Gamma Array (INGA) hosted at the Room Temperature Cyclotron (RTC) of the Variable Energy Cyclotron Centre (VECC), Kolkata. The system befits spectroscopic applications, working under a Compton suppressed detector multiplicity based event trigger as well as under condition effecting to a triggerless mode. These developments intend to befriend the user in his quest to probe the nuclear excitations. The odyssey embarks with the generation of the pulses from the detector, following a detection, and wades through processing of the pulse to extract the knowledge within and come up with a representation that embodies the acquired data in a format which can be flexibly accessed at different stages of the continued pursuit.

The Nuclear Physics Group at the UGC-DAE CSR, associated with the development of the digital daq, has members, Dr. R. Raut, Dr. S.S. Ghugre, Dr. A.K. Sinha, Mr. S. Das, Mr. S. Samanta, Mr. S. Chatterjee and Mr. K. Basu. Dr. H. Tan of XIA LLC (USA) has led the fabrication of the daq system at the manufacturing end. The development of an open source counting system was a collaborative endeavour with Prof Amitava Gupta and Shri A Jana from, the School of Nuclear Studies & Applications, Jadavpur University.

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Measurement of fusion excitation functions around the Coulomb Barrier for 18O + 116Sn system

Monday, 4 February 2019 14:50 (25 minutes)

Presenter: Dr KALITA, Kushal (Gauhati University)

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