PLPAC meeting 2024-1

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TIFR

Book of abstracts

Table of contents

1

Fragmentation dynamics of small poly-atomic molecules

Author: Prof. MISRA, Deepankar [1]

Co-Authors: Mr. SINGH, Harpreet [1]; Mr. MUKHERJEE, Jibak [1]; Mr. KUMAR, Kamal [1]; Mr. DAS, Manojit [1]

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In the present experiment, we aim to perform swift highly charged ion collisions with small poly-atomic molecular systems. We aim to study the kinetic energy released distributions and angular distributions of the fragment ions. We also intend to study the emitted electrons in coincidence with the fragment ions in a home-built Reaction Microscope setup. We will study the breakup dynamics by measuring all the particles in the final state. Hence a kinematically complete experiment will be carried out.

2

Dynamics of B-induced reaction at low energies

Prof. MAITI, MOUMITA [1]

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The study of breakup-fusion mainly focuses on weakly-bound projectiles with breakup thresholds 1.45--2.45MeV. However, 10B also has low α-separation energy (4.5MeV), suggesting it may undergo breakup and significantly impact fusion mechanisms at low energies. Measurements from 10,11B+159Tb/209Bi showed complete fusion suppression of ~15% for 10B and 7% for 11B reactions above the barrier. Since the fusion behavior of 10B and its comparison with 11B remains grossly unexplored in medium and light mass nuclei, we aim to measure fusion excitation functions for 10,11B interactions on 89Y, 59Co, 141Pr within 25--70MeV.

3

Irradiation of Zr-2.5Nb alloy with Cl 35 beam

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It is planned to perform exposures of Zr-2.5Nb specimens to 35Cl beam for various durations (1h, 8h, etc) at the pelletron facility to achieve different levels of Cl ion implantation in the specimens. These specimens will then be subjected to nodular corrosion experiments at MP&CED; to study the effect of different levels of Cl ion implantation.The mechanism for nodular corrosion in gaseous phase attributes the initiation of nodules to the defects in the oxide. Therefore, it is also planned to generate various defects in the oxide by 35Cl irradiation and study their effect on nodular corrosion

4

Exploring E1 transitions at particle-emission threshold near N = 50 shell closure through neutron pickup reaction

Author: Dr. BAGCHI, Soumya [1]

Co-Authors: Prof. PALIT, Rudrajyoti [2]; Mr. ABDULLAH, Mohammad [1]; Dr. BHATTACHARYYA, Sarmishtha [3]; Prof. HARAKEH, Muhsin [4]; Mr. KAR, Debodyuti [1]; Ms. KHOKHAR, Kalpana [1]; Mr. KHUMALO, Thuthukile [5]; Prof. LANZA, E. G. [6]; Dr. MUKHERJEE, Gopal [7]; Dr. MUKHOPADHYAY, Supriya [8]; Ms. PAL, Shinjini [1]; Dr. PELLEGRI, Luna [5]; Dr. RAJBANSHI, Subhendu [9]; Dr. ROY, Pratap [8]

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Following its discovery, numerous theoretical and experimental endeavors have been undertaken to unravel the microscopic structure of the Pygmy Dipole Resonance (PDR). However, despite these efforts, several unresolved questions persist, impeding a systematic understanding of the underlying microscopic structures of the PDR. These inquiries include whether there exists an onset of single-particle characteristics within the PDR, discerning how nuclear level densities contribute to the fragmentation observed in the PDR strength, and investigating how the distribution of strength within the PDR is influenced by the deformed shapes of nuclei in their ground states.

5

Corrosion monitoring of borosilicate glasses using TLA method

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Thin layer activation analysis (TLA) technique using a high energy ion beam is a nuclear technique for measurement of surface loss of materials in the micrometer range. It has been widely used to measure wear, corrosion or erosion in automobile industry, power plants, process industry, oil and petroleum refineries and in many high technology areas. In the proposed study the application of TLA method for corrosion monitoring of glass will be explored.

6

Production of 52Mn via natCr (p, n) 52Mn reaction and its radiochemical separation for preparation of radiopharmaceuticals

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Manganese-52 (T½ =5.6 d, Eβ+max = 575 keV; average Eβ+ = 242 keV, branching ratio β+ = 29.4 %) is an emerging radiometal that holds tremendous potential in nuclear medicine. The radioisotope can be produced in a low-energy particle accelerator using natural Cr-metal target via 52Cr (p, n) 52Mn reaction. Production, radiochemical separation and purification are the vital steps towards obtaining no-carrier-added (NCA) grade 52Mn in a form suitable for formulation of radiopharmaceuticals for cancer imaging.

7

Investigating the Cluster Structure of 10B

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In the proposed experiment, the aim is to accomplish the following measurements:
(1) Sufficient 6Li-α coincidence events for the identification 10B states through which it breaks into 6Li and α.
(2) Detection of 2α-d coincidence events to establish the α-α-d cluster configurations.
(3) A comprehensive study of all the possible breakup channels which may provide signatures of new cluster configurations in 10B.

8

Search for high-spin isomers and shears band in odd-odd 206At

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Co-Authors: Mr. NAIDU, B. S. [2]; Mr. JADHAV, S. [2]; Mr. THOMAS, Abraham V [2]; Prof. PALIT, Rudrajyoti [2]; Dr. DEO, AJAY [3]; Dr. SINGH, R. P. [4]; Mr. SINGH, Sahab [1]; Mr. ROY, Rajat [1]; Dr. DAS, Biswajit [2]; Dr. DEY, Piku [2]; Dr. KUNDU, Ananya [2]

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In the proposed experiment, we plan to search for high-spin isomers and shears band in odd-odd 206At. 206At lies at the lower boundary of the transitional region (Z>82, N<126), where competition between two extreme modes of nuclear excitations result in diverse structural phenomena. One of these aspects is nuclear isomers. Study of isomers is very important as they provide testing ground to various theoretical calculations. Another interesting phenomena is shears bands in weakly deformed nuclei in this region. We plan study shape evolution in At isotopes through study of shears bands and isomers in 206At.

9

Study of Pairing Re-entrance Phenomenon in 72Ge

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We propose to carry out an experiment to measure the angular momentum gated proton spectra from 73As*(18O+ 55Mn system). The main objective is to study the pairing re-entrance phenomenon in 72Ge. In earlier investigations on this topic, J dependent nuclear level density obtained from proton evaporation spectra in 105Ag* at the incident energy 40–50 MeV shows an unusual bump in level density of 104Pd at low excitation energy (temperature) and high J. The SMMC calculations has also predicted similar features for 72Ge at low temperature (T) and high J.

10

Study of neutron induced reaction cross section of different structural materials with covariance analysis

Ms. ., Vandana [1]; Dr. BANGOTRA, pargin [2]; Prof. ., Nand lal singh [2]; Prof. NANAL, Vandana [3]

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The current motivation of the experiment is to quantify the significant discrepancies between the experimental and theoretical data of nuclear reaction cross section and thereby, increase the productive power of theoretical models.

11

Study of Neutron induced reaction cross section measurement up to 20 MeV relevant to nuclear data generation and covariance analysis.

Author: Ms. SHARMA, Shivani [1]

Co-Authors: Dr. BANGOTRA, Pargin [1]; Prof. SINGH, Nand Lal [1]; Dr. MEHTA, Mayur [2]; Dr. SINGH, Ratan [3]; Prof. NANAL, Vandana [4]; Dr. MAKWANA, Rajnikant [5]

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The experimental nuclear measurements are needed to validate as well as to get the appropriate data set which can complete the data for entire energy range for future nuclear reactor application. The current proposal, as part of my PH.D, aims for taking results of the systematic activation cross section for few pre-decided isotopes, for which the available nuclear data is discrepant.

12

Measurement of short-lived fission products in 6Li+232Th reaction to investigate the role of neutron and proton shells

Authors: Dr. TRIPATHI, Rahul [1]; Mr. KUMAR, Satyam [1]

Co-Authors: Dr. PATRA, Sabyasachi [1]; Dr. MHATRE, Amol [1]; Dr. KUMAR, Ashwani [1]; Dr. KUMAWAT, Harphool [2]; Dr. RAMACHANDRAN, K. [2]; Dr. SANTRA, Satyaranjan [2]

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Separate file attached

13

Exploring new isotopes of Bk

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We found that there is a scope to identify the new isotopes for Bk which has half-lives greater than 10-6s. Our theoretical calculation (see Appendix IV) predicts that the next heavy nuclei with Z=97, N=139 (A=236, T1/2=0.933s (β-decay)) can be synthesized with a good residual cross-section of 87pb by the target of 209Bi and projectile of 30Si at about 147.53 MeV.

14

Measurements of pre-scission α-particle multiplicity spectra in 11B + 209Bi reaction

Author: Ms. SIRSWAL, Nidhi [1]

Co-Authors: Dr. GUPTA, Y.K. [2]; Mr. PRAJAPATI, G.K. [3]; Dr. JOSHI, B.N. Joshi [4]; Mr. SINGH, Pawan [4]

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Recent studies highlight a transition in pre-scission α-particle multiplicity from high to very low values at the Businaro Gallone point during heavy-ion induced fission of 232Th. This behavior, observed across various induced fission reactions, indicates significant dynamical effects in entrance channels suggesting a reversal in mass flow direction, leading to di-nuclear configurations and premature fission. The motivation for proposed measurements in 11B+209Bi fission lies in extending investigations on entrance channel effects observed in heavy-ion induced fission of 232Th to lower mass regions.

15

Investigation of breakup probabilities in 10B+159Tb system

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Detailed proposal attached

16

Exploring breakup probabilities in 11B induced reaction

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Detailed proposal attached

17

Measurement of charged particle emission spectra in 12C + 209Bi fission reaction

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Co-Authors: Dr. GUPTA, Y.K. [1]; Mr. PRAJAPATI, G.K. [1]; Dr. JOSHI, B.N. [1]; Ms. SIRSWAL, Nidhi [1]

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The study of nuclear fission is crucial for understanding fundamental of Nuclear physics. Nuclear fission, induced by heavy-ion fusion reactions, reveals complexities challenging our current understanding. Non-equilibrium fission, with its various observable like particle emissions, offers insights into intricate dynamics. Recent investigations in 232Th show discontinuous behaviors in pre-scission α-particle multiplicities, suggesting non-equilibrium fission. This prompts further exploration, particularly in lower mass regions, to uncover nuclear fission dynamics' nuances. Our proposal to measure charged particle multiplicities in 12C+209Bi fission aims to significantly contribute to this ongoing quest for knowledge.

18

Measurement of neutron capture reaction cross section on 88Zr isotope using Surrogate Reaction Method

Authors: Mr. DAS, Jyotisankar [1]; Dr. KUMAWAT, Harphool [2]

Co-Authors: Dr. PAL, Asim [2]; Dr. ROUT, P.C. [2]; Mr. BAISHYA, Abhijit [2]; Ms. TAYA, Payal [2]; Prof. GOWRISHANKAR, R. [3]; Ms. SINGH, TANYA [4]; Mr. MEHER, Manoj [4]; Mrs. TRIPATHI, Shachi [2]

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Neutron capture cross section data are of fundamental importance in nuclear science, such as the nuclear reactor performance, reactor waste management, nuclear security, stellar nucleosynthesis, nuclear medicine and defence applications. Obtaining the reliable neutron capture cross section data for radioactive targets remains a formidable challenge. In addition, understanding the formation of elements greater than iron, neutron capture reactions plays a crucial role. In recent years several indirect methods are developed to overcome in measuring the neutron induced reaction cross section for unstable isotopes.

19

Lifeitme measurement of 13/2+ isomeric state of 205, 207At nuclei

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Existing literatures have been studied for odd A, 199-207At mass nuclei, and it has been found that, we can investigate the lifetime of (13/2)^+ isomeric state in 205At which is unknown. In addition to that, as the study associated with 205At is very old, a scope for re-investigation is there to justify the old lifetime values for other isomeric states as well in 205At. Also, for the 207At, we can simply observe the (13/2)^+ and (21/2)^-state and calculate their unknown lifetimes.

20

Measurement of High energy gamma rays in A ~ 90 region using INGA PARIS setup

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We want to test the PARIS detector using in-beam experiment coupled to INGA. We are using Pixie based DDAQ. Two different crates, one for clover, CsI and other one for PARIS,LaBr3(Ce) detector will be used and will have to be time synchronized.
This improved setup is important to get new insight about the high spin behavior of the isotopes near A = 90.

21

Fission fragment mass and TKE distribution of 194Hg [19F+ 175Lu]

Dr. KUMAR, Vineet [1]

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In a decade since the discovery of asymmetric split in β-delayed fission of 180Tl the fission of the preactinides has witnessed considerable development both theoretically as well as experimentally. We had an ongoing experimental program to systematically explore the new kind of asymmetric fission observed in the preactinide region. In this regard we intend to measure fission fragment mass and TKE distribution of 194Hg populated in 19F+175Lu reaction. As more studies are required to understand the role of shell effects on the fission process in preactinides this measurement will be useful in constraining the theoretical models.

22

MEASUREMENT OF PROTON CAPTURE CROSS SECTIONS ON 116,119Sn

Authors: Ms. TWISHA, Munmun [1]; Prof. MUKHERJEE, Anjali [1]

Co-Authors: Dr. SHARMA, S.C. [2]; Mr. GUPTA, Ashish Kumar [1]; Dr. SHRIVASTAVA, Aradhana [2]; Dr. KRIPAMAY, Mahata [2]; Dr. RAMACHANDRAN, K [2]; Dr. KUMAR, Vineet [2]; Dr. PARKAR, Vivek [2]; Dr. PANDIT, Sanat [2]; Dr. PAL, Sanjoy [3]

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The discrepancy with stellar abundance of Sn isotopes still remains. In this respect, measurements of (p,γ) cross sections on proton rich Sn isotopes gives insight into the (γ,p) cross sections and implicitly into the dilemma involving the p-process contribution to the formation of these nuclei. Extending measurements to proton capture cross sections on Sn isotopes would provide a higher reliability in deriving global optical model parameters for the nuclei in this ass region.

23

Fission Fragment mass and TKE distribution of 216Rn [7Li+ 209Bi]

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Attached

24

Investigation of the E(5) critical point symmetry in 74Se

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Present proposal focuses to investigate the E(5) critical point symmetry in 74Se nucleus [16]. The experimental R4/2 = 2.15 for 74Se which are close to the predicted value of 2.20. The previous measurement on this nucleus extracted the B(E2) transition rates of the ground state band up to the 6+ state and within the error bars transition strength are in well agreement with the E(5) prediction. We will measure the energy and lifetime of the low-lying states and will compare with the IBA calculation to explore the E(5) symmetry in this nucleus.

25

Investigation of two-phonon gamma-vibrational states in 164Er

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Co-Authors: Mr. NAYAK, Pramod Kumar [2]; Mr. MISHRA, Prabhat Kumar [2]; Mr. PANDIT, Sanat [3]; Dr. PARKAR, Vivek [4]; Mr. DANU, Laxman Singh [2]; Dr. KUMAR, Vineet [4]; Dr. RAMACHANDRAN, K. [2]; Mr. PATALE, P. V. [2]; Mr. KUMAR, A. [4]; Dr. MAHATA, Kripamay [5]; Dr. SHRIVASTAVA, Aradhana [4]; Dr. BHAT, G. H. [6]; Prof. SHEIKH, J. A. [7]; Prof. FRAUENDORF, S. [8]; Prof. GARG, Umesh [9]; Dr. CHAKRABORTY, Anagha [10]; Prof. PALIT, Rudrajyoti [11]; Mr. MALIK, Vishal [11]; Mr. DEY, Piku [12]; Dr. KUNDU, Ananya [12]; Ms. SINDHU, A. [12]; Mr. PAL, Shouvik [12]; Mr. JADHAV, S. K. [12]; Mr. NAIDU, B. S. [12]; Mr. VAZHAPPILY, A. T. [12]

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The exotic phenomenon of two-phonon gamma-vibration in deformed nuclei has been a stimulating and extensively discussed theme in nuclear structure research. The Erbium isotopes offer a unique opportunity to experimentally observe such exotic collective excitations, and test alternative theoretical model approaches. Following evidences in 166Er and 168Er, we plan to search this excitation toward the neutron-deficient side in the Er chain of isotopes. The primary nucleus of interest is 164Er in this investigation, which we plan to study using alpha transfer reaction from 6Li projectile. INGA array, coupled with CPDA and LaBr3 detectors will be used.

26

Investigation of the Anomaly of Neutron Capture Cross Section for Production of s-process Nuclei 64,66Cu

Authors: Ms. KUMARI, Renu [1]; Prof. MANDAL, Samit Kumar [1]

Co-Authors: Ms. KHANDELWAL, Priyanka [1]; Prof. KUMAR, Suresh [1]; Prof. PALIT, Rudrajyoti [2]; Prof. NANAL, vandana [2]; Dr. SHARMA, S C [3]

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Neutron capture plays a crucial role in nucleosynthesis in massive stars (M/M_0 ⊠8), where most isotopes from Fe to Sr are created through neutron capture reactions. However, significant disparities exist in the literature regarding the neutron capture cross sections of 63Cu(n,γ)64Cu and 65Cu(n,γ)66Cu. This proposal aims to investigate these cross-sections using neutron activation and offline gamma-ray spectroscopy techniques at the thermal neutron energy range, conducted at the PLF (Pelletron Linac Facility) at TIFR, Mumbai.

27

Study of the octupole collectivity in 90Zr

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Coulex experiment

28

Investigation of octupole correlation in Zn and Ge isotopes, near N~Z=34, A~60-70 region

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This PhD thesis proposal aims to undertake experimental investigation on octupole correlation of the nucleus of mass number A~60-70 region. For this purpose, We select
68Zn and 70Ge and their close by neighbors. The systematic study of some parameters will help to explore the collective behavior of the proposed nuclei and its neighbour.

29

Exploring the di-neutron transfer reactions and their effect on barrier distributions using 16,18O off a 159Tb target

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We have recently conducted measurements on quasi-elastic scattering using 16,18O projectiles directed at 90Zr nuclei at energies near the Coulomb barrier. Our findings
reveal notable discrepancies between the data obtained for 18O and 16O, suggesting a distinct involvement of di-neutron transfer in the fusion process of 18O with 90Zr.
Specifically, the fusion barrier distribution for 18O+90Zr exhibits a skew towards lower barrier heights, contrasting sharply with the nearly Gaussian distribution observed in the case of 16O+90Zr reactions. This discrepancy implies that 16O behaves like an inert nucleus during fusion processes.

30

Creation and Tuning of Defects in Nanomaterials using Ion Beam Implantation

Author: Prof. POLSHETTIWAR, Vivek [1]

Co-Authors: Ms. SINGHVI, Charvi [2]; Ms. GUNJAN, Sharma [3]

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Our foundational hypothesis is predicated upon the notion that the deliberate bombardment of these specified nanomaterials with a selection of ionic species will catalyze the genesis of bifurcated defect modalities: i) vacancies, and ii) adatoms (doping), or a sophisticated amalgamation of both, contingent upon the interplay between the ion's type and its kinetic energy dynamics. The strategic incursion of selected metallic ions into the lattice structures is postulated to precipitate the emergence of discrete atom dopants intricately embedded within the host material matrix, potentially revolutionizing its catalytic properties.