ANIRUDDHA DEY

(Ph.D. in Experimental Nuclear Physics)

Contact Information:

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Research Interest:

Nuclear fission; Fission fragment spectroscopy; Compound and Non-compound nuclear fission processes; Mass-Total Kinetic Energy (MTKE) distribution measurements, Fission dynamics through multimodal analysis, Quasi-fission process in actinides, Nuclear Structure study of stable and exotic nuclei, Prompt Gamma-ray spectroscopy, lifetime measurements; Utilization of Multi-detector array; Programming and simulation.

Research Experience:

1. Research Scientist at Flerov Laboratory of Nuclear Reactions (FLNR), Joint Institute for Nuclear Research (JINR), Dubna, Russia (March 2023 to Present)
    - Responsible for MTKE measurements and multimodal analysis of fission fragments in heavy nuclei
2. Junior and Senior Research Fellow (JRF, SRF) in a DAE-BRNS (Department of Atomic Energy – Board of Research in Nuclear Science) sponsored project, titled 'Spectroscopic study of rare earth nuclei' (June 2017 to May 2020)
    - Dedicated to my Ph.D. work and carried out at the Nuclear Physics Division and DHRUVA nuclear reactor facility of the Bhabha Atomic Research Centre (BARC)
    - Worked on the developmental, programming, and analysis work for the state-of-art Dhruva Utilization in Research using Gamma-Array (DURGA) facility
3. Research Project Fellow in DU (Delhi University) Innovation project titled 'Astronomy using archival data' (June 2013 to May 2015)
    - Utilization of dedicated software and computational analysis approach on archival data from VLT and NASA's Kepler mission to measure light curves (Published work)

Education:

1. Ph.D. in Experimental Nuclear Physics (Visva-Bharati University, Santiniketan, India) 2022
   (In active collaboration with Bhabha Atomic Research Centre (BARC), Mumbai, India)
   Thesis title: 'Fission fragment spectroscopy in and around near-spherical and deformed nuclei'

2. Master of Science (M.Sc.) in Physics (University of Delhi, India) 2017
   Specialization: Nuclear Physics, Astrophysics, Cosmology, and String Theory
   Dissertation: 'Investigation of terrestrial sources of Gamma-rays using single crystal HGPe detector'

3. Bachelor of Science (B.Sc.) in Physics (University of Delhi, India) 2014
   Project title: 'Light curve modeling of eclipsing binaries towards the constellation of Carina'

Computational and Software Skills:

1. Computer languages: C, C++, Python, IDL, LATEX.
2. Data processing and analysis: Flipper, RADWARE, TV, LAMPS, Root, Gnuplot, Xmgrace, Candle, DAMM, OriginPro.

Technical Skills and Related Information:

- Presently working on the double-arm time-of-flight (TOF) spectrometer CORSET at FLNR, JINR, Russia. Position sensitive Micro-Channel Plate (MCP) based Start and Stop detectors are used to measure TOF. Utilizing the double-velocity method to determine the mass and energy distributions of the reaction binary products. Plan for installation of auxiliary Gamma and neutron detectors along with Bragg Ionization chamber is under process.
- Active member of the INTEREST program of JINR, Russia as a project Supervisor to guide international students. The project title is – 'Prompt gamma-ray spectroscopy using segmented High-Purity Germanium (HPGe) detector'.
- Involved in the developmental work of state-of-art – DURGA (Dhruva Utilization in Research using Gamma Array) facility at BARC, India. Installation and handling of the standard n-type Germanium Clover detectors and 1.5' $LaBr_3$(Ce) scintillator detectors, and the corresponding digital DAQ using multi-frequency digitizers on VME crate.
- Installation of the BGO Anti-Compton Shields (ACS) for the setup, maintenance by evaporation and annealing of Clover detectors, and digital signal processing from various electronic modules. Worked on beam alignment using neutron camera and shielding techniques for the nuclear reactor background reduction.
- Have worked on several experimental setups through collaborative work in different Indian lab facilities. Handled a wide range of detectors – CsI(Th), NaI(Th), Multi-Wire Proportional Counter (MWPC), single crystal HPGe, GM Counters, Low Energy Photon Spectrometer (LEPS), Silicon Surface barrier and liquid scintillators. Participated in experimental campaigns using INGA (Indian National Gamma Array) facility.

Publications in peer-reviewed journals (Recent five + 4):

(Detailed 'List of publications' is attached herewith)

1. *Multimodal Fission Dynamics in $^{235}U(n_{th}, f)$: An investigation following fission fragment spectroscopy*

   Aniruddha Dey, D. C. Biswas *et al.*,

   Nuclear Physics A 1053, 122962 (2025); DOI: 10.1016/j.nuclphysa.2024.122962
2. *Excitation energy dependency of the low-energy fission dynamics: Probing through prompt gamma-ray spectroscopy*

   Aniruddha Dey, D. C. Biswas *et al.*,

   EPJ Web of Conference 306, 01022 (2024); DOI: 10.1051/epjconf/202430601022
3. *Evidence for competing bi-faceted compound nucleus fission modes in $^{232}Th(\alpha, f)$ reaction*

   Aniruddha Dey, D. C. Biswas *et al.*,

   Physics Letters B 825, 136848 (2022); DOI: 10.1016/j.physletb.2021.136848
4. *Measurement of relative isotopic yield distribution of even-even fission fragments from $^{235}U(n_{th}, f)$ following γ-ray spectroscopy*

   Aniruddha Dey, D. C. Biswas *et al.*,

   Physical Review C 103, 044322 (2021); DOI: 10.1103/PhysRevC.103.044322
5. *Investigation of the low- and medium-spin level structure in ^{77}As*

   A. K. Mondal, A. Chakraborty, K. Mandal, U. S. Ghosh, **Aniruddha Dey**, *et al.*,

   Physical Review C 107, 064320 (2023); DOI: 10.1103/PhysRevC.107.064320

Abstracts and Conference Proceedings (Top few):

(Detailed 'List of publications' is attached herewith)

1. Title: Study of fission and quasifission reaction mechanisms through mass energy distribution measurements

   Aniruddha Dey, E. M. Kozulin *et al.*,

   28th International Scientific Conference of Young Scientists and Specialists (AYSS-2024), Dubna, Russia.

   (Awarded Best Oral Report)
2. Title: Role of entrance channel angular momentum on the mass-energy distributions of ^{224}Th

   Aniruddha Dey, E. M. Kozulin *et al.*,

   LXXIV International conference Nucleus-2024, Dubna, Russia.
3. Title: Probing prompt-neutron multiplicity through Fission Fragment Spectroscopy

   Aniruddha Dey, D. C. Biswas *et al.*,

   Proceedings of DAE Symp. on Nuclear Physics, Vol. 67, 545 (2023); IIT Indore, Madhya Pradesh, India.

   (Awarded Best Poster)
4. Title: Probing role of deformed target on the mass-energy distributions of ^{224}Th at above Coulomb barrier

   Aniruddha Dey, E. M. Kozulin *et al.*,

India-JINR workshop on elementary particle and nuclear physics (2023), JINR, Russia.

5. Title: Excitation energy dependency of the low-energy fission dynamics: Probing through prompt gamma-ray spectroscopy

   Aniruddha Dey, D. C. Biswas *et al.*,

   FUSION23 International conference on heavy-ion collisions at near-barrier energies (2023), Shizuoka, Japan.

6. Title: Fission Fragment Spectroscopy: A novel pathway to delve deep into fission dynamics

   Aniruddha Dey

   Young Physicist Colloquium, Indian Physical Society, Saha Institute of Nuclear Physics (SINP), Kolkata, India. (Awarded Young Physicist)

7. Title: Fission fragment spectroscopic studies in and around near spherical and deformed nuclei

   Aniruddha Dey

   Proceedings of DAE Symp. on Nuclear Physics, Vol. 66, 1277 (2022); Cotton University, Guwahati, India. (Awarded Best Thesis)

Awards and Certificates:

1. 'Young Physicist' award at the 38th Young Physicists' Colloquium organized by Indian Physical Society in 2023.
2. Runners-up for Prof. C. V. K. Baba Award for the Best Thesis Presentation in Nuclear Physics in 2022.
3. Qualified GATE (Physics) conducted by IIT Guwahati in 2018.
4. Shortlisted for prestigious 'ARIES Summer Astronomy School' in 2016.
5. Qualified IIT-JAM (Physics) conducted by IIT Guwahati in 2014.
6. Certificate for consecutive topper in Physics during schooling from Khalsa Model Senior Secondary School, Kolkata in 2010.

Schools and Workshops Attended (Latest five):

1. India-JINR workshop on nuclear physics, organized by JINR, Russia (October, 2023).
2. Young Scientists CGS-2022 workshop, organized by the ILL, Grenoble, France (March, 2022)
3. 1st African Nuclear Physics School, organized by the iThemba Labs, South Africa (November, 2021)
4. IUAC school on Nuclear Reactions, organized by the IUAC, New Delhi, India (November, 2021).
5. Advanced Radiation Detector and Instrumentation in Nuclear and Particle Physics (RAPID2021), organized by University of Jammu, India (October, 2021)

Ph.D. Research Summary:

Thesis title: 'Fission fragment spectroscopy in and around near-spherical and deformed nuclei'

The primary aim of my research work was to optimize the fission fragment yield measurement technique using prompt gamma-ray spectroscopy. These had been performed by utilizing all the possible methodologies based on

multifold coincidence events. During the measurement technique optimization, several of the biases had been identified and resolved. This approach was then utilized to measure the precise relative isotopic yield distribution for the most crucial fissioning system of ^{236}U, at an excitation energy of 6.5 MeV and 21.5 MeV. The results were based on two experiments – 1) thermal neutron-induced fission of ^{235}U, performed using the EXILL array at ILL, Grenoble, France, and 2) Alpha-induced fission of ^{232}Th, performed using the INGA array at VECC, Kolkata, India. Detailed simultaneous measurement of both the relative charge and mass yield distribution had been performed. The experimental results were then interpreted based on the shell structural effect of the fragment nuclei, and the influence of multichance fission in the fission dynamics. The Potential Energy Surface (PES) calculation and multimodal random neck rupture model (Brosa modes) were then used to interpret the experimental observations. These measurements allowed to extract the component for the asymmetric and symmetric modes of fission into the system. Two theoretical model calculations based on – 1) Isospin Conservation Formalism (ISCF), and 2) GEneral description of Fission (GEF), were also utilized to compare with the experimental results. Through this, the role and purity of isospin quantum number in the fission fragments had been demonstrated. The utilization of both direct and surrogate reaction to produce ^{236}U, had not only provided evidence of the Compound Nucleus fusion-fission mechanism, but also helped to investigate the influence of excitation energy and angular momentum in the fission dynamics. Detail neutron multiplicity distribution for both the fissioning system had also been measured using the coincidence rate measurement technique. Fission fragment angular momentum distribution from both the reaction had been measured using the relative intensities of the intra-band prompt-gamma transitions. In addition, the thesis comprises a dedicated section to highlight my contribution in the development of the country's first state-of-art facility – DURGA (Dhruva Utilization in Research using Gamma Array) at Bhabha Atomic Research Centre (BARC), India. This includes the details related to the detector installation, neutron beam collimation and shielding, signal processing using a digital data acquisition system via multi-frequency digitizer, and results from some test experiments.

Dissertation Students:

- S. Paul (Probing Nuclear Reaction Dynamics through Different Model Codes) in 2024.
- R. Mondal (Fission Fragment Spectroscopy: Novel Pathway for understanding fission dynamics) in 2022
- A. Pal (Title: Nuclear Isomers: Metastable States from Nanoseconds to Years) in 2022
- A. Gupta (Title: Gamma spectroscopy using large gamma array) in 2021
- S. Shankar (Title: Nuclear structure study using archival data) in 2020
- R. Gorai (Title: Valence Correlation Scheme – N_pN_n Scheme) in 2020
- K. Mallick (Title: Experimental Nuclear Physics using various types of detectors) in 2019
- H. Sankar (Title: Radiation Detectors for basic research in Nuclear Physics) in 2018

Referees:

1. Dr. E. M. Kozulin (Supervisor in JINR)
   Chief Research Scientist, Fission of heavy and superheavy nuclei group,
   Flerov Laboratory of Nuclear Reactions, JINR, Russia.
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2. Dr. D. C. Biswas (Ph.D. Mentor)
   Outstanding Scientist (OC) Retired., Nuclear Physics Division (NPD),
   Bhaba Atomic Research Centre., Mumbai, India.
   Cont. +91-7710838284, Email: dcbiswas1@rediffmail.com
3. Dr. A. Chakraborty (Ph.D. Supervisor)
   Assistant Professor, Department of Physics,
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4. Prof. A. K. Jain (Collaborator)
   Advisor, Amity Institute of Nuclear Science and Technology (AINST),
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Declaration: I do hereby declare that all the above information is true to the best of my knowledge.

Aniruddha Dey

(Date: 6th June, 2025)