



ENLIGHTENMENT TO EXCELLENCE

## UNIVERSITY OF NORTH BENGAL

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Raja Rammohunpur, Dist- Darjeeling, West Bengal, Pin-734013, India.

## Department of Physics

Print



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Subject specialization: High-Energy Physics

Areas of Research Interest: High-energy Heavy-ion Interaction.

No. of Ph.D. students: (a) Supervised: 01 (b) Ongoing: 03

No. of M.Phil. students: (a) Supervised: Nil (b) Ongoing: Nil.

No. of Publications: (a) Journal(s) : 54 (b) Conference Proceedings : 26

## Achievement &amp; Awards:

- Visiting Research Scientist in the Department of Physics & Astrophysics of the State University of New York at Buffalo, New York, USA, during 1991 - 1993.

## Professional Experiences: None

- Teaching (26 years) - Mathematical Methods in Physics, Quantum Mechanics, Statistical Mechanics, Atomic Physics, Nuclear and Particle Physics, Quantum Field Theory, Quantum Electrodynamics
- Research (30 years) - High-energy Heavy-ion Interaction (Physics Analysis and Simulation)
- Acted as a Referee - Journal of Physics G, Advances in High-energy Physics, European Physics Journal A, Indian Journal of Pure & Applied Physics.
- Thesis adjudication - 12 Ph.D. thesis of other universities.

## Administrative Experiences:

- Dean, Faculty Council for Post-graduate Studies in Science, NBU: 2013 - 2016.
- University Court Member, NBU: 2013 - 2016.
- University Executive Council Member, NBU: 2013 - 2016.
- Head of the Department of Physics, NBU: 2003 - 2005 and 2012 - 2014.

## Selective List of Publications:

*In peer reviewed journals:*

- Multifractal detrended moving average analysis of multiparticle density in relativistic nuclear collisions – P. Mali, A. Mukhopadhyay and G. Singh: accepted to be published in Physics A, (2016).
- Azimuthal correlation and collective behaviour in nucleus-nucleus collisions – P. Mali, A. Mukhopadhyay, S. Sarkar and G. Singh: Physics of Atomic Nuclei, Vol. 78, No. 2, page 258 – 267 (2015).
- Long range memory and multifractality in gold markets - P.Mali, A. Mukhopadhyay: Physica Scripta, Vol. 90, 035209 (2015).
- Multifractal detrended fluctuation analysis of particle density fluctuations in high-energy nuclear collisions – P. Mali, S. Sarkar, S. Ghosh, A. Mukhopadhyay and G. Singh: Physica A, Vol. 424, page 25 – 33 (2015).
- Multifractal characterization of gold market: a multifractal detrended fluctuation analysis – P. Mali and A. Mukhopadhyay: Physica A, Vol. 413, page 361 – 372 (2014).
- Azimuthal structure of charged particle emission in 28Si-Ag/Br interaction at 14.5A GeV/c and in 32S-Ag/Br interaction at 200A GeV/c – P. Mali, A. Mukhopadhyay, S. Sarkar and G. Singh: International Journal of Modern Physics E, Vol. 23, No. 5, page 1450027 (2014).
- Wavelet analysis of shower track distribution in high-energy nucleus-nucleus collision – P. Mali, S. Sarkar, A. Mukhopadhyay and G. Singh: Advances in High Energy Physics, Vol. 2013, Article ID 759176 (2013).
- Multifractal analysis of charged particle distribution in 28Si-Ag/Br interaction at 14.5A GeV – P. Mali, A. Mukhopadhyay and G. Singh: Fractals Vol. 20, No. 3, page 1 – 13 (2012).

9. Factorial correlator and short range correlation of charged particles produced in 28Si-Ag/Br interaction at 14.5A GeV – P. Mali, **A. Mukhopadhyay** and G. Singh: *Physica Scripta* **85**, 065202 (2012).
10. Self-affine two dimensional intermittency in 28Si-Ag/Br interaction at 14.5A GeV – P. Mali, **A. Mukhopadhyay** and G. Singh: *Acta Physica Polonica B* **43**, 479 (2012).
11. Intermittency and erraticity of charged particles produced in 28Si-Ag/Br interaction at 14.5 A GeV – P. Mali, **A. Mukhopadhyay** and G. Singh: *Canadian Journal of Physics* **89**, page 949 – 960 (2011).
12. Ring and jet-like structure and two-dimensional intermittency in nucleus-nucleus collisions at 200A GeV/c – M. K. Ghosh, P. K. Haldar, S. K. Manna, **A. Mukhopadhyay** and G. Singh: *Nuclear Physics A* **858**, page 67-85 (2011).
13. Centrality dependence of nonstatistical fluctuation in single particle density distribution in 32S-Ag/Br interactions at 200A GeV/c – M. K. Ghosh, **A. Mukhopadhyay**, D. Roychowdhury and G. Singh: *International Journal of Modern Physics E*, Vol. **19**, No. 11, page 2229 - 2246 (2010).
14. Intermittency and related issues in 16O-Ag/Br collision at 200A GeV/c – M. K. Ghosh, P. K. Haldar, S. K. Manna, **A. Mukhopadhyay** and G. Singh: *Canadian Journal of Physics*, Vol. **88(8)**, page 575-584 (2010).
15. Multifractal study of singly charged particles produced in 32S induced Ag/Br interactions at CERN – G. Singh, M. K. Ghosh and **A. Mukhopadhyay**: *International Journal of Modern Physics E*, Vol. **17(5)**, page 802-816 (2008).
16. Intermittency and multiplicity moments of charged particles produced in 32S-Ag/Br interaction at 200A GeV/c – M. K. Ghosh, **A. Mukhopadhyay** and G. Singh: *Journal of Physics G: Nuclear and particle physics*, Vol. **34**, page 177-193 (2007).
17. Erraticity moment of bin multiplicity and rapidity gap of fast TFs from 84Kr-Ag/Br interaction at 0.95 A GeV/c – B. Bhattacharjee, B. Debnath, **A. Mukhopadhyay** and S. Sengupta: *Indian Journal of Physics*, Vol. **81(7)**, page 717-726 (2007).
18. Multifractal moments of particles produced in 32S-Ag/Br interaction at 200 A GeV/c – M. K. Ghosh, **A. Mukhopadhyay** and G. Singh: *Journal of Physics G: Nuclear and Particle Physics*, Vol. **32(11)**, page 2293-2304 (2006).
19. Erraticity analysis of multiparticle production in nucleus-nucleus interactions at relativistic energies – D. Chanda, M. K. Ghosh, **A. Mukhopadhyay** and G. Singh: *Physical Review C – Nuclear Physics*, Vol. **71(3)**, page 385-396 (2005).
20. Erraticity analysis of particle production in 32S-Ag/Br interaction at 200A GeV/c – M. K. Ghosh and **A. Mukhopadhyay**: *Physical Review C - Nuclear Physics*, Vol. **68(3)**, page 349071-349077 (2003).
21. On the emission of fast and slow target fragments from 84Kr-AgBr interactions at 0.95 GeV/A – B. Bhattacharjee, **A. Mukhopadhyay**, V. Singh, S. K. Tuli and S. Sengupta: *Radiation Measurements*, Vol. **36(1-6 SPEC.)**, page 291-294 (2003).
22. Physics teaching and higher education – **A. Mukhopadhyay**: *Physics Teacher*, Vol. **39(1)**, page 11-12 (1997).
23. Nuclear collective flow in 197Au-emulsion interactions at 10.6A GeV – P. L. Jain, G. Singh & **A. Mukhopadhyay**: *Physical Review Letters*, Vol. **74(9)**, page 1534-1537 (1995).
24. Two and three-particle correlations in gold-emulsion interactions at 10.6 A GeV – **A. Mukhopadhyay**, P. L. Jain & G. Singh: *Il Nuovo Cimento A*, Vol. **108(6)**, page 775-785 (1995).
25. Intermediate mass fragment emission by Au197 projectiles at relativistic energy in nuclear emulsion – P. L. Jain, G. Singh and **A. Mukhopadhyay**: *Physical Review C*, Vol. **50(2)**, page 1085-1089 (1994).
26. Analysis of PT spectrum of projectile fragments in heavy-ion interactions. Identification of collective flow of nuclear matter – D. Ghosh, J. Roychowdhury, B. Biswas, S. Sarkar, **A. Mukhopadhyay**, N. Basu, A. Ghosh, M. Basu and J. Roy: *Il Nuovo Cimento*, Vol. **107A**, No. 9, page 1517-1522 (1994).
27. Evidence of intra- and inter-group azimuthal correlations in nuclear interactions at a few GeV/c – D. Ghosh, B. Biswas, J. Roychowdhury, **A. Mukhopadhyay** and A. Ghosh: *Mod. Phys. Lett. A*, Vol. **9(7)**, page 591-598 (1994).
28. Factorial moments and multifractal analysis at relativistic energies – P. L. Jain, G. Singh and **A. Mukhopadhyay**: *Physical Review C*, Vol. **48(2)**, page R517-R521 (1993).
29. Intermittent behaviour of nuclear multifragments – P. L. Jain, G. Singh and **A. Mukhopadhyay**: *Physical Review C*, Vol. **47(1)**, page 342-345 (1993).
30. Entropy and fractal characteristics of multiparticle production at relativistic heavy ion interactions – **A. Mukhopadhyay**, P. L. Jain and G. Singh: *Physical Review C*, **47(1)**, 410-412 (1993).
31. Fractal analysis of projectile fragments in nuclear collisions at (1-2) A GeV – P. L. Jain, G. Singh and **A. Mukhopadhyay**: *Nuclear Physics, Section A*, Vol. **561(4)**, page 651-659 (1993).
32. Intermittency and fractals in nuclear collisions at 1.52 A GeV – G. Singh, **A. Mukhopadhyay** and P. L. Jain: *Zeitschrift für Physik A, Hadrons and Nuclei*, Vol. **345(3)**, page 305-309 (1993).
33. Multiplicity distributions in high-energy heavy-ion collisions – **A. Mukhopadhyay**, P. L. Jain and G. Singh: *Il Nuovo Cimento A*, Vol. **106(7)**, page 967-978 (1993).
34. Multiplicity distributions in forward and backward hemispheres at high-energy collisions – **A. Mukhopadhyay**, P. L. Jain and G. Singh: *Il Nuovo Cimento A*, Vol. **106(6)**, page 793-810 (1993).
35. Factorial moments and short range correlation at relativistic energies – P. L. Jain, **A. Mukhopadhyay** and G. Singh: *Zeitschrift für Physik C Particles and Fields*, Vol. **58(1)**, page 1-6 (1993).
36. Cluster formation at high-energy collisions – **A. Mukhopadhyay**, G. Singh and P. L. Jain: *J. Phys. G: Nucl. Part. Phys.*, Vol. **19**, page 1137-1142 (1993).
37. Characteristics of He-nucleus interactions at relativistic energy – M. Golde, G. Singh, P. L. Jain and **A. Mukhopadhyay**: *Zeitschrift für Physik A, Hadrons and Nuclei*, Vol. **344(3)**, page 291-297 (1993).
38. An analysis of multiplicity dependence on pseudorapidity intervals at high energy collisions – P. L. Jain, **A. Mukhopadhyay** and G. Singh: *Physics Letters B*, Vol. **294(1)**, page 27-32 (1992).
39. Multifractals at relativistic energies – P. L. Jain, G. Singh and **A. Mukhopadhyay**: *Physical Review C*, Vol. **46(2)**, page 721-726 (1992).
40. Multiplicity fluctuation in heavy-ion interaction and negative binomial distribution - D. Ghosh, **A. Mukhopadhyay**, A. Ghosh and J. Roy: *Il Nuovo Cimento A*, Vol. **104(5)**, page 683-689 (1991).
41. Three-proton correlation in central 24Mg-AgBr interactions at 4.5 A GeV/c-indication of sideward flow of nuclear matter – D. Ghosh, J. Roy, **A. Mukhopadhyay** and A. Ghosh: *Il Nuovo Cimento A*, Vol. **104(3)**, page 293-298 (1991).
42. Multiplicity characteristics of symmetric and asymmetric heavy-ion interactions at 4.5A GeV/c – D. Ghosh, **A. Mukhopadhyay**, A. Ghosh, S. Sarkar, R. Sengupta and J. Roy: *Europhysics Letters*, Vol. **11(6)**, page 535-540 (1990).
43. Study of intermittency in particle production in hadron-nucleus interaction at TeV energies – D. Ghosh, J. Roy, **A. Mukhopadhyay**, S. Sarkar, J. Roychowdhury, B. Biswas, P. Ghosh and S. Naha: *Had. Jr. Suppl.*, Vol. **5**, page 205-211 (1990).
44. Validity of Nakamura-Kudo scaling of charged particle pseudorapidity distribution in relativistic heavy ion interactions – D. Ghosh, **A. Mukhopadhyay**, S. Sarkar, R. Sengupta, A. Ghosh and P. Ghosh: *Modern Physics Letters A*, Vol. **5(30)**, page 2485-2489 (1990).
45. Multiplicity characteristics of heavy-ion interactions at 4.5GeV/c per nucleon – D. Ghosh, **A. Mukhopadhyay**, A. Ghosh, R. Sengupta and J. Roy: *Nuclear Physics*, **A499(4)**, 850-860 (1989).
46. The validity of the negative binomial multiplicity distribution in the case of the relativistic nucleus-nucleus interaction – D. Ghosh, **A. Mukhopadhyay**, A. Ghosh and J. Roy: *Physics Letters B*, Vol. **218(4)**, page 431-435 (1989).
47. Two and three-particle pseudorapidity dynamical correlation in central Mg-AgBr interactions at 4.5A GeV/c - D. Ghosh, A. Ghosh, **A. Mukhopadhyay** and J. Roy: *Nuclear Physics A*, Vol. **491(4)**, page 684-693 (1989).
48. Zonal Poissonian pion multiplicity in central 24Mg-AgBr collisions at Dubna energy – D. Ghosh, **A. Mukhopadhyay**, A. Ghosh and J. Roy: *Modern Physics Letters A*, Vol. **4(13)**, page 1197- 1202 (1989)

49. Multiplicity characteristics of heavy-ion interactions at 4.5 GeV/c per nucleon – D. Ghosh, **A. Mukhopadhyay**, A. Ghosh, R. Sengupta and J. Roy: Nuclear Physics A, Vol. **499**, page 850-860 (1989).
50. A comparative study of proton-emulsion and heavy-ion-emulsion interactions at 4.5 GeV/c per nucleon – D. Ghosh, R. Sengupta, A. Ghosh, **A. Mukhopadhyay** and J. Roy: Annalen der Physik, Vol. **45(5)**, page 353-361 (1988).
51. Study of two-particle correlation among black and grey particles in central 24Mg-AgBr interactions at 4.5 GeV/c/n – D. Ghosh, J. Roy, **A. Mukhopadhyay** and A. Ghosh: Fizika, Vol. **20(3)**, page 383-389 (1988).
52. Directional Poissonic multiplicity distribution of protons – indication of side splash phenomenon – D. Ghosh, J. Roy, A. Ghosh and **A. Mukhopadhyay**: Zeitschrift für Physik A, Atomic Nuclei, Vol. **330**, page 311-313 (1988) -
53. Signature of fractionally charged projectile fragments in 24Mg-emulsion interaction – D. Ghosh, J. Roy, **A. Mukherjee** and A. Ghosh: Hadronic Journal, Vol. **10(4)**, page 217-219 (1987)
54. Evidence of multiplicity scaling of medium energy protons emitted in relativistic heavy ion collisions and antiproton annihilation in nuclei – D. Ghosh, J. Roy, R. Sengupta, A. Ghosh and **A. Mukherjee**: Physical Review C, vol. **35(4)**, page 1595-1597 (1987)

#### *In Conference Proceedings:*

55. Azimuthal anisotropy of transverse rapidity at CBM energy in the AMPT model – S. Sarkar and A. Mukhopadhyay, Proceedings of the DAE Symposium on Nuclear Physics, Sri Sathya Sai Institute of Higher Learning, Prasanthi Nilayam 515134, during Dec. 7 - 11, 2015: Vol. 60, page 766, 2015.
56. Dynamical charge fluctuation at FAIR energy – S. Ghosh and A. Mukhopadhyay, Proceedings of the DAE Symposium on Nuclear Physics, Sri Sathya Sai Institute of Higher Learning, Prasanthi Nilayam 515134, during Dec. 7 - 11, 2015: Vol. 60, page 750, 2015.
57. Charge balance function in pp collision at  $\sqrt{s} = 200$  GeV – P. Mali, A. Mukhopadhyay, S. Sarkar and S. Ghosh, Proceedings of the DAE Symposium on Nuclear Physics, Department of Physics, Banaras Hindu University during December 8 – 12, 2014: Vol. 59, page 750, 2014.
58. Elliptic flow in Au-Au collision at 20A GeV – S. Sarkar, S. Ghosh, P. Mali and A. Mukhopadhyay, Proceedings of the DAE Symposium on Nuclear Physics, Department of Physics, Banaras Hindu University during December 8 – 12, 2014: Vol. 59, page 764, 2014.
59. Collective flow in nucleus-nucleus collisions – P. Mali, S. Sarkar, S. Ghosh, A. Mukhopadhyay and G. Singh, Proceedings of the DAE International Symposium on Nuclear Physics, held at BARC, Mumbai, during December 2 – 6, 2013: Vol. 58, page 694, 2013.
60. Detrended fluctuation analysis in multiparticle production – P. Mali, S. Sarkar, S. Ghosh, A. Mukhopadhyay and G. Singh, Proceedings of the DAE International Symposium on Nuclear Physics, held at BARC, Mumbai, during December 2 – 6, 2013: Vol. 58, page 702, 2013.
61. Mass modification of rho meson at SIS 300 energy – S. Sarkar and A. Mukhopadhyay, and S. Cattopadhyay, Proceedings of the DAE International Symposium on Nuclear Physics, held at BARC, Mumbai, during December 2 – 6, 2013: Vol. 58, page 734, 2013.
62. Wavelet analysis in 28Si-Ag/Br interaction at 14.5A GeV – P. Mali, A. Mukhopadhyay and G. Singh, Proceedings of the DAE Symposium on Nuclear Physics, held at Department of Physics and Astrophysics, University Delhi, Delhi, during December 3 – 7, 2012: Vol. 57, page 784, 2012.
63. Fractality in 28Si-Ag/Br interaction at 14.5A GeV – P. Mali, A. Mukhopadhyay and G. Singh, Proceedings of the DAE Symposium on Nuclear Physics, held at Department of Physics and Astrophysics, University Delhi, Delhi, during December 3 – 7, 2012: Vol. 57, page 782, 2012.
64. Numerically modelling Bose-Einstein correlation – A. Pakrashi, P. Mali and A. Mukhopadhyay, Proceedings of the DAE Symposium on Nuclear Physics, held at Department of Physics and Astrophysics, University Delhi, Delhi, during December 3 – 7, 2012: Vol. 57, page 824, 2012.
65. 2d intermittency in 28Si-Ag/Br interaction at 14.5A GeV – P. Mali, A. Mukhopadhyay and G. Singh: Proceedings of the DAE Symposium on Nuclear Physics, held at Department of Nuclear Physics, Andhra University, Visakhapatnam, during December 26 – 30, 2011: Vol. 56, page 996, 2011.
66. Azimuthal structure of particle emission in 28Si-Ag/Br interaction at 14.5A GeV – P. Mali, A. Mukhopadhyay and G. Singh: Proceedings of the DAE Symposium on Nuclear Physics, held at Department of Nuclear Physics, Andhra University, Visakhapatnam, during December 26 – 30, 2011: Vol. 56, page 994, 2011.
67. Evidence of dynamical fluctuation of emission of pions produced in ultra-relativistic nuclear collisions at 200A GeV/c for different projectiles – P. K. Haldar, S. K. Manna, A. Mukhopadhyay and G. Singh, Proceedings of the DAE Symposium on Nuclear Physics, held at Birla Institute of Technology and Science, Pilani, Rajasthan, during December 20 – 24, 2010: Vol. 55, page 610, 2010.
68. Jet-structure in 16O-Ag/Br interaction at 200A GeV/c – P. K. Haldar, S. K. Manna, A. Mukhopadhyay and G. Singh, Proceedings of the DAE Symposium on Nuclear Physics, held at Birla Institute of Technology and Science, Pilani, Rajasthan, during December 20 – 24, 2010: Vol. 55, page 612, 2010.
69. Intermittency in 28Si-Ag/Br interaction at 14.5A GeV/c – P. Mali, A. Mukhopadhyay and G. Singh, Proceedings of the DAE Symposium on Nuclear Physics, held at Birla Institute of Technology and Science, Pilani, Rajasthan, during December 20 – 24, 2010: Vol. 55, page 616, 2010.
70. Factorial correlator in 28Si-Ag/Br collisions at 14.5A GeV/c – P. Mali, A. Mukhopadhyay and G. Singh, Proceedings of the DAE Symposium on Nuclear Physics, held at Birla Institute of Technology and Science, Pilani, Rajasthan, during December 20 – 24, 2010: Vol. 55, page 618, 2010.
71. Search for Ring and Jet-like structures in particle emission from high-energy nucleus-nucleus collisions – Proceedings of Applications of Computer and Information Sciences to Nature Research 2010 (ISBN No. 978 – 1 – 60558 – 918 – 3), page 44 – 48, (held during May 5 – 7, 2010 at SUNY @ Fredonia, NY, USA).
72. Modelling Bohr's theory of Hydrogen atom for Physics and Chemistry Education, and Computer Science Graduates – Proceedings of Applications of Computer and Information Sciences to Nature Research 2010 (ISBN No. 978 – 1 – 60558 – 918 – 3), page 59 – 63, (held during May 5 – 7, 2010 at SUNY @ Fredonia, NY, USA).
73. Two-dimensional intermittency in 16O-Ag/Br interactions at 200A GeV/c – M. K. GHosh, P. K. Haldar, S. K. Manna, A. Mukhopadhyay and G. Singh: Proceedings of the International Symposium on Nuclear Physics: Vol. 54, page 588, 2009 (held during December 8 – 12, 2009 at Bhabha Atomic Research Centre, Mumbai 400085).
74. Nonstatistical fluctuation in 16O-Ag/Br collisions at 200A GeV/c – M. K. GHosh, P. K. Haldar, S. K. Manna, A. Mukhopadhyay and G. Singh: Proceedings of the International Symposium on Nuclear Physics: Vol. 54, page 562, 2009 (held during December 8 – 12, 2009 at Bhabha Atomic Research Centre, Mumbai 400085).
75. Multifractal study of produced hadrons in 32S Induced Ag/Br collisions at CERN SPS, G. Singh, M. K. Ghosh, and A. Mukhopadhyay, presented in 50+ Years of High Energy Physics Symposium @ UB, Department of Physics, SUNY at Buffalo, NY, October 20-21, 2006.
76. Erraticity analysis of produced shower particles in nucleus-nucleus collisions at CERN SPS energy, G. Singh, A. Chanda, M. K. Ghosh, and A. Mukhopadhyay, presented in ICPAQGP-2005, Kolkata, India, February 08 -12, 2005.
77. Nuclear collective flow in 197Au-emulsion interactions at 10.6A GeV, P. L. Jain, G. Singh and A. Mukhopadhyay, presented as a poster in the Quark Matter Conference 95 held at LBL Berkeley, USA, January 9-13, 1995.
78. Fragmentation of 197Au nuclei at relativistic energy, P. L. Jain, G. Singh and A. Mukhopadhyay, Annual Meeting of the American Physical Society held at Washington D. C., USA, April 12-15, 1993.
79. Entropy and fractal characteristics of multiparticle production at relativistic heavy ion interactions, A. Mukhopadhyay, P. L. Jain and G. Singh, Annual Meeting of the American Physical Society held at Washington D. C., USA, April 12-15, 1993.
80. Pseudorapidity-interval dependence of multiplicities at relativistic energies, P. L. Jain, G. Singh and A. Mukhopadhyay, presented in the International Conference on Physics and Astrophysics of Quark-Gluon Plasma, Calcutta, India, January 20-24, 1993.