CURRICULUM VITAE

1. **NAME :** SURESH KUMAR PATRA

2. **DATE OF BIRTH :** 14TH APRIL 1964

3. **NATIONALITY :** INDIAN

4. **SEX :** MALE

5. **MARITAL STATUS :** MARRIED

6. **ADDRESS :** INSTITUTE OF PHYSICS
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7. **EDUCATIONAL QUALIFICATION :**

(1) 1985 : **B. Sc. in Physics**

Sonepur College, Sonepur, India.

Studied physics as honours and *Mathematics and Chemistry* as pass subjects. The ancilliary subject was English. Passed out with a first class in physics and distinction in the rest of the subjects.

(2) 1985 – 1987 **M. Sc. in Physics**

Sambalpur University, Burla, India.

During the first year studied advanced physics in general and in the following year specialized in *Nuclear Physics*. Passed out with a first class.

(3) 1988 – 1989 **Post M.Sc. in Physics**

Institute of Physics, Bhubaneswar, India.

During this one year course work I have studied advanced physics.

(4) 1989 – 1994 **Ph.D. in Nuclear Physics Theory.**

Institute of Physics, Bhubaneswar, India.

TITLE OF RESEARCH TOPIC:

Relativistic Mean Field Study of Beta-stable and Beta-unstable Nuclei.

8. **RESEARCH EXPERIENCE:**

(1) 1994 – 1995 **Postdoctoral Research Fellow**

Department of Physics, Tohoku University, Sendai, Japan.

(2) 1995 – 1997 **Postdoctoral Research Fellow**

Institüt für Theoretische Physik, J.W.G. University, Frankfurt, Germany.

(3) 1997 – 1999 **Postdoctoral Research Fellow**

Department of Physics, CYCU, Chung-Li, Taiwan

(4) 1999 – 2001 **Postdoctoral Research Fellow**

Department of Physics, University of Barcelona, Barcelona, Spain

(5) November 29th – December 19th 2003. Visiting Fellow

Department of Physics, University of Barcelona, Barcelona, Spain

(6) August 2001 – July 31st 2004 Sr. Lecturer

Institute of Physics, Sachivalaya Marg, Bhubaneswar, India

(7) 1st August 2004 – till date Asst. Professor

Institute of Physics, Sachivalaya Marg, Bhubaneswar, India

(8) June 2005 – December 2005 EPSRC Research Fellow

Department of Physics, University of Surrey, Guildford, U.K.

(9) April 2006 – June 2006 Re-visit in AvH Fellowship

Frankfurt Institute of Advanced Studies, Frankfurt/Main, Germany.

(10) 5th November 2007 – 19th November 2007 Visiting Fellow

Centro de Fisica das Interaccoes Fundamentals, Instituto Superior Tecnico-Edificio Ciencia (Fisica), 8th November 2007, Lisbon, Portugal

(11) 19th November 2007 – 28th November 2007

GSI, Darmstadt, for Research Collaboration

9. **TEACHING EXPERIENCE:**

I have taught Nuclear Physics course for Pre-doctoral (Post M.Sc.) students in 2002, 2003, 2004, 2007, 2008, 2009, 2010, 2011.

10. **RECIPIENT OF FELLOWSHIPS:**

- Re-visit Alexander von Humboldt Research Fellow, Germany (April 2006-June 2006).
- EPSRC Research Fellow, Govt. of U.K., June-December (2005).
- Spain Education Ministry Fellowship, Spain (1999-2001).
- National Science Council Fellow, Taiwan, (1997-99).
- Alexander von Humboldt Research Fellow, Germany, (1995-97).
- Monbusho Research Fellow, Japan, (1994-95).
- Predoctoral and Doctoral Research Fellow, Institute of Physics, Bhubaneswar (1988-94).
- National Scholarship, (1985-87).
- Apart from the above, I had also been selected for a visiting lecturer in the University of Santa Catarina, Florianopolis, Brazil, FAFRJ Research Fellow (BRAZIL), FAPESP Research Fellow (BRAZIL), Postdoctoral Fellow in University of Tel Aviv, Israel, Post-doctoral Fellow in Institute of Super-Technique, Lisbon, Portugal, Visiting Scientist in University of Gent, Belgium.

11. **Participation in (completion of) major Projects :**

- Indo-German cooperation project: Search for superheavy isotopes: A new phenomenon, INT/FRG/BMBF/P-37/2006.
- DST project: Study of drip-line nuclei, No. SR/S2/HEP-22/2003.
- DST Project: Nuclear structure and nuclear reactions for drip line nuclei in relativistic models, SR/S2/HEP-16/2005.
- CSIR Project: Relativistic semi-classical calculation of giant resonances, No. 03(1060)06/EMR-II.
- DST Project: Study of high spin states in non-relativistic and relativistic mean field formalism with good rotational symmetry, SR/S2/HEP-26/2006.

- DST Project: Study of exotic drip-line nuclei, No. SR/S2/HEP-0010/2008.
- DST Project: Structure of high spin states, K isomers, super-deformed bands in nuclei (DST Project No. SR/S2/HEP-0037/2008).

12. **SEMINAR/COLLOQUIUM/PRESENTATION GIVEN IN IMPORTANT PLACES:**

- Fission of heavy Uranium and Thorium isotopes: source of new phenomena and dynamics, invited talk given at TIFR in NUSTAR meet, 21-22 February 2011.
- Application of relativistic mean field theory, Invited talk given in the National Seminar on "Contemporary Trend in Nuclear Physics", Aligarh Muslim University, Aligarh, October 21-22, 2010.
- Neutron-rich and superheavy nuclei: Relativistic mean field theory, Invited talk given at Workshop on "Simulation studies and large scale computing", IUAC, New Delhi, 31st October 2009.
- New islands of stability in the drip-line regions manifesting new phenomena, Frontiers in Gamma rays Spectroscopy, Tata Institute of Fundamental Research, Mumbai, India, March 2-4, 2009.
- Formation of superheavy and neutron-rich nuclei in astrophysical objects, Invited talk given at "National Seminar on Advences in Physics" Berhampur University, Orissa, February 6-7, 2009.
- Summary talk given at the DAE-BRNS Symposium (India) in Nuclear Physics, Indian Institute of Technology, Roorkee, December 22-26, 2008.
- Recent developments in relativistic mean field theory, Centro de Fisica das Interaccoes Fundamentals, Instituto Superior Tecnico-Edificio Ciencia (Fisica), 8th November 2007, Lisbon, Portugal.
- Clustering in nuclei, June 2006, Department of Physics, University of Barcelona, Spain.
- Relativistic Mean Field Formalism and its Application to finite nuclei, 17th November 2005, Department of Physics, University of York, U.K.

- Relativistic Mean Field Formalism and its Recent Developments, 9th October 2005, Department of Physics, University of Surrey, U.K.
- Relativistic Mean Field Formalism and its Recent Developments, presented at Int. Workshop on "Nuclear Structure at the Extremes: New Directions", Department of Physics, H.P. University, Shimla, India March 21-24, 2005.
- Nuclear Physics: Past, Present and Future, North Orissa University, Baripada, October 17, 2004.
- Lecture given on "Relativistic semiclassical calculation of isoscalar giant resonances" at the National Workshop on "Relativistic mean field theory in nuclear physics", Institute of Physics, Bhubaneswar, India during 26-31 st July, 2004.
- Lecture given on "Recent developments in relativistic mean field formalism" at the National Workshop on "Relativistic mean field theory in nuclear physics", Institute of Physics, Bhubaneswar, India during 26-31 st July, 2004.
- Invited talk given on "Field theory motivated effective Lagrangian approach: towards a complete relativistic nuclear model" at the National Conference on "Neutrinos in Nuclear, Particle and Astrophysics", held at I I T Kharagpur, India during 26-28 th Feb, 2004.
- Invited talk given on "Field theory motivated effective Lagrangian approach: towards a complete relativistic nuclear model" at the National Workshop on "Production & Utilization of Radioactive Ion Beams from ISOL type facilities", held at Toshali Sands Resorts, Puri, India during 16-19 th Feb, 2004, organised by VECC, Kolkata.
- Lectures given on "Scaling calculations of Isoscalar Giant Resonances in Relativistic Thomas-Fermi Theory" at the National Workshop, Puri (India) on "Nuclei at extremes of Isospin and Mass", Institute of Physics, Bhubaneswar, March $10-22$ (2003).
- Invited talk on "Scaling calculations of Isoscalar Giant Resonances in Relativistic Thomas-Fermi Theory" at DAE-BRNS Symposium (India) in Nuclear Physics, Manonmaniam Sundaranar University, Tirunelveli, Tamilnadu, December $26-30$ (2002).

- ”Structure of Superheavy elements” Centro de Fisica das Interaccoes Fundamentals, Instituto Superior Tecnico-Edificio Ciencia (Fisica), Lisbon, Portugal.
- ”Structure of Superheavy elements” Department of Physics, University of Barcelona, Barcelona, Spain.
- ”The $k-i$ basis shell model: -Recent development of the Fermion Dynamical Symmetry Model,” Department of Physics, University of Barcelona, Barcelona, Spain.
- ”Relativistic Mean Field Theory and its application to negative energy states”, Department of Physics, Chung Yuan Christian University, Chung-Li, Taiwan.
- Strong Correlation of the Vacuum in Relativistic Mean Field Theory, Institute of Physics, Bhubaneswar, India.
- ”Anti-particle bound state in Relativistic Mean Field Theory”, Nuclear Physics Institute, Academic of Sciences, Rez (Prague), Czech Republic.
- ”Strong correlation of vacuum in the relativistic mean field theory”, Department of Physics, University of Gottingen, Gottingen,
- ”Halo-Structures of Light Exotic Nuclei”, GSI, Darmstadt, Germany.
- ”Negative energy bound states in relativistic mean field theory”, Institut für Theoretische Physik, J.W.G. University, Frankfurt/M, Germany.
- ”How far the magic number Z=82 is true in exotic nuclei ?”, Department of Physics, Hong Kong University, Hong Kong.
- ”Superdeformation in neutron-deficient rare-earth nuclei” Yukawa Institute, Kyoto, Japan.
- ”Shape and superdeformed structure in rare-earth nuclei”, Center for Mathematical Sciences, Office for Planing and Management, University of Aizu, Aizu-Wakamatsu, Japan.
- ”Neutron- and proton-rich nuclei near the drip-lines and its astrophysical application”, Department of Physics, Tohoku University, Sendai, Japan.

13. **PARTICIPATION IN SYMPOSIA, SCHOOLS and CONFERENCES:**

- DAE-BRNS Symposium (India) in Nuclear Physics, Birla Institute of Technology, Pilani, December 22-26, 2011.
- Nucleon-nucleon interaction and Nuclear many-body problem, Tata Institute of Fundamental Research, Mumbai, 18-27 November, 2010.
- Int. Workshop on "Nuclear Structure at the Extremes: New Directions", Department of Physics, H.P. University, Shimla, India March 21-24, 2005.
- Workshop on "Hadron Physics", held at Toshali Sands Resorts, Puri, India March 7-17, 2005, organised by Institute of Physics, Bhubaneswar.
- Workshop on "Relativistic mean field theory in nuclear physics", Institute of Physics, Bhubaneswar, India during 26-31 st July, 2004.
- Workshop on "Nuclear astrophysics using low energy accelerators", Saha Institute of Nuclear Physics, Kolkata, India 29th April, 2004.
- "Production & Utilization of Radioactive Ion Beams from ISOL type facilities", held at Toshali Sands Resorts, Puri, India during 16-19 th Feb, 2004, organised by VECC, Kolkata.
- "National Conference on Neutrinos in Nuclear, Particle and Astrophysics", held at I I T Kharagpur, India during 26-28 th Feb, 2004.
- Workshop on "Nuclear structure and decay data: Theory and evaluation", 17-28 November 2003, The Abdus Salam International Centre for Theoretical Physics, Italy.
- Nuclear Structure and Decay Data: Theory and Evaluation, ICTP, Italy, November 17−28 (2003).
- DAE-BRNS Symposium (India) in Nuclear Physics, Manonmaniam Sundaranar University, Tirunelveli, Tamilnadu, December 26−30 (2002).
- DAE-BRNS Symposium (India) in Nuclear Physics, Saha Institute of Nuclear Physics and Variable Energy Cyclotron Centre, Calcutta December 26−30 (2001).

- Spring School on Nuclear Physics, Sun-Moon Lake, Taiwan (1999).
- Physical Society of Republic of China, Academia Sinica, Taipei, Taiwan, (1999).
- 1998 School on Nuclear Physics and Few-Body Problem, Chi-theo, Taiwan (1998).
- Physical Society of Republic of China, Central National University, Chung-Li, Taiwan, (1998).
- Physical Society of Germany, Goettingen, (1997).
- International Conference on Physics of Unstable Nuclei, University of Niigata, Niigata, Japan, (1994).
- Structure of Unstable Nuclei, Yukawa Institute, Kyoto, Japan, (1994).
- National Symposium on Nuclear Structure, IUC Calcutta Centre, Puri, (1993).
- IV*th* SERC School on Nuclear Physics, Goa University, Goa, (1993).
- VIII*th* SERC School on High Energy Physics, Institute of Physics, Bhubaneswar, (1992).
- International Conference on Medium and High Energy Nuclear Physics, Saha Institute of Nuclear Physics, Calcutta, India (1991).
- Department of Atomic Energy (India) Symposium in Nuclear Physics, Madras, December, 1990, Bombay, December, 1991.
- SERC School on Nuclear Structure, Banarus Hindu University, Varanasi (1989).

14. **Ph.D. STUDENT SUPERVISION:**

I am the supervisor and co-supervisor of the following Ph.D. students.

1. Thesis Supervisor of Dr. B.K. Sharma (Ph.D. awarded)

   Title: Relativistic Nuclear Many-Body Problems

2. Thesis Co-supervisor of Dr. M.S. Mehta (Ph.D. awarded)

   Title: The Nuclear Structure Studies in the Drip lines and Superheavy Region using Relativistic Mean Field Formalism

3. Thesis Co-supervisor of Mr. A. Gangadeb

   Title: Giant dipole resonance studies of rapidly rotating hot nuclei

4. Thesis Co-supervisor of Mr. R. N. Panda

   Title: Nuclear reaction for exotic nuclei

5. Thesis Co-supervisor of Mr. M. Bhuyan

   Title: Structure of drip-line and superheavy nuclei in effective relativistic and nonrelativistic interactions.

15. **COMMITTEE SERVICE:**

- Convener of the **REFRESHER COURSE FOR COLLEGE TEACHERS** for 2001, 2002, 2003, 2004.
- Co-ordinator of the **SUMMER STUDENT VISITING PROGRAMME (SSVP)** for 2005, 2006, 2007, 2008, 2009.
- Convener of the **NATIONAL WORKSHOP ON RELATIVISTIC MEAN FIELD THEORY IN NUCLEAR PHYSICS**.
- Co-Editor of the proceeding: **RELATIVISTIC MEAN FIELD THEORY IN NUCLEAR PHYSICS**.
- Local Coordinator of the Joint Entrance Screening Test (JEST) (2008-till date).
- Local Co-ordinator of the OCES/DGFS (BARC Training School) Written Test Examination for 2006, 2007, 2008, 2009, 2010, 2011.
- Co-ordinator of the **SUMMER TEACHER VISITING PROGRAMME (STVP)** for 2011.
- Served in many internal committee of the Institute.

16. **COMPUTING EXPERIENCE :**

I have worked in several computing environments, namely IBM/*TSO*, VAX/*VMS* and almost all Unix platforms supporting X-windows, *e.g.* Sun/*Solaris*, HP/*HP-UX*, DEC/*OSF/1*, SGI/*IRIX*, PC/*Linux etc.* I have extensively programmed in FORTRAN77 for my research work.

17. **LIST OF PUBLICATIONS :**

(a) Publications in Refereed Journals:-

1. Study of Half-Lives of Proton Emitters Using Relativistic Mean Field Theory, Bidhubhusan Sahu, S. K. Agarwalla, and **S. K. Patra**, Phys. Rev. **C** (in press).

2. Properties of $Z = 120$ nuclei and the α-decay chains of the $^{292,304}120$ isotopes using relativistic and nonrelativistic formalisms, Shakeb Ahmad, M. Bhuyan and **S. K. Patra**, Communicated to Phys. Rev. **C**.

3. The α- decay chains of the $^{287,288}115$ isotopes using relativistic mean field theory, B. K. Sahu, M. Bhuyan, S. Mahapatro and S. K. Patra, Int. J. Mod. Phys. **E20** (2011) 2217.

4. Nuclear structure and reaction properties of even-even Oxygen isotopes towards drip line, A. Shukla, Sven Aberg and **S. K. Patra** J. Phys. **G38** (2011) 095103.

5. $\alpha-$decay and the fusion phenomena in heavy ion collisions using nucleon-nucleon interactions derived from relativistic mean field theory, BirBikram Singh, B. B. Sahu and **S. K. Patra**, Phys. Rev. **C83** (2011) 064601.

6. A new microscopic nucleon-nucleon interaction derived from relativistic mean field theory (arxiv: nucl-th: 1011.5732v2), BirBikram Singh, M. Bhuyan, **S. K. Patra** and Raj K. Gupta, Communicated to Phys. Lett. **B**.

7. Structure effect on one neutron removal reaction using relativistic mean field densities in Glauber model, R.N. Panda and **S.K. Patra**, Communicated to Phys. Rev. **C**.

8. Band structures and deformations of rare-earth nuclei, C. R. Praharaj, **S. K. Patra**, R. K. Bhowmik and Z. Naik, J. Phys. **G** (in press).

9. Relativistic mean-field study of the properties of Z=117 nuclei and the decay chains of the $^{293,294}117$ isotopes, M. Bhuyan, **S. K. Patra** and Raj K. Gupta, Phys. Rev. **C84** (2011) 014317.

10. Application of relativistic mean field and effective field theory densities to scattering observables for Ca isotopes, M. Bhuyan, R. N. Panda, T. R. Routray and **S. K. Patra**, Phys. Rev. **C82** (2010) 064602.

11. Elastic scattering of $p +^{16} O$ at 300 MeV in relativistic impulse approximation, M. Bhuyan, R. N. Panda and **S.K. Patra**, Orissa Journal of Physics **17** (2010) 1.

12. Formation of neutron-rich and superheavy elements in astrophysical objects, R.N. Panda and **S.K. Patra**, Journal of Modern Physics **1** (1010) 312-318.

13. Nuclear sub-structure in $^{112-122}$Ba nuclei within relativistic mean field theory, M. Bhuyan, **S.K. Patra**, P. Arumugam, Raj K. Gupta, Int. J. Mod. Phys. E **20** (2011) 1227-1241.

14. Cluster radioactive decay within the preformed cluster model using relativistic mean-field theory, BirBikram Singh, **S. K. Patra** and Raj K. Gupta, Phys. Rev. **C82** (2010) 014607.

15. Importance of preformation probability in cluster radioactive-decays using relativistic mean field theory within the preformed cluster model, BirBikram Singh, **S K Patra** and Raj K. Gupta, Int. J. of Mod. Phys. E **20** (2011) 1003-1007.

16. Influence of the symmetry energy on the giant monopole resonance of neutron-rich nuclei, M. Centelles, **S.K. Patra**, X. Roca-Maza, B.K. Sharma, P.D. Stevenson, X. Vinas, J. Phys. **G37** (2010) 075107; arXiv:0906.2906.

17. Anatomy of neck configuration in fission decay, S.K. Patra, R. K. Choudhury and L. Satpathy, J. Phys. **G37** (2010) 085103.

18. Fine structure dips in the fission fragment mass distribution for the $^{238}U(^{18}O, f)$ reaction, L. S. Danu, D. C. Biswas, A. Saxena,.... **S. K. Patra**, Phys. Rev. **C81** (2010) 014311.

19. Superdeformed and Hyperdeformed States in Z=122 Isotopes, **S. K. Patra**, M. Bhuyan, M. S. Mehta, Raj K. Gupta, Phys. Rev. **C80** (2009) 034312.

20. Nuclear reaction cross sections of exotic nuclei in Glauber model for relativistic mean field densities, **S.K. Patra**, R. N. Panda, P. Arumugam and Raj K. Gupta, Phys. Rev. **C80** (2009) 064602.

21. Isomeric state in ^{53}Co: A mean field analysis, **S.K. Patra**, F.H. Bhat, R.N. Panda, P. Arumugam and Raj K. Gupta, Phys. Rev. **C79** 044303 (2009).

22. Clusters in light, heavy, super-heavy and super-superheavy nuclei, Raj K. Gupta, S.K. Arun, Dalip Singh, Raj Kumar, NIYTI, **S.K. Patra**, P. Arumugam and B.K. Sharma, Int. J. Mod. Phys. **E17** (2008) 2244.

23. Fission of hyper-hyperdeformed ^{56}Ni: a clustering analysis within mean-field approaches, Raj K. Gupta, **S.K. Patra**, P.D. Stevenson, C. Beck and Walter Greiner, J. Phys. **G35** (2008) 075106.

24. Fission decay properties of ultra neutron-rich Uranium isotopes, L.Satpathy, **S.K. Patra** and R.K. Choudhury, PRAMANA - J. Phys. **70** (2008) 87.

25. Nuclear reaction studies of unstable nuclei using relativistic mean field formalisms in conjunction with Glauber model, A. Shukla, B. K. Sharma, R. Chandra, P. Arumugam and **S. K. Patra**, Phys. Rev. **C76** (2007) 034601.

26. Nuclear mean field and equation of state of asymmetric nuclear matter, B. Behera, T.R. Routray, **S.K. Patra** and P.K. Sahu, Nucl. Phys. **A794** 132 (2007).

27. Exotic clustering in heavy and superheavy nuclei within the relativistic and non-relativistic mean field formalisms, **S.K. Patra**, Raj K. Gupta, B.K. Sharma, P.D. Stevenson and Walter Greiner, J. Phys. **G34** (2007) 2073.

28. Phase transition and properties of compact star, B.K. Sharma, P.K. Panda and **S.K. Patra**, Phys. Rev. **C75** (2007) 035808.

29. A highly neutron-rich cluster and/or a superheavy nucleus in the compound nucleus $^{238}U - ^{238}U$: a mean field study, Raj K. Gupta, **S.K. Patra**, P.D. Stevenson and Walter Greiner, Int. J. of Mod. Phys. **E16** (2007) 1721.

30. Neutron star matter in an effective model, T.K. Jha, P.K. Raina, P.K. Panda and **S.K. Patra**, Phys. Rev. **C74** (2006) 055803; **C75** (2007) 029903.

31. Higher-multipole deformations and compactness of hot fusion reactions, Monika Manhas, Raj K. Gupta, Qingfeng Li, **S.K. Patra** and Walter Greiner, Phys. Rev. **C74** (2006) 034603.

32. Reaction cross-sections for light nuclei on ^{12}C, using relativistic mean field formalism, B.K. Sharma, **S.K. Patra**, Raj K. Gupta, A. Shukla, P. Arumugam, P.D. Stevenson and Walter Greiner, J. Phys. **G32** (2006) 2089.

33. Decrease of the spin-orbit interaction in drip-line nuclei, using relativistic mean field models, M.S. Mehta, B.K. Sharma, **S.K. Patra**, R.K. Gupta and W. Greiner, Int. J. Mod. Phys. **E15** (2006) 1149.

34. Magic numbers in exotic light nuclei near drip lines, R.K. Gupta, M. Balasubramaniam, Sushil Kumar, **S.K. Patra**, G. Münzenberg and W. Greiner, J. Phys. **G32** (2006) 565.

35. Clustering in superheavy nuclei within the relativistic mean field approach, B.K. Sharma, P. Arumugam, **S.K. Patra**, P.D. Stevenson, Raj K. Gupta and W. Greiner, J. Phys. **G32** (2006) L1.

36. Giant dipole resonance and shape transitions in medium heavy mass nuclei, P. Arumugam, A. Ganga Deb and **S.K. Patra**, European Physical Journal **A25** (2005) 199.

37. Relativistic mean field study of clustering in light nuclei, P. Arumugam, B.K. Sharma, **S.K. Patra** and Raj K. Gupta, Phys. Rev. **C71** (2005) 064308.

38. Sum rule approach to the isoscalar giant monopole resonance in drip line nuclei, M. Centelles, X. Vinas, **S.K. Patra**, J.N. De, Tapas Sil, Phys. Rev. **C72** (2005) 014304.

39. Applicability of shape parameterizations for giant dipole resonance in warm and rapidly rotating nuclei, P. Arumugam, A. Gangadeb and **S.K. Patra**, Euro. Phys. Lett. **70** (2005) 313.

40. Momentum and density dependence of the isospin part of nuclear mean field and equation of state of asymmetric nuclear matter, B. Behera, T.R. Routray, A. Pradhan, **S.K. Patra** and P.K. Sahu, Nucl. Phys. **A753** (2005) 367.

41. Giant dipole resonance in rapidly rotating hot nuclei with exact treatment of fluctuations, P. Arumugam, A. Ganga Deb and **S. K. Patra**, Acta Physica Polanica **B36** (2005) 1181.

42. Versatility of field theory motivated nuclear effective lagrangian approach, P. Arumugam, B.K. Sharma, P.K. Sahu, **S.K. Patra**, Tapas Sil, M. Centelles and X. Viñas, Phys. Lett. **B601** (2004) 51.

43. Giant dipole resonance and Jacobi transition with exact treatment of fluctuations, P. Arumugam, G. Shanmugam and **S.K. Patra**, Phys. Rev. **C69** (2004) 054313.

44. Shell overcomes repulsive nuclear force instability, L. Satpathy and **S.K. Patra**, J. Phys. **G30** (2004) 771-781.

45. Superheavy nuclei in relativistic effective Lagrangian model, Tapas Sil, **S.K. Patra**, B.K. Sharma, M. Centelles, and X. Viñas, Phys. Rev. **C69** (2004) 044315.

46. Potential energy surfaces for $N = Z$, ^{20}Ne—^{112}Ba nuclei, M. S. Mehta, T. K. Jha, **S. K. Patra**, and Raj K. Gupta, PRAMANA -J. Phys. **62** (2004) 841.

47. Shape change in Hf, W and Os-isotopes: A Non-relativistic Hartree-Fock versus Relativistic Hartree Approximation, Z. Naik, B.K. Sharma, P. Arumugam, T.K. Jha and **S.K. Patra**, PRAMANA -J. Phys. **62** (2004) 827.

48. Hot Nuclear Matter in Asymmetry Chiral Sigma Model, P. K. Sahu, T. K. Jha, K. C. Panda and **S. K. Patra**, Nucl. Phys. **A733** (2004) 169.

49. A relativistic mean-field study of magic numbers in light nuclei from neutron- to proton-drip lines, T.K. Jha, M.S. Mehta, **S.K. Patra**, B.K. Raj and Raj K. Gupta, PRAMANA -J. Phys. **61** (2003) 517.

50. New magic numbers and new islands of stability in drip-line regions in mass model, L. Satpathy and **S.K. Patra**, Nucl. Phys. **A722** (2003) 24c.

51. Systematic study of Bh isotopes in a relativistic mean field formalism, M.S. Mehta, B.K. Raj, **S.K. Patra** and Raj K. Gupta, Phys. Rev. **C66** (2002) 044317.

52. Isospin-rich nuclei in neutron star matter, Tapas Sil, J. N. De, S. K. Samaddar, X. Viñas, M. Centelles, B. K. Agrawal and S. K. Patra, Phys. Rev. **C66** (2002) 045803.

53. Multiple shape-structures in $N = Z$, neutron deficient ^{72}Kr $-$ ^{92}Pd nuclei, **S.K. Patra**, B.K. Raj, M.S. Mehta, and Raj K. Gupta, Phys. Rev. **C65** (2002) 054323.

54. Surface incompressibility from semiclassical relativistic mean field calculations, **S.K. Patra**, M. Centelles, X. Viñas, and M. Del Estal, Phys. Rev. **C65** (2002) 044304.

55. Scaling Calculation of Isoscalar Giant Resonances in Relativistic Thomas–Fermi Theory, **S.K. Patra**, X. Viñas, M. Centelles and M. Del Estal, Nucl. Phys. **A703** (2002) 240.

56. Scaling in Relativistic Thomas–Fermi Approach for Nuclei, **S.K. Patra**, M. Centelles, X. Viñas and M. Del Estal, Phys. Lett. **B523** (2001) 67.

57. Nuclei beyond the drip line, J.N. De, X. Viñas, **S.K. Patra** and M. Centelles, Phys. Rev. **C64** (2001) 057306.

58. Strange matter and its stability in presence of magnetic field, P. K. Sahu and **S. K. Patra**, Int. J. Mod. Phys. **A16** (2001) 2435.

59. Pairing properties in Relativistic Mean Field Theory obtained from Effective Field Theory, M. Del Estal, M. Centelles, X. Viñas and **S. K. Patra**, Phys. Rev. **C63** (2001) 044321.

60. Ground state spins and other properties of the odd Z=N+1 nuclei $^{61}Ga -^{97}In$, **S. K. Patra**, M. Del Estal, M. Centelles and X. Viñas, Phys. Rev **C63** (2001) 024311.

61. Effects of new non-linear couplings in relativistic effective field theory, M. Del Estal, M. Centelles, X. Viñas and **S.K. Patra**, Phys. Rev **C63** (2001) 024314.

62. Alpha-decay chain of the ^{289}114 nucleus, **S. K. Patra**, C.-L. Wu, W. Greiner and Raj K. Gupta, J. Phys. **G26** (2000) 1569.

63. Shell structure of superheavy nuclei, **S. K. Patra**, W. Greiner and Raj K. Gupta, J. Phys. **G26** (2000) L65.

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89. "Shell stabilizes repulsive nuclear force instability: a new phenomenon" - L. Satpathy and **S.K. Patra**, Accepted for poster presentation in International Nuclear Physics Conference, Göteborg, Sweden, June 27–July 2, (2004).

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Dr. Bharat Kishore Sharma who got his Ph. D. degree under my supervision is presently a Postdoctoral Fellow at TIFR, Mumbai. Also I am the co-supervisor of Dr. M. S. Mehta who already received his Ph. D. degree from Chandigarh University. Most of the Ph.D. work of Dr. T. K. Jha is also done under my supervision. Recently Mr. R. N. Panda, Mr. Anil Ganga Deb and Mr. M. Bhuyan are working for their Ph.D. and some of them will submit their thesis soon. Apart from the above, several postdoctoral fellow like Dr. P. Arumugam, Dr. S.K. Agrawala worked with me and now they are faculty members in various IITs and Universities. Presently two postdoctoral fellows are collaborating with me at Institute of Physics.

My collaboration is also going well with various groups in and outside of the country (Prof. R.K. Gupta, Panjab University, Chandigarh, Profs. B. Behera and T. R. Routray of Sambalpur University, Prof. L. Satpathy and Prof. C.R. Praharaj, IOP, Dr. R. K. Choudhury, BARC, Mumbai, Prof. Paul Stevension, University of Surray, U.K., Profs. X. Viñas and M. Centelles of Barcelona University, Spain).

In collobaration with the above groups and also working independently, I have extensively worked on several area of Nuclear Physics. My present research work is mainly divided into eight parts, e.g., (a) Giant resonances in relativistic approach, (b) Nuclear equation of states, (c) Structures of exotic and superheavy nuclei and fission of neutron-rich nuclei, (d) Field theory motivated effective lagrangian approach, (e) Application of mass formula and microscopic verification for exotic nuclei region, (f) Giant dipole resonance and Jacobi transition, (g) Nuclear Reaction. (Research work before joining, (h) Nuclear High Spin states (Nuclear spectroscopy) at Institute of Physics and work done in other important area can be found from the list of publications list).

(a) Giant Resonances in Relativistic and Non-relativistic Theory

Recently, the basic theory derived in the Relativistic Thomas-Fermi approach has been applied to discuss the virial theorem and to study the breathing-mode energy within the relativistic mean field theory. In the past few years, we analyze our self-consistent method in depth. To our knowledge, for realistic non-linear parameter sets of the relativistic mean field (RMF) theory, these are the first calculations of isoscalar giant resonances in finite nuclei carried out with the scaling method which are fully self-consistent (i.e., we do not make use of a leptodermous expansion as in previous scaling approaches). Owing to the meson-exchange nature of the relativistic model one has to deal with finite range forces, which renders the scaling method more involved than, e.g., for non-relativistic zero-range Skyrme forces. Moreover, in contrast to the non-relativistic situation, there exist two different densities, namely the baryon and the scalar density, in accordance with the fact that one has two types of fields, the vector and the scalar field.

We derive analytical expressions for the excitation energy of the isoscalar giant monopole and quadrupole resonances in finite nuclei, by using the scaling method and the extended Thomas–Fermi approach to relativistic mean field theory. We study the ability of several non-linear $\sigma - \omega$ parameter sets of common use in reproducing the experimental data. For monopole oscillations the calculations agree better with experiment when the nuclear matter incompressibility of the relativistic interaction lies in the range 220–260 MeV. The breathing-mode energies of the scaling method compare satisfactorily with those obtained in relativistic random phase approximation (RRPA) and time-dependent mean field calculations. For quadrupole oscillations all the analyzed non-linear parameter sets reproduce the empirical trends reasonably well.

By using the scaling method and the Extended Thomas-Fermi approach to Relativistic Mean Field Theory the surface contribution to the leptodermous expansion of the finite nuclei incompressibility K_A has been self-consistently computed. The validity of the simplest expansion, which contains volume, volume-symmetry, surface and Coulomb terms, is examined by comparing it with self-consistent results of K_A for some currently used non-linear $\sigma - \omega$ parameter sets. A numerical estimate of higher-order contributions to the leptodermous expansion, namely the curvature and surface-symmetry terms, is made.

We analyze the influence of the density dependence of the symmetry energy on the average excitation energy of the isoscalar giant monopole resonance (GMR) in stable and exotic neutron-rich nuclei by applying the relativistic extended Thomas-Fermi method in scaling and constrained calculations. For the effective nuclear interaction, we employ the relativistic mean field model supplemented by an isoscalar-isovector meson coupling that allows one to modify the density dependence of the symmetry energy without compromising the success of the model for binding energies and charge radii. The semiclassical estimates of the average energy of the GMR are known to be in good agreement with the results obtained in full RPA calculations. The present analysis is performed along the Pb and Zr isotopic chains. In the scaling calculations, the excitation energy is larger when the symmetry energy is softer. The same happens in the constrained calculations for nuclei with small and moderate neutron excess. However, for nuclei of large isospin the constrained excitation energy becomes smaller in models having a soft symmetry energy. This effect is mainly due to the presence of loosely-bound outer neutrons in these isotopes. A sharp increase of the estimated width of the resonance is found in largely neutron-rich isotopes, even for heavy nuclei, which is enhanced when the symmetry energy of the model is soft. The results indicate that at large neutron numbers the structure of the low-energy region of the GMR strength distribution changes considerably with the density dependence of the nuclear symmetry energy, which may be worthy of further characterization in RPA calculations of the response function.

Sum Rule Approach to the Isoscalar Giant Monopole: Using the Density-Dependent Hartree-Fock approximation and Skyrme forces together with the scaling method and constrained Hartree-Fock calculations, we obtain the average energies of the isoscalar giant monopole resonances. The calculations are done along several isotopic chains from the proton to the neutron drip lines. It is found that while approaching the neutron drip line, the scaled and the constrained energies decrease and the resonance width increases. Similar but smaller effects are found near the proton drip line, but only for the lighter isotopic chain. A qualitatively good agreement is found between our sum rule description of these giant resonances and the presently existing RPA results. The ability of the semiclassical approximations of the Thomas-Fermi type, which describe properly the average energy of the isoscalar giant monopole resonance for stable nuclei, to predict average properties for nuclei near the drip lines is also analyzed. It is found that when $\hbar$-corrections are included, the semiclassical estimates reproduce, on average, the quantal excitation energies of the giant monopole resonances for nuclei with extreme isospin values.

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[1] M. Centelles, S.K. Patra, X. Roca-Maza, B.K. Sharma, P.D. Stevenson, X. Vinas, J. Phys. **G37** (2010) 075107; arXiv:0906.2906; M. Centelles, X. Viñas, S. K. Patra, J. N. De and Tapas Sil, Phys. Rev. **C72** (2005) 014304.

(b) Equation of states

Quantum hadrodynamics is a framework for describing the nuclear many body problem in the nuclear matter. The real motivation to describe nuclear matter in a non-linear chiral SU(3) framework is that the small nuclear binding energy (in comparison to nuclear mass) arises because of a cancellation between a large lorentz scaler and four vector potentials and so it is necessary to study even ordinary nuclear system in a relativistic framework to maintain the lorentz transformation properties of the interaction.

As a first step towards this direction, in the frame work of SU(2) chiral sigma model, the nuclear matter properties at zero and finite temperature have been investigated. We have analyzed the nuclear matter equation of state by varying different parameters, which agrees well with the equation of state derived from the heavy-ion collision experiment at extreme densities and reliable realistic Dirac Brueckner Hartee Fock (DBHF) (DBHF) equation of state at low density region. We have then calculated the temperature dependent asymmetric nuclear matter, also investigated the critical temperature of liquid gas phase transition and compared with the experimental data. We found that the critical temperature in our model is in the range of $14-20$ MeV.

Recently, in SU(3) framework we incorporate the baryons and mesons as the appropriate degrees of freedom and added some more particles in the lagrangian to derive a complete nuclear equation of state. Besides the baryon octets, the spin-0, spin-1 nonets, a gluon condensate associated with broken scale invariance are incorporated. Here we include SU(3) baryon octets, N, Λ, Σ, Ξ and the pseudoscalar nonets, π, η, $\eta^{'}$, K, the vector nonets, ω, ρ, ϕ and K^{*}. The physical isoscalar mesons in the nonets come about as an admixture of the pure octet and the pure singlet states. We designed the lagrangian so as to include the various interaction terms, the kinetic energy terms and the chiral symmetry breaking term. Here we consider the mesonic masses to be generated dynamically. Assuming mean field approximation we derived various fields of equations of motion. The equation of state such as pressure and energy density as a function of baryon density are calculated from the Gibbs-Duhem relation. In this nuclear matter equation of state, there are couple of unknown parameters involving the baryon meson couping constants. These parameters are calculated by using saturation properties at the nuclear matter, i.e., binding energy per nucleon, saturation density, incompressibility etc. The correct binding energy can be obtained in this theory due to the presence of three body forces. We implemented the above derived equation of state to study the properties of high density matter and some astrophysical systems such as neutron stars.

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[1] P. K. Sahu, T. K. Jha, K. C. Panda and S. K. Patra, Nucl. Phys. **A733** (2004) 169; B.K. Sharma, P.K. Panda and S.K. Patra, Phys. Rev. **C75** (2007) 035808; T.K. Jha, P.K. Raina, P.K. Panda and S.K. Patra, Phys. Rev. **C74** (2006) 055803; **C75** (2007) 029903.

(c) Structures of exotic and superheavy nuclei

(i) Internal stucture of clusters in $^{112-122}$Ba nuclei within relativistic mean field theory:

We study for the first time the clustering structure with the internal or sub-structure of clusters in $^{112-122}$Ba nuclei within the framework of relativistic mean field theory in an axially deformed cylindrical co-ordinate. We calculate the individual neutrons and protons density distributions. From the analysis of the clustering configurations in total (neutrons-plus-protons) density distributions for various shapes of both the ground and excited states, we find different sub-structures inside the Ba nuclei considered here. The important step, carried out here for the first time, is the counting of number of protons and neutrons present in the clustering region(s). ^{12}C is shown to constitute the cluster configuration in prolate ground-states of ^{112}Ba and ^{114}Ba, and oblate-deformed excited states of ^{118,120}Ba nuclei, with ^{2,3}H and ^{4}He constituting the neck between two symmetrical fragments at the scission stage of all the $^{112-122}$Ba nuclei. Presence of other lighter clusters such as ^{6}Li, ^{8}Be, ^{14}N, and nuclei in the neighborhood of N=Z, ^{22}Na, ^{24}Mg, ^{34}Cl, ^{36}Ar and ^{40}Ca are also indicated in the ground and excited states of these nuclei. Cases of ^{6}Li and ^{8}Be in the neck region are also seen. All these results are of interest for the observed intermediate mass fragments and fusion-fission processes, and the so far unobserved evaporation residues from the decaying

Ba* compound nuclei formed in heavy ion reactions.

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[1] M. Bhuyan, S. K. Patra, P. Arumugam, Raj K. Gupta, Int. J. Mod. Phys. **E** (in press); arXiv:0906.2335v1 [nucl-th].

(ii) Superdeformed and Hyperdeformed States in Z=122 Isotopes:

We calculate the binding energy, root-mean-square radius, and quadrupole deformation parameter for the recent, possibly discovered superheavy element Z=122, using the axially deformed relativistic mean-field (RMF) and nonrelativistic Skyrme Hartree-Fock (SHF) formalisms. The calculation is extended to include various isotopes of Z=122 element, starting from A=282 to A=320. We predict highly deformed structures in the ground state for all the isotopes. A shape transition appears at about A=290 from a highly oblate to a large prolate shape, which may be considered as the superdeformed and hyperdeformed structures of the Z=122 nucleus in the mean-field approaches. The most stable isotope (largest binding energy per nucleon) is found to be ^{302}122, instead of the experimentally observed ^{292}122.

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[1] S. K. Patra, M. Bhuyan, M. S. Mehta, Raj K. Gupta, Phys. Rev. **C80** (2009) 034312.

(iii) Decay properties of ^{293,294}117:

We have calculated the binding energy, root-mean-square radius and quadrupole deformation parameter for the recently synthesized superheavy element Z=117, using the axially deformed relativistic mean field (RMF) model. The calculation is extended to various isotopes of Z=117 element, starting from A=286 till A=310. We predict almost spherical structures in the ground state for almost all the isotopes. A shape transition appears at about A=292 from a prolate to an oblate shape structure of Z=117 nucleus in our mean field approach. The most stable isotope (largest binding energy per nucleon) is found to be the ^{288}117 nucleus. Also, the Q_α-values and the mean-life times T_α for the α-decay chains of ^{293}117 and ^{294}117 are calculated, supporting the magic numbers at N=172 and/ or 184.

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[1] M. Bhuyan, S. K. Patra and Raj K. Gupta, Phys. Rev. **C** (in press).

(iv) Anatomy of neck configuration in fission decay:

The anatomy of neck configuration in the fission decay of Uranium and Thorium isotopes is investigated in a microscopic study using Relativistic mean field theory. The study includes ^{236}U and ^{232}Th in the valley of stability and exotic neutron rich isotopes ^{250}U, ^{256}U, ^{260}U, ^{240}Th, ^{250}Th, ^{256}Th likely to play important role in the r-process nucleosynthesis in stellar evolution. Following the static fission path, the neck configurations are generated and their composition in terms of the number of neutrons and protons are obtained showing the progressive rise in the neutron component with the increase of mass number. Strong correlation between the neutron multiplicity in the fission decay and the number of neutrons in the neck is seen. The maximum neutron-proton ratio is about 5 for ^{260}U and ^{256}Th suggestive of the break down of liquid-drop picture and inhibition of the fission decay in still heavier isotopes. Neck as precursor of a new mode of fission decay like multi-fragmentation fission may also be inferred from this study.

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[1] S.K. Patra, R.K. Choudhury and L. Satpathy, J. Phys. **G37** (2010) 085103; L.Satpathy, S.K. Patra and R.K. Choudhury, PRAMANA - J. Phys. **70** (2008) 87..

(v)Cluster radioactive-decay using the relativistic mean field theory within the preformed cluster model:

We have studied the (ground-state) cluster radioactive-decays using for the first time the relativistic mean field (RMF) theory within the preformed cluster model (PCM) of Gupta and collaborators. Following the PCM approach, we have deduced empirically the preformation probability P_0^{emp} from the experimental data on both the α and exotic cluster-decays, specifically of parents in the translead region having doubly magic ^{208}Pb or its neighboring nuclei as daughters. Interestingly, the RMF theory supports the concept of preformation for both the α and heavier clusters in radioactive nuclei. $P_0^{\alpha emp}$ for alpha-decays is almost constant $\sim 10^{-2} - 10^{-3}$ for all the parent nuclei considered here, and P_0^{emp} for cluster-decays of the same parents decrease with the size of clusters emitted from different parents. The results obtained for P_0^{emp} are reasonable, and are within two to three orders of magnitude of the well accepted phenomenological model of Blendowske-Walliser for light clusters.

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[1] Cluster radioactive-decay using the relativistic mean field theory within the preformed cluster model, BirBikram Singh, S.K. Patra and Raj K. Gupta, Phys. Rev. **C82** (2010) 014607.

(v) Shape change in Hf, W and Os-isotopes: A Non-relativistic Hartree-Fock versus Relativistic Hartree Approximation

We have investigated the ground-state structures of even-even Hf, W and Os-isotopes within the framework of a deformed non-relativistic Hartree-Fock and a relativistic mean field formalism. A majority of the nuclei are predicted to be prolate in shape in the relativistic calculations. On the other hand, contrary to the relativistic results, we predict a shape change in a cyclic order in the non-relativistic calculations. However, in both the cases, the magnitude of the quadrupole deformation parameter agree well with the experimental data. We also evaluated the hexadecapole deformation parameter for Hf, W and Os-isotopes and irrespective of the shape change in quadrupole moments, we find a cyclic change in hexadecapole shape from positive to negative and vice versa in both the relativistic and non-relativistic formalisms.

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[1] : Z. Naik, B.K. Sharma, P. Arumugam, T.K. Jha and S.K. Patra, *J. Phys.*- PRAMANA **62** (2004) 827.

(d) Field theory motivated effective lagrangian approach: A complete relativistic nuclear model

The relativistic mean field treatment of quantum hadrodynamics (QHD), which includes the baryons and the σ, ω and ρ mesons as relevant degrees of freedom, has proven to be very successful in dealing with the nuclear many-body problem. Since the model was proposed to be renormalizable, only cubic and quartic scalar self-interactions were included. More recently, and inspired by the modern concepts of effective field theory (EFT) and density functional theory (DFT) for hadrons, Furnstahl, Serot and Tang abandoned the idea of renormalizability and extended the relativistic mean field model by allowing other non-linear scalar-vector, vector-vector and tensor copulings (called E-RMF formalism).

In the mean field models the coupling constants and the σ meson mass are taken as effective parameters which are fitted to reproduce experimental data of a few magic nuclei. However, some times these models are extrapolated to study other scenarios at higher densities such as neutron stars or the core collapse of type II supernovae. One of the main advantage of E-RMF over the conventional RMF formalism is the successful application to analyze the ability of the relativistic mean field models based on EFT in describing such kind of situations. In particular we study the equation of state (EOS) at zero temperature for nuclear and neutron matter. It is found that due to the new couplings the density dependence of the vector field is weaker as compared with the predictions of the conventional non-linear $\sigma - \omega$ model. The E-RMF model gives an EOS for nuclear matter and for neutron matter in the regime between two and five times the saturation density compatible with the EOS obtained from the analysis of the transverse and elliptical flows in the Au+Au at several beams collisions recently reported by Danielewicz et al. Also using these parametrizations based on E-RMF, the calculated radius and mass of neutron stars is in good agreement with the values derived from experimental observations.

In the low density regime, i.e., around saturation, we study the impact of the new couplings in the E-RMF parameter sets on nuclear surface properties such as the surface energy coefficient, surface thickness and surface stiffness, neutron skin and spin-orbit force. By adding to the E-RMF parametrizations the pairing correlations through a modified BCS approach that takes into account quasibound levels owing to their centrifugal barrier and that simulates well Hartree-Bogoliubov calculations, we study isotopic (isotonic) chains of nuclei with magic neutron (proton) numbers [1]. We test this simple prescription by comparing with available Hartree-plus-Bogoliubov results. Using the new effective parameter sets we then compute separation energies, density distributions and spin–orbit potentials in isotopic (isotonic) chains of nuclei with magic neutron (proton) numbers. The new forces describe the experimental systematics similarly to conventional non-linear $\sigma - \omega$ relativistic force parameters like NL3.

Using this formalism, the isotopic and isotonic chains of superheavy nuclei are analyzed to search for spherical double shell closures beyond $Z = 82$ and $N = 126$. We take into account several indicators to identify the possible shell closures, such as two-nucleon separation energies, two-nucleon shell gaps, average pairing gaps, and the shell correction energy. We also discuss some features of the particle densities and spin-orbit potentials of selected nuclei in the superheavy region. The effective Lagrangian model (E-RMF) predicts $N = 172$ and $Z = 120$ and $N = 258$ and $Z = 120$ as stable spherical doubly magic superheavy nuclei, whereas $N = 184$ and $Z = 114$ show some magic character depending on the parameter set.

Then we developed the equation of states for symmetric and asymmetric nuclear matter and we applied the model for the study of neutron star structure. We found valuable results which has been published in reputed journals.

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(e) Application of mass formula and microscopic verification for exotic nuclei region (Shell overcomes repulsive nuclear force instability)

Nuclear physics saw the dawn of a new era in mid 1960s when newly developed shell correction method predicted the existence of superheavy elements with charge number Z=120, 164 and double humped fission barriers with the manifestation of fission isomers. These phenomena are a direct consequence of the stabilization of the nucleus by the shell effect, against the instability due to repulsive Coulomb force of proton originating from large proton number. We present the evidence of a complementary new nuclear phenomenon where the repulsive component of the nucleon-nucleon (n-n) interaction becomes disruptive due to neutron excess in a large nucleus, located in the dripline region, which is stabilized by the shell effect leading to the broadening of stability peninsula.

It is well known that the periodic table would have terminated around $Z \simeq 100$, but for the shell effect providing protection against the desruptive Coulomb force extending it presently upto $Z = 115$ with the promise for going up and eventually reaching the superheavy island. The superheavy elements lie in the extension of the stability valley characterised by similar N/Z ratio with typical value of about 1.54. This ratio which measure the preponderance of nuclear force to Coulomb force in the nucleus is 1.54, 1.55 and 1.54 for ^{208}Pb, ^{235}U and the superheavy element $^{289}X_{114}$ respectively.

The basic two-body n-n force is state dependent having both repulsive and attractive components. Had there not been any repulsive component, the nucleus would not have been stable. The odd-state interaction (triplet-triplet, singlet-singlet) of the n-n force is repulsive. As one moves across the valley of stability towards the dripline, the number of neutron-neutron pairs increases over the neutron-proton pairs, as a consequence, because of the Pauli principle this component progressively contributes larger amount of repulsive energy resulting in the instability of the nucleus. As in the case of Coulomb force, the shell effect is expected to come to the rescue of the nucleus by overcoming this instability giving rise to new magic numbers and associated new islands of stability in the dripline regions. This will shift the dripline away and broaden the stability peninsula, complementary to the case of Coulomb force which elongates it taking into its fold the superheavy elements and other intervening nuclei. Our study in Infinite Nuclear Mass model, relativistic mean field theory and shell corrections calculation give strong evidence of the new magic numbers N=100, 150, 164, and Z=78, and the associated new islands of stability around N=100, $Z \simeq 62$; N=150, Z=78 and N=164, $Z \simeq 90$ in the dripline region with N/Z ratio 1.62, 1.82 and 1.92 respectively. The last two islands are quite far from the presently known coast line being situated in a somewhat perpendicular direction to the stability line, complementary to the superheavy islands which lie along it. The corresponding magic nuclei ^{228}Pt and ^{254}Th may be termed as superheavy isotopes (SHI). This new phenomenon should have been anticipated before, purely on the consideration of the known features of nuclear dynamics and the phenomena of superheavy elements and double humped fission barriers.

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[1] Satpathy, L. & Patra, S. K. J. Phys. **G30** Nucl. Part. Phys. 771-781 (2004); *ibid* Nucl. Phys. **A722**, 24c-29c (2003).

(f) Giant dipole resonance and Jacobi transition with exact treatment of fluctuations

In recent years the Giant Dipole Resonance (GDR) studies have been proved to be a powerful tool to study hot and rotating nuclei and recently the domain of GDR spreads rapidly over different areas of theoretical and experimental interest. For instance, from the GDR γ-decay, it was possible to extract the information of lifetime of hot super-heavy system such as ^{272}Hs. By populating the isomeric states in the decay of the GDR better information about the isomers could be extracted. The measurement of GDR gamma rays from highly excited nuclei could be utilized to check the level density prescriptions. In general, the GDR observations provide us information about the geometry as well as the dynamics of nuclei even at extreme limits of temperature (T), spin (I) and isospin (τ). Several experiments have been carried out recently to study the influence of angular momentum and temperature, by observing the gamma rays from the GDR states from hot rotating nuclei. The behavior of GDR width as a function of temperature has been an interesting phenomenon and the GDR measurements at extreme spins render information about highly deformed structures. Here we address these issues with our theoretical results with more exact methods with more deformation degrees of freedom and proper inclusion of thermal effects.

In a macroscopic approach to giant dipole resonance (GDR) in hot and rotating nuclei, the observables are related to the nuclear free energy surface with consideration of thermal shape fluctuations. This formalism is revisited with more exact methods. The Nilsson-Strutinsky (NS) method extended to high spin and temperature is used for free energy calculations. Various approaches to calculate shell corrections at finite temperature and spin are compared. The GDR built on the states determined by NS method are studied with a macroscopic model comprising anisotropic harmonic oscillator potential with separable dipole-dipole interaction. Methods to parameterize the free energy, such as the Landau theory, for easier evaluation of thermal fluctuations are discussed along with a scheme to evaluate thermal fluctuations exactly. Landau theory is found to work well even in the extreme limits of spin, however, in the absence of strong shell effects. GDR as a probe for Jacobi transition leading to hyperdeformation is analyzed in the case of Zirconium isotopes.

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(g) Nuclear reaction

We calculate the nuclear reaction cross-sections of exotic nuclei in the framewo rk of the Glauber model, using as inputs the standard realativistic mean field (RMF) densities and the densities obtained from the more recently developed effective field theory motivated RMF (E-RMF). Both light and heavy nuclei are taken as the representative targets and light neutron-rich nuclei as projectiles. We find the increase of nuclear reaction cro ss-section as a function of mass number for both the target and projectile. For a further application of the method, we sugg est a mechanism for the formation of superheavy and highly neutron-rich elements in astrophysical objects. For explai ning this mechanism, we have used the nuclear fusion cross-sections obtained from the non-relativistic coupled channel calculations.

For the astrophysical application, here we calculate the reaction and the fusion cross-sections of neutron-rich heavy nuclei taking light exotic isotopes as projectiles. Results of neutron-rich Pb and U isotopes are demonstrated as the representative targets and He, B as the projectiles. The Gluaber Model and the Coupled Channel Formalism are used to evaluate the reaction and the fusion cross-sections for the cases considered. Based on the analysis of these cross-sections, we predict the formation of heavy, superheavy and super-superheavy elements through rapid neutron/light nuclei capture r-process of the nucleosynthesis in astrophysical objects.

Relativistic Impulse Approximation: In the frame work of relativistic mean field (RMF) theory, we have calculated the density distribution of protons and neutrons for $^{40,42,44,48}Ca$ with NL3 and G2 parameter sets. The microscopic proton-nucleus optical potentials for $p +^{40,42,44,48} Ca$ systems are evaluated from the Dirac NN-scattering amplitude and the density of the target nucleus using Relativistic-Love-Franey and McNeil-Ray-Wallace parametrizations. We have estimated the scattering observables, such as elastic differential scattering cross-section, analyzing power and the spin observables with the relativistic impulse approximation (RIA). The results have been compared with the experimental data for few selective cases and find that the use of density as well as the scattering matrix parametrizations are crucial for the theoretical prediction.

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[1] S.K. Patra, R. N. Panda, P. Arumugam and Raj K. Gupta, Phys. Rev. **C80** (2009) 064602; R.N. Panda and S.K. Patra, J. Mod. Phys. **1** (1010) 312-318; M. Bhuyan, R. N. Panda and S.K. Patra, O. J. Phys. **17** (2010) 1; M. Bhuyan, R. N. Panda, T. R. Routray and S. K. Patra, Phys. Rev. **C82** (2010) 064602..

(g) High Spin States

Deformed Hartree-Fock and Angular Momentum Projection gives a complete descripti on of the structure of deformed nuclei in various regions of mass. We have applied this fo rmalism to study the structure of ^{152}Ba and ^{148}Xe and other neighboring exotic nu clei. For ^{152}Ba a rich band structure is predicted including K and Shape Isomers at 10 MeV or less of excitation energy. This study is extended to Ce, Nd, Sm, Gd, Dy, Er, Yb, Hf and neighbouring nuclei covering a range of neutron numbers.

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[1] C. R. Praharaj, S.K. Patra, R. K. Bhowmik and Z. Naik, J. Phys. **G** (in press); C. R. Praharaj, M. Bhuyan, S.K. Patra, R. K. Bhowmik and Z. Naik, DAE-BRNS Symp. Nucl. Phys. **55** (2010) 208.

19. Contribution to any other activities for the Institute

- *(a) Convener of the Refresher course for college teacher (2002 to 2005):*

  Institute of Physics, Bhubaneswar was organising Refresher Course in Physics for College Teachers for several years. I was the convener of the course for 2002, 2003, 2004. In this course about 30 participants take part from various colleges of the country, each year. Extensive class room teaching was given on the subjects of Quantum Mechanics, Statistical Mechanics, Experimental Physics and Classical Mechanics and Electrodynamics. In addition a set of lectures were given on High Energy, Nuclear Physics and Solid States Physics. In the afternoon session, Computer and Laboratory works were given to the participants.

- *(b) Convener of the National Workshop on Relativistic Mean Field theory in Nuclear Physics:*

  I was convener of the National Workshop on **Relativistic Mean Field theory in Nuclear Physics.** In this National Workshop, about 40 participants from various institutions of the country had taken part. The objective of this workshop was to bring all relevant workers together to a forum to discuss the current and future research problems in nuclear physics. This workshop was consisted of lectures by the experts and selected presentations by participants. We are now processing to bring out the workshop proceedings in the form of a bound volume.

- *(c) Convener of the Summer Student Visiting Program (SSVP) 2005 to 2009:*

  Summer Student Visiting Program at Institute of Physics is an important event for the University students. I have coordinated it successfully from 2005 to 2009. In this program about 10-15 M.Sc. and B-tech students are invited to Institute of Physics to carry out summer course. Each student is assigned to work under a faculty member for six weeks and finally they sumbit a report with a presentation.

- *(d) Local Coordinator of the Joint Entrance Screening Test (JEST) (2008-till date):*

  I am the local coordinator of Institute of Physics for the Joint Entrance Screening Test (JEST) Examination from 2008 to till date. This test is a screening process jointly conducted by 22 institutions in the country for the enrolment of Ph.D. degree.

- *(e) Local Coordinator of the BARC OCES/DGFS Written Test (2006-till date):*

  I am the local coordinator for the Joint Entrance Screening Test (JEST) Examination from 2006 to till date. This test is a screening process jointly conducted by 22 institutions in the country for the enrolment of Ph.D. degree.

- *(f) Local Coordinator of KVPY written test examination for Bhubaneswar centre, 2007*:

- *(g) Appointed as a member of the Board of Studies in Physics, North Orissa University, Baripada and (ii) Utkal University, Bhubaneswar.*:

- (h) I am serving as a member in many internal committee of the Institute.

20. **PATENTS:**

- Nil

21. **AWARDS & HONOURS:**

- (i)Referee: Journal of Physics G: Nuclear and Particle Physics.
- (ii) Referee: Physical Review C.
- (iii) Referee: International Journal of Modern Physics E.
- (iv) Referee: PRAMANA: Journal of Physics.