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13-14 December, 2010

SAHA INSTITUTE OF NUCLEAR PHYSICS
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THEORY DIVISION

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De, Jadu Nath	Emeritus
Mallik, Samirnath	Emeritus
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Students

Dey, Parijat	Haque, Najmul	Chatterjee, Bhramar	Chakraborty, Sayan*
Kumar, Atanu	Sarkar, Anwesa	Chatterjee, Kalyanbrata*	Maity, Jyotirmoy*
Ghosh, Avirup	Majumdar, Arindam	Ray, Tirtha Sankar*	Muthukumar, B.*
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De Sarkar, Sangita	Mondal, Santanu	Chatterjee, Debarati*	Adhikari, Biswajit*
Chakrabarty, Somdeb	Byakti, Pritibhajan	Bandyopadhyay, Nilanjan*	
Chakraborty, Baishali	Chakraborty, Sovan	Kumar, M. C.*	

*Left after either submitting a thesis or finding a job

Equipments in the Division

The Theory Division currently has computational infrastructure at various levels – ranging from simple desktops to a modest level of supercomputing. All academic members of the Division, including the graduate students, post-doctoral associates and some of the non-academic members, are provided with desktop facilities. All faculty members in need are also given laptop facilities. It may be mentioned here that traditionally the Theory Division members have contributed immensely to the networking and computing infrastructure of the whole Institute.

The Division has considerable computational requirements and over the years has procured several systems for scientific computing. The ones that are still running and being used are listed below:

i. Compaq ES40 server comprising of 4 DEC alpha processors (in operation from 2001)
ii. IBM Power4 processor based machine comprising of 32 such processors (in operation from 2004)
iii. 2 numbers of Xeon servers (in operation from 2004-2005)
iv. Cray XD1 parallel cluster comprising of 120 single-core processors with a peak performance of about 500 Gflops (in operation from 2005-2006), sustained performance expected to be around 100 Gflops
v. IBM Blade server configured into a small parallel cluster comprising of 6 blades each having 2 dual-core processors (in operation from 2008, parallely configured in 2010)
vi. Cray XT5 2-cabinet configuration comprising of 172 compute nodes (a total of 1376 compute cores) with a peak performance of close to 14 Tflops (in operation from 2010). DDHMC lattice QCD codes produce a sustained performance of about 5 Tflops.

All the computers including the desktops are usually supported by UPS units of appropriate capacities. Appropriate air-conditioning and other civil and electrical infrastructure have been developed for the rooms where more powerful computers are housed.

The Division has adequate printing, scanning and photocopying facilities.

RESEARCH

Research in the theory division branches out in several aspects of theoretical physics. That created several subgroups within the division, which are, theoretical nuclear physics, high energy phenomenology, mathematical physics, quantum field theories and strings & gravity. Below we summarize the important results obatined during the plan period 2007-till date.

`a.Theoretical nuclear physics`:
The main focus of theoretical nuclear physics has been to study the properties of strongly interacting matter and phenomenology of heavy-ion collisions, structure of hybrid star with colour superconducting quark matter, bulk behaviour of finite nuclei and infinite nuclear matter, and dynamics of nuclei as many-body chaotic quantum systems and their application, and many interesting results have been obtained, which are briefly described below:
`i)` Properties of strongly interacting via elctromagnetic and hadronic probes: An unitary and gauge invariant theory has been formulated using an effective Lagrangian constrained by the quantum chromodynamics (QCD) within a coupled channels K-matrix approach to investigate the hadron structure by analyzing the interaction between nucleons and mesons where the hadronic interactions are described as the exchange of known mesons and baryons. This theory has been used successfully to provide a comprehensive description of all the available data on the photoproduction of the η and the K^+ meson off proton. A covariant theory has been developed to describe hypernuclear production with hadronic and electromagnetic probes. This is based on the effective Lagrangian picture and it focuses on production amplitudes that are described via excitation of the relevant baryonic resonance states. The mechanism of hypernuclear production via pion, kaon and photon induced reactions are well described by this theory. A formalism have been developed using the techniques of the effective Lagrangian method to investigate the dilepton production data in NN collisions by HADES Collaboration at GSI Dramstad. Using this method it has recently been shown that the puzzle regarding the non-description of the data by theories can be solved by including pion electromagnetic form factors.
`ii)` Heavy-ion phenomenology: The prime intention for ultra relativistic heavy-ion collisions is to study the behaviour of nuclear or hadronic matter at extreme conditions like very high temperatures and energy densities. A particular goal lies in the identification of a new state of matter formed in such collisions, the quark-gluon plasma (QGP). Various measurements taken in CERN-SPS and BNL-RHIC do lead to wealth of information for the formation of QGP through the hadronic final states. The various aspects, viz., energy-loss of energetic partons and its consequences on secondary hadron spectra and jet quenching, recombination aspect of hadronisation of QGP, fluidity aspect of QCD matter produced in RHIC, and various static and dynamic quantities through the correlation function description within perturbative and nonperturbative approach, have been investigated.
`iii)` Finite nuclei and infinite nuclear matter: Unified nuclear energy density functionals, which are simultaneously compatible with the observed properties for the finite nuclei to infinite symmetric and asymmetric nuclear matters, are obtained within the non-relativistic and relativistic mean field theories. It is shown that the unified energy density functional can be obtained within the relativistic mean field theory only if the contributions from the self-interactions and cross-interactions of σ, ω and ρ mesons up to the quartic order are included.
`iv)` Structure of hybrid stars: The static and rotating configurations of stable hybrid stars are constructed using a set of diverse equations of state for the nuclear matter and the colour superconducting quark matter. It is found that the stable hybrid stars with colour superconducting quark matter core can have masses $\sim 1.5M_{\rm solar}$ and they can rotate up to the frequencies $\sim$1kHz.
`v)` Nuclei as many-body chaotic quantum systems and their application: Nuclei at a few MeV of excitation show properties of many-body chaotic quantum systems. Spectral distribution methods are successful in describing the averaged structure of the nuclei in this domain and even going beyond, using a few input quantities and without doing any shell model diagonalisation. Recent applications including beta decay rates for stellar evolution and r-process nucleosynthesis have been carried out.

b.Mathematical physics:

The mathematical physics subgroup has found many interesting results in a wide range of subjects like classical and quantum integrable systems, quantum groups, various properties of graphene, entangled states of quantum systems, self-similar processes etc., which are described briefly in the following.

Anyon gas with competing δ and $\delta^{'}$-function potentials is proposed and exactly solved by using the Bethe ansatz. Novel quantum integrable 1D anyonic lattice and field models are constructed using braided Yang-Baxter equation, including NLS and derivative NLS anyon QFT models, discovering thus the missing link for the solvable anyon gases. Integrable sine-Gordon (SG) model with variable mass is proposed with unusual soliton solution and potential application. The SG model with integrable defect is studied at classical and quantum level, with possible scattering/creation/annihilation of soliton by the defect. A novel scheme for nonlinearizing linear equations to integrable systems is proposed, generating their Lax pair, the known systems as well as their new integrable hierarchies with nonholonomic deformation, exhibiting rich features with accelerating soliton and possible applications.

Using the underlying super Yangian quantum group symmetry, it is shown that the partition function of the $su(m|n)$ supersymmetric Haldane-Shastry (HS) spin chain satisfies a boson-fermion duality relation. It is found that the low energy excitations of the $su(m|1)$ HS spin chain are described by a conformal field theory with central charge $m/2$. Novel spectra for the D_N type of spin Calogero and spin Sutherland models are derived and exact partition functions of the corresponding spin chains are obtained by using the freezing trick. Inequivalent quantizations of some variants of the rational Calogero model are studied by imposing nontrivial boundary conditions through the method of self-adjoint extension.

The bound and scattering state spectra of both gapless and gapped graphene are analyzed in the presence of an external Coulomb charge impurity. When the Coulomb charge exceeds a certain critical value, bound states appear in these spectra. The corresponding RG flow has an UV stable fixed point at the value of the critical charge. For the subcritical case, for certain range of the system parameters, the combined effect of the short range interactions due to the charge impurity is modelled using a single real parameter appearing in the boundary conditions, given by the self-adjoint extension of the Dirac equation. This leads to a novel spectra of the low energy excitations near the Fermi points. The effect of turbulent flow to the electrical conductivity in graphene is analyzed and the method of self-adjoint extension is used to calculate electron scattering in polar molecules.

A class of entangled states of a quantum system and a second system, where pure states of the former are correlated with mixed states of the latter, are studied and the entanglement measure with reference to the nearest separable state is derived. It is shown numerically that such an entangled state drifts towards the nearest separable state through decoherence, with an additional tendency of equimixing among relevant groups of apparatus states. Fluctuations in capital markets, which seems to follow a self-similar process, are studied. Modelling of a hilly surface by using the surrogate data method of generating a self-similar process and a program to mark the coastline from the hilly surface are under construction.

c.High energy phenomenology:

i) *Phenomenology of Physics Beyond the Standard Model:*

Searches for physics beyond the Standard Model have been pursued mainly in two directions: (A) Phenomenology of R-parity violating supersymmetry - study of correlated enhancements in different meson mixing and decays, rare decays of tau lepton, muon anomalous magnetic moment, etc. (B) Phenomenology of extra dimensional theories - (i) contribution of the Kaluza-Klein (KK) excitation of Standard Model particles on the Higgs production via gluon fusion; (ii) relaxation of the lightest supersymmetric Higgs mass upper limit when supersymmetry is embedded in extra dimension; (iii) effects of KK thresholds on the running of soft supersymmetry breaking parameters.

ii) *Neutrino Physics and Supernova:*

The impact of the collective oscillations due to neutrino-neutrino interactions at the very high density region on the emitted flux of supernova neutrinos and their future detection was investigated in detail. The sensitive dependence of the emission rates on the relative fluxes in the different flavors for the neutrinos and antineutrinos was used to obtain constraints on the flux ratios for successful r-process nucleosynthesis in core collapse supernova. A study of Diffuse

Supernova Neutrino Background including the collective effects was carried out and the possibility of distinguishing the inverted neutrino mass hierarchy from the normal investigated.

iii) *Higher order QCD corrections to some BSM scenarios:*

In the recent past, various non-SUSY extensions beyond the Standard Model (BSM), *viz.* models of extra dimensions, unparticle physics etc. have been studied extensively, but was at the qualitative level— leading order in QCD. Searches of these BSM observable at the LHC demands high precision in the theoretical predictions. We have accomplished an important task of computing all the partonic contributions at next-to-leading order (NLO) level in QCD to various observable in some direct and indirect searches of extra dimension models. NLO QCD effects are large and they substantially reduce the theoretical uncertainties, thus providing an excellent opportunity to put stringent bounds on the parameters of the BSM model when the experimental results are available.

d. Quantum field theories:

Work has mainly progressed in the non-perturbative treatment and properties of theories in the areas below.

i) QFTs on the light front:

Hamiltonian light-front quantum field theory constitutes a framework for the non-perturbative solution of invariant masses and parton amplitudes of bound systems. By choosing the light-front gauge and adopting a basis function representation, we obtain a large, sparse, Hamiltonian matrix that is solvable by adapting the ab initio methods of nuclear many-body theory. We outline our approach and present illustrative features of some non-interacting systems in a cavity.

Theoretical analysis of Deeply Virtual Compton Scattering (DVCS) is particularly clear when one uses light front quantization. The Fourier transform of the amplitude is used to provide an image of the target hadron in the variable sigma which is an impact parameter in the longitudinal coordinate space. The Fourier transform exhibits diffraction patterns. The results are analogous to the diffractive scattering of a wave in optics.

ii) QFTs on lattice:

Shifting from the interesting topics of feasibility of a non-perturbative regularization of chiral gauge theories on lattice, non-perturbative gauge fixing, and lower dimensional field theories, in recent years the major activities shifted more towards numerical lattice QCD (LQCD), a main stream lattice gauge theory activity. Initial focus has been to probe the chiral regime of LQCD in terms of the behavior of the pion and rho masses and their decay constants, and the chiral condensate in dependence of the light quark masses. This is a non-trivial job keeping in mind that chiral symmetry has to be explicitly broken on the lattice by the Nielsen-Ninomiya theorem. A criterion for selection of scaling region needed for setting the lattice scale using the so-called Sommer parameter has been proposed and used to determine the lattice scale. The experimentally inaccessible tensor decay constant of the rho, important for B-meson decay studies, have been determined. Initially the simulations took place on small volumes and larger light quark masses because of limitations of hardware. Very recently larger volumes and smaller quark masses have been accessed because of installation of a more potent machine and usage of improved algorithms. On the analytic side, it has been shown explicitly that up to $o(g^2)$, parity violating terms cancel in the flavor-singlet axial Ward identity for LQCD with 'twisted mass' fermions even at finite volume and finite lattice spacing.

iii) CP-violation:

Using the zeta function regularization, the quark determinant in QCD was shown to be independent of the phase of the quark mass matrix.

This proof was then extended to include spacetime curvature.

iv) Finite temperature:

Based on the perturbative and non-perturbative approaches, various thermodynamic quantities (viz., pressure, entropy, number density, susceptibilities etc.) and dynamical quantities (correlation functions, dilepton rates etc.) for quark-gluon plasma believed to have produced in heavy-ion collisions are estimated. The results are in good agreement with lattice QCD results. In addition some aspects like huge gamma flush and 511keV line from QED plasma envisaged to be produced by ultra intense laser technology have been studied.

e. Strings and gravity:
The (intersecting) non-supersymmetric brane solutions (both single charge and two charge system) in low energy string theory have been constructed and among other things their relations to the closed string tachyon condensation have been studied. The origin of the geometric tachyon when one brane moves in the background of another has been understood and how some bound states of branes form as a result of geometric tachyon condensation were shown. The alpha-prime corrections to certain time-dependent solutions (S-branes) in heterotic string theory have been studied. Using AdS/CFT and some brane bound states the drag force on an external heavy quark moving in both relativistic and non-relativistic hot non-commutative Yang-Mills plasma has been calculated. Instability of black Dp-branes has been understood from their charge-temperature bound.

The multi-tachyon (assisted) slow-roll inflationary models, including inflation models with geometric tachyons of the NS5-D3 brane system have been studied. Certain aspects of Chern-Simons matter (ABJM) theories have been studied and new M2-brane solutions on a 'resolved' C_4/Z_4 has been obtained and also the Chern-Simons level flow has been studied. Interestingly a version of LBLG theory has been studied where a new way of looking at the BF models were provied. Some new Galilean solutions in massive type IIA string theory were constructed.

Holography and the AdS/CFT correspondence for the warped AdS_3 black hole has been analyzed using Sullivan's theorem. The dynamics of scalar fields in the background of BTZ and warped AdS_3 black holes have been studied. The universal features of the near-horizon CFT for a large class of black holes have been obtained. The quantum structure of space-time has been investigated within the framework of kappa-Minkowski noncommutative geometry. The star product, the twisted statistics and the deformed oscillator algebra for scalar fields on the kappa-Minkowski space-time have been analyzed and constraints on the noncommutativity parameter have been proposed from the GRB data. The noncommutative BTZ black hole has been studied.

Some issues in Hawking radiation in the framework of the quantum mechanics of a relativistic particle in black hole backgrounds have been clarified. Also the black hole entropy in loop quantum gravity has been studied, with the horizon area kept fixed at a definite value, unlike earlier investigations where the area was kept within a small interval. This explained a fine structure which had been observed numerically. Black hole thermodynamics has been studied through 'isolated horizons' in the 1st order formulation of gravity. Some issues regarding the phase space of extremal and non-extremal black holes have been clarified.

PUBLICATIONS

2007

1. Intersecting non-SUSY p-brane with chargeless 0-brane as black p-brane, Hua Bai, Jian-Xin Lu and Shibaji Roy, JHEP **01**, 094 (2007)

2. Boson-fermion dulaity in $SU(m|n)$ supersymmetric Haldane-Shastry spin chain, Bireswar Basu-Mallick, Nilanjan Bondyopadhaya, Kazuhiro Hikami and Diptiman Sen, Nucl. Phys. **B782**, 276 (2007)

3. Unraveling unparticles through violation of atomic parity and rare beauty, Gautam Bhattacharyya, Debajyoti Choudhury and Dilip K. Ghosh, Phys. Lett. **B655**, 261 (2007)

4. Power law scaling in Universal Extra Dimension scenarios, Gautam Bhattacharyya, Anindya Datta, Swarup K. Majee and Amitava Raychaudhuri, Nucl. Phys. **B760**, 117 (2007)

5. Hadron optics in three-dimensional invariant coordinate space from deeply virtual Compton scattering, S. J. Brodsky, D. Chakrabarti, A. Harindranath, A. Mukherjee and J. P. Vary, Phys. Rev. **D75**, 014003 (2007)

6. Energy gain of heavy quarks by fluctuations in the QGP chemical potentials, Purnendu Chakraborty, Munshi Golam Mustafa and Markus H. Thoma, Phys. Rev. **C75**, 064908 (2007)

7. Wakes in a collisional Quark-Gluon Plasma, Purnendu Chakraborty, Munshi Golam Mustafa, Rajarshi Roy and Markus H. Thoma, J. Phys. **G34**, 2141 (2007)

8. Noncommutative BTZ black hole and discrete time, B. Dolan, Kumar S. Gupta and A. Stern, Class. Quant. Grav. **24**, 1647 (2007)

9. Dipole binding in a cosmic string background due to quantum mechanics, Pulak Ranjan Giri, Phys. Rev. **A76**, 012114 (2007)

10. Quantum oscillator on complex projective space (Lobachewski space) in constant magnetic field and the issue of generic boundary conditions, Pulak Ranjan Giri, J. Phys. **A40**, 3539 (2007)

11. Asymptotic quasinormal modes of a noncommutative geometry inspired Schwarzschild black hole, Pulak Ranjan Giri, Int. J. Mod. Phys. **A22**, 2047 (2007)

12. Self-adjointness of generalized MIC-Kepler system, Pulak Ranjan Giri, Mod. Phys. Lett. **A22**, 2365 (2007)

13. Non-rotating and rotating neutron stars in the extended field theoretical model, Shashi K. Dhiman, Raj Kumar and B. K. Agrawal, Phys. Rev. **C76**, 045801 (2007)

14. Black holes, holography and moduli space metric, Kumar S. Gupta and Siddhartha Sen, Phys. Lett. **B646**, 265 (2007)

15. PDF and scale uncertainties of various DY distributions in ADD and RS model at hadron colliders, M. C. Kumar, Prakash Mathews and V. Ravindran, Eur. Phys. J. **C49**, 599 (2007)

16. Shape changing and accelerating solitons in integrable variable mass sine-Gordon model, Anjan Kundu, Phys. Rev. Lett. **99**, 154101 (2007)

17. Yang-Baxter algebra and generation of quantum integrable models, Anjan Kundu, Theor. Math. Phys. **151**, 831 (2007)

18. q-Boson in quantum integrable systems, Anjan Kundu, SIGMA **3**, 040 (2007)

19. On brane-antibrane forces, J. X. Lu, Bo Ning, Shibaji Roy and San-San Xu, JHEP **0708**, 042 (2007)

20. Non-SUSY p-branes, bubbles and tubular branes, Jian-Xin Lu and Shibaji Roy, Nucl. Phys. **B763**, 170 (2007)

21. Unparticle physics at hadron collider via dilepton production, Prakash Mathews and V. Ravindran, Phys. Lett. **B657**, 198 (2007)

22. Quantization and conformal properties of a generalized Calogero model, Stjepan Meljanac, Andjelo Samsarov, Bireswar Basu-Mallick and Kumar S. Gupta, Eur. Phys. Jour. **C49**, 875 (2007)

23. Hawking temperature from tunnelling formalism, Parthasarathi Mitra, Phys. Lett. **B648**, 240 (2007)

24. Complex fermion mass term, regularization and CP violation, Parthasarathi Mitra, J. Phys. **A40**, F525 (2007)

25. Thermodynamics of the PNJL model with nonzero baryon and isospin chemical potentials, Swagato Mukherjee, Munshi G. Mustafa and Rajarshi Roy, Phys. Rev. **D75**, 064908 (2007)

26. η-Meson production in nucleon-nucleon collisions within an effective Lagrangian model, R. Shyam, Phys. Rev. **C75**, 055201 (2007)

27. Assisted inflation from geometric tachyon, Kamal Panigrahi and Harvendra Singh, JHEP **0711**, 017 (2007)

28. Alpha-prime corrections to space-like branes, Shibaji Roy and Harvendra Singh, JHEP **0710**, 007 (2007)

29. 3-branes on Eguchi-Hanson 6D instantons, Harvendra Singh, General Relativity and Gravitation **39**, 839 (2007)

30. The N-tachyon assisted inflation, Harvendra Singh, Mod. Phys. Lett. **A22**, 2737 (2007)

31. Comment on "Can gravity distinguish between Dirac and Majorana neutrinos?" J. F. Nieves and P. B. Pal, Phys. Rev. Lett. **98**, 069001 (2007)

32. Quasinormal modes of tensor and vector type perturbation of Gauss Bonnet black hole using third order WKB approach, Sayan K. Chakrabarti, Gen. Rel. Grav. **39**, 567 (2007)

33. Density reorganisation in hot nuclei, S. K. Samaddar, J. N. De, X. Vinas and M. Centelles, Phys. Rev. **C75**, 054608 (2007)

34. Excitation energy dependence of symmetry energy of finite nuclei, S. K. Samaddar, J. N. De, X. Vinas and M. Centelles, Phys. Rev. **C76**, 041602(R) (2007)

35. Nuclear condensation and the equation of state of nuclear matter, J. N. De and S. K. Samaddar, Phys. Rev. **C76** (2007) 044607 (2007)

36. Pion propagation in real time field theory at finite temperature, Samirnath Mallik and S. Sarkar, Eur. Phys. J. **C49**, 755 (2007)

37. Nucleon propagation through nuclear matter in chiral effective field theory, Samirnath Mallik and H. Mishra, Eur. Phys. J. **C50**, 889 (2007)

38. Hard thermal effective actions in the Schwinger formulation, A. K. Das and J. Frenkel, Phys. Rev. **D 75**, 025021 (2007)

39. CPT/Lorentz invariance violation and neutrino oscillation, P. Arias, J. Gamboa, J. Lopez-Sarrion, F. Mendez and A. K. Das, Phys. Lett. **B 650**, 401 (2007)

40. The S-matrix of the Faddeev-Reshetikhin Model, Diagonalizability and PT Symmetry, A. K. Das, A. Melikyan and V. O. Rivelles, JHEP **09**, 104 (2007)

41. Thermal Operator and Dispersion Relation in QED at Finite Temperature and Chemical Potential, A. K. Das and J. Frenkel, Phys. Rev. **D 76**, 087701 (2007)

42. Hard thermal effective action in QCD through the thermal operator, A. K. Das and J. Frenkel, Phys. Rev. **D 76**, 025009 (2007)

2008

43. Correlations in the properties of static and rapidly rotating compact stars, B. K. Agrawal, Raj Kumar and S. K. Dhiman, Phys. Rev. **D77**, 087301 (2008)

44. Interacting quantum topologies and the quantum Hall effect, A. P. Balachandran, Kumar S. Gupta and Siddhartha Sen, Int. J. Mod. Phys. **A23**, 1327 (2008)

45. Coulomb dissociation of ^{9}Li and rate of the $^{8}Li(n,\gamma)^{9}Li$ reaction, Prabir Banerjee, Rajdeep Chatterjee and Radhey Shyam, Phys. Rev. **C78**, 035804 (2008)

46. D-anyons: one-dimensional anyons with competing δ-function and derivative δ-function potentials, M. T. Batchelor, X.-W. Guan and A. Kundu, J. Phys. **A41**, (FTC) 352002 (2008)

47. Low energy properties of the $SU(m|n)$ supersymmetric Haldane-Shastry spin chain, B. Basu-Mallick, Nilanjan Bandyopadhaya and Diptiman Sen, Nucl. Phys. **B795**, 596 (2008)

48. Ineuqivalent quantization of the rational Calegaro model with a Coulomb type interaction, B. Basu-Mallick, Kumar S. Gupta, S. Meljanac and A. Samsarov, Eur. Phys. J. **C58**, 159 (2008)

49. Universal Doublet-Singlet Higgs phenomenology at the LHC, Gautam Bhattacharyya, Gustavo C. Branco and Satya Nandi, Phys. Rev. **D77**, 117701 (2008)

50. **CP** violation and flavor mixings in orbifold GUTs, Gautam Bhattacharyya, Gustavo C. Branco and Joachim I. Silva-Marcos, Phys. Rev. **D77**, 011901(R) (2008)

51. Extra-dimensional relaxation of the upper limit of the lightest supersymmetric neutral Higgs mass, Gautam Bhattacharyya, Swarup K. Majee and Amitava Raychaudhuri, Nucl. Phys. **B793**, 114 (2008)

52. Radiative correction to the lightest neutral Higgs mass in warped supersymmetry, Gautam Bhattacharyya, Swarup K. Majee and Tirtha S. Ray, Phys. Rev. **D78**, 071701(R) (2008)

53. A simultaneous explanation of the large phase in $B_s - \bar{B}_s$ mixing and $B \to \pi\pi/\pi K$ puzzles in R-parity violating supersymmetry, Gautam Bhattacharyya, Kalyan B. Chatterjee and Soumitra Nandi, Phys. Rev. **D78**, 095005 (2008)

54. Universal near-horizon conformal structure and black hole entropy, Sayan K. Chakrabarti, Kumar S. Gupta and Siddhartha Sen, Int. J. Mod. Phys. **A23**, 2547 (2008)

55. Effect of collective flavor oscillation on the diffuse supernova background, Sovan Chakraborty, Sandhya Choubey, Basudeb Dasgupta and Kamales Kar, JCAP Phys. **0809**, 013 (2008)

56. Tunneling from black holes and tunneling into white holes, Bhramar Chatterjee, Amit Ghosh and Parthasarathi Mitra, Phys. Lett. **B661**, 307 (2008)

57. Origin of the geometric tachyon, A. Das, S. Panda and S. Roy, Phys. Rev. **D78**, 061901 (2008)

58. PNJL model with a Van der Monde term, Sanjay K. Ghosh, Tamal K. Mukherjee, Munshi Golam Mustafa and Rajarshi Ray, Phys. Rev. **D77**, 094024 (2008)

59. Noncommutative oscillator, symmetry and Landau problem, Pulak Ranjan Giri and P. Roy, Eur. J. Phys., **C57**, 835 (2008)

60. Localization at the threshold in noncommutative space, Pulak Ranjan Giri, Phys. Lett. **A372**, 5123 (2008)

61. Inequivalent quantization in the field of a ferromagnetic wire, Pulak Ranjan Giri, Int. J. Theor. Phys. **47**, 2583 (2008)

62. Lower bound of minimal time evolution in quantum mechaincs, Pulak Ranjan Giri, Int. J. Theor. Phys. **47**, 2095 (2008)

63. Pulak Ranjan Giri, Scaling anomaly in cosmic string background, Pulak Ranjan Giri, Eur. J. Phys. **C56**, 147 (2008)

64. Electron capture and scaling anomaly in polar molecules, Pulak Ranjan Giri, Kumar S. Gupta, S. Meljanac and A. Samsarov, Phys. Lett. **A372**, 2970 (2008)

65. Supersymmetric quantum mechanical generalized MIC-Kepler system, Pulak Ranjan Giri, Mod. Phys. Lett. **A23**, 895 (2008)

66. Twisted statistics in κ-Minkowski spacetime, T. R. Govindarajan, Kumar S. Gupta, E. Harikumar, S. Meljanac and D. Meljanac, Phys. Rev. **D77**, 105010 (2008)

67. Bound states in gapped graphene with impurities: effective low-energy description of short-range interactions, Kumar S. Gupta and Siddhartha Sen, Phys. Rev. **B78**, 205429 (2008)

68. Quantum and classical integrable sine-Gordon model with defect, I. Habibullin and Anjan Kundu, Nucl. Phys. **[FS]795**, 549 (2008)

69. Unparticle physics in diphoton production at the CERN LHC, M. C. Kumar, Prakash Mathews, V. Ravindran and Anurag Tripathi, Phys. Rev. **D77**, 055013 (2008)

70. Changing solitons in classical & quantum integrable defect and variable mass sine-Gordon model, Anjan Kundu, J. Nonlin. Math. Phys. **15**, 227 (2008)

71. Exact accelerating soliton in nonholonomic deformation of the KdV equation with two-fold integrable hierarchy, Anjan Kundu, J. Phys. **A41**, 495201 (2008)

72. Kappa-Minkowski spacetime and their star product realizations, S. Meljanac, A. Samsarov, M. Stojic and Kumar S. Gupta, Eur. Phys. J. **C53**, 295 (2008)

73. Lorentz-symmetry violating decays in a medium, Jose F. Nieves and Palash B. Pal, Phys. Rev. **D77**, 113001 (2008)

74. Spinflation from geometric tachyon, K. L. Panigrahi and H. Singh, JHEP **0805**, 088 (2008)

75. Radiative and collisional jet energy loss in the quark-gluon plasma at RHIC, Guang-You Qin, Jorg Ruppert, Charles Gale, Sangyong Jeon, Guy D. Moore and Munshi G. Mustafa, Phys. Rev. Lett. **100**, 072301 (2008)

76. Hypernuclear production by (γ, K^+) reaction within a relativistic model, R. Shyam, H. Lenske and U. Mosel, Phys. Rev. **C77**, 052201(R) (2008)

77. Production of hypernuclei with hadronic and electromagnetic probes, R. Shyam, Prog. Part. Nucl. Phys. **61**, 212 (2008)

78. Photoproduction of η meson within a coupled channels K-matrix approach, R. Shyam and O. Scholten, Phys. Rev. **C78**, 065201 (2008)

79. M2-branes on a resolved C_4/Z_4, H. Singh, JHEP **0809**, 071 (2008)

80. S-matrix approach to equation of state of nuclear matter, S. Mallik, J. N. De, S. K. Samaddar and S. Sarkar, Phys. Rev. **C77**, 032201(R) (2008)

81. Density dependence of symmetry free energy of hot nuclei, S. K. Samaddar, J. N. De, X. Vinas, and M. Centelles, Phys. Rev. **C78**, 034607 (2008)

82. Nuclear condensation and symmetry energy of dilute nuclear matter, An S-matrix approach, J. N. De and S. K. Samaddar, Phys. Rev. **C78**, 065204 (2008)

83. CPT and lepton number violation in neutrino sector: Modified mass matrix of neutrino coupled to gravity, Monika Sinha and B. Mukhopadhyay, Phys. Rev. **D77**, 025003 (2008)

84. Bound for entropy and viscosity ratio for strange quark matter, M. Bagchi, J. Dey, M, Dey, T. Gangopadhyay, S. Laha, S. Ray and Monika Sinha, Phys. Lett. **B666**, 145 (2008)

85. A simple and direct method for generating travelling wave solutions for nonlinear integrable equations, D. Bazeia, A. K. Das, L. Losano and A. Silva, Ann. Phys. **323**, 1150 (2008)

86. Thermal instability in a gravity-like scalar theory, F. T. Brandt, A. Das and J. Frenkel, Phys. Rev. **D 78**, 065030 (2008)

2009

87. Colour-singlet clustering of partons and recombination model for hadronization of quark-gluon plasma, Raktim Abir and Munshi G. Mustafa, Phys. Rev. **C80**, 051903 (2009)

88. Di-jet production at the LHC through unparticles, Neelima Agarwal, M. C. Kumar, Prakash Mathews, V. Ravindran and Anurag Tripathi, Phys. Rev. **D80**, 035015 (2009)

89. Stable configurations of hybrid stars with color-flavour-locked core, B. K. Agrawal and S. K. Dhiman, Phys. Rev. **D79**, 103006 (2009)

90. Exactly solvable D_N-type quantum spin models with long-range interaction, Bireswar Basu-Mallick, Federico Finkel and Artemio Gonzalez-Lopez, Nucl. Phys. **B812**, 402 (2009)

91. Spectral properties of supersymmetric Polychronakos spin chain associated with A_{N-1} root system, Bireswar Basu-Mallick and Nilanjan Bandyopadhaya, Phys. Lett. **A373**, 2831 (2009)

92. Probing warped extra dimension via $gg \to h$ and $h \to \gamma\gamma$ at LHC, Gautam Bhattacharyya and T.S. Ray, Phys. Lett. **B675**, 222 (2009)

93. Exploring the universal extra dimension at the LHC, Gautam Bhattacharyya, Anindya Datta, Swarup K. Majee and Amitava Raychaudhuri, Nucl. Phys. **B821**, 48 (2009)

94. Normal mode analysis for scalar fields in BTZ black hole background, Sayan K. Chakrabarti, Pulak Ranjan Giri and Kumar S. Gupta, Eur. Phys. Jour. **C60**, 169 (2009)

95. Scalar field dynamics in warped AdS_3 black hole background, Sayan K. Chakrabarti, Pulak Ranjan Giri and Kumar S. Gupta, Phys. Lett. **B680**, 500 (2009)

96. Laws of black hole mechanics from Holst action, Ayan Chatterjee and Amit Ghosh, Phys. Rev. **D80**, 064036 (2009)

97. Hawking temperature and higher order calculations, B. Chatterjee and P. Mitra, Phys. Lett. **B675**, 240 (2009)

98. Proper acceleration, geometric tachyon and dynamics of a fundamental string near Dp branes, A. Das, S. Panda and S. Roy, Class. Quant. Grav. **26**, 055004 (2009)

99. Chiral anomaly in lattice QCD with twisted mass Wilson fermion, Asit K. De, A. Harindranath and Santanu Mondal, Phys. Lett. **B682**, 150 (2009)

100. Fine-grained state counting for black holes in loop quantum gravity, A. Ghosh and P. Mitra, Phys. Rev. Lett. **102**, 141302 (2009)

101. Non-Hermitian quantum mechanics in non-commutative space, Pulak Ranjan Giri and P. Roy, Eur. Phys. Jour. **C60**, 157 (2009)

102. Deformed oscillator algebras and QFT in κ-Minkowski spacetime, T. R. Govindarajan, Kumar S. Gupta, E. Harikumar, S. Meljanac and D. Meljanac, Phys. Rev. **D80**, 025014 (2009)

103. Bound states in graphene, Kumar S. Gupta and Siddhartha Sen, Mod. Phys. Lett. **A24**, 99 (2009)

104. Direct photon pair production at the LHC to $\mathcal{O}(\alpha_s)$ in TeV scale gravity models, M.C. Kumar, Prakash Mathews, V. Ravindran and Anurag Tripathi, Nucl. Phys. **B818**, 28 (2009)

105. Diphoton signals in theories with large extra dimensions to NLO QCD at hadron colliders, M.C. Kumar, Prakash Mathews, V. Ravindran and Anurag Tripathi, Phys. Lett. **B672**, 45 (2009)

106. Unparticles in diphoton production to NLO in QCD at the LHC, M.C. Kumar, Prakash Mathews, V. Ravindran and Anurag Tripathi, Phys. Rev. **D79**, 075012 (2009)

107. Nonlinearizing linear equations to integrable systems including new hierarchies of nonholonomic deformations, Anjan Kundu, J. Math. Phys. **50** 102702 (2009)

108. Nonholonomic deformation of KdV and mKdV equations and their symmetries, hierarchies and integrability, Anjan Kundu, R. Sahadevan and L. Nalinidevi, Jour. Phys. **A42**, 115213 (2009)

109. Integrable nonautonomous NLS equations are equivalent to the standard NLS, Anjan Kundu, Phys. Rev. **E79**, 015601(R) (2009)

110. Mixing and decoherence in nearest separable states, A. Lahiri, G. Ghosh and S. Nag, Int. J. Quant. Information **7**, 829 (2009)

111. Intersecting non-SUSY branes and closed string tachyon condensation, J. X. Lu, S. Roy, Z. L. Wang and R. J. Wu, Nucl. Phys. **B813**, 259 (2009)

112. Non-supersymmetric D1/D5, F/NS5 and closed string tachyon condensation, J. X. Lu, S. Roy, Z. L. Wang and R. J. Wu, Nucl. Phys. **B819**, 282 (2009)

113. Time-reversal and parity conservation for gravitating quarks, P. Mitra, Class. Quant. Grav. **26**, 075024 (2009)

114. Gamma flashes from relativistic electron-positron plasma droplets, Munshi G. Mustafa and B. Kampfer, Phys. Rev. **A79**, (2009)

115. Holography and drag force in thermal plasma on non-commutative Yang-Mills theories in diverse dimensions, S. Roy, Phys. Lett. **B682**, 93 (2009)

116. Open and hidden strangeness production in nucleon-nucleon collisions, R. Shyam, Int. J. Mod. Phys. **E18**, 1359 (2009)

117. Dilepton production in nucleus-nucleon collisions reexamined, R. Shyam and U. Mosel, Phys. Rev. **C79**, 035203 (2009)

118. Photoproduction of hypernuclei within the quark-meson coupling model, R. Shyam, K. Tsushima and A. W. Thomas, Phys. Lett. **B676**, 51 (2009)

119. A comparative study of Dirac quasinormal modes of charged black holes in higher dimensions, Sayan K. Chakrabarti, Eur. Phys. J. **C61**, 477 (2009)

120. Galilean anti-de-Sitter spacetime in Romans theory, H. Singh, Phys. Lett. **B682**, 225 (2009)

121. More on the scalar-tensor B-F theory, H. Singh, Phys. Rev. **D80**, 066009 (2009)

122. M2-brane Flows and the Chern-Simons Level, C. Krishnan, C. Maccaferri and H. Singh, JHEP **0905**, 114 (2009).

123. SU(N) membrane $B \wedge F$ theory with dual-pairs, H. Singh, Phys. Lett. **B673**, 68 (2009)

124. Scattering effects on nuclear thermodynamic observables, S. K. Samaddar and J. N. De, Phys Rev. **C79**, 051602(R) (2009)

125. Symmetry coefficients and incompressibility of clusterized supernova matter, S. K. Samaddar, J. N. De, X. Vinas and M. Centelles, Phys. Rev. **C80**, 035803 (2009)

126. Real time propagators at finite temperature and chemical potential, Samirnath Mallik and S. Sarkar, Eur. Phys. J. **C61**, 489 (2009)

127. Spectral representation and QCD sum rules in hot nuclear matter, Samirnath Mallik and S. Sarkar, Indian J. Phys. **83(5)**, 629 (2009)

128. The structure of supersymmetry in $\mathcal{PT}$ symmetric quantum mechanics, D. Bazeia, A. Das, L. Greenwood and L. Losano, Phys. Lett. **B 673**, 283 (2009)

129. Non-commutative Supersymmetric Quantum Mechanics, A. Das, H. Falomir, J.Gamboa and F. Mendez, Phys. Lett. **B 670**, 407 (2009)

130. Effective actions at finite temperature, A. Das and J. Frenkel Phys. Rev. **D 80**, 125039 (2009)

131. Finite Temperature Effective Actions, A. Das and J. Frenkel, Phys. Lett. **B 680**, 195 (2009)

132. An alternative construction of the positive inner product in non-Hermitian quantum mechanics, A. Das and L. Greenwood, Phys. Lett. **B 678** (2009) 504

2010

133. Asymmetric nuclear matter and neutron-skin in extended relativistic mean field model, B. K. Agrawal Phys. Rev **C81**, 034323 (2010)

134. Equation of state and stability of color-superconducting quark matter in hybrid stars, B. K. Agrawal, Phys. Rev. **D81**, 023009 (2010)

135. Fermionic dual of one-dimensional bosonic particles with derivative delta function potential, Bireswar Basu-Mallick and Tanaya Bhattacharyya, Mod. Phys. Lett. **A25**, 727 (2010)

136. The spin Sutherland model of D_N type and its associated spin chain, B. Basu-Mallick, F. Finkel and A. Gonzalez-Lopez, Nucl. Phys. **B** (To appear)

137. A relativistic description of the $A(\pi^+, K^+)_\Lambda A$ reaction, S. Bender, R. Shyam and H. Lenske, Nucl. Phys. **A839**, 51 (2010)

138. A phenomenological study of 5d supersymmetry, Gautam Bhattacharyya and Tirtha S. Ray, JHEP **05**, 040 (2010)

139. A reappraisal of spontaneous R-parity violation, Gautam Bhattacharyya and Palash B. Pal, Phys. Rev. **D82**, 055013 (2010)

140. Correlated enhancements in $D_s \to \ell\nu$, $(g-2)$ of muon and lepton flavor violating τ decays with two R-parity violating couplings, Gautam Bhattacharyya, Kalyan B. Chatterjee and Soumitra Nandi, Nucl. Phys. **B831**, 344 (2010)

141. Constraints on the quantum gravity scale from κ-Minkowski spacetime, A. Borowiec, Kumar S. Gupta, S. Meljanac and A. Pachol, Europhys. Lett. (To appear)

142. Collective flavor oscillations of supernova neutrinos and r-process nucleosynthesis, Sovan Chakraborty, Sandhya Choubey, Srubabati Goswami and Kamales Kar, JCAP **1006**, 007 (2010)

143. Anatomy of the symmetry energy of dilute nuclear matter, J. N. De. S. K. Samaddar and B. K. Agrawal, Phys. Rev. **C82**, 045201 (2010)

144. Properties of static limit and rotating equilibrium sequences of compact stars: systematic correlations and constraints, S. K. Dhiman, G. Mahajan and B. K. Agrawal, Nucl. Phys. **A836**, 183 (2010)

145. Many-body quantum chaos: recent developments and applications to nuclei, J. M. G. Gomez, K. Kar, V. K. B. Kota, R. A. Molina, A. Relano and J. Retamosa, Phys. Rep. (To appear)

146. The central charge of the warped AdS_3 black hole, Kumar S. Gupta, E. Harikumar, Siddhartha Sen and M. Sivakumar, Mod. Phys. Lett. **A25**, 2065 (2010),

147. Geometric finiteness, holography and quasinormal modes for the warped AdS_3 black hole, Kumar S. Gupta, E. Harikumar, Siddhartha Sen and M. Sivakumar, Class. Quant. Grav. **27**, 165012 (2010)

148. Turbulent flow in Graphene, Kumar S. Gupta and Siddhartha Sen, Europhys. Lett. **90**, 340003 (2010)

149. Scattering in Graphene with impurities: a low energy effective theory, Kumar S. Gupta, A. Samsarov and Siddhartha Sen, Eur. Phys. J. **B73**, 389 (2010)

150. Quark number susceptibility in hard thermal loop pertubation theory, Najmul Haque and Munshi G. Mustafa, Phys. Rev. **D** (To appear)

151. Quantum integrable 1D anyon models: construction through braided Yang-Baxter equation, Anjan Kundu, SIGMA **6**, 080 (2010)

152. Two-fold integrable hierarchy of nonholonomic deformation of the DNLS and the Lenells-Fokas equation, Anjan Kundu, J. Math. Phys. **51**, 022901 (2010)

153. Remarks on the instability of black Dp-branes, J. X. Lu and Shibaji Roy, Phys. Lett. **B686**, 254 (2010)

154. Drag force in a hot non-relativistic, non-commutative Yang-Mills plasma, Kamal L. Panigrahi and Shibaji Roy, JHEP **1004**, 003 (2010)

155. Dilepton production in nucleon-nucleon collisions around 1 GeV/nucleon: A theoretical update, R. Shyam, Pramana J. Phys. **75**, 185 (2010)

156. Dilepton production in proton-proton and quasi-free proton-neutron reactions at 1.25 GeV, R. Shyam and U. Mosel, Phys. Rev. (rapid communications) (To appear)

157. The associated photoproduction of K^+ meson off proton within a coupled-channels K-matrix approach, R. Shyam, O. Scholten and H. Lenske, Phys. Rev. **C81**, 015204 (2010)

158. Hamiltonian light-front field theory in a basis function approach, J. P. Vary, H. Homkanen, Jun Li, P. Maris, S. J. Brodsky, A. Harindranath, G. F. de Teramond, P. Sternberg, E. G. Ng and C. Yang, Phys. Rev. **C81**, 035205 (2010)

159. Relativistic expansion of electron-positron-photon plasma droplets and photon emission, R. Yaresko, Munshi G. Mustafa and B. Kampfer, Physics of Plasmas 17, 103302 (2010)

160. Examining the efficacy of isotope thermometry in the S-matrix approach, S. K. Samaddar and J. N. De, Phys. Rev. **C81**, 041601(R) (2010)

161. QCD sum rule for nucleon in nuclear matter, Samirnath Mallik and S. Sarkar, Eur. Phys. J. **C65**, 247 (2010)

162. Relativistic spectral function of nucleon in hot nuclear matter, Samirnath Mallik, S. Ghosh and S. Sarkar, Phys. Rev. **C82**, 045202 (2010)

163. Analytic structure of ρ meson propagator at finite temperature, Samirnath Mallik, S. Ghosh and S. Sarkar, Eur. Phys. J. **C**, (2010) (To appear)

164. HERWIRI1.0: MC realization of IR-improved DGLAP-CS parton showers, S. Joseph, Swapan Majhi, B. F. L. Ward and S. A. Yost, Phys. Lett. **B685**, 283 (2010)

165. New approach to parton shower MC's for precision QCD theory: HERWIRI 1.0(31), S. Joseph, Swapan Majhi, B. F. L. Ward and S. A. Yost, Phys. Rev. **D81**, 076008 (2010)

166. Traveling wave solutions of nonlinear partial differential equations, D. Bazeia, A. Das, L. Losano and M. J. d. Santos, Appl. Math. Lett. **23**, 681 (2010)

INDIVIDUAL PROFILES OF FACULTY MEMBERS

BRIEF CV

1. NAME: KAMALES KAR

2. ACADEMIC PROFILE:

Ph.D. - University of Rochester, USA, 1979
Thesis title: A statistical method for the study of beta decay giant resonances (Supervisor: J.B. French)
M.Sc. - University of Delhi, India, 1973
B.Sc. - University of Calcutta, India, 1971
Graduate Teaching and Research Assistant, University of Rochester, USA, 1973-79
Post-Doctoral Fellow, University of Toronto, Canada, 1979-80
Visiting Scientist, Physical Research Laboratory, Ahmedabad, 1981-1983
Lecturer C (1983-86), **Reader D** (1986-89), **Associate Professor E** (1989-94), **Professor F** (1994-2000), **Professor G** (2000-2004), **Senior Professor H** (Feb. 1, 2004 to date).

2010 SINP Foundation Day Prize for High Impact Publication in 2008

3. ESSENTIAL STRENGTH OF RESEARCH OUTPUT:

My contribution in research started in the area of nuclear structure physics, in particular using models based on group theory and to describe the structure in a statistical framework using concepts of random matrix theory. Some elegant formalism was developed and its application to describe the observed properties of nuclei in comparison with other models. Later in my career I moved to the area of nuclear astrophysics, in particular to the theory of core collapse supernova explosions. Different physics aspects during the collapse were studied and one of the early calculations of the delayed neutrino heating mechanism were done by us. Another important area was the weak interaction rates during the presupernova and the early stages of collapse. A method to calculate the beta decay rates based on spectral distribution method was proposed by us. Even after the dedicated large shell model results carried out in the last decade our method is still referred. Then I moved into the area of neutrino physics and different aspects of the solar neutrino problem. One of the early analysis of Sudbury Neutrino Obervatory charged current results was performed by our group at SINP and the work received high citation. My interest in the study of nuclei continued, particularly a study of quantum chaos in nuclei and its consequences in observed nuclear properties. On the other hand the very interesting physics of neutrinos interacting with matter in the high density of supernovae and the neutrino-neutrino interaction itself modifying the emitted neutrino number also happens to be my present research interest. I give below brief statements of the physics issues of some of these areas:

A. COLLECTIVE FLAVOR OSCILLATION AND SUPERNOVA NEUTRINOS:

Collective flavor neutrino oscillations driven by neutrino-neutrino interactions inside core collapse supernova are found to substantially change the resultant neutrino fluxes. These oscillations depend on the initial energy spectra, relative luminosities of neutrinos of different flavors. It has been found that departure from energy equipartition among different flavors can give rise to one or more sharp spectral swaps over energy termed as splits. We study the occurence of splits in the neutrino and antineutrino spectra varying the initial relative fluxes for different models of initial energy spectrum in both normal and inverted hierarchy. We also explore the effect of the spectral splits on the electron fraction, Y_e, that governs r-process nucleosynthesis inside supernovae and find exclusion plots for the luminosities. The collective oscilation in turn significantly affect the diffuse supernova neutrino background (DSNB), created by all core-collapse supernovae that have exploded in the past. We find the event rate of DSNB in currently running and planned large-scale detectors meant for observing both e-neutrino and anti-e-neutrino and probe the potential of their future detection.

B. NUCLEAR STATISTICAL SPECTROSCOPY AND QUANTUM CHAOS

Nuclei excited by a few MeV behave as many body quantum chaotic systems. In that energy domain predictions based on Random Matrix Theory apply for the different fluctuation measures involving the energies and wavefunctions. But one can define random matrix ensembles to describe the averaged properties of nuclei as well like the smoothed density of states, sum rule strengths and strength distributions for nuclear transition operators. I contributed in showing that such descriptions indeed work through comparison with many large shell model calculations and then used ’spectral distribution methods’ to calculate these quantities globally for many nuclei. Our studies also found measures for which real nuclei agree with the ’Embedded’ Gaussian Orthogonal Ensemble (EGOE) predictions and not the GOE ones.

C. BETA DECAY RATES FOR ASTROPHYSICS

The beta decays of neutron rich nuclei play a crucial role in different astrophysical scenarios. We constructed a model for calculating the rates for supernova and stellar evolution. As little information is known about the structure of the very neutron rich nuclei, model calculations are required to predict their properties. Such a model based on statistical spectroscopy is used to calculate the beta decay rates and halflives and is being extended to nuclei near the drip line. The need for such calculations is felt by astro-nuclear physicists for throwing light on the r-process path particularly near the waiting point nuclei.

D. NEUTRINO OSCILLATION AND THE SOLAR NEUTRINO PROBLEM

A global analysis of the deficit of the detected solar neutrinos compared to Standard Solar Model predictions for different detectors using the phenomenology of neutrino oscillations was carried out. In particular a 2-flavor and a 3-flavor analyses of the first results of the Sudbury Neutrino Observatory (SNO) done at SINP disfavored the small mixing angle solution.

E. EVOLUTION OF TYPE II SUPERNOVAE

Study of the evolution of type II supernovae starting with a one-zone collapse calculation and checking the effects of new physics inputs were done over the years. A model calculation was done to find the possibility of pre-heating of the supernova shock in a self-consistent framework.

4. FUTURE RESEARCH PLAN

My research plans for the near future are: i) a realistic three flavor study of collective supernova neutrino oscillation and extracting neutrino properties from predicted future supernova neutrino detection ii) a spectral distribution study of the structure of very neutron-rich nuclei as well as double beta transitions. Also a better understanding of the onset of chaos in nuclei will be attempted.

5. LIST OF IMPORTANT PUBLICATIONS:

1. 'Quantum many-body chaos: Recent developments and applications to nuclei', J.M.G. Gomez, K. Kar, V.K.B. Kota, R.A. Molina, A. Relano and J. Retamosa, *Physics Reports* (to appear)
2. 'Collective flavor oscillations of supernova neutrinos and r-process nucleosynthesis', Sovan Chakraborty, Sandhya Choubey, Srubabati Goswami and Kamales Kar, *J. of Cosmology and Astropart. Phys.* **06** 007 (2010)
3. 'Effect of collective flavor oscillations on the diffuse supernova background', Sovan Chakraborty, Sandhya Choubey, Basudeb Dasgupta and Kamales Kar, *J. of Cosmology and Astropart. Phys.* **0809** 013 (2008)
4. 'Upper limit on the cosmic gamma-Ray burst rate from high energy diffuse neutrino background', Pijushpani Bhattacharjee, Sovan Chakraborty, Srirupa Das Gupta and Kamales Kar *Phys. Rev.* **D 77** 043008 (2008)
5. 'Group symmetries in two-body random matrix ensembles generating order out of chaos', V.K.B. Kota and K. Kar, *Phys. Rev.* **E** (2002)
6. 'Three generation neutrino oscillation parameters after SNO', Abhijit Badyopadhyay, Sandhya Choubey, Srubabati Goswami and Kamales Kar, *Phys. Rev.* **D 65**:073031 (2002)
7. 'Impact of the first SNO results on neutrino mass and mixing', Abhijit Bandyopahyay, Sandhya Choubey, Srubabati Goswami and Kamales Kar, *Phys. Lett.* B 519 83 (2001)
8. 'Transition strengths and quantum chaos in large shell model spaces', J.M.G. Gomez, K. Kar, V.K.V. Kota, J. Retamosa and R. Sahu, *Phys. Rev.* **C 64** 034305 (2001)
9. 'How degenarate can cosmological neutrinos be ?', Palash B. Pal and Kamales Kar, *Phys. Lett.* **B451** 136 (1999)
10. 'Effect of flavour oscillations on the detection of supernova neutrinos', Sandhya Choubey, Debasish Majumdar and Kamales Kar, *Journal of Physics* **G25** 1001 (1999)
11. 'Accelerator, reactor and atmospheric neutrino data: a three flavour oscillation analysis', Srubabati Goswami, Kamales Kar and Amitava Raychaudhuri, *Int. J. Mod. Phys.* **A12** 781 (1997)
12. 'Gamow-Teller strengths in fp shell', S.Sarkar and K.Kar, *Phys. Lett.* **B387** 227 (1996)
13. 'Beta decay rates of fp shell nuclei with A > 60 in massive stars at the presupernova stage ', K.Kar, A.Ray and S.Sarkar, *Astrophys. Jour.* 434 662 (1994)
14. 'Preheating of unshocked material by electron-neutrino burst in core-bounce supernovae ', A.Ray and K.Kar, *Phys. Rev. Lett* **63** 2435 (1989)
15. 'Late time neutrino heating and energetics of stalled shocks in Type II supernovae ', A.Ray and K.Kar, *Astrophys. Jour.* **319** 143 (1987)
16. 'The Gamow-Teller decay strength in Wigner supermultiplet scheme ', Kamales Kar, *Phys. Rev.* **C28** 2446 (1983)
17. 'A statistical method for the study of beta decay giant resonances ', Kamales Kar, *Nucl. Phys.* **A368** 285 (1981)

"“Two page write up”

1. Gautam Ghosh, Ph.D. (1978) University of Calcutta

2. Predoctoral Fellow Saha Institute of Nuclear physics 1972-78, Teacher in a undergraduate college 1978-79, Postdoctoral Fellow University of Munich 1980-81, Institute Laue Langevin, Grenoble 1981-82, CSIR Pool Officer Saha Institute 1983. Joined this Institute as lecturer in 1983. Awarded Alexander von Humboldt Fellowship in 1980.

3. Areas of research in the past. Coherent state formalism: Applications to nuclear and plasma physics, Dissipative effects in nuclei: Giant resonance energies and widths, Semiclassical calculation of level densities, Approximation methods in optical scattering, Geometric phase in quantum mechanics, Quantum Chaos and Decoherence in bipartite systems.

Below I provide a report on the last two items which were the subject of my research for the last ten years.

Dynamical aspects of quantum chaos:

i. Whenever a kicked rotor is coupled to some external heat bath the diffusive nature of the dynamics is restored in the quantum evolution also, though it is suppressed in the quantum evolution of the isolated kicked rotor. The log-linear growth of the classical entropy is governed by the Lyapunov exponent of the isolated kicked rotor. For sufficiently strong coupling to the heat bath the quantum von Neumann entropy follows the same growth law even for kick strengths far below the critical kick strength when the last of the KAM tori breaks.

ii. The study of the RDM associated with some subsystem within a chosen system illustrates that the time evolution of the RDM bahaves differently depending upon whether the system itself is chaotic or regular. The time evolution of the von Neumann entropy or the linear entropy calculated from the RDM is pseudo-random in nature in the former case while it is quasi-periodic in the latter.

Mixing and decoherence to nearest separable states in Quantum Measurements. We consider a class of entangled states of a quantum system (S) and a second system (A) where pure states of the former are correlated with mixed states of the latter and work out the entanglement measure with reference to the nearest separable state. Such 'pure-mixed' entanglement is expected when the system S interacts with a macroscopic measuring apparatus in a quantum measurement, where the quantum correlation is destroyed in the process of environment induced decoherence whereafter only the classical correlation between S and A remains, the latter being large compared to the former. We present numerical evidence that the entangled S-A state drifts towards the nearest separable state through decoherence, with an additional tendency of equimixing among relevant groups of apparatus states.

4. I have one and a half years of service left. In this period I would like to see whether quantum chaos can throw some light on the measurement problem. Just as classical chaos explains irreversibility even in low dimensional systems by introducing exponential divergence of trajectories in a similar way quantum chaos by introducing fluctuations in the density matrix may effect the complete erasure of information in the off diagonal elements. There will thus be a perfect decoherence and not one arising from technological incompetence.

5. List of important Publications starting from the recent ones

[1] Mixing and decoherence to nearest separable states in quantum measurements, A. Lahiri, G. Ghosh and S. Nag (2008), ArXiv : 0807.0541 (2008); International Journal of Quantum Information, 7 (2009) 829.

[2] Quantum chaos: Reduced density matrix fluctuations in coupled systems, S. Nag, A. Lahiri and G. Ghosh, Physica D 204 (2005) 110.

[3] Entropy production due to coupling to a heat bath in the kicked rotor problem, S. Nag, A. Lahiri and G. Ghosh, Phys. Lett. A 292 (2001) 43.

[4] Generalized annihilation operator coherent states, G. Ghosh, J. Math. Phys. 39 (1998) 1366.

[5] Action-angle variables in quantum mechanics, A. Lahiri, G. Ghosh and T. K. Kar, Phys. Lett. A 238 (1998) 239.

[6] A factorization property of the Berry phase, B. Dutta-Roy and G. Ghosh, J. Phys. A 26 (1993) 1875.

[7] The Berry phase and the Hannay angle, G. Ghosh and B. Dutta-Roy, Phys. Rev. D37 (1988) 1709.

[8] Classical limit of the Hydrogen atom, D. Bhaumik, B. Dutta-Roy and G. Ghosh, J. Phys. A19 (1986) 1355.

[9] Semiclassical calculation of one particle-one hole and two particle-two hole level densities, G. Ghosh, R. W. Hasse, P. Schuck and J. Winter, Phys. Rev. Lett. 50 (1983) 1250.

[10] The coherent state approach to the Vlasov equation, G. Ghosh, B. Dutta-Roy and D. Bhaumik, Plasma Physics 19 (1977) 1051.

Kolkata, 25.06.2010

Career Profile of A. Harindranath

Theory Division, Saha Institute of Nuclear Physics, Kolkata, India.

Ph. D. : 1985, City University of New York (U.S.A.). Subject: Theoretical Nuclear Physics.
Position held & date of joining SINP (in a permanent position): Associate Professor (E), joined on June 1, 1994. Present position: Professor (H).

Academic positions (Post Doctoral/Teaching etc.) prior to joining SINP in permanent position:

Sl. No.	Position Held	Univ./Inst.	Period	
			From	To
1.	Postdoctoral Research Associate	Iowa State University	1985	1986
2.	Visiting Associate	California Institute of Technology	1986	1987
3.	Visiting Associate	Ohio State University	1987	1988
4.	Postdoctoral Research Associate	Ohio State University	1988	1994

Summary of research highlights after joining SINP:

(1) Application of light front field theory to deep inelastic scattering in which we (a) established a new sum rule for twist four longitudinal structure function, (b) elucidated the role of orbital angular momentum in the decomposition of proton spin and (c) established the direct connection between transverse spin in light front QCD and transverse polarized deep inelastic scattering. (2) Nonperturbative studies in two dimensional scalar filed theories and QCD in which we performed a thorough investigation of two dimensional scalar theory and transverse lattice QCD. We established many new results and in the former, the complementarity of light front and Euclidean lattice approaches to nonperturbative quantum field theory. (3) Currently I am studying issues related to chiral symmetry in QCD.

53 publications in International refereed journals.

Important Publications

1. J.P. Vary, H. Honkanen, Jun Li, P. Maris, S.J. Brodsky, A. Harindranath, G.F. de Teramond, P. Sternberg, E.G. Ng, C. Yang, *Hamiltonian light-front field theory in a basis function approach*, Phys. Rev. **C 81**, 035205 (2010). (Cited 5 times)

2. Asit K. De, A. Harindranath, Santanu Mondal. *Chiral anomaly in lattice QCD with twisted mass Wilson fermion*, Phys. Lett. **B682**, 150 (2009).

3. S.J. Brodsky, D. Chakrabarti, A. Harindranath, A. Mukherjee, J.P. Vary, *Hadron optics in three-dimensional invariant coordinate space from deeply virtual Compton scattering*, Phys. Rev. **D 75**, 014003, (2007). (Cited 18 times)

4. Asit K. De, A. Harindranath, Jyotirmoy Maiti, Tilak Sinha, *Investigations in 1+1 dimensional lattice ϕ^4 theory*, Phys. Rev. **D 72**, 094503 (2005). (Cited 2 times)
5. Dipankar Chakrabarti, A. Harindranath, Lubomir Martinovic and James P. Vary, *Kinks in discrete light cone quantization*, Phys. Lett. **B 582**, 196 (2004). (Cited 11 times)
6. Dipankar Chakrabarti, Asit K. De, A. Harindranath, *Fermions on the light front transverse l attice*, Phys. Rev. **D 67**, 076004 (2003). (Cited 7 times)
7. A. Harindranath, Asmita Mukherjee and Raghunath Ratabole, *Transverse spin in QCD and transverse polarized deep inelastic scattering*, Phys. Lett. **B 476**, 471 (2000). (Cited 23 times)
8. A. Harindranath and Rajen Kundu, *On orbital angular momentum in deep inelastic scattering*, Phys. Rev. **D 59**, 116013 (1999). (Cited 54 times)
9. K.G. Wilson, T.S. Walhout, A. Harindranath, W.-M. Zhang, R.J. Perry, and St. D. Glazek, *Nonperturbative QCD: A weak coupling treatment on the light front*, Phys. Rev. **D 49**, 6720 (1994). (Cited 246 times)
10. W.-M. Zhang and A. Harindranath, *Light-front QCD: II. Two-component theory*, Phys. Rev. **D 48**, 4881 (1993). (Cited 72 times)
11. Wei-Min Zhang, Avaroth Harindranath, *Role of longitudinal boundary integrals in light front QCD*, Phys. Rev. **D 48**, 4868 (1993). (Cited 51 times)
12. Stanislaw D. Glazek, Avaroth Harindranath, Stephen Pinsky, Junko Shigemitsu, Kenneth Wilson, *On the relativistic bound state problem in the light front Yukawa model*, Phys. Rev. **D 47**, 1599 (1993). (Cited 65 times)
13. R. J. Perry, A. Harindranath and K. G. Wilson, *Light front Tamm-Dancoff field theory*, Phys. Rev. Lett. **65**, 2959 (1990). (Cited 179 times)
14. R.J. Perry, A. Harindranath, *Renormalization in the light front Tamm-Dancoff approach to field theory*, Phys. Rev. **D 43**, 4051 (1991). (Cited 77 times)
15. A. Harindranath and J. P. Vary, *Solving ϕ_2^4 by discretized light front quantization*, Phys. Rev. **D 36**, 1141 (1987). (Cited 70 times)
16. A. Harindranath and J. P. Vary, *Quark cluster model predictions for the nuclear Drell-Yan process*, Phys. Rev. **D 34**, 3378 (1986). (Cited 15 times)
17. L. S. Celenza, A. Harindranath, A. Rosenthal, and C. M. Shakin, *Evidence for the modification of nucleon properties in nuclei from traditional nuclear physics experiments*, Phys. Rev. **C 31**, 946 (1985). (Cited 27 times)
18. L. S. Celenza, A. Harindranath, and C. M. Shakin, *Microscopic foundations of Dirac phenomenology*, Phys. Rev. **C 31**, 63 (1985). (Cited 3 times)

(Citation information from SPIRES Database.)

Anjan Kundu , Senior Professor

Educational Background

1). 1981 : Ph.D. *Theor. Phys. Dept., Patrice Lumumba (PL) Univ., Moscow* 2). 1977: Integrated M.SC (Phys.) (*with Excellence*), *PL Univ, Moscow*

Earlier Appointments

1). 1983-85: BITS, Pilani, *Lecturer* 2). 1983: Jadavpur Univ., *CSIR-Pool Officer*

3). 1982-83: Joint Inst. for Nucl. Res. (Dubna, Moscow) *Res. Associate* 4). 1981-82: PL Univ (Moscow), *PDF*

Awards Honors and Distinctions :

1. Senior Associate, International Centre for Theoretical Physics (ICTP), Trieste, Italy (2006-2011)
2. *Humboldt Foundation Fellowship* (Senior), Germany [1993-4,1996, 2004, 2006]
3. Special Scholarship and Badges for *Excellent grades* in University (1973-1977)
4. Govt of India Scholarship for study abroad (1971-1977) 5. *National Merit Scholarship*, l970
6. *National Science Talent Search Certificate & Scholarship*, 1970

Essential Strength of Research

Pioneering contributions to the understanding of integrable nonlinear systems both at the classical and quantum levels through theoretical frameworks, which include gauge-unification of solitonic systems [18,17], invention of original ancestor model scheme for unifying quantum integrable systems based on our extension of the quantum group [10] and a new braided Yang-Baxter equation (BYBE) [12,13] for solving non-ultralocal models including exactly solvable anyon models. I have proposed several new integrable models, including the well known Kundu equation [17,18], Kundu-Eckhaus equation [18], Radhakrishnan-Kundu-Lakshmanan (RKL) and Basumallick-Kundu [8] models and discovered several new quantum integrable systems, including relativistic quantum Toda chain [14], quantum derivative NLS model [15], pioneering 1D anyon gas models [9,3].

Future Research Plan

My most recent research contributions are the novel nonultralocal quantum group and quantum integrable anyonic oscillators, anyonic quantum field NLS and derivative NLS models, obtained through our BYBE. The future plan is to find the exact Bethe ansatz solutions, correlation functions and corresponding novel nonultralocal vertex models for such 1D anyon models. The plan is also to find solvable nonabelian anyon models, applicable toward stable quantum computers, as proposed in the celebrated work of Kitaev.

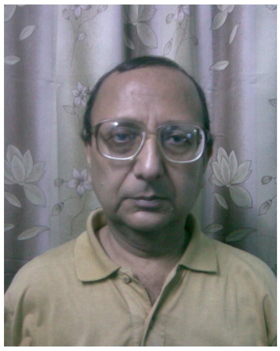
It would be a challenging problem to solve at the quantum level the variable mass and defect sine-Gordon models proposed by us recently [4,5], which preserve integrability with unusual properties of soliton deformation/creation/annihilation.

A pioneering scheme for nonlinearizing linear equations to integrable systems is proposed by me recently [2], where integrable perturbations were found for a series of nonlinear systems [1,2]. Future plan is to extend our scheme to discrete models and apply such new integrable systems, admitting exact accelerating solitons to nonlinear optics and other areas. An ambitious programe is to couple our nonlinearization scheme with Zakharov's dressing method to propose new method for soliton construction using solution of linear equation.

Explaining recent experiments on magnetic pattern in MnSI through our novel noncircular symmetric topological solitons [19] is an immediate problem to be undertaken.

List of important publications

1. Anjan Kundu, *J. Math Phys.* **51**, 022901 (2010) *Two-fold integrable hierarchy of nonholonomic deformation of the DNLS and the Lenells-Fokas equation*
2. Anjan Kundu, *J. Math Phys.* **50**, 102702 (2009) *Nonlinearizing linear equations to integrable systems including new hierarchies of nonholonomic deformations*
3. M. T. Batchelor, X.-W. Guan, A. Kundu, *J. Phys.* (FTC) **A 41**, 352002 (2008) *D-anyons: one-dimensional anyons with competing δ-function and derivative δ-function potentials*
4. Habibullin, I. and Kundu, A. , *Nucl. Phys.* **B [FS] 795** (3), 549-568 (2008) *Quantum and classical integrable sine-Gordon model with defect*
5. Anjan Kundu, *Phys. Rev. Lett.* **99**, 154101-4 (2007) *Shape changing and accelerating solitons in integrable variable mass sine-Gordon model*
6. Anjan Kundu, *J Math Phys* **44** (2003) 4589 : *Unifying scheme for generating discrete integrable systems including inhomogeneous and hybrid models*
7. Anjan Kundu, *Nucl. Phys.* **B 618** (2001) 500-522 *Integrability and exact solution of correlated hopping multi-chain electron systems*
8. B. Basu-Mallick and Anjan Kundu, *Phys. Rev.*, **B 62** (2000) 9927 : *Exact solution of Calogero model with competing long-range interactions*
9. Anjan Kundu, *Phys. Rev. Lett.*, **83**, 1275-9 (1999) *Exact solution of double-delta function Bose gas through interacting anyon gas*
10. Anjan Kundu, *Phys. Rev. Lett.*, **82** , 3936-40 (1999) *Algebraic approach in unifying quantum integrable models*
11. Holger Frahm and A Kundu *J. Phys.* **C 11**, L557-62 (1999) *Phase diagram of an exactly solvable t-J ladder model*
12. L Hlavaty and A Kundu, *Int J. Mod. Phys.* **A 11** (1996) 2143-2165 *Quantum Integrability of Nonultralocal Models through Baxterisation of Quantised Braided algebra*
13. Anjan Kundu, *Mod Phys Lett*, **A 10**, 2955-66 (1995) *Exact Bethe ansatz solution of nonultralocal quantum mKdV model*
14. A. Kundu *Phys. Lett.* **A 190**, 79-84 (l994) *Generation of a quantum integrable class of discrete-time or relativistic periodic Toda chains*
15. A. Kundu & B Basu-mallick *J. Math. Phys.* **34** 1252 (1993) *Classical and Quantum integrability of a novel derivative NLS model related to quantum group structures*
16. S. Ghosh & Anjan Kundu *Phys. Rev. Lett.*, **63**, (1989) 1207-10 : *Test of integrability for SU(2) nonlinear σ- models*
17. Anjan Kundu, *Physica* D: Nonlinear Physics, **25**, 399-406 (l987) *Exact solutions to higher order nonlinear equations through gauge transformation*
18. Anjan Kundu, *J. Math. Phys.* , **25**, 3433-8 (l984) *Landau-Lifshitz and higher order nonlinear systems gauge generated from NLS type equations*
19. Anjan Kundu, *Phys. Lett.*,**B110**, 61-3 (1982) *Instanton in anisotropic sigma-models*
20. Anjan Kundu & Yu.P. Rybakov, *J. Phys.* , **A 15**, 269-75 (l982) *Closed vortex-type solution with Hopf index*



1. Name: **PARTHASARATHI MITRA**
2. Educational background:
   (a) B. Sc. 1971 (First class) from Presidency College, Calcutta University
   (b) M. Sc. 1973 (First in first class) from Calcutta University
   (c) Ph.D. 1980 from Bombay University for research work at TIFR
3. Postdoctoral work: at Hamburg, Germany and Halifax, Canada
4. First employment: Reader, North Bengal University, 1986-1989
5. At SINP since: 1989
6. Honours:
   (a) Fellow of National Academy of Sciences, India
   (b) Theoretical Physics Seminar Circuit speaker, several times
   (c) Chaired sessions at numerous conferences
7. Teaching:
   Taught 'Quantum Mechanics', 'Electromagnetism', 'Mathematical Methods', 'Field Theory' and 'Black Hole Physics' to numerous batches of Post - M. Sc. students, diverse subjects to Undergraduate Associates and 'Gravitation' to students of Amal Kumar Raychaudhuri School on General Relativity at SINP.
8. Guidance:
   Guided four Ph. D. students, partially guided one more and collaborated with other divisional students as well as postdoctoral fellows. Supervised quite a few Post-M. Sc. reviews.
9. Main areas of research:

   I. BLACK HOLE PHYSICS

   Entropy of matter around black holes, Extremal black hole entropy, Entropy in loop quantum gravity, Black hole radiation in quantum mechanics

   II. ANOMALIES IN FIELD THEORY

   Covariant and consistent anomalies, Gauss law commutator, Anomalous Gauge Models, Second Class Constraints, Global anomaly, Strong CP

   III. LATTICE GAUGE THEORY

   Lattice fermions

   IV. TWO DIMENSIONAL FIELD THEORIES

   Schwinger-like models
10. Future plans: Will continue to work in black hole physics and on anomalies

List of important publications

1. A. Ghosh and P. Mitra, Fine-grained state counting for black holes in loop quantum gravity (2009) – **Phys. Rev. Lett.** 102,141302
2. P. Mitra, Time-reversal and parity conservation for gravitating quarks (2009) – Class. Quant. Grav. 26, 075024
3. B. Chatterjee and P. Mitra, Hawking temperature and higher order calculations (2009) – Phys. Lett. B675,240
4. B. Chatterjee, A. Ghosh and P. Mitra, Tunnelling from black holes and tunnelling into white holes (2008) – Phys. Lett. B661,307
5. P. Mitra, Complex fermion mass term, regularization and CP violation (2007) – J. Phys. A40,F525
6. P. Mitra, Hawking temperature from tunnelling formalism (2007) – Phys. Lett. B648,240
7. A. Ghosh and P. Mitra, An improved estimate of black hole entropy in the quantum geometry approach (2005) – Phys. Lett. B616,114
8. H. Banerjee, D. Chatterjee and P. Mitra, Is there still a strong CP problem? (2003) – Phys. Lett. B573,109
9. B. Muthukumar and P. Mitra, Non-commutative oscillators and the commutative limit (2002) – Phys. Rev. D66,27701
10. P. Mitra, Entropy of extremal black holes in asymptotically anti-de Sitter (1998) spacetime – Phys. Lett. B441,89
11. A. Ghosh and P. Mitra, Understanding the area proposal for extremal black hole entropy (1997) – **Phys. Rev. Lett.** 78,1858
12. A. Ghosh and P. Mitra, Comment on extreme state of charged black hole (1996) – Phys. Rev. Lett. 77,4848
13. P. Mitra and A. Rahaman, The nonconfining Schwinger model (1996) – Ann. Phys. 249,34
14. A. Ghosh and P. Mitra, Entropy for extremal Reissner - Nordström black holes (1995) – Phys. Lett. 357B,295
15. A. Ghosh and P. Mitra, Entropy in dilaton black hole background (1994) – **Phys. Rev. Lett.** 73, 2521
16. P. Mitra, Quantization of gauge theories with global anomalies (1994) – Lett. in Math. Phys. 31,111
17. P. Mitra, Chiral Schwinger model with a Faddeevian regularization (1992) – Phys. Lett. 284 B, 23
18. P. Mitra and R. Rajaraman, New results on systems with second class constraints (1990) – Ann. Phys. (N.Y.) 203,137
19. P. Mitra, Algebraic consistency of anomalous gauge theories (1988) – **Phys. Rev. Lett.** 60,265
20. H. Banerjee, R. Banerjee and P. Mitra, Covariant and consistent anomalies in even-dimensional chiral gauge theories (1986) – Z. Phys. C32,445
21. P. Mitra and P. Weisz, On bare and induced masses of Susskind fermions (1983) – Phys. Lett. 126B,355
22. P. Mitra, Geometry of nondegenerate Susskind fermions (1983) – Nucl. Phys. B227,349
23. P. Mitra, Lattice fermions and tomography (1983) – **Phys. Rev. Lett.** 51,2021
24. P. Mitra and P. Roy, Operator solution to broken $QCD(N)_2$ for massless quarks (1978) – Phys. Lett. 79B,469
25. P. Mitra, Elasticity, factorization and S-matrices in 1+1 dimensions (1977) – Phys. Lett. 72B,62

Palash Baran Pal

Division: Theory
Designation: Senior Professor
Personal homepage: http://www.saha.ac.in/theory/palashbaran.pal/

Professional and Educational History

- ***Degrees :***
  B.Sc. (1972-1975) Presidency College, Calcutta University, Calcutta, India
  M.Sc. (1975-1977) Calcutta University, Calcutta, India
  Ph.D. (1979-1983) Carnegie-Mellon University, Pittsburgh, USA
- ***Post-doctoral Research Associateships :***
  (1984-86) University of Maryland, College Park, USA
  (1986-89) University of Massachusetts, Amherst, USA
  (1989-92) University of Oregon, Eugene, USA
  (1992-94) University of Texas, Austin, USA
- ***Extended visitorships :***
  University of Puerto Rico, Río Piedras, Puerto Rico
  École Polytechnique, Palaiseau, France
  International Centre for Theoretical Physics, Trieste, Italy
- ***Faculty positions :***
  Associate Professor (1994-97), Indian Institute of Astrophysics, Bangalore, India
  Associate Professor (1997-1999), Saha Institute of Nuclear Physics, Calcutta, India
  Professor (8/99-present), Saha Institute of Nuclear Physics, Calcutta, India

Award : Rabindra Smriti Prize for scientific writing in Bengali, 2004. Author of 3 academic books and 8 books in Bengali on popular topics of science.

Fields of research interest

- Weak interactions, with specific emphasis on neutrino physics
- Beyond the standard model, including left-right symmetric model and grand unification
- Particle properties in material medium, commonly (and inappropriately) known as finite temperature field theory
- Particle properties in background magnetic fields
- Astrophysics and Cosmology related to Particle Physics
- Linearized theory of gravity

Selected publications

- Massive Neutrinos in Physics and Astrophysics (with R. N. Mohapatra), World Scientific, 3rd edition, 2004
- Radiative decays of massive neutrinos: P B Pal, L Wolfenstein; Phys. Rev. D25 (1982) 766.
- Electromagnetic properties of neutrinos in a background of electrons: J C DOlivo, J F Nieves, P B Pal; Phys. Rev. D40 (1989) 3679.
- Minimal rephasing invariant CP-violating parameters with Dirac & Majorana fermions: J F Nieves, P B Pal; Phys. Rev. D36 (1987) 315.
- Strong-CP question in SU(3)cX SU(3)LX U(1)N models: P B Pal; Phys. Rev. D52 (1995) 1659. hep-ph/9411406
- P- and CP- odd terms in the photon self energy within a medium: J F Nieves, P B Pal; Phys. Rev. D39 (1989) 652, 40 (1989) 2148(E).
- Field-theoretic derivation of Wolfenstein matter-oscillation formula: P B Pal, T N Pham; Phys. Rev. D40 (1989) 259.
- Dirac, Majorana and Weyl neutrinos: P B Pal; http://xxx.lanl.gov/abs/1006.1718

Recent Publications:

- Gravitational decay of the Z-boson : J F Nieves, P B Pal; Phys. Rev. D72 (2005) 093006. hep-ph/0509321
- Perturbative vs Schwinger-propagator method for the calculation of amplitudes in a magnetic field : J F Nieves, P B Pal; Phys. Rev. D73 (2006) 105003 (hep-ph/0603024)
- Radiative neutrino decay and CP-violation in R-parity violating supersymmetry : G Bhattacharyya, P B Pal, H Päs, T J Weiler; Phys. Rev. D74 (2006) 053006 (hep-ph/0608131)
- Comment on "Can gravity distinguish between Dirac and Majorana neutrinos?" : J F Nieves, P B Pal; Phys. Rev. Lett. 98 (2007) 069001 (gr-qc/0610098)
- Lorentz-symmetry violating decays in a medium : J F Nieves, P B Pal; Phys. Rev. D77 (2008) 113001 (arXiv:0712.4345 [hep-ph])
- Angular momentum non-conserving decays in isotropic media : J F Nieves, P B Pal; Eur. Phys. J. C 63 (2009) 331 (arXiv:0907.3000)
- A reappraisal of spontaneous R-parity violation : G Bhattacharyya, P B Pal; Phys. Rev. D82 (2010) 055013 (arXiv/1006.0631)

1. ***Name:*** DR. RADHEY SHYAM

2. ***Division and current position***: Theory Division, Senior Prof. H+ (since Feb. 2008)

3. ***Academic Profile*:**

*(i). **Details of previous Scientific employment and academic positions held:***

(a) Saha Institute of Nuclear Physics: Senior Professor H, Feb. 2004 – Jan 2008; **(b) Saha Institute of Nuclear** Physics: Professor, August. 1993 - Jan. 2004; **(c) Saha Institute of Nuclear Physics**, Associate Professor, 1987 – 1993; **(d) Saha Institute of Nuclear Physics**, Assistant Professor, 1986 – 1987; **(e) Bhabha Atomic Research Centre**, Scientific Officer (SE), 1985 – 1986; **(f) GSI, Darmstadt, Germany**, Guest Scientist, 1982 - 1985; **(g) Daresbury Laboratory, UK**, Research Associate, 1980 – 1982; **(h) Forschungszentrum Juelich, Germany**, Research Associate, 1977 -1979; (i) **Institute fuer Theoretische Physik, Universitaet Giessen, Germany**, Guest Prof., 1990-91, 2009-2010.

(ii). Professional recognitions, awards, fellowships received.

(a). Awarded a research fellowship by the Alexander von Humboldt foundation, Bonn, Germany Jan. 1979 - Dec. 1980 and April 1987 - June 1987; **(b).** Regular associate of the Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, 1992 -1999; **(c).** Senior associate of the Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, 2003-2008**. (d).** More than 1000 citations of my research publications in international research journals with h-index of creditable 21; **(e).** More than 12 invited talks in the international conferences held outside India; **(f)** Selected as expert to referee papers for the International (Phys. Rev. Lett., Phys. Rev. C, Nuclear Physics A, International Journal of Modern Physics and J. Phys. G) and national (Pramana) research journals; (**g**). Acted as expert reviewer for the research grant applications made to National Science Foundation, USA and SERC, India; **(h). A**cted as expert reviewer for the faculty job applications made to the Tata Institute of Fundamental Research, Mumbai, India and Institute of Physics, Bhubaneshwar, India**.**

4. ***Strength of the Research output during last 5 years*:**

Extensive investigations have been carried out mostly on following topics recently.

(i). Coupled-Channels K-matrix analysis of the meson production in photonuclear Reactions.

We have formulated a theory within a coupled channels K-matrix approach to investigate the hadron structure by analyzing the interaction between nucleons and mesons where the hadronic interactions are described as the exchange of known mesons and baryons. Effective Lagrangians with parameters constrained by the quantum chromodynamics (QCD) describe various vertices involved in these interactions. The formalism obeys unitarity and is gauge invariant. This theory has been used successfully to provide a comprehensive description of all the available data on the photoproduction of the η and the K^+ meson off proton (see Refs. 5 and 9).

(ii). Hypernuclear production using hadronic and electromagnetic probes

We have developed a covariant theory to describe hypernuclear production with hadronic (pion and proton) and electromagnetic (photon and electron) probes (Refs. 3,4,7,8). This is based on the effective Lagrangian picture and it focuses on production amplitudes that are described via excitation of the relevant baryonic resonance states. The mechanism of hypernuclear production via pion, kaon and photon induced reactions are well described by this theory.

(iii). Dilepton production in elementary nucleon-nucleon collisions.

The recent data on the dilepton production in proton-proton and quasi-free proton-neutron collisions taken by the HADES collaboration at GSI Darmstadt, have thrown new challenges before the theoreticians. We have developed a formalism to investigate the dilepton production in *NN* collisions using techniques of the Effective Lagrangian method (Ref. 6). We have very recently shown that the puzzle regarding the non-description of the data by theories can be solved by including pion electromagnetic for factors . (see Ref. 10).

5. *Future Research Plans.*

We intend to extend our coupled-channels K-matrix formalism to study the electroproduction of pions and strange meson off protons. This involves including the Regge trajectory exchanges in the t-channel scattering amplitudes. This would enable this theory to describe experiments performed with electrons of kinetic energies in excess of 3.0 GeV which of relevance to the measurements planned at the upgraded facility in JLab, USA.

We propose to extend our theory of hypernuclear production to describe the production of cascade (Ξ) hypernuclei for which the first set of measurements will soon be performed at the J-PARC facility in Japan using (K^-, K^+) reactions. Cascade particle has the strangeness S = -2. Therefore, the states of the Ξ - hypernuclei are regarded as the doorway to access multi-strangeness systems which is significant step to extend the study the role of the strangeness in hadron physics.

We would like to develop microscopic structure models to investigate the spectroscopy of double hypernuclei. The study of these multi-hyperon states will be beneficial not only to the PANDA project but also to the studies in nuclear-astrophysics

6. List of significant recent publications:

(10) Dilepton production in proton-proton and quasi-free proton-neutron reactions at 1.25 GeV**,** **R. Shyam** and U. Mosel, Phys. Lett. B (submitted, June 2010), arXiv:1006:3873 [hep-ph].

(9) The associated photoproduction of K^+ meson off proton within a coupled-channels K-matrix approach, **R. Shyam**, O. Scholten and H. Lenske, Phys. Rev. C 81 (2010) 015204.

(8) A relativistic description of the A (π^+, K^+) $_{\Lambda}$A reaction, S. Bender, **R. Shyam**, H. Lenske, Nucl. Phys. A 839 (2010) 51.

(7) Photoproduction of hypernuclei within the quark-meson coupling model, **R. Shyam**, K. Tsushima, and A. W. Thomas**,** Phys. Lett. B 676 (2009) 51.

(6) Dilepton production in nucleon-nucleon collisions reexamined, **R. Shyam** and U. Mosel, Phys. Rev. C 79 (2009) 035203.

(5). Photoproduction of η meson within a coupled channels K-matrix approach, **R. Shyam** and O. Scholten, Phys. Rev. C 78, (2008) 065201.

(4) Production of hypernuclei with hadronic and electromagnetic probes, **R.Shyam**, Progr. Part. and Nucl. Phys. 61 (2008) 212.

(3) Hypernuclear production by (γ,K^+) reaction within a relativistic model, **R. Shyam**, H. Lenske, U. Mosel, Phys. Rev. C 77 (2008) 052201(R).

(2) η meson production in nucleon-nucleon collisions within an effective Lagrangian model, **R. Shyam**, Phys. Rev. C 75 (2007) 055201.

(1) Hyperon production in near threshold nucleon-nucleon collisions, **Radhey Shyam**, Phys. Rev. C 73 (2006) 035211.

GAUTAM BHATTACHARYYA

Specialisation: Particle Physics Phenomenology

E-mail: gautam.bhattacharyya@saha.ac.in

- Born: 20 Feb 1966; M.Sc. Physics 1988 (Calcutta U., Ranked 1st); Ph.D 1993 Title: Testing physics beyond the Standard Model from precision electroweak measurements. Supervior: Prof. Amitava Raychaudhuri, Calcutta U.
- **Postdocs**: CERN Theory Division, Geneva (1994-95); INFN, Pisa, Italy (1996-97).
  Permanent Job: SINP (1998 -).
- **Awards**: B.M. Birla Science Prize in Physics (2005), Adjunct Faculty of Tata Institute of Fundamental Research, Mumbai (2009-12); Paid Scientific Associateship at CERN (5 months in 2007), Regular Associateship of ICTP (1998-2005).
- **Publications** (till Sept'10): Journals 65, Conf Proceedings 22.
- **Top 10 Citations** (from SPIRES, till Sep'10): 165, 163, 117, 107, 84, 81, 80, 67, 53, 47. Not correlated to the 10 papers listed below. Citations of big collaborative project reports excluded from the above counting.
- **Plenary talks** on Supersymmetric Models (mainly on R-parity violation), and on Alternative approaches to Electroweak Symmetry Breaking, in various International Conferences.
- **Organizations**: Convener, DAE-HEP (2004), NOC/LOC member of National/International conferences.
- **Ph.D students**: Paramita Dey obtained PhD in 2006 (currently postdoc in Aachen, Germany); Tirtha Sankar Ray, CSIR S.P.M. fellow, obtained Ph.D in 2010 (currently Postdoc at Saclay, France); Kalyan Brata Chatterjee still working for Ph.D.
- **Main research direction:** Phenomenology of Physics beyond the Standard Model (e.g., Supersymmetry/ Extra Dimension), in view of results expected primarily from the LHC.
  Specific plan : Correlation studies between new physics signals from Colliders and extraordinary results (like enhanced decay rates or large CP violation) in Flavour Experiments (e.g. Belle/BaBar/CLEO) for possible discrimination between different types of new physics.

Some important journal publications in the entire career

:

1. A phenomenological study of 5d supersymmetry, **G. Bhattacharyya** and T.S. Ray, JHEP 05 (2010) 040 [arXiv:1003.1276 [hep-ph]].
2. Correlated enhancements in $D_s \to \ell\nu$, $(g-2)$ of muon and lepton flavor violating τ decays with two R-parity violating couplings, **G. Bhattacharyya**, K.B. Chatterjee and Soumitra Nandi, Nucl. Phys. B 831 (2010) 344-357 [arXiv:0911.3811 [hep-ph]].
3. Probing warped extra dimension via $gg \to h$ and $h \to \gamma\gamma$ at LHC, **G. Bhattacharyya** and T.S. Ray, Phys. Lett. B 675 (2009) 222-225 [arXiv:0902.1893 [hep-ph]].
4. Probing Universal Extra Dimension at the International Linear Collider, **G. Bhattacharyya**, P. Dey, A. Kundu and A. Raychaudhuri, Phys. Lett. B 628 (2005) 141-147 [hep-ph/0502031].
5. A comparison of ultraviolet sensitivities in universal, nonuniversal, and split extra dimensional models, P. Dey and **G. Bhattacharyya**, Phys. Rev. D 70 (2004) 116012 (7 pages) [hep-ph/0407314].
6. Effects of R-parity violation on direct CP violation in B decays and extraction of γ, **G. Bhattacharyya** and A. Datta, Phys. Rev. Lett. 83 (1999) 2300-2303 [hep-ph/9903490].
7. Naturalness constraints on gauge mediated supersymmetry breaking models; **G. Bhattacharyya** and A. Romanino, Phys. Rev. D 55 (1997) 7015-7019 [hep-ph/9611243].
8. New LEP bounds on B-violating scalar couplings: R-parity violating supersymmetry or diquarks; **G. Bhattacharyya**, D. Choudhury and K. Sridhar, Phys. Lett. B 355 (1995) 193-198 [hep-ph/9504314].
9. New LEP constraints on some supersymmetric Yukawa interactions that violate R-parity; **G. Bhattacharyya**, J. Ellis and K. Sridhar, Mod. Phys. Lett. A 10 (1995) 1583-1592 [hep-ph/9503264].
10. Oblique electroweak corrections and new physics; **G. Bhattacharyya**, S. Banerjee and P. Roy, Phys. Rev. D 45 (1992) 729-733, Rapid Communication; Erratum- ibid. D 46 (1992) 3215.

Asit K De

Professor, Theory Division, SINP

Educational Background

PhD in 1988 from The Ohio State University, USA in Theoretical Particle Physics (QFTs on Lattice)

Academic Profile

POST-DOC 1 : *1988-92*

Institute of Theoretical Physics, RWTH Aachen, Germany (concurrently, a visiting scientist position at HLRZ, Forschungszentrum, Juelich, Germany)

POST-DOC 2: *1992-94*

Physics Department, Washington University, St. Louis, MO, USA

FACULTY POSITION: *1994 TILL NOW*

Theory Division, Saha Institute of Nuclear Physics

PHD STUDENTS

1. Subhasish Basak, PhD in ***2003***, Post-docs in U of Maryland, USA and Indiana University, USA, currently a faculty member in National Institute of Science Education and Research (NISER), Bhubaneswar, India

2. Tilak Sinha, PhD in ***2006***, currently teaching in a College in Kolkata area, India

3. Sangita De Sarkar & Anwesa Sarkar: Current students (joined less than a year ago)

Essential Aspects of Research

General Area of specialization: Quantum Field Theories regularized on a space-time discrete Euclidean Lattice

Broad Areas: 1) Chiral symmetry breaking, 2) Regularization of chiral gauge theories, 3) Short distance behavior of non-asymptotically-free theories, 4) Lattice fermions, 5) Fermion algorithms, 6) Lower dimensional field theories, 7) Lattice QCD

Highlights of Research Work:

- Non-perturbative investigation of fermion mass generation and dynamical chiral symmetry breaking with fermions of different representations of the gauge group and interplay between the Higgs transition and the chiral transition.
- First ever attempt to put a lattice chiral gauge theory through a non-perturbative numerical test. Demonstration of the problem of gauge degrees of freedom strongly coupling to physical degrees of freedom
- Establishment of triviality upper bound of Yukawa coupling generated fermion mass and evidence for equivalence of four-fermion theory and Yukawa theory in terms of universality class
- 'Demonstration' of a successful U(1) lattice chiral gauge theory with domain-wall fermions and nonperturbative gauge-fixing.

- Identification of a region of parameter space of pure U(1) lattice gauge theory with suitably extended space of irrelevant couplings for possible nonperturbative properties.
- Comprehensive treatment of fermions on a transverse lattice on the light front and proposals for the solution of fermion doubling.
- Comprehensive understanding of the 1+1 dimensional renormalized scalar theory with quartic coupling through studies of the theory on lattice in the scaling region of the broken-symmetry phase and emergence of an universal amplitude in the theory.
- Investigation of QCD on lattice with 2 light sea quarks, new proposal for scale setting
- Cancellation of parity violating terms in anomaly calculation in a vector-like gauge theory with twisted mass fermions

Future Directions

- Investigation of the chiral regime of QCD on lattice with Wilson-type sea quarks, calculation of hadronic observables
- Possible extension of current work to Symanzik-improved gauge action and 2+1 light sea quarks
- Testing non-perturbative gauge fixing on lattice for the non-Abelian case

Selected List of Publication

1. A. De and J. Shigemitsu, *Probing the SU(2) gauge-Higgs system with fermions,* **Nucl.Phys. B307 (1988) 376**.
2. W. Bock, A.K. De, K. Jansen, J. Jersak, T. Neuhaus and J. Smit, *Decoupling doublers of chiral lattice fermions in a quenched fermion-Higgs model*, **Phys. Lett B232 (1989) 486**.
3. W. Bock and A.K. De, *Unquenched investigation of fermion masses in a chiral fermion theory on the lattice*, **Phys. Lett. B245 (1990) 207**.
4. W. Bock, A.K. De, K. Jansen, J. Jersak, T. Neuhaus and J. Smit, *Phase diagram of a lattice SU(2)XSU(2) scalar-fermion model with naive and Wilson fermions*, **Nucl. Phys. B344 (1990) 207**.
5. W. Bock, A.K. De, C. Frick, K. Jansen and T. Trappenberg, *A search for an upperbound for the renormalized Yukawa coupling in a lattice fermion-Higgs model*, **Nucl. Phys. B371 (1992) 683**.
6. W. Bock, A.K. De and J. Smit, *Fermion masses at strong Wilson-Yukawa coupling in the symmetric phase*, **Nucl. Phys. B388 (1992) 243**.
7. W. Bock, A.K. De, E. Focht and J. Smit, *Fermion-Higgs model with strong Wilson-Yukawa coupling in two dimensions*, **Nucl. Phys. B401 (1993) 481**.
8. S. Basak and A.K. De, *Kramers Equation Algorithm with Kogut-Susskind fermions on lattice*, **Phys. Lett. B430 (1998) 320**.
9. S. Basak and Asit K. De, *Chiral Gauge Theory on Lattice with Domain Wall Fermions,* **Phys. Rev. D64 (2001) 014504**.
10. Dipankar Chakrabarti, Asit K. De and A. Harindranath, *Fermions on the light front transverse lattice*, **Phys. Rev. D67 (2003) 076004**.
11. S. Basak, Asit K. De and T. Sinha, *On the continuum limit of the gauge-fixed compact U(1) gauge theory,* **Phys. Lett. B580 (2004) 209**.
12. Asit K. De, A. Harindranath, J. Maiti and T. Sinha, *Topological charge in 1+1 dimensional lattice phi^4 theory*, **Phys. Rev. D72 (2005) 094504**.
13. Asit K. De, A. Harindranath and Jyotirmoy Maiti, *On Scale Determination in Lattice QCD with Dynamical Quarks*, arXiv: 0803.1281[hep-lat], **PoS LAT2008:087,2008**.
14. Asit K De, A. Harindranath and Santanu Mondal, *Chiral Anomaly in Lattice QCD with Twisted Mass Wilson Fermion*, **Phys. Lett. B682 (2009)150**.

Name : **KUMAR SANKAR GUPTA**

Education : Ph.D. Syracuse University, Syracuse, USA, 1992.
M.S. Syracuse University, Syracuse, USA, 1988.
B.Sc., Presidency College, Calcutta, India, 1985.

Positions : Professor G, Saha Institute of Nuclear Physics (8/2007 - present).
Professor F, Saha Institute of Nuclear Physics (8/2004 - 7/2007).
Associate Professor,Saha Institute of Nuclear Physics (8/2000-8/2004).
Reader, Saha Institute of Nuclear Physics (1996-2000).
Faculty Fellow, S.N.Bose National Centre (1995-1996).
Visiting Assistant Professor, Iowa State University (1994-1995).
Postdoctoral Fellow, University of Rochester (1992-1994).

Awards : Regular Associateship, Abdus Salam ICTP, Trieste, Italy, 2003 - 2010.
PI of Indo-Croatian (DST) & Indo-French (CEFIPRA) Project.
Slovak National Scholarship, Bratislava, Slovakia, 2007.
Graduate Fellowship, Syracuse University, USA, 1991-1992.
Graduate Assistantship, Syracuse University, USA, 1986-1991.
Graduate Scholarship, Syracuse University, USA, 1986-1991.
National Scholarship, Govt. of West Bengal, 1980, 1982.

Essential strength of research

My main focus at the last few years have been in the areas of **quantum aspects ofblack holes, noncommutative gravity, noncommutative quantum field theoriesand mathematical and topological aspects of systems in lower dimensions.** Ihave worked extensively on the **near-horizon conformal structure of black holes** andblack hole entropy. I have shown that there is a universal structure to the near-horizon CFT, which indicates its relevance for a very wide class of black holes. I have also usedgeometrical and topological methods to establish holography for a large class of blackholes. In another area, I have investigated **noncommutative gravity** and **noncommutative quantum field theory**. I have shown that a noncommutative black hole has a very different geometry compared to the usual including the possibility for quantization of the time operator. In addition, I have found new type of statistics for a class of noncommutative field theories and have obtained the corresponding deformed oscillator algebra. I have studied the effect of charge impurities in graphene using **self-adjoint extensions of differential operators**. I have obtained a novel spectrum depending on the choiceof the self-adjoint extension. I have recently found the effect of topology on the critical charge in graphene. Finally, I was able to found new class of solutions to Calogero models using self-adjoint extensions.

Future Research Plans

In the medium term, I would like to analyze the concept of **holography** in the context of **black hole physics**. It is well known that both holography and noncommutativity appears at the Planck scale. It would therefore be interesting to analyze how these concepts fit together, which leads to **noncommutative holography**. This can be studied using quasinormal modes using scalar field theory on noncommutative black holes which would provide a step towards understanding the true quantum picture of black hole physics. In addition, quantum field theory on a fuzzy and noncommutative spaces will be studied. In particular, I would like to understand the quantum field theory on Κ**-Minkowski spaces** and their symmetries, which is also relevant for Planck scale physics. Such a study can be adapted to analyze black hole evaporation within the noncommutative setup as well.I would also like to study the **effects of topology and geometry in graphene**, especially in the presence of a Coulomb charge impurity. It would be interesting to analyze the bound state spectrum in such systems and also study the effect of topology on the supercritical charges. This study can be used to analyze certain deep concepts of quantum mechanics for strongly interacting systems with possible experimental predictions using graphene as a sample.

Selected Important Publications

1. **The Central Charge of the Warped** AdS3 **Black Hole**, Kumar S. Gupta, E. Harikumar, Siddhartha Sen, M. Sivakumar, Mod. Phys. Lett. **A 25**, 2065 (2010).

2. **Geometric Finiteness, Holography and Quasinormal Modes for theWarped AdS3 Black Hole**, Kumar S. Gupta, E. Harikumar, Siddhartha Sen, M. Sivakumar,Class. Quant. Grav. **27**, 165012 (2010).

3. **Turbulent Flow in Graphene**, Kumar S. Gupta and Siddhartha Sen, Europhys.Lett. **90**, 34003 (2010).

4. **Scattering in Graphene with Impurities : a Low Energy Effective Theory**,Kumar S. Gupta, A. Samsarov and Siddhartha Sen, Eur. Phys. Jour. **B 73**, 389 (2010).

5. **Deformed Oscillator Algebras and QFT in** K**-Minkowski Spacetime**, T.R.Govindarajan, Kumar S. Gupta, E. Harikumar, S. Meljanac and D. Meljanac, Phys.Rev. **D 80**, 025014 (2009).

6. **Scalar Field Dynamics in Warped AdS3 Black Hole Background**, Sayan K.Chakrabarti, Pulak Ranjan Giri and Kumar S. Gupta, Phys. Lett. **B 680**, 500 (2009).

7. **Normal Mode Analysis for Scalar Fields in BTZ Black Hole Background**, Sayan K. Chakrabarti, Pulak R. Giri and Kumar S. Gupta, Eur. Phys. J. **C 60**, 169 (2009).

8. **Bound States in Graphene**, Kumar S. Gupta and Siddhartha Sen, Mod. Phys. Lett. **A 24**, 99 (2009).

9. **Bound States in Gapped Graphene with Impurities : Effective Low-Energy Description of Short-Range Interactions**, Kumar S. Gupta and Siddhartha Sen, Phys. Rev. **B 78**, 205429 (2008).

10. **Inequivalent Quantization of the Rational Calogero model with a Coulomb Type Interaction**, B. Basu-Mallick, Kumar S. Gupta, S. Meljanac and A. Samsarov, Eur. Phys. J. **C 58**, 159 (2008).

11. **Twisted Statistics in** K**-Minkowski Spacetime**, T. R. Govindarajan, Kumar S. Gupta, E. Harikumar, S. Meljanac and D. Meljanac, Phys. Rev. **D 77**, 105010 (2008).

12. **Universal Near-horizon Conformal Structure and Black Hole Entropy**, Sayan K. Chakrabarti, Kumar S. Gupta and Siddhartha Sen, Int. Jour. Mod. Phys. **A 23**, 2547 (2008).

13. **Interacting Quantum Topologies and the Quantum Hall Effect**, A.P. Balachandran, Kumar S. Gupta, Seckin Kurkcuoglu, Int. Jour. Mod. Phys. **A 23** 1327 (2008).

14. **Kappa-Minkowski Space-time and the Star Product Realizations**, S. Meljanac, A. Samsarov, M. Stojic and Kumar S. Gupta, Eur. Phys. J. C **53**, 295(2008).

15. **Electron Capture and Scaling Anomaly in Polar Molecules**, P. R. Giri, Kumar S. Gupta, S. Meljanac and A. Samsarov, Phys. Lett. **A 372**, 2967 (2008).

16. **Noncommutative BTZ Black Hole and Discrete Time**, B. Dolan, Kumar S. Gupta and A. Stern, Class. Quantum Grav. **24**, 1647 (2007).

17. **Black Holes, Holography and Moduli Space Metric**, Kumar S. Gupta and Siddhartha Sen, Phys. Lett. **B646**, 265 (2007).

18. **Quantization and Conformal Properties of a Generalized Calogero Model**, S. Meljanac, A. Samsarov, B. Basu-Mallick and Kumar S. Gupta, Eur. Phys. J. C **49**, 875 (2007).

Brief Curriculum Vite

1. Name, Passport-sized photograph MUNSHI GOLAM MUSTAFA
and educational background: Ph. D.

2. Academic profile including earlier appointments,awards etc:

Visting /Postdoctoral Positions:

Sl. No.	Position Held	Institution	Period
1	Research Associate	Institute of Phys., Bhubaneswar, India	Feb'95 to Oct.'95
2	Post-doctoral Fellow	VECC, Kolkata, India	Nov'95 to July'97
3	A. v. Humboldt Fellow	University of Giessen, Germany	Jan'99 to March'00
4	Visiting Fellow	University of Giessen, Germany	April'02 to June'02
5	A. v. Humboldt Fellow	University of Giessen, Germany	July'02 to March'03
6	Visiting Fellow	University of McGill, Canada	June'07 to Sept'07
7	FZD Fellow	FZ Dresden-Rossendorf, Germany	July'08 to Sept'08
8	Visiting Fellow	FZ Dresden-Rossendorf, Germany	July'10 to Aug'10
9	Guest Scientist	Helmholtz Int. Center for FAIR, Frankfurt, Germany	Sept'10 to Dec'10

Permanent Positions:

Sl. No.	Position Held	Institution	Period
1	Reader	Saha Institute of Nuclear Physics	From 01/08/97 to 31/07/01
2	Associate Professor	Saha Institute of Nuclear Physics	From 01/08/01 to 31/07/05
3	Professor 'F'	Saha Institute of Nuclear Physics	From 01/08/05 to 31/07/08
4	Professor 'G'	Saha Institute of Nuclear Physics	Since August 1'08

3. Essential strength of research/development output:

The principal goal of the relativistic heavy-ion experiments is to explore the phase structure of the underlying theory of strong interaction - Quantum Chromodynamics (QCD) - by creating in the laboratory the new state of matter Quark Gluon Plasma (QGP). Over the years I have been involved in addressing various important issues of this newly emerging field of QGP and contributed in large extent, which have important relevance for the phenomenology of ongoing heavy-ion experiments.:
(i) Chemical equilibration in QGP and its implications to electromagnetic probes (photons and dilepton) both at soft and hard momenta scale. **(ii)** Energy-losses, both collisional and radiative, and their consequences on secondary hadron spectra and jet quenching. **(iii)** Recombination aspect of hadronisation of quark-gluon plasma. **(iv)** Fluidity aspect of QCD matter produced in RHIC. **(v)** Wake phenomena due to a fast moving charge particle and its consequences, viz., stopping power, dynamical Debye screening, long range correlation, Mach shock waves and Cerenkov like radiation in QGP within the weak coupling limit of QCD. **(vi)** Various static and dynamic quantities through the correlation function description within perturbative and nonperturbative approach. QCD

motivated model also employed for obtaining quantities related to fluctuations and fluctuation of fluctuations. **(vii)** Various thermodynamic properties and their implications to quark -hadron phase transition using various constraints as essential ingredients to describe the various configuration of the system. **(xi)** Stability features of small strangelets within a QCD motivated phenomenological model.

4. Future research/development plan:

We are now at a very interesting situation of this new area of research where the SPS era has drawn to a close and presently the tremendous efforts are underway to understand the results from RHIC BNL, and, of course, the results from LHC CERN will start to appear at the end of this year. In a second generation experiment, e.g. FAIR, the energy range from 10 to 45 GeV/u is also to be scanned searching for: **(A) indications of the deconfinement phase transition at high baryon densities, which is complementary to the investigations performed at the RHIC BNL, and in the future at LHC CERN, (B) the critical point providing direct evidence for a phase boundary, (C) in-medium modifications of hadrons in dense matter, and (D) exotic states of matter such as condensates of strange particles.**

In view of this an extensive amount of theoretical study is required in favour of the relevant observables which are very sensitive to high density effects and phase transition and I would like to take some of the following research programs:
(i) The study of key questions of QCD-like confinement, chiral symmetry restoration and the nuclear equation of state at high densities.
(ii) The exploration of the QCD phase diagram in the region of moderate temperatures but very high baryon densities.
(iii) The study of collective flow of charmonium and multistrange hyperons, which will shed light on the production and proagation of these probes in dense baryonic matter.
(iv) The study of short-lived vector mesons and their possible in-medium mass modification, and their decay into electron-positron pairs. These penetrating probes carry undistorted information from the dense fireball. Also the near threshold production of charmonium states and open charm - sensitive to the possible onset of chiral symmetry restoration, and the possible formation of the exotic multiquark states, especially kaon clusters and strangelets.

5. List of important publications starting with recent publications:

1) Radiative and collisional jet energy loss in the quark-gluon plasma at RHIC (with Guang-You Qin, Jorg Ruppert, Charles Gale, Sangyong Jeon and Guy D. Moore); **Phys. Rev. Lett.100: 072301, 2008.**
2) Colour-singlet clustering of partons and recombination model for hadronization of quark-gluon plasma (with Raktim Abir); **Phys. Rev .C80: 051903 (R), 2009.**
3) Gamma flashes from relativistic electron-positron plasma droplets (with B. Kampfer); **Phys. Rev. A79: 1(R), 2009.**
4) Susceptibilities and speed of sound from PNJL model (with Sanjay K. Ghosh, Tamal K. Mukherjee and Rajarshi Ray) **Phys. Rev. D73: 114007, 2006.**
5) Energy loss of charm quarks in the quark-gluon plasma: Collisional versus radiative, **Phys. Rev. C72: 014905, 2005.**
6) Quenching of hadron spectra due to the collisional energy loss of partons in the quark gluon plasma (with Markus H. Thoma), **Acta Phys. Hung. A22: 93-102, 2005.**
7) Quark number susceptibility in hard thermal loop approximation (with Purnendu Chakraborty and Markus H. Thoma), **Eur. Phys. J. C23: 591-596, 2002.**
8) Finite temperature meson correlation functions in HTL approximation (with F. Karsch and Markus H. Thoma), **Phys. Lett. B497: 249-258, 2001.**
9) Radiative energy loss of heavy quarks in a quark gluon plasma (with Dipali Pal, Dinesh K. Srivastava and Markus H. Thoma), **Phys. Lett. B428: 234-240, 1998.**
10) Propagation of charm quarks in equilibrating quark - gluon plasma (with Dipali Pal and Dinesh K. Srivastava), **Phys. Rev. C57: 889-898,1998.**
11) Expanding quark - gluon plasmas: Transverse flow, chemical equilibration and electromagnetic radiation (with Dinesh K. Srivastava and Berndt Mueller), **Phys. Rev. C56: 1064-1074, 1997.**

NAME TARUN KANTI ROY

ACADEMIC PROFILE
Ph. D (Sc.), Jadavpur University, 1987
Title of Thesis: Deuteron stripping and pickup reactions with breakup

Appointments (SINP):

Scientist B,	1984-1987
Lecturer,	1987-1990
Reader,	1990-1995
Assoc Professor,	1995-2001
Professor F,	2001-2007
Professor G,	since 2007

PAST RESEARCH:
1) Modeling low energy nuclear reactions
2) Light scattering by small particles
3) Localization and mobility in aperiodic lattices
4) Noise reduction in chaotic systems
5) Hopf bifurcations in reversible systems
6) Discrete breathers in nonlinear lattices

RECENT WORKS:
Self-similar processes: generation and prediction

- i) Generation of time series of a self-similar processes by surrogates (a set of random numbers with the same distribution as the increments of the process), following a power law. Test of the time series by the characteristics reproduced.
- ii) Method applied to predict Internet traffic, a self-similar process and was able to predict in most cases.
- iii) Application to capital markets:- The time series of exchange rates of USD-JPY, which is heavily traded in capital markets were analyzed. The increments of the rates were found to have characteristics of a self-similar time series (with H ~ 0.58 +/- 0.02). While in some cases there was good agreement in predicting the future trend, in others the method did not produce satisfactory results. At present I am trying to find out why there is disagreement in such cases.
- iv) Construction of hilly and rough surfaces: - Methods available in the literature to construct rough surfaces to study their structure are lengthy and time consuming. Using the power law behaviour and the surrogate data method it is possible to construct such surfaces in a much lesser time and with larger sizes. Rough hilly surfaces on a matrix of size 1024 X 1024 have been constructed from which the coastline (zero height of

the surface) can also be determined. Coastlines have been found to be fractal in nature, but their relation to the Hurst parameter of the surfaces has not yet been determined. Presently a program is being developed to determine the coastline.

Some publications

Generation and prediction of self-similar processes by surrogates, D. Chakraborty and T.K. Roy, Fractals 14 (2006) 17

Self-similar and fractal nature of Internet traffic, D. Chakraborty, A. Ashir, T. Suganuma, G.M. Keeni, T.K. Roy and N. Shiratori, Intl. J. of Network Management, 14 (2004) 119

Breathers in a discrete non-linear Schroedinger type model: Exact stability results, A. Lahiri, S. Panda and T.K. Roy, Phys. Rev. E66 (2002) 056603.

Discrete breathers: Exact solutions in piece-wise linear models, A.Lahiri, S. Panda and T.K. Roy, Phys. Rev. Letts. 84 (2000) 3570

Noise reduction in chaotic time series data, A. Bhowal and T.K. Roy, Pramana, Journal of Physics, 52 (1999) 25

Resonant collisions in four dimensional reversible maps: A description of scenarios, A. Lahiri, A. Bhowal and T.K. Roy, Physica D112 (1997) 95

Reversible Hopf bifurcations in four-dimensional maps, T.K. Roy and A. Lahiri, Phys. Rev. A44 (1991) 4937

Localisation and mobility edges in a one-dimensional lattice with a self-similar Feigenbaum structure, T.K. Roy and A. Lahiri, J. Phys.: Condens. Matter 3 (1990) 1153

Approximate formulae for the scattering of radiation from infinitely long homogeneous right circular cylinders, S.K. Sharma, T.K. Roy and D.J. Sommerford, J. Mod. Optics, 35 (1988) 1213

Effect of break-up channels on (d,pn) coincidence cross-section in post form break-up theories, R. Shyam, T.K. Roy and S. Mukherjee, Nucl. Phys. A491 (1989) 227

Deuteron break-up contributions to stripping and pick-up, T.K. Roy and S. Mukherjee, J. Phys. G13 (1987) 1239

Name: Shibaji Roy

Educational Background:

S.No.	Degree	Subjects	Marks Obtained (class)	Year	University
1.	B.Sc.(Hons.)	Physics (main) Chemistry Mathematics	65.4% (1st)	1981	Presidency College Calcutta Univ.
2.	M.Sc.	Physics	71.4% (1st)	1983	Calcutta Univ.
3.	Ph.D.	High Energy & Math. Phys.		1991	Univ. Rochester NY, USA

Post-Doc. Experience:

S.No.	Year (from-to)	Institute	Place & Country
1.	1991-93	International Centre for Theoretical Physics	Trieste, Italy
2.	1993-95	Univ. of Groningen	Groningen, The Netherlands
3.	1995-97	Univ. of Santiago de Compostela	Santiago de Compostela, Spain

Work Experience:

S.No.	Period	Place of Employment	Designation
1.	Aug 97 - Aug 00	Saha Institute of Nuclear Physics	Reader
2.	Aug 00 - Feb 04	-Do-	Associate Professor
3.	Feb 04 - till date	-Do-	Professor

Essential Strength of Research Output:

My research has been in the various aspects of string theory and M-theory. In recent years I have worked on non-perturbative symmetries and using that we have constructed different bound state solutions in string theory. We have used AdS/CFT type correspondence to obtain various gauge theories they correspond to. We have taken Penrose limit to some of these bound states and obtained information about some gauge theories which are otherwise difficult to obtain. We have also constructed non-supersymmetric brane solutions (both time dependent and static) in string theory and M-theory. Time dependent solutions were used to study certain interesting cosmological solution in four dimensions. The static solutions were used to study the open string as well as closed string tachyon condensation in string theory. Recently we have used AdS/CFT correspondence to study energy loss of a quark moving in hot plasma from string theory calculations.

Future Research Plan:

My future research will be to continue to the study of non-supersymmetric branes and how they can be used to study the gauge theory/string theory correspondence and the entropy calculation of nonsupersymmetric black holes. We would like to understand the phase structure of both relativistic and non-relativistic black branes and see how they can shed light on the phase transition on the gauge theory side or some condensed matter systems after taking the near horizon limit. Also, we are interested to study the fluid/gravity correspondence for the brane bound state solutions and see how to extract various transport parameters for the fluid they correspond to.

List of Important Publications:

1. J. X. Lu, S. Roy, Z. L. Wang and R. J. Wu, "Intersecting non-SUSY branes and closed string tachyon condensation," Nucl. Phys. B **813** (2009) 259.

2. J. X. Lu and S. Roy, "Delocalized non-SUSY p-branes, tachyon condensation and tachyon matter", JHEP **11** (2004) 008.

3. S. Roy, "Accelerating cosmologies from M/String theory compactifications", Phys. Lett. **B567** (2003) 322.

4. S. Roy, On supergravity solutions of space-like Dp-branes", JHEP **0208** (2002) 025.

5. I. Mitra and S. Roy, "(NS5, Dp) and (NS5, D$(p+2)$, Dp) bound states in type IIB and type IIA string theories", JHEP **0102** (2001) 026.

6. J. X. Lu and S. Roy, "Non-threshold (F,Dp) bound states", Nucl. Phys. **B560** (1999) 181.

7. J. X. Lu and S. Roy, "An SL(2,Z) multiplet of type IIB superfivebranes", Phys. Lett. **B428** (1998) 289.

8. S. Panda and S. Roy, "BRST cohomology ring in $\hat{c}_M < 1$ NSR string theory", Phys. Lett. **B358** (1995) 229.

9. A. Das, W. -J. Huang and S. Roy, "Zero curvature condition and 2D gravity theories", Int. Jour. Mod. Phys. **A7** (1992) 3447.

10. P. K. Panigrahi, S. Roy and W. Scherer, "Canonical quantization of the interacting CP^1 nonlinear σ-model with the Chern-Simons term", Phys. Rev. **D38** (1988) 3199.

Bijay Kumar Agrawal

Educational background:

Degree	University/Institute	Year
B.Sc.	Kurukshetra University Kurukshetra, India	1986
M.Sc.	Kurukshetra University Kurukshetra, India	1988
Post M.Sc.	Institute of Physics Bhubaneswar,India	1989
PhD.	Institute of Physics Bhubaneswar,India	1995

Academic profile including earlier appointments, awards etc:

May 1996 - April 1997	Visiting Scientists	Bhabha Atomic Research Centre, Bombay India.
May 1997 - August 1997	Visiting Fellow	Institute of Physics, Bhubaneswar, India.
Sept.1997 – Sept. 2000	Research Associate	Saha Institute of Nuclear Physics, Kolkata India.
Nov.2001- Dec. 2004.	Post Doc.	Cyclotron Institute, Texas A\&M University, USA.

Essential strength of research output:

- We have resolved the issue that the energy density functional derived within the non-relativistic and relativistic mean field approaches yield quite different values for the incompressibility coefficient for the nuclear matter.
- We have demonstrated the necessity for the appropriate extension of the existing relativistic mean field models in order to explain simultaneously the properties of finite nuclei and the density dependence of the nuclear symmetry energy coefficient.
- Extended version of the relativistic mean field theory is shown to describe better the properties of the super heavy nuclei.
- Nuclear giant multipole resonances are studied using fully self-consistent Hartree-Fock based random-phase approximation.
- We pointed out for the first time that most of the calculations performed using Hartree-Fock based random-phase approximation to

determine the energies of the nuclear giant multipole resonances suffer from large errors due to the lack of Self-consistency.

Future research plan:

We would like to develop an improved energy density functional which can be reliably employed for the accurate description of the wide variety of phenomena in finite nuclei.

List of important publications:

1. Asymmetric nuclear matter and neutron-skin in extended relativistic mean field model, B. K. Agrawal, Phys. Rev. C81, 034323(2010).
2. Equations of state and stability of color-superconducting quark matter cores in hybrid stars, B. K. Agrawal, Phys. Rev. D81, 023009 (2010).
3. Correlations in the properties of static and rapidly rotating Compact stars B. K. Agrawal, Raj Kumar and S. K. Dhiman, Phys. Rev. D77, 087301 (2008).
4. Effects of ω meson self-coupling on the properties of finite nuclei and neutron stars, Raj Kumar, B. K. Agrawal and S.K. Dhiman, Phys. Rev. C74, 034323 (2006).
5. Effects of self-consistency violation in Hartree-Fock RPA Calculations for nuclear giant resonances revisited, Tapas Sil, S. Shlomo,B. K. Agrawal and P.-G. Reinhard, Phys. Rev. C73, 034316 (2006).
6. Determination of the parameters of a Skyrme type effective interaction using the simulated annealing approach, B.K. Agrawal, S. Shlomo and V. Kim Au, Phys. Rev.C72, 014310 (2005).
7. Consequences of self-consistency violations in Hartree-Fock random-phase approximation calculations of the nuclear breathing mode energy B. K. Agrawal and S. Shlomo, Phys. Rev. 70, 014308 (2004).
8. Nuclear matter incompressibility coefficient in relativistic and nonrelativistic microscopic models, B. K. Agrawal, S. Shlomo and V. Kim Au, Phys. Rev. C68, 031304(R) (2003).
9. Self-consistent Hartree-Fock based random phase approximation and the spurious state mixing, B. K. Agrawal, S. Shlomo and A. I. Sanzhur, Phys. Rev.C67,034314(2003).
10. Equation of state of finite nuclei and liquid-gas phase transition J. N. De, B. K. Agrawal and S. K. Samaddar, Phys. Rev. C59, R1 (1999).

Name: Bireswar Basu-Mallick

Educational backgrounds: B. Sc. (Physics Hons.) from Presidency College, Calcutta University; M. Sc. in Physics from Calcutta University; Ph. D. in Physics from Calcutta University (work done in Saha Institute of Nuclear Physics).

Academic Profile: Worked as a Post-doctoral Fellow in Institute of Mathematical Sciences, Chennai, India, as a Visiting Fellow in Tata Institute of Fundamental Research, Mumbai, India, and as a JSPS Post-doctoral Fellow in University of Tokyo, Japan.

Obtained JSPS Post-doctoral Fellowship from the Japanese Society for the Promotion of Science for the years 1997-1999; awarded Senior Associateship of The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy for the years 2008-2013.

Highlights of recent research output:

1. Found a novel connection between the bound states of quantum integrable derivative nonlinear Schrödinger model and Farey sequence in number theory.

2. Found new solutions of Calogero model with nontrivial boundary conditions by using the method of self-adjoint extension.

3. Derived exact partition function of the $su(m|n)$ supersymmetric Haldane-Shastry spin chain and established a boson-fermion duality relation for this spin chain by using the representation theory of Yangian quantum group.

4. Studied the low energy excitations of the supersymmetric Haldane-Shastry spin chain and shown that such excitations for $SU(m|1)$ spin chain are described by a conformal field theory of m non-interacting Dirac fermions which have only positive energies.

5. Found exact spectra of spin Calogero model and spin Sutherland model associated with the D_N type of root system and computed the exact partition functions of the related spin chains by taking the freezing limit.

Future research plan:

I would like to continue my research on quantum integrable spin chains and dynamical models with long-range interaction. In particular, I would like to study the connection of this class of quantum integrable systems with generalized exclusion statistics and Yangian quantum groups, field theoretical limits of these systems and statistical properties of their spectra like energy level distribution and nearest neighbor spacing distribution. I am also interested in exploring the connection between the bound states of some quantum integrable systems with short-range interactions and number theory.

List of important publications:

1. B. Basu-Mallick, F. Finkel and A. Gonzalez-Lopez: The spin Sutherland model of D_N type and its associated spin chain, arXiv:0909.2968

2. B. Basu-Mallick, F. Finkel and A. Gonzalez-Lopez: Exactly solvable D_N-type quantum spin models with long-range interaction, Nucl. Phys. B812 (2009) 402.

3. B. Basu-Mallick, Nilanjan Bondyopadhaya and Diptiman Sen: Low energy properties of the $SU(m|n)$ supersymmetric Haldane-Shastry spin chain, Nucl. Phys. B 795 (2008) 596.

4. B. Basu-Mallick, Nilanjan Bondyopadhaya, Kazuhiro Hikami and Diptiman Sen: Boson-fermion duality in $SU(m|n)$ supersymmetric Haldane-Shastry spin chain. Nucl. Phys. B 782 (2007) 276.

5. B. Basu-Mallick and Nilanjan Bondyopadhaya: Exact partition function of $SU(m|n)$ supersymmetric Haldane-Shastry spin chain, Nucl.Phys. B757 (2006) 280.

6. Bireswar Basu-Mallick and Kazuhiro Hikami: Supersymmetric spin chain, published in *Concise Encyclopedia of Supersymmetry,* Kluwer Academic, 2004 (Eds. W. Siegel, J. Bagger and S. Duplij), page 452.

7. B. Basu-Mallick, Pijush K. Ghosh and Kumar S. Gupta: Novel quantum states of the rational Calogero models without the confining interaction, Nucl. Phys. B 659 (2003) 437.

8. B. Basu-Mallick and Tanaya Bhattacharyya: Jost solutions and quantum conserved quantities of an integrable derivative nonlinear Schrödinger model, Nucl. Phys. B 668 (2003) 415.

9. B. Basu-Mallick, Tanaya Bhattacharyya and Diptiman Sen: Novel multi-band quantum soliton states for a derivative nonlinear Schrödinger model, Nucl. Phys. B 675 (2003) 516.

10. B. Basu-Mallick: Spin dependent extension of Calogero-Sutherland model through anyon like representations of permutation operators, Nucl. Phys. B 482 (1996) 713.

Name: **Amit Ghosh**
Educational background: M.Sc., Ph.D. (physics)

Academic profile:

1. Ph.D., SINP, 1997
2. Postdoctoral Fellow, CERN, Geneva, 1997 – 1999
3. Postdoctoral Fellow, Center for geometry and gravitational physics, Penn State University, USA, 1999-2002
4. Faculty, SINP, since 2002

Research:

1. Ph.D. : 1992 – 1997
    1. Quantum field theories in 1+1 dimensions : A 1-parameter family of Schwinger model is shown to exist where in the infinite limit of the parameter the Fermions become free. These models are applied to the scattering of massless fermions off a magnetically charged dilatonic black hole in 1+1 dimensions and it is shown that the standard loss of unitarity occurs.
    2. Quantum black holes in 3+1 dimensions : It is shown that a nonzero entropy can be assigned to the 'singular-horizon' BPS solutions in string theory. This is extended to non-singular extremal Reissner-Nordtroem black holes also. The nonzero entropy of such a black hole is shown to arise from Euclidean path integrals where a sum over topologies is needed and the extremal limit is to be taken 'after' quantization.
2. CERN : 1997 – 1999
    1. Black hole entropy : 1-dimensional gas model for black holes. One of the first attempt to show that it may be possible to study QGP phase transition from a gas of 5-dimensional AdS-Schwarzschild black holes obeying a Van-der-Waals like equation of state.
    2. String cosmology : Tensor and scalar perturbations are studied in open pre-big-bang cosmology. 1-loop back reactions due to particle productions to inflation are studied in pre-big-bang phase which may help the universe to exit to a FRW phase.
3. Penn State : 1999 – 2002
    1. Black hole entropy : Near-horizon conformal structures are analyzed. It is shown that the Virasoro algebra arises as a subalgebra of diffeomorphisms for vector fields that are not smooth on the horizon. For smooth vector fields, the central extension vanishes.
    2. Quantum field theory on spin networks : QED on spin networks is formulated.
4. SINP : 2002 – 2010
    1. Counting of spin network states of black holes : A method for finding the distribution of spin-states whose contribution to entropy dominates significantly over others is suggested. An expansion off the dominant distribution gives the log-correction.
    2. Thermodynamics of black hole horizons : Study of local thermodynamic properties of horizons. The phase space of a generic black hole horizon also includes the extremal horizons. It shows that the bulk thermodynamic properties keep a blind eye to the extremal and non-extremal cases.
    3. Local symmetries of black hole horizons : An important issue to formulate an effective theory for a quantum black hole. It rules out SU(2) Chern-Simons theories.

Future plan:

1. Non-perturbative properties of quantum field theories : Several curious connections, perhaps accidental, between gravity and non-perturbative gauge theories have been found recently in the context of AdS/QCD. This is unclear why this should happen. So it needs a thorough investigation.
2. Quantum black holes and gravity : Hawking radiation from local quantum horizons. Quantum states of black holes in any quantum theory of gravity (beyond an effective theory). Quantization of Riemannian structure irrespective of any unification.

Selected list of publications:

1. Local symmetries of non-expanding horizons.
   Rudranil Basu, Ayan Chatterjee, Amit Ghosh. Apr 2010.
   e-print: arXiv:1004.3200[gr-qc]
2. Laws of Black Hole Mechanics from Holst Action.
   Ayan Chatterjee, Amit Ghosh. Dec 2008.
   Published in Phys.Rev.D80:064036,2009.
   e-print: arXiv:0812.2121[gr-qc]
3. Fine-grained state counting for black holes in loop quantum gravity.
   A. Ghosh, P. Mitra. Sep 2008.
   Published in Phys.Rev.Lett.102:141302,2009.
   e-print: arXiv:0809.4170[gr-qc]
4. Polymer QED.
   Amit Ghosh. Mar 2007.
   International Workshop on Theoretical High Energy Physics, Roorkee, India, 2007.
   Published in AIP Conf.Proc.939:320-325,2007.
5. Counting black hole microscopic states in loop quantum gravity.
   A. Ghosh, P. Mitra. May 2006.
   Published in Phys.Rev.D74:064026,2006.
   e-print: hep-th/0605125
6. An Improved lower bound on black hole entropy in the quantum geometry approach.
   A. Ghosh, P. Mitra. Nov 2004.
   Published in Phys.Lett.B616:114-117,2005.
   e-print: gr-qc/0411035
7. Black hole entropy calculations based on symmetries.
   Olaf Dreyer, Amit Ghosh, Jacek Wisniewski. Jan 2001.
   Published in Class.Quant.Grav.18:1929-1938,2001.
   e-print: hep-th/0101117
8. Back reaction to dilaton driven inflation.
   A. Ghosh, R. Madden, G. Veneziano. Aug 1999.
   Published in Nucl.Phys.B570:207-226,2000.
   e-print: hep-th/9908024
9. On the thermodynamics of a gas of AdS black holes and the quark hadron phase transition.
   John R. Ellis, A. Ghosh, N.E. Mavromatos. Feb 1999.
   Published in Phys.Lett.B454:193-202,1999.
   e-print: hep-th/9902190
10. Quantum fluctuations in open pre - big bang cosmology.
    A. Ghosh, G. Pollifrone, G. Veneziano. Jun 1998.
    Published in Phys.Lett.B440:20-27,1998.
    e-print: hep-th/9806233
11. Understanding the area proposal for extremal black hole entropy.
    A. Ghosh, P. Mitra Sep 1996.
    Published in Phys.Rev.Lett.78:1858-1860,1997.
    e-print: hep-th/9609006
12. Entropy for extremal Reissner-Nordstrom black holes.
    Amit Ghosh, P. Mitra. Nov 1994.
    Published in Phys.Lett.B357:295-299,1995.
    e-print: hep-th/9411128
13. Entropy in dilatonic black hole background.
    A. Ghosh, P. Mitra. Jun 1994.
    Published in Phys.Rev.Lett.73:2521-2523,1994.
    e-print: hep-th/9406210

1. **Name:** Prakash Mathews
2. **Present position:** Professor F
3. **Division:** Theory
4. **Academic qualifications: Ph.D.** (*IIT Kanpur*)
5. **Area of Research:** High Energy Physics
6. **Academic profile:**

- ***Earlier Appointments***

○ Associate Professor-E	Saha Inst. Nucl. Phys.	2004
○ Lecturer	University of Hyderabad	2001

- ***International Fellowships and Associateship***

○ **Associate** at the Abdus Salam International Center for Theoretical Physics, **Italy**, for the period Jan 2002 - Dec 2009.

○ **Commonwealth Fellow** at the Institute of Particle Physics Phenomenology, University of Durham, **UK**, Sept 2004 - Feb 2005.

○ **FAPESP Fellow** at the Instituto de Fisica Teorica, Sao Paulo, **Brazil**, Oct 1999 - June 2001.

7. Current Research Interest:

High Energy Physics Phenomenology, with special emphasis on Physics beyond the Standard Model and perturbative QCD.

Collider signatures of physics beyond the Standard Model

○ Extra dimension models ○ Unparticle physics ○ Excited leptons ○ Non commutative space-time etc.

Quantum Chromodynamics

○ Higher order QCD corrections to some beyond Standard Model process ○ Using NRQCD to study heavy quarkonium production ○ Polarised and unpolarised structure functions of proton and photon.

8. Important recent contributions:

• NLO-QCD corrections to extra dimension models:

In a series of recent papers we for the ***first time*** **evaluated next-to-leading order QCD corrections for both large extra dimension and warped extra dimension models**.

Colliders currently in operation are hadron colliders (Tevatron and LHC) and to make quantitative predictions it is mandatory to have the QCD effects under control— this has been our main effort off late. *Stabilisation of the various physical observables with respect to the factorisation and renormalisation scales at NLO is an important result.*

These NLO-QCD corrections substantially reduces the theoretical uncertainties and are essential for extra dimensional searches at hadron colliders. Our results are being used by the experimental collaborations CDF and DØ at Tevatron and the CMS collaboration at LHC for their studies.

- **Collider phenomenology of beyond Standard Model physics:**

We have studied the various beyond Standard Model scenarios *viz.* extra dimensions, unparticle physics, excited leptons and non commutative space time and looked at collider signatures at the various colliders *viz.* hadron, linear collider including the γ-γ option and the eP collider. We have constrained the extra dimension model parameters using data from Tevatron and HERA, using both direct and indirect searches of extra dimensions.

9. List of Important Publication:

- Direct photon pair production at the LHC to $\mathcal{O}(\alpha_s)$ in TeV scale gravity models, ***Nucl. Phys. B818 (2009) 28***, M. C. Kumar, P. Mathews, V. Ravindran, A. Tripathi.
- Unparticle physics at hadron collider via dilepton production, ***Phys. Lett. B657 (2007) 198***, P. Mathews, V. Ravindran, **Cited 80 times**
- Next-to-Leading Order QCD corrections to the Drell-Yan Cross section in models of TEV-Scale Gravity, ***Nucl. Phys. B713 (2005) 333***, P. Mathews, V. Ravindran, K. Sridhar and W. L. van Neerven. **Cited 38 times**
- Direct Signals for Large Extra Dimensions in the Production of Fermion Pairs at Linear Colliders, ***Phys. Rev. D64 (2001) 035005***, O. J. P. Eboli, M. B. Magro, P. Mathews and P. G. Mercadante.
- Compton scattering in noncommutative space-time at the NLC, ***Phys. Rev. D63 (2001) 075007***, P. Mathews. **Cited 39 times**
- Probing Large Extra Dimensions Using Top Production in Photon-Photon Collisions, ***Phys. Lett. B461 (1999) 196***, P. Mathews, P. Poulose and K. Sridhar.
- Testing TeV scale quantum gravity using dijet production at the Tevatron, ***JHEP 0007 (2000) 008***, P. Mathews, S. Raychaudhuri and K. Sridhar. **Cited 56 times**
- Large extra dimensions and deep-inelastic scattering at HERA, ***Phys. Lett. B455 (1999) 155***, P. Mathews, S. Raychaudhuri and K. Sridhar. **Cited 62 times**
- Getting to the top with extra dimensions, ***Phys. Lett. B450 (1999) 343***, P. Mathews, S. Raychaudhuri and K. Sridhar. **Cited 81 times**
- J/Ψ Spin Asymmetries in the Colour-Octet Model, ***Phys. Rev. D55 (1997) 7144***, S. Gupta and P. Mathews.
- Bloch-Nordsieck Thermometers: One-loop Exponentiation in Finite Temperature QED, ***Nucl. Phys. B458 (1996) 189***, S. Gupta, D. Indumathi, P. Mathews and V. Ravindran.

Name: Harvendra Singh
Present Position : Professor 'F' **Division/Section**: Theory, SINP
Qualification/Year: Ph.D, IOP Bhubaneswar, 1998

Academic Profile

I) Permanent positions held:

Assistant Professor at IIT, Guwahati, July 2003 - January 2005 .

II) Visiting positions held:

Sl. #	Positions held	Uni./Inst.	Duration
1.	Research Collaborator	NUS, Singapore	15.9.05-30.9.05
2.	Junior Associate	ICTP, Trieste	01.5.06-25.6.06
3.	Junior Associate	ICTP, Trieste	26.6.08-07.8.08
4.	Visitor	CERN, Geneva	08.8.08-23.8.08

III) Post-doctoral positions:

Sl. #	Position held	Univ./Inst.	From	To
1.	INFN Fellow	INFN/Univ. of Padova (Italy)	1997	1999
2.	Research Associate	Saha Institute of Nuclear Physics	1999	2000
3.	Humboldt Fellow	Univ. of Halle (Germany)	2000	2002
4.	Visiting Fellow	HRI, Allahabad	2002	2003

IV) Awards, honours or distinctions: INFN Fellowship (1997-99), Humboldt Fellowship (2000-02), ICTP Associateship (since 2005)

Essential Strength of Research Output

During my beginning years I mainly worked upon duality symmetries of the string effective action with cosmological constant. During subsequent years I worked on many concurrent topics; like AdS/CFT correspondence, aspects of non-commutativity, flux compactifications, PP-waves spacetimes etc. Particularly, we studied $SU(2) \times SU(2)$ $D = 4, N = 4$ gauged supergravity and constructed new supersymmetric vacuas; namely $AdS_3 \times R^1$ *axio-vac* and 1/2-supersymmetric domain-wall solutions. Significantly, subsequently Cowdall & Townsend found that our *axio-vac* solution could be obtained as the near horizon limit of the intersecting NS1-NS5-NS5 branes. The near horizon geometry of these branes is $AdS_3 \times S^1 \times S^3 \times S^3$. On the non-commutativity, we studied various NCOS and NCYM decoupling limits of D-brane bound states having explicit $B_{\mu\nu}$-field backgrounds. We studied the decoupling limits of $((F, D1), D3)$ bound state configurations and found the dual noncommutative Yang-Mills (NCYM) and noncommutative open-string theories (NCOS).

In the work with Louis and Haack, we provided an $O(4, 20)$ symmetric compactifications of the Romans' massive type-IIA supergravity on $K3$ in the presence of Ramond-Ramond 'fluxes'. An interesting observation was that the RR-fluxes and the mass parameter organized themselves into a vector of the duality group $O(4, 20)$. In this way fluxes and masses became *indistinguisable* from each other in $D = 6$ theory. In the subsequent works, we studied more compactifications of massive type IIA theory on T^2 and T^4 with RR-fluxes. Another important aspect of flux compactifications is that the fluxes generate potential for the moduli fields and thus lift the degeneracy of the string moduli space. The KKLT flux compactification to achieve a de Sitter vacua provided new direction towards cosmological model building. We focussed on the study of inflationary models with open-string tachyon playing the role of the inflaton. We have been able to show with relative success that 'assisted inflation', a slow-roll phenomenon, could be realised if we involve a large number of unstable Dp-branes in our model. We also studied 'geometric tachyon' inflationary models involving NS5-D3 branes.

Future Plans

Very recently BLG/ABJM type Chern-Simons matter field theories describing multiple M2-branes have been a subject of attention. These are new holographic CFTs dual to 11-dimensional anti-de Sitter spacetimes. We have made useful contribution in this research too. I have plan to further study matter Chern-Simons theories describing membranes. I am already working on a problem involving non-relativistic CFTs dual to propagating massive vector fields in Galilean AdS geometry. These Galilean spacetimes interestingly have time and space scaling differently and thus breaking the Lorentzian symmetry. These have some interesting condensed matter physics applications too.

Some Important Publications

1. H. Singh, "Galilean anti-de-Sitter spacetime in Romans theory," Phys. Lett. B **682**, 225 (2009) [arXiv:0909.1692 [hep-th]].

2. C. Krishnan, C. Maccaferri and H. Singh, "M2-brane Flows and the Chern-Simons Level," JHEP **0905**, 114 (2009) [arXiv:0902.0290 [hep-th]].

3. H. Singh, "SU(N) membrane $B \wedge F$ theory with dual-pairs," Phys. Lett. B **673**, 68 (2009) [arXiv:0811.1690 [hep-th]].

4. H. Singh, "M2-branes on a resolved C_4/Z_4," JHEP **0809**, 071 (2008) [arXiv:0807.5016 [hep-th]].

5. H. Singh, "(A)symmetric tachyon rolling in de Sitter spacetime: A universe devoid of Planck density," Nucl. Phys. B **734**, 169 (2006) [arXiv:hep-th/0508101].

6. H. Singh, "M5-branes with 3/8 supersymmetry in pp-wave background," Phys. Lett. B **543**, 147 (2002) [arXiv:hep-th/0205020].

7. H. Singh, "Duality symmetric massive type II theories in D = 8 and D = 6," JHEP **0204**, 017 (2002) [arXiv:hep-th/0109147].

8. M. Haack, J. Louis and H. Singh, "Massive type IIA theory on K3," JHEP **0104**, 040 (2001) [arXiv:hep-th/0102110].

9. J. X. Lu, S. Roy and H. Singh, "((F, D1), D3) bound state, S duality and noncommutative open string / Yang-Mills theory", JHEP **0009**, 020 (2000) [arXiv:hep-th/0006193].

10. H. Singh, "New supersymmetric vacua for D = 4, N = 4 gauged supergravity," Phys. Lett. B **429**, 304 (1998) [arXiv:hep-th/9801038].

11. S. Kar, J. Maharana and H. Singh, "S duality and cosmological constant in string theory," Phys. Lett. B **374**, 43 (1996) [arXiv:hep-th/9507063].

12. R. Parwani and H. Singh, "The Pressure of hot (g**2 phi**4) theory at order g**5," Phys. Rev. D **51**, 4518 (1995) [arXiv:hep-th/9411065].

Astroparticle physics & cosmology division

1. Summary of the research activity and list of publications.
2. Individual profiles of the faculty members:

AstroParticle Physics & Cosmology (APC) Division :

Preamble:

This is a newly created Division (formed in May 2010) in the Institute, with faculty members drawn from the existing Theory Division and the erstwhile India-based Neutrino Observatory (INO) Section of the Instiute. One new faculty member, Dr. Mala Das, has joined the Division in July 2010.

The mandate of this new Division is to "engage in theoretical and experimental/observational research in various areas of AstroParticle Physics involving topics in the interfaces of Cosmology, Particle Physics, Neutrino Physics and Astrophysics". This new Division has emerged from the "Centre for AstroParticle Physics" (CAPP) which came into existence during the 11-th Plan period (2007–2012). The goal of CAPP is to foster interdisciplinary reasearch in the area of Astroparticle Physics. The CAPP now functions as a "Centre" under the APC Division, and has Associate Members from the APC Divison, the Theory Division and the (Applied) Nuclear Physics Division.

Scientific		**Technical**	**Adm/Auxilliary**
Pijushpani Bhattachajee	Sr. Prof.	None	None
Parthasarathi Majumdar	Sr. Prof.		
Debades Bandyopadhyay	Prof.		
Debasish Majumdar	Prof.		
Ambar Ghosal	Prof.		
Mala Das	Assoc. Prof.		

Ph. D. Students

Soumini Chaudhury, Srijit Bhattacharjee, Lab Saha, Rana Nandi, Susmita Kundu, Susnata Seth, Debabrata Adak, Anirban Biswas, Mainak Chakraborty, Abhishek Majhi

Post Doc. – None

Equipments for R&D work on Superheated Drop Detectors (SDD) used in the WIMP Dark Matter search experiment:

1. High Pressure Autoclave
2. Dry rotary pump
3. Microscope with analysis software
4. Agilent educational tool (CRO, waveform generator, multimeter, power supply, software for signal communication)
5. Hot cum cold bath
6. Ultrasonic bath
7. A 14" telescope
8. Oscilloscope
9. CdZnTe Detector for Double Beta Decay Experiment

Computational resources

1. A 8-node (32 processors) Blade server
2. 6 Blade servers

<u>Research Activities</u>:

In addition to ongoing research in several theoretical areas of astroparticle physics and cosmology (described in more details below), the APC Division has initiated new research activitties in the Institute in two major experimental/observational areas of contemporary interest in Astroparticle Physics, namely, (a) a WIMP (Weakly Interacting Massive Particle) Dark Matter search experiment using Superheated Drop Detectors (SDD), and (b) Observational High Energy Gamma Ray Astronomy using the High Altitude Gamma Ray (HAGAR) Telescope system located at Hanle, Ladakh (J&K).

For the Dark Matter search experiment, so far the main efforts have gone towards the development of the basic in-house laboratory facilities for carrying out the R&D work on SDDs. The CAPP-SINP Dark Matter search group is now a member of the ongoing international PICASSO Collaboration which is carrying out a WIMP Dark Matter search experiment using SDD in the SNOLab underground facility at Sudbury, Canada. [CAPP-SINP members involved: *Mala Das, Satyajit Saha, Sudeb Bhattacharya, Susnata Seth, Pijushpani Bhattacharjee*]

For the *Observational High Energy Gamma Ray Astronomy* programme, the CAPP-SINP group has recently joined the HAGAR Collaboration with members from the Tata Institute of Fundamental Research (TIFR), Mumbai, and Indian Institute of Astrophysics (IIA), Bangalore. This activity at SINP is currently in its beginning stages, and there is no result to report yet. [CAPP-SINP members involved: *Lab Saha, Pijushpani Bhattacharjee*]

CAPP has also procured a 14″ optical telescope for teaching and demonstration of fundamental concepts of astronomy and for outreach activities. An observatory dome is being set up on the roof of the Institute building for housing the telescope.

The APC Division members are also working on a variety of theoretical issues of contemprary interest in Astroparticle physics, including, to mention a few, the study of implications of self-consistent models of the phase space distribution of the dark matter in the Galaxy for the phenomenology of WIMP direct- and indirect detection, ultrahigh energy cosmic ray-, gamma ray- and neutrino astrophysics, study of exotic forms of matter such as hyperons and Bose-Einstein Condensates of Kaons in the dense interior of neutron stars and their possible observational consequences, thermal holography and black hole stability, entropy of isolated horizons etc.

More details of the specific experimental and theoretical activities being carried out are described below:

Important Results:

Experimental/observational research :

- **R&D on Superheated Drop Detectors (SDD) related to WIMP Dark Matter search experiment**: The basic infrastructure for fabrication of SDDs for radiation and particle detection has been developed. A SDD consists of drops of superheated liquid of low boiling point suspended in a viscous gel or in a polymer medium. When radiation or a particle is incident on a drop, a bubble of the gas phase of the liquid can be nucleated inside the drop if the energy deposition by the radiation or the particle in the liquid drop exceeds a certain critical energy which depends on the composition of the liquid and on its temperature and pressure. Bubbles above a critical size expand, sending accoustic waves through the medium which can be picked by suitable sensors placed on the wall of the detector. Analysis of the characteristics of the acoustic pulses — their amplitudes, pulse shapes, etc. can be used to discriminate between various kinds of particles initiating the bubble nucleation events. The detector can be made sensitive to some desired types of particles and at the same time insensitive to other types of particles and radiation by suitably controlling the ambient temperature and pressure of the liquid, which essentially changes the threshold energy of detection. SDDs are being used by the PICASSO Collaboration searching for WIMP Dark Matter particles, and the CAPP-SINP group is involved in R&D work towards the development of large mass, low background SDDs as well as simulation and data analysis studies.

  An active drop counting device using condenser microphone has been developed at the CAPP-SINP laboratory for recording of bubble nucleation events and measuring the acoustic pulse characteristics. Neutron energy spectrum of ^{252}Cf source has been measured using this active device with a SDD consisting of superheated drops of R114 ($C_2Cl_2F_4$; b.p. 3.7^oC) in a soft gel matrix. The analysis of pulse height of the signals at neutron- and gamma-ray sensitive temperatures has been shown to provide clear identification of and discrimination between neutron and gamma-ray induced events. In another study, the threshold degree of metastability of superheated liquid drop in polymer matrix for high energy heavy ion induced nucleation was studied in collaboration with Hokkaido University and HIMAC, Japan. Studies with different sensitive liquids and different supporting matrix to reduce the background radioactivity are also in progress.

Theoretical research:

- The dynamics of the dwarf spheroidal (dSph) galaxies in the gravitational field of the Galaxy has been investigated with particular reference to their susceptibility to tidal break-up. Based on the observed paucity of the dSphs at small Galactocentric distances, it is hypothesized that subsequent to the formation of the Milky Way and its satellites, those dSphs that had orbits with small perigalacticons were tidally disrupted, leaving behind a population that now has a relatively larger value of its average perigalacticon to apogalacticon ratio and consequently a larger value of its r. m. s. transverse to radial velocities ratio compared to their values at the time of formation of the dSphs. The implications of this hypothesis is studied for the phase space distribution of the dSphs and that of the dark matter (DM) halo of the Galaxy within the context of a self-consistent model in which the functional form of the phase space distribution of DM particles follows the King model i.e. the 'lowered isothermal' distribution and the potential of the Galaxy is determined self-consistently by including the gravitational cross-coupling between visible matter and DM particles. This analysis, coupled with virial arguments, yields an estimate of $\gtrsim 270\,\mathrm{km\,s^{-1}}$ for the circular velocity of any test object at galactocentric distances of $\sim 100\,\mathrm{kpc}$, the typical distances of the dSphs. The corresponding self-consistent values of the relevant DM halo model parameters, namely, the local (i.e., the solar neighbourhood) values of the DM density and velocity dispersion in the King model and its truncation radius, are estimated to be $\sim 0.3\,\mathrm{GeV/\,cm^3}$, $> 350\,\mathrm{km\,s^{-1}}$ and $\gtrsim 150\,\mathrm{kpc}$, respectively. Similar self-consistent studies with other possible forms of the DM distribution function will be useful in assessing the robustness of these estimates of the Galaxy's DM halo parameters.

- Upper limits on the ratio $f_{\mathrm{GRB/CCSN}}(z) \equiv R_{\mathrm{GRB}}(z)/R_{\mathrm{CCSN}}(z) \equiv f_{\mathrm{GRB/CCSN}}(0)(1+z)^{\alpha}$, the ratio of the rate, R_{GRB}, of long-duration Gamma Ray Bursts (GRBs) to the rate, R_{CCSN}, of core-collapse supernovae (CCSNe) in the Universe (z being the cosmological redshift and $\alpha \geq 0$), are derived by using the upper limit on the diffuse TeV–PeV neutrino background given by the AMANDA-II experiment in the South Pole, under the assumption that GRBs are sources of TeV–PeV neutrinos produced from decay of charged pions produced in $p\gamma$ interaction of protons accelerated to ultrahigh energies at internal shocks within GRB jets. For the assumed "concordance model" of cosmic star formation rate, R_{SF}, with $R_{\mathrm{CCSN}}(z) \propto R_{\mathrm{SF}}(z)$, the derived conservative upper limits are $f_{\mathrm{GRB/CCSN}}(0) \leq 5.0 \times 10^{-3}$ for $\alpha = 0$, and $f_{\mathrm{GRB/CCSN}}(0) \leq 1.1 \times 10^{-3}$ for $\alpha = 2$, for example. These limits are already comparable to (and, for $\alpha \geq 1$, already more restrictive than) the current upper limit on this ratio inferred from other astronomical considerations, thus providing a useful independent probe of and constraint on the CCSN-GRB connection. Non-detection of a diffuse TeV–PeV neutrino background by the up-coming IceCube detector in the South pole after three years of operation, for example, will bring down the upper limit on $f_{\mathrm{GRB/CCSN}}(0)$ to below few $\times 10^{-5}$ level, while a detection will confirm the hypothesis of proton acceleration to ultrahigh energies in GRBs and will potentially also yield the true rate of occurrence of these events in the Universe.

- Direct detection of Weakly Interacting Massive Particle (WIMP) candidates of Dark Matter (DM) is studied within the context of a self-consistent truncated isothermal model of the finite-size dark halo of the Galaxy. The halo model, based on the "King model" of the phase space distribution function of collisionless DM particles, takes into account the modifications of the phase-space structure of the halo due to the gravitational influence of the observed visible matter in a self-consistent manner. The parameters of the halo model are determined by a fit to a recently determined circular rotation curve of the Galaxy that extends up to ~ 60 kpc. Unlike in the Standard Halo Model (SHM) customarily used in the analysis of the results of WIMP direct detection experiments, the velocity istribution of the WIMPs in this model is non-Maxwellian with a cut-off at a maximum velocity that is self-consistently determined by the model itself. For the model that provides the best fit to the rotation curve data, the 90% C.L. upper limit on the WIMP-nucleon spin-independent cross section from the recent results of the CDMS-II experiment, for example, is $\sim 5.3 \times 10^{-8}$ pb at a WIMP mass of ~ 71 GeV. It is also found, using the original 2-bin annual modulation amplitude data on the nuclear recoil event rate seen in the DAMA experiment, that there exists a range of small WIMP masses, typically $\sim$ 2 – 16 GeV, within which DAMA collaboration's claimed annual modulation signal purportedly due to WIMPs is compatible with the null results of other experiments. These results, based as they are on a self-consistent model of the dark matter halo of the Galaxy, strengthen the possibility of low-mass ($\lesssim 10\,\mathrm{GeV}$) WIMPs as a candidate for dark matter as indicated by several earlier studies performed within the context of the SHM.

- The canonical partition function of quantum gravitating systems with horizons is shown to be completely described by the *boundary* partition function. This leads to a general criterion for thermal stability of black holes derived without any use of classical spacetime geometry. Asymptotically flat black holes are generically seen to violate this inequality, while for AdS black holes, stability is acquired in a region of parameter space, whose boundary signifies a generalized Hawking-Page phase transition characterized by a divergent heat capacity.

- Isolated horizons are shown to be described by an $SU(2)$ Chern Simons theory gauge fixed to $U(1)$ with appropriate additional constraints on the $U(1)$ sources that reveal their $SU(2)$ underpinning. Depending upon how bulk local Lorentz invariance is gauge fixed, they can also be described by an $ISO(2)$ theory gauge fixed to $U(1)$ with appropriate additional constraints. The entropy count is argued to correspond to precisely the same area law with the same logarithmic corrections as found a decade ago.

- Electrodynamics is formulated based on a fundamental physical vector potential which is divergenceless but has no gauge freedom. The free photon propagator is manifestly gauge free in this formulation. The Abelian Higgs model yields a physical spectrum without having to choose any gauge. The Coleman-Weinberg phenomenon for scalar QED yields a *physical* scalar/vector mass ratio in contrast to the original, *gauge-dependent* one. Generalization to linearized gravity and 2 form fields is demonstrated.

- Gravitational radiation drives the r-modes unstable due to Chandrasekhar-Friedman-Schutz mechanism. This instability may play an important role in regulating spins of young neutron stars as well as old, accreting neutron stars in low mass x-ray binaries and provides clues to the absence of very fast rotating neutron stars in nature. The r-mode instability may be damped by the large bulk viscosity coefficient due to non-leptonic processes around temperature 10^{10} K. In this connection, the bulk viscosity coefficients and damping time scales due to non-leptonic processes $n + p \rightleftharpoons p + \Lambda$ and $n \rightleftharpoons p + K^-$ in K^- condensed matter and its influence on the r-mode instability in neutron stars is investigated. It is noted that the bulk viscosity due to the non-leptonic process involving K^- mesons in the condensate alone could not damp the r-mode instability. However the bulk viscosity due to the non-leptonic processes involving hyperons in K^- condensed matter effectively damp the r-mode instability in neutron stars.

- The problem of extracting information about composition and equation of state (EoS) of dense matter in neutron star interior using axial w-modes has been studied. The EoS with kaon condensates may lead to the appearance of a new stable branch of superdense stars, called the third family, beyond the neutron star branch. It is found that first axial w-mode frequencies of superdense stars in the third family are higher than those of the corresponding stars in the neutron star branch. Consequently neutrons stars might be distinguished from superdense stars of the third family.

- The neutral components of the extra doublet added to the Standarnd Model (Inert Doublet Model) are stable and can be considered as probable candidate of Cold Dark Matter. The detection rates calculations are made for three different types of Dark Matter experiments, namely, 76 Ge (like GENIUS), DAMA (NaI) and XENON (131 Xe).

- The rates of upward going muons induced by neutrinos from Weakly Interacting Massive Particle (WIMP) annihilation products in the sun are computed The recent CDMS bounds on WIMPnucleon scattering cross-sections for different WIMP masses are used in our rate calculation. It is observed that representation of SK upper bounds on WIMP induced up-going muon rates allows an enhancement in the calculated rates in all individual channels. An estimation of this enhancement has been made as a function of WIMP mass assuming branching fractions for each different channels to be 1 (maximum).

- A simplest extension of the Standard Model is considered through the incorporation of a real scalar singlet and an additional discrete Z_2 symmetry. The model admits the neutral scalar singlet to be stable and thus, a viable component of dark matter. The parameter space of the model is explored keeping in view the constraints arise from different dark matter direct detection experiments like CDMS, XENON-10 and XENON-100, CoGeNT etc.

- Direction sensitive direct detection of Weakly Interacting Massive Particles as Dark matter would provide an unambiguous non-gravitational signature of Dark Matter (DM). The directional detection rates are calculated with their daily and yearly modulations in a earth-bound dark matter experiments considering detailed features of the geometry and dynamics of the earth-sun system along with the solar motion in galactic frame.

- Possibility of identifying the deviation from tribimaximal mixing in neutrino mass matrix texture is investigated considering ultrahigh energy (UHE) neutrinos from Gamma Ray Bursts (GRBs) considering a ratio of number of muon tracks to the shower generated due to electrons and hadrons. Analysis shows that it is very difficult to detect such deviation in case of possible detection of UHE neutrinos at ICECUBE.

- Deviation from tribimaximal mixing through generation of nonzero U_{e3} within the framework of see-saw mechanism and Zee mechanism and corresponding allowed CP violation , $m_{\nu ee}$ in the context of a modified Altarelli-Feruglio A_4 symmetric model.

- 'Four zero' Yukawa coupling matrix coupled with 'Mu-tau' symmetry has been investigated within the framework of type-I seesaw mechanism. The number of allowed textures drastically reduces to only 'four' out of 'seventy two' possible forms. We have studied the prameter space allowed by present oscillation data and further generation of nonzero U_{e3} through RG group running.

- A further detailed study on generation of baryon asymmetry due to leptogenesis is also investigated.

List of Publications

1. *Generalized Hawking-Page phase transition*, Parthasarathi Majumdar, Class. Quant. Grav. **24**, 1747 (2007).

2. *Bulk viscosity in kaon condensed matter*, Debarati Chatterjee and Debades Bandyopadhyay, Phys. Rev. **D 75** 123006 (2007).

3. *Exotic bulk viscosity and its influence on neutron star r-modes*, Debarati Chatterjee and Debades Bandyopadhyay, Astrophys. and Space Science **308** 451 (2007).

4. *Probing deviations from tri-bimaximal mixing through ultra high energy neutrino signals*, Debasish Majumdar and Ambar Ghosal, Phys. Rev. **D 75** 113004 (2007).

5. *Beta decay rates of nulclei with* $65 < A < 75$ *for presupernova and supernova evolution*, Debasish Majumdar and Kamales Kar, Pramana: J. Phys. **68** 423 (2007).

6. *Constraining CP violation in a softly broken* A_4 *symmetric Model*, B. Adhikary and A. Ghosal, Phys. Rev. **D75**, 073020 (2007).

7. *Dynamics of dwarf-spheroidals and the dark matter halo of the Galaxy*, R. Cowsik, Charu Ratnam, Pijushpani Bhattacharjee, Subhabrata Majumdar, New Astron. **12** 507 (2007).

8. *Critical temperature of antikaon condensation in nuclear matter*, S. Banik, W. Greiner and D. Bandyopadhyay, Phys. Rev. **C 78** 065804 (2008).

9. *Hyperon bulk viscosity in the presence of antikaon condensates*, D. Chatterjee and D. Bandyopadhyay, Astrophys. J. **680** 686 (2008).

10. *Dark matter candidate in a heavy Higgs model- direct detection rates*, Debasish Majumdar and Ambar Ghosal, Mod. Phys. Lett. **A 23** 2011 (2008).

11. *A GEANT-based study of atmospheric neutrino oscillation parameters at INO*, Abhijit Samanta, Sudeb Bhattacharya, Ambar Ghosal, Kamales Kar, Debasish Majumdar and Amitava Raychaudhuri, Int J. Mod. Phys. **A23** 233 (2008).

12. *Probing pseudo-Dirac neutrino through detection of neutrino induced muons from GRB neutrinos*, Debasish Majumdar, Pramana- J. Phys. **70** 51 (2008).

13. *Nonzero* U_{e3}*, CP violation and leptogenesis in a see-saw type softly broken* A_4 *symmetric model*, B. Adhikary and A. Ghosal, Phys. Rev. **D78**, 073007 (2008).

14. *Upper Limit on the Cosmic Gamma-Ray Burst Rate from High Energy Diffuse Neutrino Background*, Pijushpani Bhattacharjee, Sovan Chakraborty, Srirupa Das Gupta, Kamales Kar, Phys. Rev. **D77** 043008 (2008).

15. *An active drop counting device for superheated drop emulsion detector*, M. Das, A. S. Arya, C. Marick, D. Kanjilal and S. Saha, Rev. Sci. Instrum. **79**, 113301 (2008).

16. *Threshold ss of superheated drop emulsion detector to heavy ions*, Mala Das, Nakahiro Yasuda, Teruko Sawamura, Radiat. Meas. **43** S62 (2008).

17. *Probing dense matter in neutron stars with axial w mode*, D. Chatterjee and D. Bandyopadhyay, Phys. Rev. **D 80** 023011 (2009).

18. *Shear viscosity in antikaon condensed matter*, R. Nandi, S. Banik and D. Bandyopadhyay, Phys. Rev. **D 80** 123015 (2009).

19. *Hyperon bulk viscosity in strong magnetic fields*, M. Sinha and D. Bandyopadhyay, Phys. Rev. **D 79** 123001 (2009).

20. *Holography, Gauge-Gravity Connection and Black Hole Entropy*, Parthasarathi Majumdar, Int. J. Mod. Phys. **A24** 3414 (2009).

21. *Entropy of Isolated Horizons revisited*, Rudranil Basu, Romesh K. Kaul, Parthasarathi Majumdar, Phys. Rev. **D82**, 024007 (2010).

22. *'Mu-Tau' symmetry, tribimaximal mixing and four zero neutrino Yukawa textures,*, B. Adhikary, A. Ghosal and P. Roy, JHEP **0910** 040 (2009).

23. *Interpreting the bounds on Dark Matter induced muons at Super-Kamiokande in the light of CDMS data*, Abhijit Bandyopadhyay, Sovan Chakraborty, Debasish Majumdar, Int. J. Mod. Phys. **A25** 3741 (2010).

24. *Direct detection of WIMPs : Implications of a self-consistent truncated isothermal model of the Milky Way's dark matter halo*, Soumini Chaudhury, Pijushpani Bhattacharjee, Ramanath Cowsik, JCAP **1009** 020 (2010).

25. *Constraining scalar singlet dark matter with CDMS, XENON and DAMA and prediction for direct detection rates*, Abhijit Bandyopadhyay, Sovan Chakraborty, Ambar Ghosal and Debasish Majumdar, JHEP (accepted) (2010).

26. *Neutron-gamma discrimination by pulse analysis in superheated drop detector*, M. Das, S. Seth, S. Saha, S. Bhattacharya and P. Bhattacharjee, Nucl. Instrum. Meth. **A 622**, 196 (2010).

27. *Investigations on R134a as alternative sentitive liquid for superheated drop emulsion detector*, M. Das, R. Sarkar, P. K. Mondal, S. Saha, B. K. Chatterjee and S. C. Roy, Pramana - J. of Phys. (to appear) (2010).

28. *Circular Orbits in Extremal Reissner Nordstrom Spacetime*, Parthapratim Pradhan, Parthasarathi Majumdar, Phys. Lett. **A** (to appear) (2010).

PROFILE (August 2010)

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Male
Born : 20 October 1955
Nationality : Indian

Present Position and Address :

Sr. Professor 'H' & Head,	**Tel :**	+91-33-2337 5345 thru 49, x-3301
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KOLKATA-700 064. INDIA.		pijushpani@gmail.com

Educational Background :

- Ph.D. (Theoretical Physics) (1984) : Imperial College, University of London, London, England.
  Thesis : *Implications of phase transitions in the early universe* (1984) (Advisor : Prof. T.W.B. Kibble, FRS).
- Ph.D. (Physics) (1983) : Delhi University, Delhi, India.
  Thesis : *Application of Quantum Chromodynamics to quark matter* (1981) (Advisor : Prof. S.N. Biswas).
- M.Sc. (Physics) (1976) : Delhi University, Delhi, India : 1st Class.
- B.Sc. (Physics) (1974) : Gauhati University, Guwahati, Assam, India : 1st Class.

Major Fellowships, etc. :

- January 1997 – January 1999: U. S. National Academy of Sciences (NAS)/National Research Council (NRC) Resident Senior Research Associateship at the Laboratory for High Energy Astrophysics of NASA/Goddard Space Flight Center, Greenbelt, Maryland, USA.
- October 1980–January 1984 : "1851 Exhibition Fellowship" of the "1851 Royal Commission", London, England. Worked at the Theoretical Physics Group, The Blackett Laboratory, Imperial College, London, England.

Faculty Positions :

- November 2005 – present : Theory (now at AstroParticle Physics & Cosmology) Division, Saha Instituite of Nuclear Physics, Kolkata, India.
- November 1992– October 2005 : Indian Institute of Astrophysics, Bangalore, India.

Post-doctoral Positions :

- March 1989 – February 1992 : Astronomy & Astrophysics Center, Enrico Fermi Institute, University of Chicago, Chicago, USA,
  &
  NASA/Fermilab Astrophysics Center, Fermi National Accelerator Laboratory, Batavia, Illinois, USA
- May 1985 – February 1989 : Tata Institute of Fundamental Research, Bombay, India

Current areas of research :

- Topics, in general, on the interface areas between High Energy Particle Physics and Astrophysics/Cosmology.
- Nature and distribution of Dark Matter in the Galaxy.
- Physics and Astrophysics of Ultrahigh-energy (UHE) cosmic rays (CR), gamma rays and neutrinos
- Search for WIMP Dark Matter particles using Superheated (liquid) Droplet Detectors (Experiment).
- Observational High Energy Gamma Ray Astronomy using the HAGAR Gamma Ray Telescope system at Hanle, Ladakh.

Selected Publications :

- Direct detection of WIMPs : Implications of a self-consistent truncated isothermal model of the Milky Way's dark matter halo
  — Soumini Chaudhury, Pijushpani Bhattacharjee and Ramanath Cowsik,
  JCAP (2010, in press) [also available at *arXiv*:1006.5588].
- Upper Limit on the Cosmic Gamma-Ray Burst Rate from High Energy Diffuse Neutrino Background
  — P. Bhattacharjee, S. Chakraborty, S. Das Gupta, and K. Kar, *Phys. Rev.* D77, 043008 (2008).
- $B - L$ cosmic strings and baryogenesis
  — P. Bhattacharjee, N. Sahu and U. A. Yajnik, *Phys. Rev.* D70, 083534 (2004).
- The proton synchrotron model of TeV gamma ray bursts and their detectability by AMANDA/ICECUBE type detectors
  — P. Bhattacharjee and N. Gupta, *Astroparticle Phys.* 20, 169 (2003).
- Origin and Propagation of Extremely High Energy Cosmic Rays
  — P. Bhattacharjee and G. Sigl, *Physics Reports* 327, 109–247 (2000).
- Cosmic Topological Defects, Highest Energy Cosmic Rays, and the Baryon Asymmetry of the Universe
  — P. Bhattacharjee, *Phys. Rev. Lett.* 81, 260 (1998).
- Tev and Superheavy Particles from Supersymmetric Topological Defects, the Extragalactic Gamma Ray Background, and the Highest Energy Cosmic Rays
  — P. Bhattacharjee, Q. Shafi, and F.W. Stecker, *Phys. Rev. Lett.* 80, 3698–3701 (1998).
- Dispersion velocity of Galactic dark matter particles
  — R. Cowsik, C. Ratnam and P. Bhattacharjee, *Phys. Rev. Lett.* 76, 3886 (1996).
- Survivability of cosmological quark nuggets in the chromoelectric flux-tube fission model of baryon evaporation
  — P. Bhattacharjee, J. Alam, B. Sinha, and S. Raha, *Phys. Rev.* D48, 4630 (1993); D49, 4306 (1994) (Erratum).
- Grand unified theories, topological defects and ultrahigh-energy cosmic rays
  — P. Bhattacharjee, C.T. Hill, and D.N. Schramm, *Phys. Rev. Lett.* 69, 567 (1992).
- Cosmic strings and ultrahigh-energy cosmic rays
  — P. Bhattacharjee, *Phys. Rev.* D40, 3968–3975 (1989).
- Baryon number from collapsing cosmic strings
  — P. Bhattacharjee, T.W.B. Kibble, and N. Turok, *Phys. Lett.* B 119, 95 (1982).
- Possible existence of quark-stars
  — J. D. Anand, P. Bhattacharjee, and S. N. Biswas, *Jour. Phys.* A12, L347 (1979).

Parthasarathi Majumdar

- **Born :** 18 October 1953.
- **PhD :** Brandeis University (USA), 1981.
- **Postdoctoral :** Tata Inst of Fund Res (1981-83), Saha Inst of Nucl Phys (1983-85), Univ of Maryland (1987-89).
- **Faculty Appointments :** SINP (1985-91), Inst of Math Sciences (1991-2002), SINP (2002-now).
- **Currently :** Senior Professor 'H' (since 2004).
- **Research Highlights (since 2005) :**
  - Thermal holography and stability of quantum Schwarzschild black holes.
  - Gauge-free formulation of gauge theories and radiative Higgs effect.
  - Aspects of extremal black holes.
  - Two-form fields in a Randall-Sundrum scenario.
- **Research Projects (ongoing and future):**
  - Infrared instabilities in perturbative graviton-scalar field theory (ongoing).
  - Thermal holography and stability of charged and rotating quantum black holes (ongoing).
  - Possible violation of Lorentz invariance at Planckian energies (ongoing).
  - Gravitational Collapse and Horizon Quantization (started).
  - Extremal rotating black holes as possible Dark Matter candidates.
  - Gauge-free formulations in various contexts: super-Higgs effect, cosmological perturbations, QCD, two-form fields.
- **Teaching :** Have taught consistently during the last three decades at SINP, IMSc and, since 2007, also at St Xavier's College as Honorary Guest Faculty. Subjects taught include: Math Physics (SINP and SXC), Special Relativity (SXC), Electrodynamics (IMSc, SINP and SXC), Quantum Mechanics (SINP), Quantum Field Theory (IMSc and SINP), General Relativity (IMSc, SINP, SXC) and Supersymmetric Field Theories (IMSc).

- **PhD Supervision :** Soumitra Sengupta (1991) and Ayan Chatterjee (2009: co-supervised with Amit Ghosh) at SINP; Saurya Das (1997), Arundhati Dasgupta (1999) and Soumen Basak (2003) at IMSc. Currently supervising : Srijit Bhattacharjee, Abhishek Majhi and Partha Pradhan. Co-supervising : Rudranil Basu (with Prof. S. K. Paul, S N Bose Ctr.) and Oindrila Ganguly (with Prof. D. Gangopadhyay, S N Bose Ctr.)
- **List of Journal Publications (since 2005) :**
  - *Entropy of Isolated Horizons revisited*, Rudranil Basu, Romesh K. Kaul, Parthasarathi Majumdar. Published in Phys.Rev.D82:024007,2010. e-Print: arXiv:0907.0846 [gr-qc]
  - *Holography, Gauge-Gravity Connection and Black Hole Entropy*, Parthasarathi Majumdar, Published in Int.J.Mod.Phys.A24:3414-3425,2009. e-Print: arXiv:0903.5080 [gr-qc].
  - *Generalized Hawking-Page phase transition*, Parthasarathi Majumdar, (Saha Inst.). Published in Class.Quant.Grav.24:1747-1754,2007. e-Print: gr-qc/0701014.
  - *Kalb-Ramond field interactions in a braneworld scenario*, Ayan Chatterjee, Parthasarathi Majumdar. Published in Phys.Rev.D72:066013,2005. e-Print: hep-th/0507085.
  - *Universal criterion for black hole stability*, Ashok Chatterjee, Parthasarathi Majumdar. Published in Phys.Rev.D72:044005,2005. e-Print: gr-qc/0504064.
- **List of Conference Proceedings (since 2005) :**
  - *Holography, CFT and Black Hole Entropy*, Parthasarathi Majumdar. Invited talk at International Conference on Recent Developments in Theoretical Physics (THEOPHYS-07), Kolkata, India, 4-7 Dec 2007. Also, invited talk at Meeting on Non-Perturbative Gauge Theories and Gravity, Kolkata, West Bengal, India, 7-12 Jan 2008. e-Print: arXiv:0802.1398 [gr-qc]
  - *Quantum black holes: Entropy and thermal stability*, Parthasarathi Majumdar. Prepared for International Workshop on Theoretical High Energy Physics (IWTHEP 2007), Roorkee, UA, India, 15-20 Mar 2007. Published in AIP Conf.Proc.939:180-191,2007.
- **List of Papers Submitted :**
  - *Electroweak Theory without a Higgs potential: Radiative Effects*, Srijit Bhattacharjee, Parthasarathi Majumdar. e-Print: arXiv:1006.1712 [hep-ph] submitted to JHEP.
  - *Circular Orbits in Extremal Reissner Nordstrom Spacetimes*, Parthapratim Pradhan, Parthasarathi Majumdar, e-Print: arXiv:1001.0359 [gr-qc] submitted to JRG.
  - *Gauge-free Electrodynamics*, Parthasarathi Majumdar, Srijit Bhattacharjee. e-Print: arXiv:0903.4340 [hep-th] submitted to EPJC.

1. **Name : Debades Bandyopadhyay**
2. Date of birth: 16.06.1961
3. Present position: Professor 'G'
4. Division: Astroparticle Physics and Cosmology Division

5. Educational Qualifcations

1981 B.Sc. in Physics from Maulana Azad College, University of Calcutta.
1984 M.Sc. in Physics from the University of Calcutta.
1985 Post M.Sc. Associateship course in Physics, SINP.
1990 Ph.D. (Sc) degree from the University of Calcutta.

6. i. Academic profle including earlier employment

Oct. 1985-Sep. 90 Research Fellow in the Theory Division of SINP.
Sep. 1990- Sep. 91 Research Associate in the Theory Division of SINP.
Dec. 1991- May 93 Postdoctoral researcher at the Institute for Theoretical Physics, Frankfurt University, Germany.
Sep. 1993- July 97 Visiting Fellow in the Theory Division of SINP.
July 1997 Joined Reader(D) position in the Theory Division of SINP.
August 2001 Promoted to Associate Professor (E) position.
August 2005 Promoted to Professor (F) position.
August 2008 Promoted to Professor (G) position.

ii. Fellowships, Awards, honours or distinctions

December 1991- May 1993 Alexander von Humboldt Fellowship, Germany.
June 2003 - May 2005, Project based Personnel exchange Programme (PPP) of DST, India - DAAD, Germany.
Dec 2008- Nov 2011, Research Group Linkage Programme of Alexander von Humboldt Foundation, Germany.
11 January 2010 Foundation Day medal of Saha Institute of Nuclear Physics.

7. Essential strength of research/development output

My research interest focuses on neutron star physics. In particular, we are interested in novel phases of dense matter such as hyperons, Bose-Einstein condensates of antikaons and quarks in the neutron star interior. We obtained mass-radius relationship of rotating and nonrotating neutron stars including exotic matter such as hyperons, Bose-Einstein condensates of antikaons and quarks and found our results to be consistent with recent observations on neutron stars. Further we predicted a new family of compact stars, called the third family, including Bose-Einstein condensates of antikaons beyond the neutron star branch.
We investigated nonradial oscillations of neutron stars with exotic forms of dense matter and how detections of those pulsating modes such as r-modes and axial w-modes could be used to probe the neutron star interior. In this connection, we estimated bulk viscosities due to nonleptonic processes involving hyperons and antikaon condensate and showed that the kaon bulk viscosity might not damp the r-mode instability.

8. Future research/development plan

The influence of strong magnetic fields on the composition, equation of state and neutrino emissivity of neutron stars was investigated in relativistic mean field models by us. This has potential applications to neutron stars with strong magnetic fields called magnetars.
We plan to study neutron star crust in strong magnetic fields. In particular, we shall focus on the properties of nuclei and their stability in the inner crust in strong magnetic fields. Further we want to investigate the transport properties such as shear viscosity and its implication for gravity waves in neutron stars.
Magnetars might eject crustal matter due to tremendous magnetic stress on the crust. The ejected matter of the inner crust expands to much lower densities. It would be worth studying the decompression of the crustal matter which might lead to interesting phenomena.

9. List of selected publications

1. Shear viscosity in antikaon condensed matter, R. Nandi, S. Banik and D. Bandyopadhyay, **Phys. Rev. D80** (2009) 123015.
2. Probing dense matter in neutron stars with axial w-modes, D. Chatterjee and D. Bandyopadhyay, **Phys. Rev. D80** (2009) 023011.
3. Hyperon bulk viscosity in strong magnetic fields, M. Sinha and D. Bandyopadhyay, **Phys.Rev. D79** (2009) 123001.
4. Critical temperature of antikaon condensation in nuclear matter, S. Banik, W. Greiner and D. Bandyopadhyay, **Phys. Rev. C78** (2008) 065804.
5. Bulk viscosity and r-modes of neutron stars, D. Chatterjee and D. Bandyopadhyay, **Journal of Physics G35** (2008) 104078.
6. Hyperon bulk viscosity in the presence of antikaon condensate, D. Chatterjee and D. Bandyopadhyay, **Astrophysical Journal 680** (2008) 686.
7. Bulk viscosity in kaon condensed matter, D. Chatterjee and D. Bandyopadhyay, **Phys.Rev. D75** (2007) 123006.
8. Effect of hyperon-hyperon interaction on bulk viscosity and r-mode instability in neutron stars, D. Chatterjee and D. Bandyopadhyay, **Phys. Rev. D74** (2006) 023003.
9. Rotating compact stars with exotic matter, S. Banik, M. Hanauske, D. Bandyopadhyay and W. Greiner, **Phys. Rev. D70** (2004) 123004.
10. Color superconducting quark matter core in the third family of compact stars, S. Banik and D. Bandyopadhyay, **Phys. Rev. D67** (2003) 123003.
11. Bose-Einstein condensation in dense nuclear matter and strong magnetic fields, P. Dey, A. Bhattacharyya and D. Bandyopadhyay, **J. Phys. G28** (2002) 2179.
12. Third family of superdense stars in the presence of antikaon condensates, S. Banik and D. Bandyopadhyay, **Phys. Rev. C64** (2001) 055805.
13. Antikaon condensation and the metastability of protoneutron stars, S. Banik and D. Bandyopadhyay, **Phys. Rev. C63** (2001) 035802.
14. Antikaon condensation in neutron stars, S. Pal, D. Bandyopadhyay, W. Greiner, **Nucl. Phys. A674** (2000) 553.
15. Rapid cooling of magnetized neutron stars, D. Bandyopadhyay, S. Chakrabarty, P. Dey and S. Pal, **Phys. Rev. D58** (1998) 121301(R).
16. Quantizing magnetic field and quark-hadron phase transition in a neutron star, D. Bandyopadhyay, S. Chakrabarty and S. Pal, **Physical Review Letters 79** (1997) 2176.
17. Dense Nuclear Matter in a Strong Magnetic field, S. Chakrabarty, D. Bandyopadhyay and S. Pal, **Physical Review Letters 78** (1997) 2898.
18. Pion chemical potentials in Heavy Ion Collisions: Relativistic Quantum Molecular Dynamic Analysis, D. Bandyopadhyay, M. Gorenstein, H. Stöcker , W. Greiner and H. Sorge, Z. **Phy. C 58** (1993) 461.
19. Thermostatic properties of finite and infinite nuclear systems, D. Bandyopadhyay, C. Samanta, S.K. Samaddar and J.N. De, **Nucl. Phys. A511** (1990) 1.

1. Name, photograph, educational background

i) Name (in full) **DEBASISH MAJUMDAR**

ii) Educational Qualification M.Sc., Ph.D. (Physics)

2. Academic profile including earlier appointments

Examination	University/Institution	Year
Bachelor of Science (Physics Honours)	St. Xavier's College,Calcutta	1986
Master of Science (Physics)	Visva Bharati University West Bengal, India	1988
Doctor of Philosophy (Physics)	Physical Research Laboratory Ahmedabad, INDIA Thesis submitted to The Maharaja Sayajirao University of Baroda, Baroda, India, in December, 1994, Degree awarded in November, 1995	1995

Earlier appointments

1) Research Scholar at Physical Research Laboratory, Ahmedabad, INDIA, during the period August 1988 - December 1994.

2) Post Doctoral Fellow at Physical Research Laboratory, Ahmedabad, INDIA, during the period December 1994 - April 1995.

3) Post Doctoral Fellow at Institute of Physics, Bhubaneswar, INDIA, April 1995 - June 1997.

4) Research Associate at Department of Physics, University of Calcutta, Calcutta, INDIA, June 1997 - April 2000.

5) Senior Research Associate at Theory Division, Saha Institute of Nuclear Physics, Kolkata, India, May 2000 - April 2003.

6) Visiting Scientist, INO (India-based Neutrino Observatory) Section, Saha Institute of Nuclear Physics, Kolkata, India, May 2003 - March 2005.

7) Associate Professor E, INO Section, Saha Institute of Nuclear Physics, Kolkata, India, April 2005 - August 2007.

8) Professor F, Astroparticle Physics and Cosmology Division, Saha Institute of Nuclear Physics, (Present).

3. **Essential strength of research/development output**

- Theoretical investigation of the nature of Dark Matter and Dark Energy will help understanding these two important but enigmatic components of the universe
- Theoretical estimation of precision measurement capability of the still unknown neutrino parameters like θ_{13} mixing angle leptonic CP violation and/or mass hierarchy which all will add up to understand the physics beyond Standard Model of particle physics.

4. **Future research/development plan**

- Dark Matter Candidates and theoretical formalism for signatures of Dark Matter in the Dark Matter detection experiments. Understanding of some recent findings related to Dark Matter search. Dark Matter annihilations in gravitating bodies and the signatures of annihilation products.
- Understanding the Dark Energy problem and theoretical investigation for explaining Dark Energy and acceleration of the universe.
- Detailed physics study/simulation of neutrinos from neutrino factory with iron calorimeter (ICAL) at INO (India-based Neutrino Observatory) as end detector.

5. **List of important publications starting with recent publications**

- Abhijit Bandyopadhyay, Sovan Chakraborty, Ambar Ghosal, *Debasish Majumdar*, "Constraining Scalar Singlet Dark Matter with CDMS, XENON and DAMA and Prediction for Direct Detection Rates", Int. J. Mod. Phys. A, to appear.
- *Debasish Majumdar*, Ambar Ghosal, "Dark Matter candidate in a Heavy Higgs Model - Direct Detection Rates", Mod. Phys. Lett. **A23**, 2011 (2008).
- *Debasish Majumdar*, Ambar Ghosal, "Probing deviations from tri-bimaximal mixing through ultra high energy neutrino signals", Phys. Rev. **D75**, 113004 (2007).
- India-based Neutrino Observatory: Project Report. Volume I. By INO Collaboration (M.Sajjad Athar et al.). INO-2006-01, May 2006. 233pp.
- *Debasish Majumdar*, "Detection rates for Kaluza-Klein dark matter, Phys. Rev. **D67**, 095010 (2003).
- *Debasish Majumdar*, "Mass and scalar cross-sections for neutralino dark matter in anomaly mediated supersymmetry breaking model", J. Phys. **G28**, 2747 (2002).
- Srubabati Goswami, *Debasish Majumdar*, Amitava Raychaudhuri, "Solar neutrino rates, spectrum, and its moments: An MSW analysis in the light of Super-Kamiokande results, Phys. Rev. **D63**, 013003 (2001).
- Sandhya Choubey, Srubabati Goswami, *Debasish Majumdar*, "Status of the neutrino decay solution to the solar neutrino problem", Phys. Lett. **B484**, 73 (2000).
- *Debasish Majumdar*, Amitava Raychaudhuri "New variables for neutrino oscillation diagnostics at Super-Kamiokande and the Sudbury Neutrino Observatory" Phys. Rev. **D60** 053001 (1999).
- Sandhya Choubey, *Debasish Majumdar*, Kamales Kar, "Effect of flavor oscillations on the detection of supernova neutrinos" J. Phys. **G25**, 1001 (1999).
- V.K.B. Kota, *D. Majumdar*, "Bivariate distributions in statistical spectroscopic studies: III. Non interacting particle strength densities for one-body transition operators", Z. Phys. **A351**, 365-376 (1995).
- V.K.B. Kota, *D. Majumdar*, "Bivariate distributions in statistical spectroscopic studies: IV. Interacting particle Gamow-Teller strength densities and β-decay rates of fp-shell nuclei for presupernova stars", Z. Phys. **A351**, 377-384 (1995).
- V.K.B. Kota, *D. Majumdar*, R. Haq and R.J. Leclair, "Bivariate Densities in a Partitioned Embedded Ensemble with Configuration Mixing: A Shell Model Example", Can. J. Phys., **77**, 893 (1999).
- *Debasish Majumdar*, "Unparticle decay of neutrinos and it's effect on ultra high energy neutrinos. e-Print: arXiv:0708.3485, **cited 37 times**, unpublished.

1. **NAME** : **AMBAR GHOSAL**
(Astroparticle Physics and Cosmology Division)

2. **Educational Qualification** Ph.D in "High Energy Physics, Theory",Visva-Bharati, Santiniketan, India, August 1997.

Academic recognitions

(a) National Merit Scholarship, 1980. (b) JSPS (Japan Society for the Promotion of Science) Post Doctoral Fellowship for Foreign Researchers, February, 2000.

3.**Academic Profile**

(a). At Harish Chandra Research Institute of Mathematics and Mathematical Physics, Chhatnag Road, Jhusi, Allahabad 211 019, India as Visiting Fellow from September 1996 to September 1998.

b). At Saha Institute of Nuclear Physics , T.N.P. Division, Sector- 1, Block- AF, Bidhannagar, Kolkata 700 064, India as Research Associate from September 1998 to January 2000.

c). At University of Shizuoka, Department of Physics, 52-1 Yada, Shizuoka-shi, Shizuoka, Japan 422 8526 as a JSPS Post Doctoral Fellow from February 2000 to January 31, 2002.

d). At Saha Institute of Nuclear Physics , Sector- 1, Block- AF, Bidhannagar, Kolkata 700 064, India as Visiting Scientist from March 07, 2002 to April 04, 2005.

e). At Saha Institute of Nuclear Physics , Sector- 1, Block- AF, Bidhannagar, Kolkata 700 064, India as Associate Professor 'E' from April 07, 2005, as Professor 'F' from August 01,2007 (till continuing).

4. Essential strength of research/development output : This research work will act as window to understand beyond standrd model physics.

5. Research Plan

The following area I have planned to investigate during the next few years :

Neutrino mass matrix and model building :

1) Recently, we have investigated a version of A_4 symmetric model proposed by Altarelli and Feruglio (Nuc.Ph.B,2006) which gives rise to tribimaximal mixing. In this work, we have generated non-zero U_{e3} through radiative mechanism due to the modification of the model adding extra symmetries and scalar fields. Further, we have also investigated CP violation phenomenology as well as a seesaw version of the model through a single parameter perturbation of the Dirac neutrino mass matrix to study baryogenesis through leptogenesis. However, quark sector of the model has not been addressed in the above works. Recently, for an unified description of quark and lepton sector discrete S_4 symmetry is proposed. In this project, we will investigate the phenomenology of such discrete symmetry to generate nonzero U_{e3}, CP violation, leptogenesis and baryogenesis as well.

2) Recently, we have also studied prediction of $\mu - \tau$ symmetry and tribimaximal mixing in the context of fourzero neutrino Yukawa textures. In extension of that, in this project, we have planned to study baryogenesis through leptogenesis both flavor independent and flavor dependent cases. First of all, we will study the fourzero MSSM textures with θ_{13} =0 with $\tan\beta$ as a free parameter. For a large non-zero θ_{13} $\tan\beta$ is restricted and thereby constrain the parameter space to admit the value η_B within 3σ range.

3) Inverse seesaw version of fourzero textures will be studied in detail to see nonzero θ_{13}, CP violation, leptogenesis and baryogenesis to rule out non compatable forms among the seventytwo different fourzero textures.

5. List of Publications

1. B. Adhikary, A. Ghosal and P. Roy, "'Mu-Tau' symmetry, tribimaximal mixing and four zero neutrino Yukawa textures," JHEP **0910**, 040 (2009) [arXiv:0908.2686 [hep-ph]].
2. B. Adhikary and A. Ghosal, "Nonzero U_{e3}, CP violation and leptogenesis in a see-saw type softly broken A_4 symmetric model," Phys. Rev. D **78**, 073007 (2008) [arXiv:0803.3582 [hep-ph]].
3. D. Majumdar and A. Ghosal, "Probing deviations from tri-bimaximal mixing through ultra high energy neutrino signals," Phys. Rev. D **75**, 113004 (2007) [arXiv:hep-ph/0608334].
4. D. Majumdar and A. Ghosal, "Dark Matter candidate in a Heavy Higgs Model - Direct Detection Rates," Mod. Phys. Lett. A **23**, 2011 (2008) [arXiv:hep-ph/0607067].
5. B. Adhikary, B. Brahmachari, A. Ghosal, E. Ma and M. K. Parida, "A(4) symmetry and prediction of U(e3) in a modified Altarelli-Feruglio model," Phys. Lett. B **638**, 345 (2006) [arXiv:hep-ph/0603059].
6. A. Ghosal, "A neutrino mass model with reflection symmetry," Mod. Phys. Lett. A **19**, 2579 (2004).
7. A. Ghosal, Y. Koide and H. Fusaoka, "Lepton flavor violating Z decays in the Zee model," Phys. Rev. D **64**, 053012 (2001) [arXiv:hep-ph/0104104].
8. Y. Koide and A. Ghosal, "Bimaximal neutrino mixing in a Zee-type model with badly broken flavor symmetry," Phys. Rev. D **63**, 037301 (2001) [arXiv:hep-ph/0008129].
9. Y. Koide and A. Ghosal, "Democratic universal seesaw model with three harmless sterile neutrinos," Phys. Lett. B **488**, 344 (2000) [arXiv:hep-ph/0006084].
10. A. Ghosal, "A two parameter texture of nearly bi-maximal neutrino mixing," Phys. Rev. D **62**, 092001 (2000) [arXiv:hep-ph/0004171].
11. A. Ghosal, "Almost degenerate neutrino mass in an SU(2)qL x SU(2)lL x U(1)Y model," Phys. Lett. B **398**, 315 (1997).
12. N. Gaur, A. Ghosal, E. Ma and P. Roy, "Radiative neutrino mass matrix for three active plus one sterile species," Phys. Rev. D **58**, 071301 (1998) [arXiv:hep-ph/9806272].

Name : Mala Das

Designation : Associate Professor

Division : Astroparticle Physics & Cosmology

Educational Background :

Ph.D (Experimental Physics) : (2001), Bose Institute ; University of Calcutta

MSc (Physics) : (1995), University of Calcutta

BSc : (1993), Vidhyasagar College for Women ; University of Calcutta (*Abani Banerjee medal*)

Career Profile :

1. 2001 – 2002 : 2004 - 2005 : VECC, Kolkata
2. 2002 - 2004 : Hokkaido University, Japan (*JSPS fellowship*)
3. 2007 : Low noise underground lab (LSBB), France, SIMPLE collaboration
4. 2005 – 2010 : SINP (RA & DST WOS-A) & Univ. de Montreal, Canada (visiting) under PICASSO collaboration.

Research Interest :

WIMP dark matter search experiment using superheated droplet detector, background reduction for future large mass detector, data analysis.

Physics of bubble nucleation in superheated drop detector, instrumentation, detector development, application, radiation dosimetry.

Radioactive ion beam target, ECR ion source, He-jet two stage skimmer system.

Selected Publications :

- Mala Das, S Seth, S Saha, S Bhattacharya, P Bhattacharjee (2010), "Neutron-gamma discrimination by pulse analysis with superheated drop detector", *Nucl. Instrum. Meth. A* (in press).

- Mala Das, R. Sarkar, P. K. Mondal, S. Saha, B. K. Chatterjee, S. C. Roy (2010), “Nucleation efficiency of R134a as a sensitive liquid for superheated drop emulsion detector’ *Pramana* (in press).
- Mala Das, A. S. Arya, C. Marick, D. Kanjilal, S. Saha (2008), An active drop counting device for superheated drop emulsion detector”, *Rev. Sci. Instrum* **79**, issue-11, Nov, 113301.
- Mala Das, Nakahiro Yasuda, Teruko Sawamura, (2008) “Threshold ss of superheated drop emulsion detector to heavy ions”, *Radiat. Meas*. **43**, Aug, S62.
- Mala Das, N. Yasuda, A. Homma, T. Sawamura, (2005) “Threshold temperature of heavy ion induced nucleation in superheated emulsion” *Nucl. Instrum. Meth.* **A 543**, Issues 2-3, 11 May, 570.
- Mala Das, T. Sawamura, (2005) “Superheated emulsions in neutron spectrometry by varying ambient pressure” *Nucl. Instrum. Meth.* **A 536**, Issues 1-2, 1 January, 123.
- Mala Das, T. Sawamura, (2004) “Estimation of nucleation parameter for neutron induced nucleation in superheated emulsion” *Nucl. Instrum. Meth*. **A 531**, 577.

- Mala Das, T. Sawamura, M. Kitaichi, S. Sawamura, (2004) “Application of superheated emulsion in neutron spectrometry at 45MeV electron LINAC”. *Nucl. Instrum. Meth.* **A 517** (1-3), 34.

- Mala Das, T. Sawamura, M. Abe, J. H. Kaneko, A. Homma, F. Fujita, S. Tsuda, T. Nishitani, (2004) “Superheated emulsions – as high energy neutron dosemeters” *Rad. Prot. Dosim.* **110** (1-4), 325.
- Mala Das, B. Roy , B. K. Chatterjee, S. C. Roy, (2003) “Use of basic principle of nucleation in determining temperature-threshold neutron energy relationship in superheated emulsions”, *Radiat. Phys. Chem*.**66**, 323.
- Mala Das, B. K. Chatterjee, B. Roy and S. C. Roy, (2000) “How high the temperature of a liquid be raised without boiling?” *Phys. Rev. E* **62**, 5843.
- Mala Das, B. Roy, B. K. Chatterjee and S. C. Roy, (2000) “A sensitive neutron dosimeter using superheated liquid”, *Appl. Rad. Iso.* **53**, 759.
- Mala Das, B. K. Chatterjee, B. Roy and S. C. Roy, (2000) “Superheated drop as a neutron spectrometer”, *Nucl. Instrum. Meth.* **A452**, 273.
- Mala Das, B. Roy , B. K. Chatterjee and S. C. Roy, (1999) “Efficiency of neutron detection of superheated drops of Freon-22”, *Radiat. Meas.* **30**, 35.