CURRICULUM VITAE

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Current Areas of Research: Theoretical study of equation of state of asymmetric nuclear matter and nuclear multifragmentation in intermediate energy heavy ion collisions. Properties of hot and dense hadronic matter and Quark-Gluon Plasma in ultra-relativistic energy heavy ion collisions.

Academic positions:

- *July 2011 – present*: Associate Professor G at Tata Inst. of Fundamental Research, Mumbai.
- *Aug 2007 – June 2011*: Reader-F at Tata Institute of Fundamental Research, Mumbai.
- *Sep 2006 – Aug 2007:* Reader at Central University of Hyderabad.
- *May 2005 – Aug 2006*: Visiting Scientist at Tata Institute of Fundamental Research, Mumbai.
- *Oct 2002 – Mar 2005*: Postdoctoral Research Associate at NSCL, Michigan State University, East Lansing, Michigan, USA.
- *Jun 2000 – Sep 2002:* Postdoctoral Research Associate at Cyclotron Institute, Texas A&M University, College Station, Texas, USA.
- *Sep 1998 – May 2000:* Postdoctoral Research Associate with Alexander von Humboldt Fellowship at Institut für Theoretische Physik, J.W. Goethe Universität, Frankfurt am Main, Germany.
- *Jan 1997 – Jun 1998:* Research Associate, Saha Institute of Nuclear Physics, Calcutta, India.
- *Sep 1996 – Dec 1996:* Visiting Research student, Niels Bohr Institute, Copenhagen, Denmark.

Education:

- *Jan 1997:* Ph.D in Theoretical Nuclear Physics (*Thesis title:"Properties of hot nuclear systems*"), Saha Institute of Nuclear Physics, Calcutta, India.
- *Aug 1992:* Post M.Sc in Physics, Saha Institute of Nuclear Physics, India.
- *May 1991:* M.Sc. in Physics, University of Calcutta, India.
- *Sep 1988:* B.Sc. in Physics, University of Calcutta, India.

Publications and Citations:

Refereed Article 60; Citations > 2000; Hirsch-Index: 23
Top Citations: 1× top cite 500+, 4× top cite 100, 5× top cite 50

Awards and Honors:

National Merit Scholarship, India, 1988
Saha Institute of Nuclear Physics Fellowship, India, 1992
Rosenfeld Foundation Fellowship, Denmark, 1996
Alexander von Humboldt Fellowship, Germany, 1998

Scientific Reviewer of:

Physical Review Lett., Phys. Rev. C&D
Physics Lett. B, Nuclear Phys. A
Jour. of Physics G: Nuclear & Particle
Pramana: Indian Journal Physics

Research

Heavy ion collisions from low Fermi energy domain to ultra-relativistic energies provide an unique opportunity to study the properties of novel states of matter away from normal conditions. The research program concentrate on the development of fundamental models of nuclear physics with an emphasis to study:

I. The structure and dynamics of neutron-rich asymmetric nuclear systems and the density dependence of nuclear symmetry energy in intermediate energy heavy ion collisions;

II. The signatures and properties of the quark-gluon plasma formed in ultra-relativistic energy heavy ion collisions.

• Intermediate Energy Heavy Ion Collisions

Heavy ion collisions at intermediate energies result in a hot and compressed nuclear matter that expands, enters mechanical and chemical instability regions of the nuclear phase diagram, and spontaneously disassembles into several nuclei and nucleons. This nuclear multifragmentation phenomenon, interpreted as liquid-gas phase transition, posses theoretical challenges to understand (i) properties of hot and dense matter formed and (ii) the poorly known density dependence of nuclear symmetry energy, $E_{\rm sym}(\rho)$, that determines the structure and dynamics of stable neutron-rich and exotic nuclei.

An isospin dependent transport model

For a reliable investigation of the fragmentation dynamics and $E_{\rm sym}(\rho)$, we have formulated an isospin dependent transport model (AIRT) by explicit inclusion of isospin dependence in both the mean-field and two-body baryon-baryon, baryon-meson and meson-meson collisions with isospin dependent Pauli blocking. Population of high-spin nuclear isomeric states produced in projectile fragmentation reactions was studied in AIRT model to understand the neutron-proton isospin dynamics.

Relativistic mean-field model

Developed a relativistic mean-field (RMF) model where the interaction between the nucleons is mediated by the exchange of σ-ω-ρ mesons with an additional isoscalar-isovector term $\sim \Lambda_v \omega^2 \rho^2$. The density dependence of $E_{\rm sym}(\rho)$ was explored by simultaneously varying the couplings $(\Lambda_v, g_{\rho N})$ with the constraint that the well-estimated $E_{\rm sym}(\rho = \rho_0) \simeq 32$ MeV is unaltered. Predicted a rather soft density dependence of $E_{\rm sym}(\rho)$ from the model comparison with the measured neutron skin thickness of several finite nuclei. The effects of the constrained $E_{\rm sym}(\rho)$ (within a narrow range) on the liquid-gas phase transition in hot n-p asymmetric nuclear matter and supernova was explored in the model.

Statistical multifrgamentation models

Developed statistical models of prompt multifragmentation and sequential binary decay to investigate the break-up mechanism, thermodynamic properties of the system and the effects $E_{\rm sym}(\rho)$. Demonstrated that the transport properties in nuclear multifragmentation, viz. the shear viscosity to entropy density ratio η/s for a system of fragments and nucleons behaves similar to that for water especially in the vicinity of critical temperature T_c for liquid-gas phase transition.

The main motivation is to formulate comprehensive theory/model to constrain the poorly known density dependence of nuclear asymmetry energy, which is important for understanding the nuclear structure at low densities, and crucial for heavy ion physics and astrophysics at high densities.

• **Ultra-Relativistic Energy Heavy Ion Collisions**

In ultra-relativistic energy heavy ion collisions (as in RHIC, LHC), much higher temperatures and densities are reached. The quarks and gluons confined with the hadrons are then liberated leading to a quark-gluon plasma (QGP) formation. To search for novel QCD effects and to recognize new physics due to QGP formation, sophisticated transport and statistical models have been formulated.

A multiphase transport model

Developed A MultiPhase Transport (AMPT) model that encompasses the entire evolution stage − initial parton production, subsequent parton transport, hadronization, and further hadron rescattering till freeze-out. To study rare particle production processes, the AMPT model was extended by embedding additional hard jets obtained from leading order pQCD calculation for p+p collision. These jets loose energy dominantly via soft gluon radiation during their passage in the QGP medium. Incorporated center-of-mass energy dependence in both the cross-sections for jet and soft hadron productions in initial N-N collisions. The model could be reliably extended for studies at LHC and higher energies.

Demonstrated within the AMPT model that the measured elliptic flow, HBT radii, dihadron correlations at RHIC are quite sensitive to the initial parton density and the parton scattering cross section. Presented the first clear evidence of Mach cones from the energy lost by the jet in the partonic medium which lead to the observed dihadron angular correlation. Demonstrated in the AMPT model, that η/s of the QGP at RHIC is remarkably similar to the lower bound $\eta/s = 1/4\pi$ obtained in the AdS/CFT conjecture that indicates the formation of a nearly perfect plasma at RHIC.

Employed a new procedure to studied correlation between event planes for different harmonics in heavy ion collisions at LHC to gather crucial information of the matter formed. The AMPT model described the LHC data remarkably, and new correlators was predicted which could be tested in experiments and in different models within the new method.

Proposed a new method, viz the principal component analysis (PCA), to study anisotropic flow and flow fluctuations in relativistic heavy ion collisions. In this method, all informations in two-particle correlations can be understood in a physically transparent way. Used the AMPT model and showed within PCA the usual flow harmonics v_n, higher modes of flow, and their fluctuations which could provide additional information on QGP properties.

Hagedorn resonance gas model

Developed a statistical for hadron production where an initial massive Hagedorn States (HS) ($m > 2$ GeV) decayed via sequential binary emission to lighter Hagedorn states and/or low-lying measured hadrons. The decay chain continued till all stable hadrons were produced. The model was found to be in good agreement with SPS/CERN and RHIC heavy ion collision data for the yield ratios and spectra of stable hadrons at a Hagedorn temperature of $T_H \approx 170$ MeV. The η/s for the Hagedorn resonance gas (calculated from Kubo formalism) showed a minimum of about 0.3 near T_c. This suggests that as the QGP will cool, the η/s in the deconfined phase near T_c, will make a relatively smooth transition (or crossover) without any discontinuity into the confined phase of hadrons. Within this model the abundance of multi-hypernuclei exhibited a maximum at FAIR energy regime. Further at RHIC energy, the low-mass dilepton yield was found to be somewhat enhanced due to contributions from the massive Hagedorn states.

Relativistic dissipative hydrodynamic model

The correct formulation of the relativistic dissipative hydrodynamics, widely applied in heavy ion collision studies, is far from settled. Starting with the relativistic Boltzmann equation, the collision term was generalized to include nonlocal effects. The resulting equations for dissipative quantities, viz, the bulk viscous pressure, shear stress tensor and particle diffusion current could generate all second-order terms that are allowed by symmetry. Some of these terms have been missed in the traditional Israel-Stewart and other approaches. The importance of these terms was demonstrated numerically within a one-dimensional scaling expansion of matter in relativistic heavy-ion collisions.

Proposed an alternate theory of relativistic fluid dynamics where the dissipative equations were obtained by invoking second law of thermodynamics from entropy four-current. The derivation removed the long-standing ambiguity in the relaxation time for bulk viscosity which showed critical slowing down near transition temperature and does not lead to cavitation.

Derived a new expression for the nonequilibrium phase-space distribution function $f(x,p)$ (up to second order), based on Chapman-Enskog-like (CE) iterative solution of the Boltzmann equation in the relaxation-time approximation. While the widely used Grad's method lead to violation of the experimentally observed $1/\sqrt{m_T}$ scaling of the Hanbury Brown-Twiss longitudinal radii R_l, the alternative CE method was analytically shown to be devoid of such an unphysical behavior.

Calculated the entropy four-current up to third order in gradient expansion by employing the Chapman-Enskog-like (CE) approach. Unlike the second- and third-order entropy four-current obtained in the Grads 14-moment approximation method, the entropy flux in the third-order CE expression was found non-vanishing and also showed better agreement with the exact solution of the Boltzmann equation as well as with the parton cascade BAMPS code.

A coupled parton transport plus relativistic viscous hydrodynamic model
Developed a coupled Boltzmann and relativistic viscous hydrodynamics model. Used the AMPT model for the initial nonequilibrium evolution phase with nucleons and partons, and modeled the ensuing near-equilibrium evolution of the QGP/hadronic matter within (2+1)-dimensional viscous hydrodynamics code VISH2+1. The anisotropic flow harmonics $v_n(p_T)$ (for $n = 2 - 6$) were found insensitive to the changes in switch-over time from AMPT to hydrodynamic evolution, and also to the use of Grad's or Chapman-Enskog-like single-particle distribution functions. The model described remarkably well the RHIC and LHC $v_n(p_T)$ data at various centralities with a constant $\eta/s = 0.08$ and 0.12, respectively.

Hydrodynamic fluctuations in relativistic heavy ion collisions
Formulated hydrodynamic fluctuations within causal second-order viscous hydrodynamic evolution. Developed a simulation model for (1+1) non-boost-invariant expansion of matter which was tested against analytic solutions for Riemann and Landau-Khalatnikov wave propagation. Phenomenological effects of thermal fluctuations was studied for two-particle rapidity correlations with conformal and lattice QCD equations of state. Ridge-like two-pion correlations were found at small rapidity-width which persisted at large rapidities. The early freeze-out at large rapidities in (1+1)-dim resulted in more enhanced correlation as compared to the boost-invariant expansion.

The main plan was to make a systematic effort to explore key observables so that certain observables may provide unambiguous information towards understanding the properties of the quark-gluon plasma and therefrom the underlying fundamental theory of strong interactions − the quantum choromodynamics.

List of Publications

1. '*Microcanonical simulation of multifragmentation of exotic nuclear shapes*', Subrata Pal, S.K. Samaddar, A. Das, and J.N. De, Physics Letters B 337 (1994) 14. [cited 11 times]

2. '*Recombination effect in nuclear multifragmentation*', Subrata Pal, S.K. Samaddar, A. Das, and J.N. De, Nuclear Physics A 586 (1995) 466. [cited 15 times]

3. '*Signature of exotic nuclear shapes from IMF-IMF correlations*', Subrata Pal, S.K. Samaddar, and J.N. De, Nuclear Physics A 589 (1995) 489.

4. '*Effect of neighboring fragments on sequential binary decay*', Subrata Pal, S.K. Samaddar, and J.N. De, Nuclear Physics A 591 (1995) 719.

5. '*Distinction between multifragmentation mechanisms from IMF-IMF correlation functions*', Subrata Pal, Nuclear Physics A 594 (1995) 156.

6. '*Refined Thomas-Fermi description of hot nuclei*', J.N. De, N. Rudra, Subrata Pal, and S.K. Samaddar, Physical Review C 53 (1996) 780. [cited 17 times]

7. '*The effect of flow on nuclear multifragmentation in a quantum statistical model*', Subrata Pal, S.K. Samaddar, and J.N. De, Nuclear Physics A 608 (1996) 49. [cited 23 times]

8. '*Dense nuclear matter in a strong magnetic field*', Somenath Chakrabarty, Debades Bandyopadhyay, and Subrata Pal, Physical Review Letters 78 (1997) 2898. [cited 133 times]

9. '*Quantizing magnetic field and quark-hadron phase transition in a neutron star*', Debades Bandyopadhyay, Somenath Chakrabarty, and Subrata Pal, Physical Review Letters 79 (1997) 2176. [cited 102 times]

10. '*Weakly interacting quark matter in an ultrastrong magnetic field*', Somenath Chakrabarty, Debades Bandyopadhyay, and Subrata Pal, International Journal of Modern Physics A 13 (1998) 295.

11. '*Multiplicity scaling in nuclear fragmentation*', Subrata Pal, S.K. Samaddar, J.N. De, and B. Djerroud, Physical Review C 57 (1998) 3246.

12. '*Protoneutron star in a strongly quantizing magnetic field*', Debades Bandyopadhyay, Subrata Pal, and Somenath Chakrabarty, 'Proceedings of the Workshop on *Physics and Astrophysics with Radioactive Ion beam* at Puri', Journal of Physics G 24 (1998) 1647.

13. '*Rapid cooling of magnetized neutron stars*', Debades Bandyopadhyay, Somenath Chakrabarty, Prantick Dey, and Subrata Pal, Physical Review D 58 (1998) R121301. [cited 23 times]

14. '*Strong magnetic field in a protoneutron star*', Subrata Pal, Debades Bandyopadhyay, and Somenath Chakrabarty, Journal of Physics G 25 (1999) L117.

15. '*Neutron star properties in the quark-meson coupling model*', S. Pal, M. Hanauske, I. Zakout, H. Stöcker, and W. Greiner, Physical Review C 60 (1999) 015802. [cited 93 times]

16. '*Meson mass modification in strange hadronic matter*', Subrata Pal, Song Gao, Horst Stöcker, and Walter Greiner, Physics Letters B 465 (1999) 282.

17. '*Neutron star properties in a chiral SU(3) model*', M. Hanauske, D. Zschiesche, S. Pal, S. Schramm, H. Stöcker, and W. Greiner, The Astrophysical Journal 537 (2000) 958. [cited 34 times]

18. '*Hot hypernuclear matter in the modified quark meson coupling model*', I. Zakout, H. Jaqaman, S. Pal, H. Stöcker, and W. Greiner, Physical Review C 61 (2000) 055208.

19. '$\bar{K}^0$ *condensation in neutron stars*', Subrata Pal, Debades Bandyopadhyay, and Walter Greiner, Nuclear Physics A 674 (2000) 553. [cited 45 times]

20. '*Antiflow of kaons in relativistic heavy ion collisions*', Subrata Pal, C.M. Ko, Ziwei Lin, and Bin Zhang, Physical Review C 62 (2000) 061903(R). [cited 27 times]

21. '*Charged particle rapidity distributions at relativistic energies*', Ziwei Lin, Subrata Pal, C.M. Ko, B.-A. Li and Bin Zhang, Physical Review C 64 (2001) 011902. [cited 101 times]

22. '*Strangeness equilibration in heavy ion collisions*', Subrata Pal, C.M. Ko, and Ziwei Lin, Physical Review C 64 (2001) 042201(R). [cited 27 times]

23. '*Multiphase transport model for heavy ion collisions at RHIC*', Zi-wei Lin, Subrata Pal, C.M. Ko, B.-A. Li and Bin Zhang, Nuclear Physics A 698 (2002) 375. [cited 64 times]

24. 'J/ψ *production in relativistic heavy ion collisions from a multi-phase transport model*', Bin Zhang, C.M. Ko, Bao-An Li, Zi-wei Lin, and Subrata Pal, Physical Review C 65 (2002) 054909. [cited 70 times]

25. '*Phi meson production in relativistic heavy ion collisions*', Subrata Pal, C.M. Ko, and Zi-wei Lin, Nuclear Physics A 707 (2002) 525. [cited 65 times]

26. '*Partonic effects on pion interferometry at RHIC*', Zi-wei Lin, C.M. Ko, and Subrata Pal, Physical Review Letters 89 (2002) 152301. [cited 149 times]

27. '*Partonic effects in heavy ion collisions at RHIC*', C.M. Ko, Zi-wei Lin, and Subrata Pal, Heavy Ion Physics 17 (2003) 219. [cited 11 times]

28. '*Finding the remnants of lost jets at RHIC*', Subrata Pal and Scott Pratt, Physics Letters B 574 (2003) 21. [cited 37 times]

29. '*Multistrange baryon production in relativistic heavy ion collisions*', Subrata Pal, C.M. Ko, and Ziwei Lin, Nuclear Physics A 730 (2004) 143. [cited 25 times]

30. '*Entropy production at RHIC*', Subrata Pal and Scott Pratt, Physics Letters B 578 (2004) 310. [cited 48 times]

31. 'Ξ *production at AGS energies*', Subrata Pal, C.M. Ko, J.M. Alexander, P. Chung, and R.A. Lacey, Physics Letters B 595 (2004) 158.

32. '*Entropy and phase space density at RHIC*', Scott Pratt and Subrata Pal, Acta Phys. Hung. A 24 (2005) 119.

33. '*Quark recombination and elliptic flow*', Scott Pratt and Subrata Pal, Physical Review C 71 (2005) 014905. [cited 38 times]

34. ‘*Diomega production in relativistic heavy ion collisions*’, Subrata Pal, C.M. Ko, and Z.Y. Zhang, Physics Letters B 624 (2005) 210.

35. ‘*Hadron production from resonance decay in relativistic collisions*’, Subrata Pal and Pawel Danielewicz, Physics Letters B 627 (2005) 55.

36. ‘*A Multi-Phase Transport Model for Relativistic Heavy Ion Collisions*’, Ziwei Lin, C.M. Ko, B.-A. Li and Bin Zhang, and Subrata Pal, Physical Review C 72 (2005) 064901. [cited 659 times]

37. ‘*Resonance production in relativistic heavy ion collisions in a binary emission model*’, Subrata Pal, Physical Review C 78 (2008) 011901(R).

38. ‘*Angular momentum population in fragmentation reactions*’, Subrata Pal and Rudrajyoti Palit, Physics Letters B 665 (2008) 164.

39. ‘*Nuclear symmetry energy effects in finite nuclei and neutron star*’, Bharat K. Sharma and Subrata Pal, Physics Letters B 682 (2009) 23. [cited 15 times]

40. ‘*Partonic effects on dijet correlations in relativistic heavy ion collisions*’, Subrata Pal, Physical Review C 80 (2009) 041901(R).

41. ‘*Shear viscosity to entropy density ratio of a relativistic Hagedorn resonance gas*’, Subrata Pal, Physics Letters B 684 (2010) 211. [cited 39 times]

42. ‘*Shear viscosity to entropy density ratio in nuclear multifragmentation*’, Subrata Pal, Physical Review C 81 (2010) 051601(R). [cited 15 times]

43. ‘*Nuclear symmetry energy effects on liquid-gas phase transition in hot asymmetric nuclear matter*’, Bharat K. Sharma and Subrata Pal, Physical Review C 81 (2010) 064304.

44. ‘*Role of isospin physics in supernova matter and neutron stars*’, Bharat K. Sharma and Subrata Pal, Physical Review C 82 (2010) 055802.

45. ‘*Suppression of high p_T hadrons in Pb+Pb collisions at LHC*’, Subrata Pal and Marcus Bleicher, Physics Letters B 709 (2012) 82. [cited 22 times]

46. ‘*Low mass dilepton production in relativistic Hagedorn resonance gas*’, Subrata Pal, Physical Review C 85 (2012) 011901(R).

47. ‘*New relativistic dissipative fluid dynamics from kinetic theory*’, Amaresh Jaiswal, Rajeev S. Bhalerao, and Subrata Pal, Physics Letters B 720 (2013) 347. [cited 26 times]

48. ‘*Boltzmann equation with a nonlocal collision term and the resultant dissipative fluid dynamics*’, Amaresh Jaiswal, Rajeev S. Bhalerao and Subrata Pal, Journal of Physics Conference Series 422 (2013) 012003. [cited 11 times]

49. ‘*Complete relativistic second-order dissipative hydrodynamics from the entropy principle*’, Amaresh Jaiswal, Rajeev S. Bhalerao, and Subrata Pal, Physical Review C 87 (2013) 021901(R). [cited 32 times]

50. ‘*Production of antinuclei and hypernuclei in a relativistic Hagedorn resonance gas model*’, Subrata Pal and Walter Greiner, Physical Review C 87 (2013) 054905.

51. '*Medium information from anisotropic flow and jet quenching in relativistic heavy ion collisions*', Subrata Pal and Marcus Bleicher, Journal of Physics Conference Series 420 (2013) 012027.

52. '*Event-plane correlators*', Rajeev S. Bhalerao, Jean-Yves Ollitrault, and Subrata Pal, Physical Review C 88 (2013) 024909. [cited 42 times]

53. '*Particle production in relativistic heavy-ion collisions: A consistent hydrodynamic approach*', Amaresh Jaiswal, Rajeev S. Bhalerao, Subrata Pal, and V. Sreekanth, Physical Review C 88 (2013) 044911. [cited 15 times]

54. '*Relativistic viscous hydrodynamics for heavy-ion collisions: A comparison between Chapman-Enskog and Grad's methods*', Amaresh Jaiswal, Rajeev S. Bhalerao, Subrata Pal, and V. Sreekanth, Physical Review C 89 (2014) 054903. [cited 32 times]

55. '*Relativistic third-order viscous corrections to the entropy four-current from kinetic theory*' Chandrodoy Chattopadhyay, Amaresh Jaiswal, Subrata Pal, and Radoslaw Ryblewski, Physical Review C 91 (2015) 024917. [cited 17 times]

56. '*Collective flow in event-by-event partonic transport plus hydrodynamics hybrid approach*', Amaresh Jaiswal, Rajeev S. Bhalerao, Subrata Pal, Physical Review C 92 (2015) 014903. [cited 20 times]

57. '*Characterizing flow fluctuations with moments*' Rajeev S. Bhalerao, Jean-Yves Ollitrault, and Subrata Pal, Physics Letters B 742 (2015) 94. [cited 29 times]

58. '*Transport models for relativistic heavy ion collisions at the Relativistic Heavy Ion Collider and Large Hadron Collider*', Subrata Pal, Pramana, Journal of Physics 84 (2015) 717.

59. '*Principal component analysis of event-by-event fluctuations*' Rajeev S. Bhalerao, Jean-Yves Ollitrault, Subrata Pal, and Derek Teaney, Physical Review Letters 114 (2015) 152301. [cited 36 times]

60. '*Nonlinear hydrodynamic response confronts LHC data*' Li Yan, Subrata Pal, and Jean-Yves Ollitrault, Nuclear Physics A 596 (2016) 340.

61. '*Effects of initial-state dynamics on collective flow within a coupled transport and viscous hydrodynamic approach*', Chandrodoy Chattopadhyay, Rajeev S. Bhalerao, Jean-Yves Ollitrault, and Subrata Pal, arXiv:1710.03050, submitted to Physical Review C.

62. '*Thermal noise in a boost-invariant matter expansion in relativistic heavy-ion collisions*', Chandrodoy Chattopadhyay, Rajeev S. Bhalerao, and Subrata Pal, arXiv:1711.10759, submitted to Physical Review C.

63. '*Radiative heavy quark energy loss in an expanding viscous QCD plasma*, Sreemoyee Sarkar, Chandrodoy Chattopadhyay, and Subrata Pal, arXiv:1801.00637, submitted to Physical Review C.

Invited Presentations at Conferences and Workshops

1. '*Percolation model for nuclear multifragmentation*', S. Pal and S.K. Samaddar, 38th DAE Symposium on Nuclear Physics, University of Calicut, Calicut, December 1993.

2. '*Recombination effects on multifragmentation*', S. Pal, S.K. Samaddar, and J.N. De, 39th DAE Symposium on Nuclear Physics, Utkal University, Bhubaneswar, December 1994.

3. '*Effects of flow on nuclear multifragmentation*', S. Pal, S.K. Samaddar, and J.N. De, 40th International DAE Symposium on Nuclear Physics, Bhabha Atomic Research Centre, Bombay, December 1995.

4. '*Rapid cooling of stars in a strong magnetic field*', S. Pal, D. Bandyopadhyay, and S. Chakrabarty, 3rd Int. Conf. on Physics and Astrophysics of Quark Gluon Plasma, Jaipur, March 1997.

5. '*Stability of strange hadronic matter*', S. Pal, Poster at Quark Matter '99, Proc. 14th Int. Conf. on Ultra-Relativistic Nucleus-Nucleus Collisions, Torino, May 1999.

6. '*Equation of state of neutron star matter with magnetic field*', S. Pal, Workshop EOS2000, The Nuclear Equation of State: Status and Perspectives, Darmstadt, February 2000.

7. '*Kaon in-medium potential from directed flow*', S. Pal, C.M. Ko and Z. Lin, Notre Dame Workshop on Nuclear Incompressibility, Notre Dame, January 2001.

8. '*Elliptic flow from AMPT model*', S. Pal, Z. Lin, C.M. Ko, Workshop on Two-Particle Inteferometry and Elliptic Flow at RHIC, Brookhaven National Laboratory, Upton, June 2002.

9. '*Remnants of jet quenching at RHIC*', S. Pal and S. Pratt, INT Workshop on The First Three Years of Heavy-Ion Physics at RHIC, Institute for Nuclear Theory, University of Washington, Seattle, April, 2003.

10. '*Jet quenching at RHIC*', S. Pal, Midwest Nuclear Theory Get-Together, Argonne National Laboratory, Chicago, October 2003.

11. '*Entropy as a signal for QGP formation*', S. Pal and S. Pratt, Collective Flow and QGP properties, Brookhaven National Laboratory, Upton, November 2003.

12. '*Entropy production at RHIC*', S. Pal and S. Pratt, Poster at Quark Matter 2004, Proc. 17th Int. Conf. on Ultra-Relativistic Nucleus-Nucleus Collisions, Oakland, Jan 2004.

13. '*Resonances at relativistic collisions*', S. Pal and P. Danielewicz, 51st Gordon Research Conference on Nuclear Chemistry, New London, June 2004.

14. '*Hadron production through statistical decay of heavy resonances*', S. Pal and P. Danielewicz, American Physical Society Meeting, Division of Nuclear Physics Fall Meeting, Chicago, October 2004, Bull. Am. Phys. Soc. (2004).

15. '*Quark Recombination and Elliptic Flow*', S. Pal, Workshop on Supercomputing Relativistic Heavy-Ion Collision Physics, Tata Institute of Fundamental Research, Mumbai, December 2005.

16. '*Viscous Hydrodynamics at RHIC*', S. Pal, R.S. Bhalerao, and S. Gupta, Workshop on Supercomputing Relativistic Heavy-Ion Collision Physics, Tata Institute of Fundamental Research, Mumbai, December 2005.

17. '*Elliptic flow at RHIC*', S. Pal, Proc. DAE-BRNS 50th Symposium on Nuclear Physics, Bhabha Atomic Research Centre, Mumbai, December, 2005, ed. S. Kailas, S. Kumar, L.M. Pant, Prime Time Education, Mumbai, 2005, p. 162.

18. '*Partonic effects on dijet correlations at RHIC*', QGP Meet'08 at Variable Energy Cyclotron Center, Kolkata, November 2008.

19. '*Population of high spin states in fragmentation reactions*', S.Pal and R. Palit, Proceedings of DAE-BRNS symposium on Nuclear Physics at IIT Roorkee, December 2008, Vol 53, 239 (2008).

20. '*Medium information from parton energy loss*, S. Pal, 6th International Conference on Physics and Astrophysics of Quark Gluon Plasma (ICPAQGP 2010)" Goa, India December 6-10, 2010.

21. '*Nuclear Asymmtery Energy in multifragmentation*', Nucleus-Nucleus Collision Around Fermi Energy (NNCAFE-2010) at VECC, India, December 2010.

22. '*Theoretical study of Quark-Gluon-Plasma with jet quenching*', DAE-BRNS symposium on Nuclear Physics at Andhra University, December 26-30, 2011.

23. '*Medium information from anisotropic flow and jet quenching in relativistic heavy ion collisions*', International Conference on Nucleus-Nucleus Collisions, Texas, USA, May 27-June 1, 2012.

24. '*Jet quenching in heavy ion collision within transport model*', Workshop on High Energy Physics and Phenomenology (WHEPP 13), Puri, India, December 12-21, 2013.

25. '*Correlation between event-planes: a new probe to flow in heavy-ion collisions*', Frankfurt Institute for Advanced Studies, Frankfurt, Germany, May 2014.

26. '*Collective flow in ultra-relativistic heavy-ion collisions*', International Workshop on Frontiers of QCD, IIT Bombay, December 2-5, 2014.

27. '*Principal component analysis of flow* ', 2nd Heavy Flavour Meet-2016, Saha Institute, Kolkata, February 3-5, 2016.

Seminars and Colloquia

1. '*In-medium effects on multifragmentation*', Saha Institute of Nuclear Physics, Kolkata, June 1995.

2. '*Quantum statistical model for multifragmentation*', Niels Bohr Institute, Copenhagen, November, 1996.

3. '*Nuclear multifragmentation models*', Rajabazar Science College, Calcutta, January 1997.

4. '*Strange Hadronic Matter*', J.W. Goethe Universität, Frankfurt, October 1999.

5. '*In-medium effects on nuclear matter potential*', J.W. Goethe Universität, Frankfurt, March 2000.

6. '*In-medium kaon potential from kaon flow*', Texas A&M University, College Station, June 2001.

7. '*Strangeness production at RHIC*', NSCL-Michigan State University, East Lansing, May 2002.

8. '*A Multiphase Transport model at RHIC energies*', Texas A&M University, College Station, June 2002.

9. '*QGP signals at RHIC*', NSCL-Michigan State University, East Lansing, October 2003.

10. '*Jet quenching - a signal for QGP at RHIC?*', Wayne State University, Detroit, March 2004.

11. '*Soft particle yield from jet quenching*', Brookhaven National Laboratory, Upton, September 2004.

12. '*Hadron production in a statistical model*', Ohio State University, Columbus, November 2004.

13. '*Particle production at RHIC*', NSCL-Michigan State University, East Lansing, February 2005.

14. '*Quark Gluon Plasma at RHIC*', Indian Institute of Technology-Kanpur, Kanpur, April 2005.

15. '*Sequential binary emission for hadron production*', Variable Energy Cyclotron Centre, Kolkata, May 2005.

16. '*Hadron production from resonance decay*', Tata Institute of Fundamental Research, Mumbai, October 2005.

17. '*Hadron production from parton coalescence*', Institute of Physics, Bhubaneswar February 2006.

18. '*Elliptic flow from parton recombination*', Saha Institute of Nuclear Physics, Kolkata, March 2006.

19. '*Quark Gluon Plasma at RHIC*', Institute of Mathematical Sciences, Chennai, October 2006.

20. '*New information on the dense medium produced in relativistic heavy ion collisions at RHIC and LHC*', Frankfurt Institute for Advanced, Studies (FIAS), Frankfurt, Germany, June, 2012.

21. 'New method to study collective flow in relativistic heavy ion collisions', Saha Institute of Nuclear Physics, Kolkata, December 2012.

    '*Collective flow in ultra-relativistic energy heavy ion collisions*', TIFR Centre for Interdisciplinary Sciences, Hyderabad, Dec 19-23, 2016.