CURRICULUM VITÆ

NAME : **HIRANMAYA MISHRA**

ADDRESS FOR CORRESPONDENCE :

Hiranmaya Mishra
Theoretical Physics Division
Physical Research Laboratory
Navrangpura, Ahmedabad- 380 009
INDIA

Phone - (91) 79-26314477
Cable - R E S E A R C H
Fax - (91)-79-26314900
Telex - 0121-6397
email - hm@prl.res.in

PERSONAL DATA:

Nationality : Indian
Date of Birth : July 17, 1962
Sex : Male

ACADEMIC AND EMPLOYMENT RECORD :

- High School Certificate examination (1978), (First Class).
- Intermediate in Science, (1980), (First Class), **First Class First** in Sambalpur University
- Bachelor of Science (Hons. with Distinction), Physics Honours, (1982), (First class), other subjects were Mathematics, Chemistry and English, **First Class First** in Sambalpur University.
- Master in Science (Physics), Indian Institute of Technology, Kharagpur (1984) (First class).
- Diploma in Advanced Physics, Institute of Physics, Bhubaneswar(1985), **First** position in the batch.
- Doctoral Scholar in Institute of Physics, Bhubaneswar 1985-91.
- Senior Research Associate in DST project (SP/S2/K-45/89) at Institute of Physics, Bhubaneswar 1991-93.
- Post Doctoral Fellow at Physical Research Laboratory, Ahmedabad since July 1993 – July 1995.
- Ph.D. in Science (PHYSICS) from Utkal University, April 94.
- CSIR Research Associate, Mehta Research Institute , Allahabad, August 1995-March 1996
- Alexander von Humboldt Fellow, Physics Department, University of Bielefeld, Germany, April 1996, July 1997

- Joined Physical Research Laboratory in the Theory Division as **Scientist D** in July 1997.
- **Reader**, Physical Research Laboratory from 1st July 2001.
- Visiting Scientist, Department of Physics, University of Bielefeld from July 15th 2001 till July 14th 2002 on sabbatical from PRL, Ahmedabad.
- Promoted to **Associate Professor** from 1st January 2008.
- **Visiting Scientist**, Institut for Theoretical Physics, J W Goethe University, Frankfurt, May 2008–July 2008.
- **Visiting Professor**, School of Physics, Jawaharlal Nehru University, New Delhi July 2008 till 15th May 2009.

SCHOLARSHIPS/ AWARDS

- **National Scholarships** throughout (From Class VII till M. Sc.).
- **L. K. Panda Award** for securing first position in Dip. In Advance Physics course at Institute of Physics, Bhubaneswar.
- **Alexander von Humboldt** fellowship .

Teaching experience

I gave courses on **Mathematical Physics** in the years 1997-98 and 1998-99 to the graduate students' course work at Physical Research Laboratory, Ahmedabad. This apart I also gave lectures on **Mathematical Physics** to college teachers' training program held at Physical Research Laboratory, Ahmedabad in June 2000. I also gave course to the graduate students on **Classical Electrodynamics** for the session 2002-2003. I am teaching the course on **Classical Electrodynamics** for the session 2006-2007.

This apart two students are working with me on the projects (i) "Equation of state for strongly interacting matter and properties of neutron stars" and (ii) " Superfluidity with cold atoms" as a part of their pre-doctoral coursework.

Two students are presently working with me for their **PhD** and **one post doctoral fellow** is associated with me now.

This apart I have given a series of lectures on **"Thermal Field Theory"** to PhD students/PDFs in the **DST- SERC school on Theoretical High Energy Physics** held in IIT Mumbai in Feb 2008 as a part of the main courses offered in this school.

I have also taught the course on **Subatomic Physics** to the **M.Sc.** students in **Schhol of Physics, Jawaharlal Nehru University (JNU)** Monsoon Semester, 2008.

Science Administration

1. I have been in the academic committee of PRL, Ahmedabad for two years whose responsibility is to look after the the phd and post doctoral research program in our laboratory.

2. I am in the Interview Committee of PRL for recruiting Ph.D. students in our laboratory almost every year since 1997. I am also involved in setting question papers for the written tests for these selections.

3. I am member of review committees for PhD as well as Post Doctoral fellows in our laboratory regularly.

4. Co-Director of DST SERC School in Theoretical High Energy Physics organised by PRL in 2006.

5. I have been one of the referees for reviewing various project proposals from DST as well as DAE BRNS.

6. I have been **PhD thesis examiner** for Viswabharati University, Shantiniketan, Kalyani University, Utkal University, Berhampur University , Sardar Patel University, Anand, Gujurat., Calcutta University, Kolkata

7. Coordinator of Heavy Quarkonia Group in the workshop on Relativistic heavy Ion Collision Nov. 2005, TIFR, Mumbai.

8. Member of Organising committee of International Workshop on Physics and Astrophysics of Hadronic Matter, Nov. 6–11, Shantiniketan, India.

9. Member, National Organising Committee, DAE-BRNS Workshop on Hadronic Physics, Aligarh 2008.

AREA OF RESEARCH :

Non-perturbative variational methods for studying bound states in quantum field theory, Vacuum structure in QCD, Finite temperature quantum field theory, Nuclear matter and QCD at finite temperatures in the context of Quark gluon plasma, Phase transitions, Chiral symmetry breaking, Solvable models in field theory, magnetic field structure in neutron stars, hybrid stars, phase structure of strongly interacting matter, correlation functions in QCD, QCD sum rules at finite temperature, color superconductivity, superconductivity with cold fermionic atoms. BCS-BEC crossover transition in cold fermionic atoms.

TITLE OF THESIS : Composite and extended objects in quantum field theory : a reappraisal

THESIS SUPERVISOR : Professor S. P. Misra

SOME RECENT INVITED TALKS

- "Superfluidity in quark matter and ultracold atoms", Lecture given at Academic staff college, Jawaharlal Nehru University, February 2009.
- "Ground state structure and superfluidity in Cold atoms", **two** invited lectures given at workshop on cold atoms held at IISER Kolkata, Kalyani, West Bengal 12-13 Dec. 2008.
- " Relativistic BCS-BEC Crossover– A variational approach", Invited talk given at International Conference on Cold Atoms 2008", IISER, Kolkata, Kalyani, West Bengal, 14-16 Dec. 2008.
- "Relativistic BCS-BEC crossover in fermionic matter", Seminar in AstroPhysics group, Institute for Theoretical Physics, Univ. of Frankfurt, June 2008
- "Relativistic BCS-BEC crossover in Quark matter", **Invited Talk** given at Workshop on High Energy Physics Phenomenology (WHEPP X), Jan 2-Jan 13, 2008, Institute for Mathematical Sciences, Chennai.
- "Gapless superconductivity : from Quark matter to ultracold atoms", **Theory Colloquium**, given at TIFR, Mumbai 18 September, 2007.
- "Superconductivity in neutron stars", Talk given at Department of Physics, Berhampur University, August 17, 2007.
- "Gapless superconductivity : from Quark matter to ultracold atoms", Talk given at Center for Theoretical Physics, Jamia Milia Islamia, Delhi, 17 August 2006.
- "Superconductivity : from Quark matter to ultra cold atoms", Colloquium given at Institute of Physics Bhubaneswar, 26 June 2006.
- "Gapless superconductivity :from Quark matter to cold atoms", Talk given at Indian Association for Cultivation of Science, Kolkata, 15 June 2006.
- "Gapless superconductivity : from Quark matter to cold atoms", Talk given at Saha Institute of Nuclear Physics, Kolkata, June13th , 2006
- " Gapless superconductivity: from quark matter to cold atoms", Talk given at School of Physics, Jawaharlal Nehru University, April 19th, 2006.
- "Color superconducting strange quark matter at finite temperature", **Plenary talk** given at International Conference on Physics and Astrophysics of Quark Gluon Plasma-05", Kolkata 7-12 Feb. 2005.
- " QCD and dense matter in QCD from lattices to stars", Institute for Nuclear Theory program INT04-1, 5-9 April, 2004, Seattle, USA.
- "Color neutral quark matter and gapless modes'**Invited talk** given at conference 'QGP meet'03', held at VECC, Kolkata, India, 5 May - 7 May, 2003.
- "Chiral symmetry breaking, color superconductivity and color neutral quark matter'**Invited talk** given at *workshop on quarks and Mesons, BARC, Mumbai* Feb 2003.

- “Color superconductivity in charge neutral quark matter” **Invited Talk** given at ’Visitors’ Program’, Physics Department, Delhi University, June 2003.
- “ Quark matter phase diagram, Color superconductivity and astrophysical implications” **Invited talk** given at *workshop on Nuclear Astrophysics, IUCAA, Pune* September 2000.
- “ Chiral symmetry breaking, color superconductivity and quark matter phase diagram”– Talk given at *Center for theoretical studies, Bangalore*- September 2000.

Summary of Recent Research work

'Strongly interacting matter' has been broadly the area of my research. I alongwith my collaborators have been studying strongly interacting systems in quantum field theory in a nonperturbative manner using variational methods. This has been done using an ansatz for the 'ground state' in quantum field theory and then minimizing the energy density, free energy or thermodynamic potential, as the case may be.

Below I summarize my recent research work since about last five years. The references here shall corresponds to the number in the complete list of publication.

The understanding of the properties of matter at high densities (few times nuclear matter densities) has developed rapidly over last few years. At densities that are high enough such that the nucleons are crushed into its constituent matter i.e. quark matter, and, the quark matter that results must be in one of a family of (color) superconducting phases. The large possibilities of different color superconducting phases arises because of extra degrees of freedom like color and flavor apart from the spin degrees of freedom as compared to usual superconductivity with electrons as well as external conditions like charge neutrality. Although color superconductivity in quark matter was known since about more than two decades back, a lot of activity started after Frank Wilczek and Krishna Rajagopal showed that the superconducting gap can be as large as about 100 MeV in realistic densities dense matter that could be there in the core of neutron star stars. The essence of color superconductivity is quark pairing driven by the BCS mechanism which operates when there is attractive interaction between fermions at a Fermi surface. In QCD, the fundamental theory for strong interaction,the quark quark interaction is attractive and strong between quarks that are antisymmetric in color as well as in flavor and hence the cold dense quark matter should be generically color superconducting. This is the area that I have mostly focused my research activity during last few years. I,alongwith my collaborators have investigated the possibility of simultaneous existence of condensates in quark quark channels as well as in quark- antiquark channel– the later being related to chiral symmetry breaking which gives rise to finite constituent mass for quarks. Indeed, we found an window in the density where pairing between quarks having 'constituent masses' (arising from chiral symmetry breaking) could be possible [8]. Studying properties of color superconducting phases in heavy ion collision experiments seems unlikely in the present accelerators. However, in the future accelerator facility planned at GSI, Darmstadt, for compressed baryonic matter experiments, one possibly can hope for observing fluctuations signifying precursory phenomena of color superconducting phase of quark matter.

On the otherhand, it is natural to expect some color superconducting phase to exist in the core of compact stars. To consider however the matter in the interior of neutron stars extra constraints of charge neutrality has to be imposed on the matter otherwise the star will not be in a gravitationally stable configuration. We tried to impose these constraints on the stellar matter with introduction of appropriate chemical potentials while minimizing the thermodynamic potential [3,6]. One of the main and perhaps interesting result of such an investigation was that of stable 'gapless' superconducting modes: namely when the (color)superconducting gap is nonzero, but the excitation energy of the quasi particles is zero at certain momenta. Such modes seem to appear for densities that could be realized in the interior of neutron stars. This will have interesting phenomenological consequences regarding cooling of neutron stars and transport properties of the matter in their interior as the gapless excitation will be the dominant dynamical mode. Incidentally, ours is one of the first papers showing the possibility of such gapless modes in charge neutral color superconducting quark matter.

We have also studied in detail the effect of temperature such a color superconducting matter that is charge neutral[3] including the strange quarks with the mass of the later being determined self consistently. Recently, we have also incorporated the effect of six quark determinant interaction – the so called t-Hooft term on the superconducting matter. The light flavor superconductivity gets favored due to such types of interaction [2].

The possibility of such gapless superconducting modes lies on a rather general mechanism of formation of Cooper pairs of fermions of species differing in their Fermi momenta and in general can be possible to have such novel phase of matter which can be superconducting and normal at the same time depending upon the momentum of the fermions. Indeed Wilczek -(*Nobel Prize* winner, 2004 for his work on Quantum Chromo Dynamics) and his collaborators in MIT showed that such possibility could be realizable for ultra cold fermionic atoms which has become a subject of intense research recently. We have also applied our techniques developed for quark matter to the case of cold fermionic atoms to describe such a breached pairing phase and suggested a possible experimental scenario for detection of such a phase [6]. At a personal level- it is intellectually rather pleasing to note that this work has also been cited by Wilczek's recent work on superconductivity in cold fermionic atoms.

The pairing phenomena in case of strong interacting field could be more complex in the intermediate densities. It is likely that such a strongly interacting relativistic fermionic matter could also be in a crystalline phase i.e. the Cooper pairs having nonzero momentum. This is the LOFF phase, first explored by Larkin- Ovchinnikov and Fulde- Ferrel in the context of electron superconductivity in presence of magnetic impurities. We have very recently explored the 'phase diagram' of ultra cold fermionic atoms. We obtain explicitly the state for different values of the mismatch of the chemical potential for weak as well as strong couplings including the BCS-BEC crossover regime. Comparing the thermodynamic potential we show that the LOFF phase is stable in the weak coupling regime, (ii) the LOFF window is maximum on the positive coupling side near the Feshbach resonance (iii) the existence of stable breached pairing states with single Fermi surface for large positive coupling [1].

I have also tried to look into the medium modification of hadronic properties. In particular, we attempted to calculate nucleon properties in nuclear matter using chiral perturbation theory which is an effective theory of strong interaction based only on the approximate chiral symmetry of QCD Lagrangian and its spontaneous breaking. While this theory is eminently successful in dealing with pionic processes, its direct applications to many nucleons has been problematic. In particular the one loop formula for the shift of the nucleon mass in nuclear matter is much too large to be acceptable. We show that the problem in this effective theory lies in approximating the two nucleon scattering amplitude as a constant given by the s-wave scattering length. Following Weinberg's method, we modify this constant amplitude by a momentum dependent amplitude satisfying Lippman- Schwinger equation. This leads to a reduced mass shift of the nucleon in a nuclear medium [4].

Research Plan

I would like to look further into fermion pairing problems both in relativistic matter as well as in nonrelativistic systems. If The following includes a list of research problems that I am right now actively involved and wish to pursue in near future.

- r-mode instability of neutron stars.

  A rapidly rotating neutron star will quickly slowdown if it is unstable with respect to bulk flows known as r-modes which transfer star's angular momentum to gravitational radiation. This phenomena will occur if damping is sufficiently small and hence it provides a probe for the viscosity of the matter in the interior of the star. Instability of r-modes could limit neutron star rotational frequencies. We plan to look into r-mode oscillation within a hybrid star model where the hadronic outer crust is modeled by a chiral effective field theory while the inner core quark matter is described by the NJL model including color superconductivity. We would like to calculate the bulk viscosity in both the models and study its effect on r-mode instability in neutron stars.

- Relativistic BCS-BEC cross over

  Any arbitrary weak attractive interaction in many fermion system leads to formation of Cooper pairs. Cooper pairs are typically of a size which is larger than the inter particle distances. However, this picture changes at large couplings and the Cooper pair become bound states and superfluidity is realized by BEC of molecular bosons composed of the fermions. This cross over is experimentally studied in cold non relativistic fermionic systems. Apart from atomic system, there is strong motivation to study relativistic BCS BEC cross over. Dense quark matter is believed to be a color superconductor. To describe the same a BCS approach is usually emplyed both in QCD or in effective theories of the same like NJL models. However, quark matter in the core of compact stars could be in a strong coupling regime where a BEC like picture may be more appropriate. The antiparticle contributions can become important near the cross over regime as the chemical potential become negligible and the relativistic BCS BEC cross over can have a richer phase structure than its non relativistic counterpart. We would like to study the BCS BEC cross over within a variational approximations in a relativistic boson fermion model. The effects of condensate fluctuations shall also be included through squeezed coherent state type ansatz for the ground state. The phase digram will be studied in detail by considering effect of temperature, coupling as well as density mismatch.

- Color superconductivity in presence of magnetic fields

  Our present knowledge of QCD at high baryon density indicates that quark matter might be in a color superconducting phase and the viable signature of such a phase of matter could be in the neutron star interior. It is known that neutron stars have strong magnetic fields as large as 10^{12}–10^{14} Gauss on the surface and the magnetars can have even stronger magnetic fields. In color superconductivity, although the BCS pair condensate is electrically charged, a linear combination of photon and one of the gluon can remain mass less. The effect of such a long range magnetic field seem to strengthen the condensation. We would like to study this effect in terms of having condensates out of the quarks occupying different Landau levels in presence of the magnetic field.

- LOFF condensate in noncommutative field theories

  The effect of noncommutative interactions on the pairing mechanism between fermions is analyzed. We use use the variational technique to analyze the ground state of the noncommutative four-Fermi interaction. Due to the noncommutative nature of the interaction the model supports fermion pairs with a total non-zero net momentum. This effect is similar to the Larkin-Ovchinnikov-Fulde-Furrel (LOFF) type of pairing that is encountered when there are two-species of fermions available at finite density. Such LOFF type of pairing is driven by the scale associated with the noncommutative theory. This work is in progress and will be reported soon.

- Fermion pairing in cold atoms

  Cold fermionic atoms have attracted lot of attention recently regarding pairing phenomena. With the help of magneto optical traps and Feshbach resonance the strength as well as nature of the interaction of the cold fermionic atoms can be controlled. This gives rise to possibility of studying different phases that has been proposed for dense quark matter on table top experiments. We attempt to study a variational nonperturbative method to discuss pairing of fermions with nonzero momentum (LOFF pairing), breached pairing, mixed phases for cold fermionic atoms and study the phase diagram in the coupling and density plane. The effect of temperature, trap geometry will also be studied including the effects of condensate fluctuations.

NAME : HIRANMAYA MISHRA

List of publications

Articles in journals and communicated for publication

1. *"Relativistic BCS-BEC crossover: a variational approach"*, Bhaswar Chatterjee, Hiranmaya Mishra and Amruta Mishra, arXiv:0804.105(hep-ph),Phys Rev. D79,14003 (2009).

2. *"LOFF and breached pairing with cold fermionic atoms"*, Amruta Mishra and Hiranmaya Mishra, Eur. phys. jou. D53, 75-87 (2009).

3. *"Constraints on nuclear matter parameters in an effective chiral model"*, T.Jha and H. Mishra, Physical Rev. C78, 065802 (2008).

4. *"Pairing in spin polarised two species fermionic mixtures with mass asymmetry"*, Salman Silotri, Dillip Angom , Hiranmaya Mishra and Amruta Mishra, arXiv:0805.1784 (cond-mat) Eur. Phys. Jou. D49, 383-390 (2008).

5. ''*On attributes of a rotating neutron star with a hyperon core"*, T.K. Jha, H. Mishra and V. Sreekanth, arXiv:0710.539[nucl-th], Phys. Rev C77, 045801 (2008).

6. *"Color superconductivity and determinant interaction in strange quark matter"*, Amruta Mishra and Hiranmaya Mishra, arXiv:hep-ph/0605223, Phys Rev D **74**,054024,(2006).*

7. *"Nucleon propagation through nuclear matter in chiral effective field theory"*, S. Mallik and H. Mishra Eur. J. Phys.C,50, 889-896(2007)*.

8. *"Color superconductivity and gapless modes in strange quark matter at finite temperature"*, A. Mishra and H. Mishra, Phys Rev. D71, 074023 (2005).

9. *"QCD sum rules for nucleon two-point function in nuclear medium"*, S. Mallik and H. Mishra, arXiv:nucl-th/0410117 (communicated)*.

10. *"Interior gap superfluidity in a two-component Fermi gas of atoms"*, B. Deb, A. Mishra, H. Mishra, P. K. Panigrahi, Rapid Communication, Phys. Rev. A70, 011604(R),(2004). **cond-mat/0308369***.

11. *"Chiral symmetry breaking, color superconductivity and color neutral quark matter: a variational approach"*, A. Mishra and H. Mishra, hep-ph/0306105, Phys Rev. D69,014014, 2004*.

12. *" Chiral symmetry breaking, Color superconductivity and quark matter phase diagram: A variational approach"*, Hiranmaya Mishra and J.C. Parikh ,Nucl.Phys A679, 597, (2001). *

13. *"Leptogenesis with heavy majarona neutrino revisited"*, Raghavan Rangarajan and Hiranmaya Mishra, Phys. Rev. D61:043509,2000.*

14. *"Meson correlators at finite temperature*, Varun Sheel, Hiranmaya Mishra and Jitendra C Parikh, Phys Rev D59: 034501, (1999)*.

15. *"Rotating compact objects with magnetic fields"*, Anshu Gupta, A. Mishra, H. Mishra and A.R. Prasanna, Class. Quant. Grav. 15, 3131, (1998).*.

16. *"Hadronic Correlators at finite temperature*, Varun Sheel, Hiranmaya Mishra and Jitendra C Parikh, Prog. Theo. Phys. Suppl.129, 137 (1997)*.

17. *"Vacuum Structure and Effective Potential at Finite Temperature: A Variational Approach"*, Amruta Mishra and Hiranmaya Mishra, Jour. Phys. G23, 143, (1997).

18. *"Quark propagators and meson correlators in QCD vacuum* , Varun Sheel, Hiranmaya Mishra and Jitendra C Parikh, Int. J. Mod. Phys. E6, 275 (1997).

19. *"Hadronic correlators and condensate fluctuations in QCD vacuum"* , Varun Sheel, Hiranmaya Mishra and Jitendra C Parikh, Phys. Lett. B173, 177, (1996).

20. *"Vacuum structure in QCD with quark and gluon condensates"*, A. Mishra, H. Mishra, Varun Sheel, S.P. Misra and P. K. Panda, Int. J. Mod. Phys. E5, 93 (1996).

21. *"Confinement, Quark Matter Equation of State and Hybrid Stars"*, S. B. Khadkikar, A. Mishra, H. Mishra, Modern Physics Letters A10, 2651 (1995).

22. *"Gluon Condensates,Quark Matter Equation of State and Quark Stars"*, A. Mishra, H. Mishra, S. P. Misra and P. K. Panda, Z. Phys. C63, 681 (1994).

23. *"A variational approach to bound states in quantum field theory"*, H. Mishra and S. P. Misra, Z. Phys. C61, 97, 1994.

24. *"Chiral symmetry breaking and pion wave function"*, H. Mishra and S.P. Misra, Phys. Rev. D48, 5376, 1993.

25. *"Gluon Condensates at finite baryon densities and temperature"*, A. Mishra, H. Mishra and S. P. Misra, Z. Phys. C59, 159 (1993).

26. *"Neutron matter - Quark matter phase transition and quark star"* H. Mishra, S. P. Misra, P. K. Panda and B. K. Parida, Int. J. Mod. Phys. E2, 547 (1993).

27. *"Effective Potentials in QCD and Chiral Symmetry Breaking"*, A. Mishra, H. Mishra and S. P. Misra, Z. Phys. C57, 241 (1993).

28. *"QCD at finite temperatures: A variational approach"*, A. Mishra, H. Mishra, S. P. Misra and S. N. Nayak, Z. Phys. C57, 233 (1993).

29. *"Gaussian effective potentials and Bogoliubov transformations"*, H. Mishra and A. R. Panda J. Physics G (Nucl. Part. Phys.)8, 1301 (1992).

30. *"Hot nuclear matter: A variational approach"*, H. Mishra, S. P. Misra, P. K. Panda and B. K. Parida, Int. J. of Mod. Phys. E 1, 405 (1992)

31. *"A non-perturbative variational approach to vacuum structure of QCD"*, A. Mishra, H. Mishra, S. P. Misra and S. N. Nayak, Pramana(Jou. of Phys.)37, 59 (1991).

32. *"Higgs particles production through vacuum excitations"*, A. Mishra, H. Mishra, S. P. Misra and S. N. Nayak, Phys. Rev D44,110 (1991).

33. “1+1 dimensional supersymmetry at finite temperature : a variational approach”, A. Mishra, H. Mishra, S.P. Misra and S.N. Nayak, Phys. Lett. B251, 541 (1990).

34. *“Nuclear matter with constituent meson quanta”*, A.Mishra, H.Mishra and S. P. Misra, Int. Jou.of Mod. Phys.A5, 3391 (1990).

35. *“A variational approach to Gross-Neveu Model”*, A. Mishra, H. Mishra and S. P. Misra, Int. Jou. of Mod. Phys.A 2331 (1988)

36. *“Constitutent radidiation quanta in bound states: a fresh look”*, H. Mishra, S. P. Misra and S. Panda, Ind. J. of Phys. 62B, 21 (1988).

37. *“Quantum magnetic monopoles”*, H. Mishra and S. P. Misra, Ind. J. of Phys. 62A, 420 (1988).

Articles in the proceedings of conferences

1. ”Working Group report: Quark Gluon Plasma”, Pradip Roy etal, Pramana **72**:285–296, 2009.

2. “Color superconducting strange quark matter at finite temperature”, Amruta Mishra and Hiranmaya Mishra, J. Phys. **G**50 223-229, 2006, Proceedings of International Conference on Physics and Astro physics of Quark Gluon Plasma-05 Kolkata 7-12 Feb. 2005.

3. “Working Group Report- Heavy Ion Physics and QGP”, M.G. Mustafa etal, arXiv:hep-ph/0607117, Pramana **67**:961–982,2006 .

4. A. Mishra and H. Mishra: “Chiral symmetry breaking, color superconductivity and gapless modes in color neutral matter”, To appear in the proceedings of XLII International winter meeting on Nuclear Physics, Bormio, Italy, Jan.26-31 2004.

5. A. Mishra and H. Mishra: “Chiral symmetry breaking, color superconductivity and color neutral quark matter”, proceedings of Workshop on “Mesons and Quarks”, held at BARC, Mumbai,Narosa Publishing House, Pgs. 306-320, 2004.

6. *“Vacuum structure in QCD and correlation Function”*, H. Mishra, Invited talk prepared for DAE Nuclear Physics symposium, Chandigarh, India, Dec. 27-31, 1999 ; to appear in the proceedings.*

7. *“Gluon Condensates at finite baryon densities and temperature”*, A. Mishra, H. Mishra and S. P. Misra, proccedings of International Conference of physics and Astrophysics of QGP, Calcutta,19-23 Jan 1993, Pg.s 396-399.

Preprints

1. *Chiral symmetry breaking, color superconductivity and gapless modes in 2SC+S quark matter,hep-ph/0408353.*

2. *“Meson Correlators in QCD vacuum –is saturation the right approach?”*, Varun Sheel, Hiranmaya Mishra and Jitendra C Parikh, hep-ph/ 9411402.

3. *A nonperturbative approach to quark antiquark potential in quantum chromodynamics.*, A. Mishra, H. Mishra, S.P. Misra and S.N. Nayak Institute of Physics, Bhubaneswar preprint IP/BBSR/90-35.

4. *Quantum corrections to Supersymmetry - A variational calculation.* A. Mishra, H. Mishra, S.P. Misra and S.N. Nayak Institute of Physics, Bhubaneswar preprint IP/BBSR/92-21.