Prof. Anuradha Misra

Research Group : Theoretical High Energy Physics

Research Area

Light Front field Theory, Resummation in Quantum Chromodynamics, Spin Physics, Physics Beyond Standard Model

Education

B.Sc. 1980, University of Allahabad

M.Sc. 1983, I.I.T., Kanpur

Ph.D. 1989, I.I.T., Kanpur,

Thesis title **:** Some Results in Chiral Anomaly, Trace Anomaly and Energy Momentum Tensor

Thesis Supervisor : Prof. S.D.Joglekar

Professional Experience

Position held	**Period of appointment**	**Institution**
Head of the Department	November 2013 – October 2016	University of Mumbai
Professor	November 2008 till date	University of Mumbai
Reader	April 2003 – November 2008	University of Mumbai
Lecturer	June 1995 – March 2003	University of Mumbai
Research Associate	Oct 1994 – June 1995	Mumbai University
Research Associate	May 1994 – June 1994	H.R.I., Allahabad
Collaborator Lecturer	Jan 1994 – March 1994	SUNY, Stony Brook, New York, USA
Guest Lecturer	Jan 1993-Dec 1993	SUNY, Stony Brook, New York, USA
Research Associate	Dec 1990-March1991	SINP, Calcutta

Awards & Honours

- Research Award of University of Mumbai 2018-19
- Senior Associate, ICTP, Trieste, Italy
- INSA visiting fellowship for the academic year 2013-2014
- Best Outgoing Student in M. Sc.(Physics) , 1983, IIT Kanpur
- X rank in state in U.P. Board Intermediate Examination 1978

Teaching

Courses taught at University of Mumbai for M.Sc. (Physics) students

- Classical Mechanics
- Mathematical Methods in Physics
- Classical Electrodynamics
- Quantum Mechanics
- Particle Physics
- Quantum Field Theory
- Nuclear Particle Physics (Core)

Courses taught at University of Mumbai for Ph.D. students

- Theoretical Physics

Courses taught at State University of New York, Stony Brook, NY and at UM-DAE Centre of Excellence in Basic Sciences at University of Mumbai

- Electricity & Magnetism
- Particle Physics

Courses taught at National and International Schools for graduate students and advanced researchers:

Participated in following SERC and other advanced schools in Theoretical High Energy Physics as Lecturer/Guest Lecturer:

- XIII SERC Main School at Vishva Bharti University at Shanti Niketan as Guest Lecturer (Feb 1998).
- XIV SERC Preparatory School at IISc, Bangalore as a Guest Lecturer (June 1998).
- XXIII SERC Main School at IIT, Bombay as Lecturer(December 2003).
- XXV SERC Main School at University of Punjab, Chandigarh as guest lecturer (April 2010).

- Advanced International School on QCD at LHC at HRI, Allahabad in Nov 2007 as a Guest Faculty. This school was an advanced school for research scholars as well as senior researchers.
- RADCOR Advanced School at SINP, Kolkatta as a faculty (September 2011).
- Lecture Workshop in HEP (LWHEP 2013) at IIT, Bombay as a lecturer (January 2013).
- The Journey of Particle Physics : From Electron to the Higgs particle : Talks delivered at **INSPIRE camp at SMVDU, Jammu, July, 2016** as a mentor for school children.
- The Fascinating World of Elementary Particles : Talk delivered at **INSPIRE camp at Panjab University, Chandigarh, April, 2018** as a mentor for school children

Courses taught at Science Academies' Refresher Courses

- **Probability Theory** at Science Academies' Refresher Course in Statistical Mechanics in November 2013 in collaboration with Homi Bhabha Centre for Science Education and Research, TIFR, Mumbai
- **Quantum Mechanics** at Science Academies' Refresher Course on the theme "Applications of Quantum Mechanics : Atoms, Molecules and Radiation" in Dec-2015-Jan 2016
- **Quantum Mechanics** at Science Academies' Refresher Course on "Foundations of Physics" at IWSA, Mumbai, Dec. 2014
- **Quantum Mechanics** at Science Academies' Refresher course on Quantum Mechanics at T. Dayanand Science College, Latur in April, 2016
- Resource person for all the UGC sponsored refresher courses held at the Department of Physics, University of Mumbai in the last 21 years.

Research

Broad Research Area : Quantum Field Theory and Particle Physics

Specialization: Quantum Chromodynamics (QCD) and formal aspects of Light Front Field Theory (LFFT)

LFFTs have emerged in the last two decades, as a strong candidate for explaining the long range features of strongly interacting systems whereas perturbative Quantum Chromodynamics(pQCD) is the firmly established theory of strong interactions at high energies or short distances which has been tested extensively by comparison with experiments at various collider facilities around the world.

Light Front Field Theory

THEP group is involved in formal aspects of LFFTs. A coherent state method has been developed to deal with Infra-red divergences in Light Front Field

Theory(LFFT). We have applied this method to QED up to O(e^4) and to QCD up to O(e^2) for demonstrating the cancellation of divergences in transition matrix amplitudes calculated in coherent state basis. We have constructed an all order proof of IR cancellation for LFQED. We are now investigating IR and collinear divergences in QCD using the light front coherent state approach.

THEP group has also been working on establishing the equivalence of covariant and light front field theories.

Resummation Methods in QCD

In collaboration with our Dutch and IMSc collaborators, we have been studying the application of threshold and joint resummation schemes in prompt photon production. In an earlier work, we have considered the impact of the subleading term of the kind lnN/N on the p_T spectrum of prompt photons produced in hadronic collisions. Recently, we have improved our results by including the contribution of fragmentation functions and by considering the next-to-leading terms of this kind. The effect of this class of corrections on other processes of interest is part of our future plans.
Preliminary studies involving JR indicate that recoil effects at higher order can be phenomenologically relevant. One of the objectives of the ongoing work is a thorough analysis of the JR technique and its relation to recoil effects as well as a study of matching procedures involved.
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Spin Physics

One of the main research interests of THEP group is study of transverse single spin asymmetries(TSSA's) which arise in collision of unpolarized lepton or proton beams off transversely polarized proton targets with the aim of investigating the transverse spin structure of the proton. The group has been involved in TSSAs arising in in open and closed charmonium systems and in prompt photon production. With collaborators from IISc Bangalore and IIT, Bombay, we have discussed the possibility of using electroproduction of J/ψ as a probe of gluon Sivers function by measuring single spin asymmetry (SSA) in experiments with transversely polarized protons and electron beams. In this work, we used color evaporation model of charmonium production. One can use SSA in charmonium production to study and compare various models of charmonium production. We have also studied single spin asymmetries in D meson production and prompt photon production and discussed the possibility of using these processes as a probe of Gluon Sivers function

Physics Beyond Standard Model

In collaboration with TIFR, Mumbai and with M.Sc. project students, we have been studying extra dimensional models which are viable candidates to explore the physics beyond standard model.

We are also investigating the Stuckelberg mechanism in supersymmetric QED in collaboration with IIT Bombay and I.MSc., Chennai.

Brief description of various ongoing research projects of THEP group can be found at

Light Front Field Theory

Spin Physics

Resummation Methods in QCD

Research Group Members

Current Ph.D. Students

- **Deepesh Bhamre**
  Thesis Title : Study of Light Front Field Theory methods and their Application to Quantum Chromodynamics

- **Siddhesh Parwal**

  Thesis Title : Study of Single Spin Asymmetries in Open and Closed Charm production

- **Bilal Reshi**

  Thesis Title : Radiation Hard Detectors for Future Colliders
  Co-supervised with Prof. R. Varma, IIT Bombay

- **Radhika Vinze**

  Thesis Title : Signals for extension of the Standard Electroweak Model and Backgrounds in the context of Collider Studies
  Co guide : Prof. Sreerup Raychaudhuri, TIFR, Mumbai

Former Ph. D. Students

- **Swati Patel**

  Thesis Title : Theoretical Investigation of Renormalization in Light Front Field Theory

  Present position : Physics & Maths Tutor, Liverpool, UK

- **Jai More**

  Thesis Title : Study of Method of Asymptotic Dynamics and Coherent State Formalism in Light Front Field Theory

Present position : DST Woman Scientist, IIT, Bombay

- **Vaibhav Rawoot**

  Thesis Title : Single Spin Asymmetry and Quarkonium Systems
  Present position : Assistant Professor, Amity University, Panvel, Mumbai

- **Mahendra Kushwaha**

  Thesis Title : Finite Range Studies of ^{40}Ca(p, 2p)^{39}K and ^{24}Mg(^{12}C, 2 ^{12}C)^{12}C Knockout Reactions

  Co-supervised with Dr. Sudhir Jain, BARC

  Present position : Senior Scientific Officer cum Scientist-B
  Central Forensic Science Laboratory, Pune

- **Anamika Parihari**

  Thesis Title : Effect of Projectile Breakup on Fission Fragment Angular and Mass Distribution for 6,7Li+235,238U Reactions.

  Co- supervised with Dr. Basant Nayak, BARC

  Present position : Research Associate, IUAC, New Delhi

- **Namrata Mangalani**

  Thesis Totle **:** Searches for Extra Dimensions at the Large Hadron Collider and beyond

  Co- supervised with Prof. K. Sridhar, TIFR, Mumbai

  Present postion : Assistant Professor, Shah and Anchor Kutcchi Engineering College, Mumbai

- **Bipin Sonawane**

  Thesis Title : Single Spin Asymmetries in Charmonium Production and Gluon Sivers Function

  Present position : Assistant Professor, Amity University, Panvel, Mumbai

Collaborators

- Prof. Rohini M. Godbole, I.I.Sc., Bangalore, India
- Prof. Eric Laenen, Nikhef, Amsterdam, Netherlands
- Prof. Wim Beenakker, Radboud University, Nijmegen, Netherlands
- Dr. Melissa Van Beekweld, Netherlands

Selected Publications

1. Coherent States in Null Plane QED, Anuradha Misra, Physical Review D 50, 4088(1994)
2. Discrete Light-Front Quantization and Coherent State Basis, Anuradha Misra, Physical Review D53, 5874(1996)
3. Equivalence of covariant and light front QED at one loop level, Swati M. Patel and Anuradha Misra, Phys. Rev. D 71, 125011 (2005)
4. Sivers Effect and Transverse Single Spin Asymmetry in $e+p^\uparrow \to e+J/ψ+X$. Rohini M. Godbole, Anuradha Misra, Asmita Mukherjee, Vaibhav S. Rawoot, Physical Review D 85, 094013 (2012).
5. Infra-red Divergences in Light-Front QED and Coherent State Basis, Jai D. More and Anuradha Misra, Phys. Rev. D 86,065037 (2012).
6. Transverse Single Spin Asymmetry in $e + p^\uparrow \rightarrow J/\psi + X$ and Transverse Momentum Dependent Evolution of Sivers function, Rohini Godbole, Anuradha Misra, Asmita Mukherjee, Vaibhav Rawoot, Phys.Rev. D88, 014029 (2013).
7. Fermion self-energy correction in light-front QED using coherent state basis, Jai D. More and Anuradha Misra, Phys.Rev. D 87, 085035 (2013).
8. Cancellation of Infra red divergences to all orders in LFQED, Jai D. More and Anuradha Misra, Phys.Rev. D89 (2014) 105021 arXiv:1402.4924 [hep-th].
9. Transverse single spin asymmetry in $e+p^\uparrow \rightarrow e+J/\psi+X$ and $Q2$ evolution of Sivers function, Rohini M. Godbole, Abhiram Kaushik, Anuradha Misra, and Vaibhav S. Rawoot, Phys. Rev. D 91, 014005 (2015)
10. Transverse Single Spin Asymmetry in $p+ p^\uparrow \rightarrow D +X$, Rohini M. Godbole,Abhiram , Kaushik and Anuradha Misra, Phys. Rev. D 94, 114022 (2016)
11. Transverse single spin asymmetry in $p+p^\uparrow \rightarrow J/\psi+X$, Rohini M. Godbole, Abhiram Kaushik, Anuradha Misra, Vaibhav S. Rawoot, Bipin Sonawane, Phys. Rev. D 96, 096025 (2017)
12. Transverse Single Spin Asymmetry in low virtuality electroproduction of open charm as a probe of gluon Sivers function, Rohini M. Godbole,Abhiram , Kaushik and Anuradha Misra, Phys. Rev. D 97, 076001 (2018).
13. Light-Cone 2017: Theory and Experiment for Hadrons on the Light-Front, Anuradha Misra and Chueng R. Ji, GHP Newsletter March 2018, American Physical Society Topical Group on Hadronic Physics, p-14 (2018). http://www.aps.org/units/ghp/ , Contribution to American Physical Soceity Newsletter.
14. LIGHT-CONE 2017: Frontiers in Light-Front Hadron Physics: Theory and Experiment, Anuradha Misra, James P Vary, Few-Body Systems, 59, 132 (2018).
15. Probing the gluon Sivers function through direct photon production at RHIC, Rohini M Godbole, Abhiram Kaushik, Anuradha Misra and Siddhesh Padwal, Phys. Rev. D 99, 014003 (2019), hep-ph/1810.07113.
16. Next-to-leading power threshold effects for resummed prompt photon production Melissa van Beekveld, Wim Beenakker, Rahul Basu, Eric Laenen, Anuradha Misra,and Patrick Motylinski, Phys. Rev. D 100, 056009 (2019)
17. KK Higgs produced in association with a top quark pair in the bulk RS model, N Manglani, A Misra, K Sridhar, The European Physical Journal C 79, 967, 2019.

Complete list of publications can be found at Google Scholar page

Books authored/edited

Light Cone 2017 : Frontiers in Light Cone Hadron Physics : Theory and Experiment

Editors : Anuradha Misra and James P. Vary

Sponsored Research Projects

- Theoretical investigations of infrared divergence, renormalization and zero mode problem in Light-Front Field Theory
  Period: September 1997 – September 1999
  Funding agency : DST (Young Scientist Scheme)
- Theoretical study of method of asymptotic dynamics in Light-Front Field Theories.
  Period : July 2002 – 2003
  Funding agency : University Of Mumbai(Minor Project Scheme)
- Theoretical investigations in Light-Front Field Theory.
  Period : May 2007 – 2010
  Funding agency :DST, India.
- Resummation methods and their applications in Quantum Chromodynamics
  Period: September 2010-2014.
  Funding agency: DAE-BRNS, India
- Study of transverse momentum dependent formalism of pQCD and its applications to charmonium systems
  Period : October 2015-2018
  Funding agency :DST SERB, India

International Visits (Last two years)

- CERN theory division, Geneva,Switzerland as visiting scientist
  December 15, 2016 – June 15, 2017
  Oct 1, 2017- Oct 31, 2017
- University of Torino, Italy
  March 9, 2017- March 19, 2017
- Nikhef & Univ. of Amsterdam, Netherlands as visiting scientist
  May 8, 2017- June 7, 2017
- ICTP, Trieste, Italy as Senior Associate
  November 1, 2017- Nov, 30, 2017
- Theory division, Jeferson Lab, Newport, VA, USA
  May, 2018 (one week)
- University of Stony Brook, June 2019 (one week)
- ICTP, Trieste as Senior Associate
  Oct-Nov. 2019

Selected Talks at International Conferences

- Threshold and Joint Resummation in Prompt Photon Production: Including Soft-Collinear Effects, Talk presented at workshop on "Getting Ready for the physics LHC P" at H.R.I., Allahabad, Feb. 16-20, 2009.
- Soft and Collinear Effects in Threshold and Joint Resummation, Talk presented at Review Meeting of SERC Schools in THEP at IIT, Bombay on 21. 05. 2010 – 22. 05. 2010.
- Transverse Single Spin Asymmetry and Charmonium Production, Rohini Godbole, Anuradha Misra, Asmita Mukherjee and Vaibhav Rawoot, Talk presented at LC2012 at Delhi University, December 2012.
- Single Spin Asymmetry in Charmonium Production, Talk presented at "LC 2014 : Theory and Experiment for Hadrons on the Light Front" at North Carolina State University, May 26-31, 2014.
- Single Spin Asymmetry in Electroproduction of J/psi and QCD evolved TMD's, Talk presented at QCD evolution workshop (QCD2014) at Santa Fe, USA , May 12-16, 2014.

- Heavy Flavour production as probe of Gluon Sivers Function, Talk presented at Instituto Superior Técnico (IST) of the University of Lisbon, Portugal, September 5-8, 2016.
- Soft - Collinear Effects in Threshold and Joint Resummation at International Light Cone Conference LC 2017, Mumbai : September 22, 2017
- Equivalence of Light - Front and Covariant QED and the Form of the Gauge Boson Propagator, Light Cone 2018, Jefferson Lab, Newport USA

Outreach and Organization

- Frontiers in Physics, Lecture Workshop for students sponsored by Indian Academy of Sciences , Oct, 2006.
- UGC sponsored Refresher Course in Theoretical Physics, Jan 2011.
- Science Academies' Refresher Course in Theoretical Physics, July 2012.
- Lecture Workshop in Perturbative QCD and Higgs Physics, Jan7-11, 2013 , in collaboration with IIT, Bombay.
- Science Academies' Refresher Course in Statistical Mechanics to be held in November 2013 in collaboration with HBCSE, TIFR.
- Science Academies' Refresher Course on the theme "Applications of Quantum Mechanics : Atoms, Molecules and Radiation" in Dec-2015-Jan 2016.
- Science Academies' Refresher Course on "Mathematical Methods in Physics and their Applications" in Oct-2016.
- GIAN course by Prof. Eric Laenen on "Introduction to Quantum Chromodynamics" in Nov-2016
- GIAN course on Light Front Hadron Physics by Prof. Stanley J. Brodsky, Stanford University, USA and Prof. Chueng R. Ji, North Carolina State University, USA at University of Mumbai, September 2017
- International Light Cone Conference LC 2017 at University of Mumbai, September 2017

Membership of Academic Bodies

- Member, International Light Cone Advisory Committee http://www.ilcacinc.org/

- Chairperson, Board of Studies in Physics, University of Mumbai
- Former Member, Campus Development Council, University of Mumbai
- Member, Academic Council, University of Mumbai
- Member, Academic Board, UMDAE-CBS, University of Mumbai
- Member, Academic Board, SIES College
- On the panel of referees for Physical Review Letters, Physical Review D, FBS and Pramana
- On the panel of referees for DS Kothari fellowship.
- Paper setter for national level examination
- Member of Academic Team for International Junior Science Olympiad 2013 held at Pune in December 2013
- Member, Academic Team Indian Physics Olympiad 2015
- Member of DST review committee for INSPIRE fellows

Contact

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