Ratna Koley, Ph.D.

Department of Physics Presidency University, Kolkata ratna.physics@presiuniv.ac.in



Employment History

2013 - · · · ·		Assistant Professor, Department of	f Physics,	Presidency	University.
----------------	--	------------------------------------	------------	------------	-------------

2009 – 2013 📕 Assistant Professor, WBES, Bethune College, Kolkata.

Research Positions

2008 – 2009	DST Fast Track Young Scientist, Indian Association for the Cultivation of Science, Kolkata.
2008	Research Associate - II, Indian Association for the Cultivation of Science, Kolkata.
2006 – 2008	Post Doctoral Fellow, Inter University Center for Astronomy and Astrophysics, Pune.

Education

2006	Ph.D. in Physics, IIT Kharagpur
	Thesis title: Studies on Aspects of Gravity and Geometry in Dimensions $D{\neq}4$
2001	M.Sc. in Physics, Jadavpur University
	Specialization: High Energy Physics
1999	B.Sc. in Physics, Burdwan Raj College, The University of Burdwan

Research Interests

- Blackhole Physics: Quasi Normal Modes, Shadow
- Physics of the Early Universe: Primordial Magnetic Fields, Black Holes and Gravitational Waves.
- Physics in Higher Dimensions: Braneworld Models, Stability, Field Localization.
- Physics Teaching: Pedagogical Study in Quantum Mechanics and General Relativity.

Agency Funded Research Projects

- Project Title : Primordial Magnetic Fields and their imprints on successive phases of evolution Funding Agency : Department of Higher Education, Science and Technology and Bio-technology (WBHESTBT), Govt. of West Bengal Period : March 2018 to April 2022 Fund Awarded: Rs. 11, 95, 800/-Role : Principal Investigator
 Project Title : Gravity, cosmology and phenomenology in higher dimensions
- 2. Project Title : Gravity, cosmology and phenomenology in higher dimensions Funding Agency : Department of Science and Technology (DST), India Period : Sep 2008 to June 2009 Fund Awarded: Rs. 12, 17,700/-Role : Principal Investigator

Research Publications

Journal Articles

S. Roy, S. Chatterjee, and R. Koley, "Shadow of higher dimensional collapsing dark star and blackhole," *Eur. Phys. Journal C*, vol. 84, no. 47, 2024. *P* DOI: 10.1140/epjc/s10052-023-12379-w. arXiv: 2309.02709 [gr-qc].

P. Gayen and R. Koley, "Scalar and Spinor Quasi Normal Modes of a 2D Dilatonic Blackhole," *General Relativity and Gravitation*, vol. 55, p. 129, 2023. *P* DOI: 10.1007/s10714-023-03178-5.

P. Baral, A. Ray, R. Koley, and P. Majumdar, "Gravitational Waves with Orbital Angular Momentum," *Eur. Phys. J. C*, vol. 80, no. 4, p. 326, 2020. *P* DOI: 10.1140/epjc/s10052-020-7881-2. arXiv: 1901.08804 [gr-qc].

S. K. Roy, R. Koley, and P. Majumdar, "Probing the post-Minkowskian approximation using recursive addition of self-interactions," *Phys. Rev. D*, vol. 102, no. 8, p. 084 045, 2020. *O* DOI: 10.1103/PhysRevD.102.084045. arXiv: 2007.02887 [gr-qc].

5 S. K. Roy, R. Koley, and P. Majumdar, "Kinematics of Two-particle Scattering in Black Hole Backgrounds," *Phys. Rev. D*, vol. 100, no. 6, p. 064 052, 2019. *O* DOI: 10.1103/PhysRevD.100.064052. arXiv: 1905.09089 [gr-qc].

R. Koley and S. Samtani, "Magnetogenesis in Matter - Ekpyrotic Bouncing Cosmology," *JCAP*, vol. 04, p. 030, 2017. *O* DOI: 10.1088/1475-7516/2017/04/030. arXiv: 1612.08556 [gr-qc].

A. Banerjee and R. Koley, "Inflationary field excursion in broad classes of scalar field models," *Phys. Rev. D*, vol. 94, no. 12, p. 123 506, 2016. *O* DOI: 10.1103/PhysRevD.94.123506. arXiv: 1512.08759 [hep-th].

R. Koley, J. Mitra, and S. SenGupta, "Scalar Kaluza-Klein modes in a multiply warped braneworld," *EPL*, vol. 91, no. 3, p. 31 001, 2010. *9* DOI: 10.1209/0295-5075/91/31001. arXiv: 1001.2666 [hep-th].

R. Koley, J. Mitra, and S. SenGupta, "Fermion localization in generalised Randall Sundrum model," *Phys. Rev. D*, vol. 79, p. 041 902, 2009. *P* DOI: 10.1103/PhysRevD.79.041902. arXiv: 0806.0455 [hep-th].

10 R. Koley, J. Mitra, and S. SenGupta, "Modulus stabilization of generalized Randall Sundrum model with bulk scalar field," *EPL*, vol. 85, no. 4, p. 41 001, 2009. *O* DOI: 10.1209/0295-5075/85/41001. arXiv: 0809.4102 [hep-th].

R. Koley, J. Mitra, and S. SenGupta, "Chiral fermions in a spacetime with multiple warping," *Phys. Rev. D*, vol. 78, p. 045 005, 2008. *O* DOI: 10.1103/PhysRevD.78.045005. arXiv: 0804.1019 [hep-th].

R. Koley and S. Kar, "Braneworlds in six dimensions: New models with bulk scalars," *Class. Quant. Grav.*, vol. 24, pp. 79–94, 2007. *9* DOI: 10.1088/0264-9381/24/1/004. arXiv: hep-th/0611074.

R. Koley and S. Kar, "Exact bound states in volcano potentials," *Phys. Lett. A*, vol. 363, pp. 369–373, 2007. *O* DOI: 10.1016/j.physleta.2006.11.031. arXiv: quant-ph/0611068.

R. Koley and S. Kar, "A Novel braneworld model with a bulk scalar field," *Phys. Lett. B*, vol. 623, pp. 244–250, 2005, [Erratum: Phys.Lett.B 631, 199 (2005)]. *O* DOI: 10.1016/j.physletb.2005.09.063. arXiv: hep-th/0507277.

15 R. Koley and S. Kar, "Bulk phantom fields, increasing warp factors and fermion localisation," *Mod. Phys. Lett. A*, vol. 20, pp. 363–372, 2005. *P* DOI: 10.1142/S0217732305015586. arXiv: hep-th/0407159.

16 R. Koley and S. Kar, "Scalar kinks and fermion localisation in warped spacetimes," *Class. Quant. Grav.*, vol. 22, no. 4, pp. 753–768, 2005. *O* DOI: 10.1088/0264–9381/22/4/008. arXiv: hep-th/0407158.

R. Koley, S. Pal, and S. Kar, "Geodesics and geodesic deviation in a two-dimensional black hole," *Am. J. Phys.*, vol. 71, pp. 1037–1042, 2003. *O* DOI: 10.1119/1.1566426. arXiv: gr-qc/0302065.

Conference Proceedings

- R. Koley, "Localization of fields on brane," in *Workshop on Physics of Warped Extra Dimensions* (*PWED 2008*), Dec. 2008. arXiv: 0812.1423 [hep-th].
- 2 R. Koley and S. Kar, "Brane world models with bulk scalars: Examples," in *Proceedings of* 23rd *Conference of IAGRG (Dec. 7 10, 2004) held at Jaipur, India, Page No. 111-115, Dec. 2008.*

Selected Presentation & Participation in Conference/Workshop/Seminar:

Presentation:

- Invited Talk, Conference on "Beyond Standard Models in Particle Physics and Gravity", IACS, Kolkata (22 23 December, 2022)
 Title: Title: Primordial Magnetic Fields and Gravitational Waves in Matter Ekpyrotic Bouncing Cosmology
- Poster, 23rd International Conference on General Relativity and Gravitation, Beijing, China (Online) (3 8 July, 2022)
 Title : Gravitational Wave Beams with Orbital Angular Momentum
- Invited Talk, Workshop on "Astrophysics and Astronomy for Women in India", Department of Physics, Diamond Harbour Women's University in association with ICARD, University of North Bengal (sponsored by IUCAA, Pune), (31 January 1 February, 2020) Title : Large Scale Magnetic Fields in the Universe
- **Talk**, International conference on "Emerging Issues in Cosmology and Particle Physics (EICP2)", Department of Physics, Visva-Bharati, Shantiniketan (12 - 14 January, 2020) **Title :** *Primordial Magnetic Field in Bouncing Cosmology*
- Invited Visit and Talk, Astrophysics and Cosmology Research Unit, University of KwaZulu-Natal, Durban, South Africa (9 - 25 November, 2017)
 Title : Aspects of Primordial Magnetogenesis
- **Poster**, 35th Meeting of Astronomical Society of India, Jaipur (6 10 March, 2017) **Title :** *Magnetogenesis in Matter-Ekpyrotic Bouncing Universe*
- **Invited Talk**, Topical Conference on Gravitation, Cosmology and Astrophysics (Eastern Region, 2016), Visva Bharati, Shantiniketan (24 September, 2016) **Title :** *Aspects of Primordial Magnetogenesis*
- Talk, International conference "COSMOCRUISE 2015: At the Edge of Discovery", Barcelona, Spain (2 9 September, 2015) Title : Primordial Magnetogenesis: role of nonlinear electromagnetism
- **Invited Talk** Bethune College, Kolkata (10 January, 2013) **Title :** *The Higgs Boson and the LHC : greatest success of human intellect !!*
- **Invited Talk** at 2nd BCTP Workshop at Bonn University, Germany (4 8 October, 2010) **Title :** Fermions in warped spacetime and smallness of the cosmological constant
- **Invited Talk**, National Conference, North Bengal University, (12 February, 2009) **Title :** *Fermions in warped spacetime and smallness of the cosmological constant*
- Invited Visit and Talk, Harish-Chandra Research Institute (HRI) on (15 19 September, 2008) Title : Fermions in warped spacetime and smallness of the cosmological constant
- Invited Talk, Workshop on Physics of Warped Extra Dimensions, IIT, Kharagpur (21 23 February, 2008)

Title : Localization of fields in braneworlds

• **Talk**, 24th Conference of the IAGRG (IAGRG-24) at Jamia Milia Islamia, New Delhi (5 - 8 February, 2007)

Title : Brane worlds in six dimensions : new models with bulk scalars

Participation:

- International conference "Less Travelled Path of Dark Matter: Axions and Primordial Black Holes", ICTS, India (9 13 November 2020)
- International conference "Physics of the Early Universe An Online Precursor" ICTS, India (31 August 03 September, 2020)
- Two-day International Workshop "Testing General Relativity using Gravitational Waves", Indian Association for the Cultivation Of Science (IACS) & Indian Institute of Technology, Gandhinagar (IITGN), (13 14 August, 2020)
- National conference on "Gravity at Different Length Scales", the Gravity Group, Indian Association for the Cultivation of Science, Kolkata (25 27 February, 2019)
- International conference on Universe after the first 200 million years cosmic dawn, reionization and post reionization", Presidency University (11 13 December, 2017)
- Third "Saha Theory Workshop: Aspects of Early Universe Cosmology" (16 20th January, 2017)
- Third meeting of TCGC at IIT, Kharagpur (February, 2015)
- Workshop on Statistical Applications to Cosmology and Astrophysics (STATCOSMO15), ISI, Kolkata (10 13 February, 2015)
- Saha theory workshop : cosmology at the interface, SINP, Kolata (28 30 January, 2015)
- Second meeting of TCGC at Presidency University, Kolkata (August, 2014).
- First meeting of TCGC at SINP, Kolkata (February, 2014).

Academic Visits at Institutes



Mentoring

- Research Level:
 - 1. Pabitra Gayen (UGC Research Fellow) (2020 Present) Topic of Research: *Geometrical and Observational Aspects of Different Theories of Gravity*
 - 2. Abhisek Das (WBHESTBT Project Fellow) (2018 2021) Topic of Research: Primordial Magnetic Fields and Their Imprints on Successive Phases of Evolution

• Post Graduate Level:

- 2023 2024:
 - 1. Saikat Sinha (Ongoing)
- 2022 2023:
 - 1. Sampurna Bhar (Project Title: Black Hole and Wormhole shadows: a tool to test gravity)
 - 2. Tanmay Mandal (Project Title: Gravitational Waves on Cosmological Background)
 - 3. Mehedi Hassan Mollah (Project Title: Early Universe Through Gravitational Wave)
- 2021 2022:
 - 1. Setabuddin (Project Tile: Probing GR and Modified Gravity Theory withGravitational Waves)
- 2020-2021:
 - 1. Alorika Kar (Project Title: Analysis of Inflationary Potentials to explore Primordial Black Holes as Possible Candidate for Dark Matter)
 - 2. Santanu Sarkar (Project Title: Single Field Inflation Model Which Favours The Formation of Primordial Black Holes)
- 2019-2020:
 - 1. Soumendra Kishore Roy (Project Title: Post Minkowskian Approximation from Self Interactins and Hawking radiation from Blackhole Binary Merger)
 - 2. Pratyusava Baral (Project Title: Radiation with Phase Structure in Electromagnetism and Gravity)
 - 3. Soumanti Chakraborty (Project Title: Blackhole production in the inflationary universe)
 - 4. Anupreet Ghosh (Project Title: Primordial Magnetic Field, its effect on CMB and Faraday rotation)
- 2018-2019:
 - 1. Anarya Ray (Project Title: Gravitational Radiation From Relativistic Sources (joint supervisor)
- 2018:
 - 1. Amitabha Banerjee (Project Title: BACTERIA AROUND A BLACK HOLE : Analogue Gravity with Active Nematic Fluid (joint supervisor))
- 2017:
 - 1. Abhisek Das (Project Title: Particle creation in expanding background)
 - 2. Shahbaz Akhter (Project Title: Distinction between R^2 inflation and Higgs inflation)
 - 3. Surajit Biswas (Project Title: The quantum Higgs phenomenon in massless scalar electrodynamics (joint supervisor))
- 2016:
 - 1. Bhaskar Biswas (Project Title: How much inflation is there a study by phase space analysis)
 - 2. Pritam Palit (Project Title: Addressing the eta problem in inflationary cosmology (joint supervisor))
- 2015:
 - 1. Argha Banerjee (Project Title: Inflation in Brane World Gravity)
 - 2. Arpan Kundu (Project Title: Study of Inflationary Magnetogenesis)
- 2014
 - 1. Subhankar Mandal (Project Title: Geodesic Flow in Black Hole Spacetime)

• Bachelor's Level:

- 2024:

1. Paramita Patra

- 2023:
 - 1. Sagnik Roy

(Project Title: Geodesic Motion and Matter Perturbation in Witten Bubble Spacetime)

2. Soham Chatterjee

(Project Title: SCALAR AND GRAVITATIONAL PERTURBATION IN EXTRA DIMENSIONAL SCHWARZSCHILD AND MORRIS-THORNE SPACETIME)

- 2022:

1. Rounak Nath

(Project Tile: Quantum Mechanics in Curved Spacetime)

- 2021:

- 1. Sagnik Bhattacharjee (Project Title: Gravitational Collapse)
- 2. Sauvik Chatterjee

(Project Title: Highly Oscillatory Second Order Linear Differential Equations(SOLDE) in Physics : Homogeneous and Inhomogeneous)

3. Tanbir Islam

(Project Title: COMPARISON OF ELECTROMAGNETIC AND GRAVITATION FIELD: WITH THE HELP OF VISUALISATION)

- 2020:

1. Arit Bala

(Project Title: The Hamilton-Jacobi formalism: in geometry and cosmology)

- 2019:

- 1. Dwaipayan Mukherjee (Project Title: The Late Universe Acceleration: Dark Energy)
- 2. SAGAR DAM (Project Title: STUDY ABOUT THE EARLY UNIVERSE ACCELERATION: COSMIC INFLATION)

- 2018:

- Pratyusava Baral (Project Title: Gravitational Waves as Tetrad Fluctuation)
- Sagnik Chaudhuri (Project Title: Aspects of the Dirac Monopole)
- 3. Soumendra Kishore Roy (Project Title: Black Hole as Particle Accelerator)
- 4. SOUMIK GOSWAMI (Project Title: A STUDY OF MODIFIED NEWTONIAN DYNAMICS)
- 2017:
 - 1. Aratrika Dey (Project Title: DOES NATURE ALLOW SUPERLUMINAL MOTION?)
- 2016:
 - 1. Arnab Laha (Project Title: DYNAMICS OF A PARTICLE IN CURVED SPACETIME)
 - 2. Deep Ghosh (Project Title: SOLUTION OF GEODESIC EQUATIONS IN CURVED SPACETIME)

- Research Level:
 - Advanced Quantum Field Theory for PhD Coursework at Presidency University
 - Research Methodology for PhD Coursework at Presidency University

• Postgraduate Level :

- Classical Mechanics for M.Sc. 1st year at Presidency University
- General Theory of Relativity for M.Sc. final year at Presidency University
- Advanced Quantum Mechanics for M.Sc. 1st year at Presidency University
- Quantum Field Theory for M.Sc. final year at Presidency University
- Classical Field Theory for M.Sc. first year at Presidency University
- Electrodynamics Tutorial for M.Sc. 1st year course at I.I.T. Kharagpur in Spring 2003
- Physics Laboratory for M.Sc. 1st year at I.I.T. Kharagpur in Spring 2003, 2004 and 2005

• Undergraduate Level :

- Statistical Mechanics Lab. for B.Sc. 3rd Yr. at Presidency University
- Introduction to Python for B.Sc. 1st Yr. at Presidency University
- Special Theory of Relativity for B.Sc. 1st/3rd Yr. at Presidency University
- Physical Optics for B.Sc. 2nd/3rd Yr. at Presidency University
- Classical Mechanics for B.Sc. 1st Yr at Presidency University
- Classical Electrodynamics for B.Sc. 3rd Yr. at Presidency University
- Statistical Mechanics Lab. for B.Sc. 3rd Yr. at Presidency University
- Electromagnetic Physics Lab. for B.Sc. 3rd Yr. at Presidency University
- Classical Mechanics Lab. for B.Sc. 1st Yr. at Presidency University
- Optics Lab. for B.Sc. 2nd Yr. at Presidency University
- Electronics and Electrical Lab. for B.Sc. 3rd Yr. at Presidency University
- Special Theory of Relativity for B.Sc. 3rd Yr. at Bethune College
- Mathematical Methods for B.Sc. 1st Yr. at Bethune College
- Quantum Mechanics for B.Sc. 3rd Yr. at Bethune College
- Elementary Particle Physics for B.Sc. 3rd Yr. at Bethune College
- Physical Optics for B.Sc. 2nd Yr. at Bethune College

• Teaching Assistantship at IUCAA :

- Refreshers' Course tutorial for College Teachers at IUCAA for "Introduction to General Relativity"
- Refreshers' Course tutorial for College Teachers at IUCAA for "Introduction to Cosmology"