

# Dr. Ratna Koley, Ph.D.

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## Employment

- Assistant Professor, Department of Physics, Presidency University.

## 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* Elective: *Gravitation and Cosmology*
- 1999 **B.Sc. in Physics, The University of Burdwan**

## Research Interests

- Early Universe Cosmology:** Primordial – Magnetic Fields, Black Holes, Gravitational Waves.
- Blackholes & Exotic Compact Objects:** Shadow, Quasi Normal Modes, Echo
- Higher Dimensions:** Braneworld, 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 : Dept. of Higher Education, Science and Technology and Bio-technology (WBHSTBT)    Period : March 2018 to April 2022    Fund Awarded: Rs. 11, 95, 800/-  
Role : Principal Investigator
- 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

- 1 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. [DOI: 10.1140/epjc/s10052-023-12379-w](#). arXiv: 2309.02709 [gr-qc].
- 2 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. [DOI: 10.1007/s10714-023-03178-5](#).
- 3 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. [DOI: 10.1140/epjc/s10052-020-7881-2](#). arXiv: 1901.08804 [gr-qc].
- 4 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. 084045, 2020. [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. 064052, 2019. [DOI: 10.1103/PhysRevD.100.064052](#). arXiv: 1905.09089 [gr-qc].
- 6 R. Koley and S. Samtani, "Magnetogenesis in Matter - Ekpyrotic Bouncing Cosmology," *JCAP*, vol. 04, p. 030, 2017. [DOI: 10.1088/1475-7516/2017/04/030](#). arXiv: 1612.08556 [gr-qc].
- 7 A. Banerjee and R. Koley, "Inflationary field excursion in broad classes of scalar field models," *Phys. Rev. D*, vol. 94, no. 12, p. 123506, 2016. [DOI: 10.1103/PhysRevD.94.123506](#). arXiv: 1512.08759 [hep-th].
- 8 R. Koley, J. Mitra, and S. SenGupta, "Scalar Kaluza-Klein modes in a multiply warped braneworld," *EPL*, vol. 91, no. 3, p. 31001, 2010. [DOI: 10.1209/0295-5075/91/31001](#). arXiv: 1001.2666 [hep-th].
- 9 R. Koley, J. Mitra, and S. SenGupta, "Fermion localization in generalised Randall Sundrum model," *Phys. Rev. D*, vol. 79, p. 041902, 2009. [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. 41001, 2009. [DOI: 10.1209/0295-5075/85/41001](#). arXiv: 0809.4102 [hep-th].
- 11 R. Koley, J. Mitra, and S. SenGupta, "Chiral fermions in a spacetime with multiple warping," *Phys. Rev. D*, vol. 78, p. 045005, 2008. [DOI: 10.1103/PhysRevD.78.045005](#). arXiv: 0804.1019 [hep-th].
- 12 R. Koley and S. Kar, "Braneworlds in six dimensions: New models with bulk scalars," *Class. Quant. Grav.*, vol. 24, pp. 79–94, 2007. [DOI: 10.1088/0264-9381/24/1/004](#). arXiv: hep-th/0611074.
- 13 R. Koley and S. Kar, "Exact bound states in volcano potentials," *Phys. Lett. A*, vol. 363, pp. 369–373, 2007. [DOI: 10.1016/j.physleta.2006.11.031](#). arXiv: quant-ph/0611068.
- 14 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)]. [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. [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. [DOI: 10.1088/0264-9381/22/4/008](#). arXiv: hep-th/0407158.
- 17 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. [DOI: 10.1119/1.1566426](#). arXiv: gr-qc/0302065.

### Conference Proceedings

- 1 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 23<sup>rd</sup> 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 :** *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 2<sup>nd</sup> 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, Kolkata (28 - 30 January, 2015)
- Second meeting of TCGC at Presidency University, Kolkata (August, 2014).
- First meeting of TCGC at SINP, Kolkata ( February, 2014).





**Organisation:**

2017 International conference on Universe after the first 200 million years - cosmic dawn, reionization and post reionization", Presidency University (11 - 13 December, 2017)

2014 Second meeting of TCGC at Presidency University, Kolkata (August, 2014).

## **Academic Visits at Institutes**

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- 2017  Astrophysics and Cosmology Research Unit (ACRU), School of Mathematics, Statistics and Computer Sciences, University of KwaZulu-Natal, Durban (November, 2017)
- 2015  Center for Theoretical Physics, Visitor's Programme at IIT Kharagpur (February and May, 2015).
- 2011  Theoretical High Energy Physics Group at Physikalisches Institut, Bonn University, Germany (Apr 22 - May 27, 2011)
- 2010  Theoretical High Energy Physics Group at Physikalisches Institut, Bonn University, Germany (Oct 11 - Nov 12, 2010)

## **Mentoring**

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- **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 Title: Probing GR and Modified Gravity Theory with Gravitational 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 Title: 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:
1. Pratyusava Baral  
(Project Title: Gravitational Waves as Tetrad Fluctuation)
  2. 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)

## Teaching

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- **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 :**

- Fluid mechanics for B. Sc. 1st Yr. at Presidency University
- 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"