

# **RAGHAVAN RANGARAJAN**

Professor, Theoretical Physics Division  
Physical Research Laboratory, Navrangpura, Ahmedabad 380 009  
**Date of Birth:** December 9, 1966

## **EDUCATION:**

*Ph.D., Physics*, 1994, University of California, Santa Barbara  
*A.B., Physics (cum laude)*, 1988, Princeton University, New Jersey  
*Higher Secondary Certificate*, 1984, Jai Hind College, Mumbai Ranked 16th in the Merit List

## **EMPLOYMENT DETAILS:**

Professor, Physical Research Laboratory, Ahmedabad, July 2014 - Present  
Associate Professor, Physical Research Laboratory, Ahmedabad, January 2008 - June 2014  
Reader, Physical Research Laboratory, Ahmedabad, July 2001 - December 2007  
Scientist D, Physical Research Laboratory, Ahmedabad, November 1997 - June 2001  
Post-Doctoral Fellow, Astroparticle Physics Group, Houston Advanced Research Center, Texas, September 1995 - September 1997  
Post-Doctoral Fellow, High Energy Theory Group, Physics Dept., University of California, Santa Barbara, September 1994 - June 1995  
Lecturer, Physics Dept., University of California, Santa Barbara, June 1994 - July 1994, January 1995 - June 1995  
Research Assistant, Physics Dept., University of California, Santa Barbara, June 1990 - September 1994, and Center for Particle Astrophysics, University of California, Berkeley (1992-1993)  
Teaching Assistant, Physics Dept., University of California, Santa Barbara, September 1988 - December 1990  
Assistant Laboratory Instructor, Physics Dept., Princeton University, January 1988 - June 1988  
Undergraduate Research Assistant, Physics Dept., Princeton University, January 1985 - June 1988  
Summer Intern, Lawrence Berkeley Laboratory, California, June 1985 - September 1985

## **SUMMARY OF RESEARCH:**

My research interests are in cosmology and particle physics, particularly in inflation (a period of accelerated expansion in the early Universe), and in high energy phenomena that occur in an inflationary Universe. I have been interested in the dynamics of inflation, in the generation of energy density perturbations during inflation, in the production of unwanted particles in the early Universe after inflation, etc. In addition, I have also been interested in understanding mechanisms to explain the observed matter-antimatter asymmetry of the Universe, or baryogenesis. In the past I have worked on different scenarios of baryogenesis involving black hole evaporation, heavy Majorana neutrinos, inflaton decay, out-of-equilibrium decays of heavy particles and baryogenesis during the electroweak phase transition.

## **COURSES TAUGHT:**

**At PRL**

General Relativity and Cosmology

Advanced Quantum Mechanics

Advanced Quantum Mechanics and Quantum Field Theory

Quantum Field Theory

Quantum Mechanics

Electrodynamics

Mathematical Methods in Physics

### **Other courses**

Modern Physics (IIT Gandhinagar, 2010-11)

Cosmology (short course at IIT Gandhinagar, 2010)

Thermal Field Theory (XXIII SERC Main School in Theoretical High Energy Physics, IIT Bombay, 2008)

Lecturer in refresher courses for college teachers at Sardar Patel University, Vallabh Vidyanagar and Saurashtra University, Rajkot.

Physics for Physics/Engineering students (2 courses at University of California, Santa Barbara, 1995)

Physics for Biology students (University of California, Santa Barbara, 1994)

Physics Laboratory (Asst. Laboratory Instructor at Princeton University, 1988)

### **Other Academic Programmes:**

Since 2003 I have been coordinating a programme called the **Advanced B.Sc. (Physics) Programme** for college students of Gujarat. This programme of the Gujarat Science Academy and the Vikram A. Sarabhai Community Science Centre, with Gujarat Science City and St. Xavier's College, Ahmedabad as partners, aims to identify motivated students in the colleges of Gujarat and to provide them with an opportunity to challenge themselves with an enhanced curriculum in Physics. In the first 5 years, the programme was a weekly programme with classes every Sunday, tutorials during the week, and project work at research institutes during the summer. Currently it functions as a 3-week residential programme in the summer. Courses are taught by scientists from PRL, IPR and ISRO allowing college students to come in contact with active researchers. In addition, career counselling is provided on opportunities in Physics.

This has been a successful programme and alumni of the programme have subsequently gone for higher studies to IITs, IISERs, Pune University, State University of New York at Stony Brook (USA), University of Kwa-Zulu Natal (S. Africa), University of St. Andrews (Scotland) and National Central University (Taiwan). Some others have joined scientific organizations such as PRL, IPR, Gujarat Science City and VASCSC as employees, science educators and project associates.

Since 2015 I am one of the coordinators of a national programme called **Physics Training and Talent Search (PTTS)** which is similar to the programme above but for students from across India. It will also cater to M.Sc. students from 2017.

### **PROFESSIONAL AFFILIATIONS, AWARDS,**

### **FELLOWSHIPS OF SCIENTIFIC BODIES**

1. Member, Senate of the Indian Institute of Technology, Gandhinagar, 2010-2012, 2014-16, 2016-
2. Member, Academic Committee, Physics Programme, GSFC University, Vado-

dara, 2016-

3. Member, National Advisory Board, IIT Guwahati Quality Improvement Programme for College Teachers, 2016-
4. Member, Board of Studies, Dept. of Physical Sciences, PDPIAS, Charotar University of Science and Technology, 2016-
5. Council Member, Indian Association for General Relativity and Gravitation, 2012-2016
6. Member, Board of Studies, Dept. of Physics, St. Xavier's College, Ahmedabad 2014-2016
7. Member, Board of Editors, Physics Education (a journal of the Indian Association of Physics Teachers - IAPT), 2011-
8. Member of the First Academic Advisory Council of the Indian Institute of Technology, Gandhinagar, 2011
9. Fellow, Gujarat Science Academy, 2003-
10. Associate, Indian Academy of Sciences, Bangalore, 1998-2001
11. Elected Member, Sigma Xi (National Scientific Research Society), Princeton University, 1988
12. (School) National Talent Search Examination scholarship recipient 1984; National Merit Scholarship recipient 1982; Aryabhata Science Scholarship (Govt. of Gujarat) 1982

### **CONFERENCES/SCHOOLS ORGANISED:**

1. National Organising Committee, 25th International Conference on Supersymmetry and Unification of Fundamental Interactions (SUSY 2017), to be held at TIFR, Mumbai, December 4-8, 11-15, 2017
2. Coordinator, Physics Training and Talent Search (PTTS), a 2-week residential programme for B.Sc. and M.Sc. students from across India, since 2015
3. Coordinator, Advanced B.Sc. Physics Programme, currently a 3-week residential summer programme for college students of Gujarat, since 2003
4. Scientific Organising Committee, International Conference on Gravitation and Cosmology (ICGC 2015), IISER Mohali, December 14-18, 2015
5. National Organising Committee, 14th Workshop on High Energy Physics Phenomenology (WHEPP XIV), IIT Kanpur, December 4-13, 2015
6. National Organising Committee, 13th Workshop on High Energy Physics Phenomenology (WHEPP 13), Puri, December 12-21, 2013
7. Scientific Organising Committee, Particle Physics at the Crossroads, Edinburgh Delhi Particle Physics Symposium, New Delhi, February 15-17, 2013

8. Organising Committee, ICTS Programme on CP Violation in Elementary Particles and Composite Systems, Mahabaleshwar, February 7-23, 2013
9. Working Group Coordinator for Astroparticle Physics and Cosmology, and Local Organising Committee, 11th Workshop on High Energy Physics Phenomenology (WHEPP 11), Physical Research Laboratory, Ahmedabad, 2010
10. National Organising Committee, 18th DAE-BRNS High Energy Physics Symposium (HEP08), BHU, Varanasi, 2008
11. National Organising Committee, 10th Workshop on High Energy Physics Phenomenology (WHEPP 10), Institute of Mathematical Sciences, Chennai, 2008
12. Director, XXI SERC Main School in Theoretical High Energy Physics, Physical Research Laboratory, Ahmedabad, 2006
13. Working Group Coordinator for Neutrino and Astroparticle Physics, 8th Workshop on High Energy Physics Phenomenology (WHEPP 8), IIT Bombay, 2004
14. Co-convener of the College Teachers Training Course, Physical Research Laboratory, Ahmedabad, 1999
15. Co-convener of the Lecture Series for Ahmedabad College Lecturers, Physical Research Laboratory, Ahmedabad, 1998

I also maintain a portal that provides a listing of all conferences, workshops and schools in India on Gravitation, Cosmology and Particle Physics. This has greatly helped organisers of events and the cosmology and particle physics community in general in India.

### **SEMINARS AND COLLOQUIA PRESENTED:**

I have presented numerous seminars during visits and conferences at various institutions including IISER Bhopal, TIFR, Mumbai, IISER Mohali, IIT Guwahati, IISER Pune, Institute of Physics, Bhubaneswar, Jamia Millia Islamia, IISER Kolkata, Indian Institute of Science, Bangalore, IIT Madras, Hyderabad University, Delhi University, IIT Kanpur, Harish-Chandra Research Institute, Allahabad, the Institute of Mathematical Sciences, Chennai, BHU, Varanasi, IIT Kharagpur, Panjab University, and the University of Michigan, Ann Arbor, University of Pennsylvania, University of California at Irvine and at Santa Barbara, University of Hawaii, Honolulu, Oxford University and Lancaster University.

### **CONTRIBUTIONS TO THE GENERAL MANAGEMENT OF PRL**

Served on the following committees at PRL:

- Administrative Advisory Committee (currently)
- Academic Committee (three times, including July-September 2016 as Chair)
- Post-Doctoral Fellowship (PDF) Committee
- Committee to select Head, Academic Services

- JRF Selection Committee
- Canteen Pricing Committee
- Library Committee
- Staff Welfare Committee
- National Science Day Committee (3 times)

Co-coordinator of the Career Opportunities Cell (currently inactive) to help PRL students and PDFs seek employment outside of academia

Created an online application form for the PRL Ph.D. programme which was the precursor to the current online application form

Co-coordinator of the Interface of Cosmology and Particle Physics Programme (iCAPP) programme, 2010-2012

Coordinator of the Cosmology Journal Club, 2010-2012

Participated in the drafting of the MOU between PRL and IIT Gandhinagar

Editor, *PRL News*, 2006-2008

Coordinator of the *Theoretical Physics Seminars* for different periods

Actively involved in the Theoretical Physics Division's activities at the *PRL Open House* (2006) and in the PRL exhibit at the *92nd Indian Science Congress* at Ahmedabad (2005)

### **ANY OTHER INFORMATION:**

I am actively involved in popularisation of science and in encouraging young students who may wish to consider a career in physics. I have given a large number of **popular science talks** on particle physics and cosmology. In addition I often make presentations on A Career as a Physicist. As mentioned above, I am also an **Editor of Physics Education**, a journal of the Indian Association of Physics Teachers (IAPT).

I maintain a **website that provides career guidance** and information for Physics students (<http://www.sayantanghosh.50megs.com>). I have also mentored a number of college students over the years, including engineering students with an interest in Physics, many of whom have subsequently pursued higher studies in Physics.

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## BOOKS:

1. *Surveys in Theoretical High Energy Physics 2: Lecture Notes from SERC Schools*, Texts and Readings in Physical Sciences - 15, edited by Raghavan Rangarajan and M. Sivakumar, Hindustan Book Agency, 2014.
2. *Cosmology - The Story of our Universe in Scientific Perspectives of Jainism*, edited by Samani Chaitanya Prajna, N. Bhandari and N. L. Kachhara, To be published.

## JOURNAL PUBLICATIONS:

*Impact factors and Publishers:*

Journal of Cosmology and Astroparticle Physics (Institute of Physics, UK) 5.634  
Physical Review D (American Physical Society) 4.506  
Astroparticle Physics (Elsevier) 3.425  
Modern Physics Letters A (World Scientific) 1.338  
Physical Review Letters (American Physical Society) 7.645  
Journal of High Energy Physics (Springer) 6.023  
Nuclear Physics B (Elsevier) 3.735  
The Astrophysical Journal (Institute of Physics, UK) 5.909  
Physical Review B (American Physical Society) 3.718

*Please note that the convention is to list authors alphabetically in my area of research.*

## PUBLICATIONS:

1. S. Das, G. Goswami, J. Prasad and R. Rangarajan: Constraints on Just Enough Inflation Preceded by a Thermal Era, *Physical Review D*, Vol. 93, 2016, 023516
2. G. Gupta, R. Rangarajan and A. A. Sen: Thawing Quintessence from the Inflationary Epoch to Today, *Physical Review D*, Vol. 92, 2015, 123003
3. M. Dhuria, C. Hati, R. Rangarajan and U. Sarkar: The  $eejj$  Excess Signal at the LHC and Constraints on Leptogenesis, *Journal of Cosmology and Astroparticle Physics*, Vol. 09, 2015, 0352015
4. M. Dhuria, C. Hati, R. Rangarajan and U. Sarkar: Falsifying Leptogenesis for a TeV Scale  $W_R^\pm$  at the LHC, *Physical Review D*, Vol. 92, 2015, 031701(R) (*Rapid Communications*)
5. S. Das, G. Goswami, J. Prasad and R. Rangarajan: Revisiting a Pre-inflationary Radiation Era and its Effect on the CMB Power Spectrum, *Journal of Cosmology and Astroparticle Physics*, Vol. 06, 2015, 001
6. R. Adhikari, A. Dasgupta, C. S. Fong and R. Rangarajan: Nonthermal  $CP$  Violation in Soft Leptogenesis, *Physical Review D*, Vol. 91, 2015, 096001
7. M. Dhuria, C. Hati, R. Rangarajan and U. Sarkar: Explaining the CMS  $eejj$  and  $e$  missing  $p_T jj$  Excess and Leptogenesis in Superstring Inspired  $E_6$  Models, *Physical Review D*, Vol. 91, 2015, 055010
8. N. Mahajan, R. Rangarajan and A. Sarkar: Supersymmetric Flat Directions and Resonant Gravitino Production, *Physical Review D*, Vol. 90, 2014, 023522

9. R. Rangarajan and A. Sarkar: Kinetic and Chemical Equilibrium of the Universe and Gravitino Production, *Astroparticle Physics*, Vol. 48, 2013, 37
10. M. Bastero-Gil, A. Berera, N. Mahajan and R. Rangarajan: Power Spectrum Generated during Inflation, *Physical Review D*, Vol. 87, 2013, 087302
11. A. Berera and R. Rangarajan: Quantum Phase of Inflation, *Physical Review D*, Vol. 87, 2013, 043514
12. N. Mahajan and R. Rangarajan: Remarks on Non-Gaussian Fluctuations of the Inflaton and Constancy of  $\zeta$  outside the Horizon, *Physical Review D*, Vol. 83, 2011, 043510
13. R. Rangarajan and N. Sahu: Perturbative Reheating and Gravitino Production in Inflationary Models, *Physical Review D*, Vol. 79, 2009, 103534
14. R. Rangarajan and N. Sahu: Gravitino Production in an Inflationary Universe and Implications for Leptogenesis, *Modern Physics Letters A*, Vol. 23, 2008, 427
15. A. Shafieloo, T. Souradeep, P. Manimaran, P. Panigrahi and R. Rangarajan: Features in the Primordial Spectrum from WMAP: A Wavelet Analysis, *Physical Review D*, Vol. 75, 2007, 123502
16. J. R. Bhatt and R. Rangarajan: Thermalization in Thick Wall Electroweak Baryogenesis, *Physical Review D*, Vol. 75, 2007, 087305
17. K. Bhattacharya, S. Mohanty, R. Rangarajan: Temperature of the Inflaton and Duration of Inflation from WMAP Data, *Physical Review Letters*, Vol. 96, 2006, 121302
18. J. R. Bhatt and R. Rangarajan: Studying Electroweak Baryogenesis using Evenisation and the Wigner Formalism, *Journal of High Energy Physics*, Vol. 0503, 2005, 57
19. J. R. Bhatt and R. Rangarajan: The Kinetic Equation for Electroweak Baryogenesis, *Physical Review D*, Vol. 70, 2004, 127301
20. R. Adhikari and R. Rangarajan: Baryon Number Violation in Particle Decays, *Physical Review D*, Vol. 65, 2002, 083504
21. R. Rangarajan, S. Sengupta and A. Srivastava: Electroweak Baryogenesis in a Cold Universe, *Astroparticle Physics*, Vol. 17, 2002, 167
22. R. Rangarajan and D. V. Nanopoulos: Inflationary Baryogenesis, *Physical Review D*, Vol. 64, 2001, 063511
23. R. Rangarajan and H. Mishra: Leptogenesis with Heavy Majorana Neutrinos Reexamined, *Physical Review D*, Vol. 61, 2000, 043509
24. J. Kim, J. L. Lopez, D. V. Nanopoulos, R. Rangarajan and A. Zichichi: Light-Gravitino Production at Hadron Colliders, *Physical Review D*, Vol. 57, 1998, 373
25. A. D. Dolgov, K. Freese, R. Rangarajan and M. Srednicki: Baryogenesis During Reheating in Natural Inflation and Comments on Spontaneous Baryogenesis, *Physical Review D*, Vol. 56, 1997, 6155
26. J. L. Lopez, D. V. Nanopoulos and R. Rangarajan: New Supersymmetric Contributions to  $t \rightarrow cV$ , *Physical Review D*, Vol. 56, 1997, 3100
27. J. Kim, J. L. Lopez, D. V. Nanopoulos and R. Rangarajan: Enhanced Supersymmetric Corrections to Top-Quark Production at the Tevatron, *Physical Review D*, Vol. 54, 1996, 4364
28. R. Rangarajan: Constraints on Baryogenesis from the Decay of Superstring Axions, *Nuclear Physics B*, Vol. 454, 1995, 369
29. R. Rangarajan: Cosmological Constraints on the Scale of Supersymmetry Breaking, *Nuclear Physics B*, Vol. 454, 1995, 357

30. T. Falk, R. Rangarajan and M. Srednicki: The Angular Dependence of the Three-Point Correlation Function of the Cosmic Microwave Background Radiation as Predicted by Inflationary Cosmologies, *The Astrophysical Journal*, Vol. 403, 1993, L1
31. T. Falk, R. Rangarajan and M. Srednicki: The Dependence of Density Perturbations on the Coupling Constant in a Simple Model of Inflation, *Physical Review D*, Vol. 46, 1992, 4232
32. R. Rangarajan and M. Srednicki: Chaotic Dark Matter, *Physical Review D*, Vol. 46, 1992, 3350
33. S. John and R. Rangarajan: Optimum Structures for Classical Wave Localization: An Alternative to the Ioffe-Regel Criterion, *Physical Review B (Rapid Communication)*, Vol. 38, 1988, 10101

### CONFERENCE PUBLICATIONS:

1. R. Rangarajan: Inflation after Planck and BICEP2, Proceedings of the XXI DAE-BRNS High Energy Physics Symposium, IIT Guwahati, 2014, *Springer Proceedings in Physics*, Vol. 174, 2016, 453
2. R. Rangarajan: Resonant Gravitino Production in the Early Universe, Proceedings of the XXI DAE-BRNS High Energy Physics Symposium, IIT Guwahati, 2014, *Springer Proceedings in Physics* Vol. 174, 2016, 463
3. R. Rangarajan: Resolving the Inflationary Power Spectrum, Proceedings of the Symposium on Cosmology and Particle Astrophysics (CosPA 2013), Hawaii, e-published at <http://www.slac.stanford.edu/econf/C131112/>
4. R. Rangarajan: Remarks on Non-Gaussian Fluctuations of the Inflaton and Constancy of  $\zeta$  outside the Horizon, Proceedings of the International Conference on Gravitation and Cosmology 2011 (ICGC 2011), *Journal of Physics Conference Series*, Vol. 484, 2014, 012066
5. R. Rangarajan and A. Srivastava, and others: Working Group Report: Cosmology and Astroparticle Physics, 11th Workshop on High Energy Physics Phenomenology (WHEPP 11), Physical Research Laboratory, Ahmedabad, *Pramana*, Vol. 76, 2011, 693
6. R. Rangarajan: Gravitino Production in an Inflationary Universe and Implications for Leptogenesis, *Proceedings of the 18th DAE-BRNS High Energy Physics Symposium*, BHU, Varanasi, 2008
7. R. Rangarajan: WMAPping the Inflationary Universe, *Proceedings of the 17th DAE-BRNS High Energy Physics Symposium (HEP06)*, IIT Kharagpur, 2006
8. S. Goswami and R. Rangarajan, and others: Working Group Report: Neutrino and Astroparticle Physics, 8th Workshop on High Energy Physics Phenomenology (WHEPP 8), IIT Bombay, *Pramana*, Vol. 63, 2004, 1391
9. R. Rangarajan: Baryogenesis in the Early Universe, Proceedings of the Workshop on Cosmology: Observations Confront Theories, IIT Kharagpur, *Pramana*, Vol. 53, 1999, 1061
10. S. Boughn, C. O'Neill, R. Rangarajan and S. Van Hook: How Good is the Earth as a Gravitational Wave Detector?, *Proceedings of the International Symposium on Experimental Gravitational Physics*, Guangzhou, 1987