

Curriculum Vitæ

S. Shankaranarayanan

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Present position

- Assistant Professor, Indian Institute of Science Education and Research-Trivandrum, India; 08/2009-

Previous positions

- Marie Curie Fellow, Institute of Cosmology and Gravitation (ICG), Portsmouth, UK; 10/2007 - 07/2009
- Max Planck Fellow, Albert Einstein Institute (AEI), Golm, Germany; 08/2006 - 10/2007
- Post-doctoral Fellow, International Centre for Theoretical Physics (ICTP), Trieste, Italy; 10/2003-08/2006
- Post-doctoral Fellow, University of Azores, Açores, Portugal; 10/2002-09/2003

Education

- Ph. D., Inter University Center for Astronomy and Astrophysics, Pune, India; 2002
- M. Sc., Indian Institute of Technology-Madras, Chennai, India; 1997
- B. Sc. (Hons.), S. S. S. Institute of Higher Learning (Deemed University), Bangalore, India; 1995

Honors and Awards

- Buti Foundation Award-2010, Indian Physics Association, Mumbai, India; 2012
- Head of the Partner Group of Max Planck Institute for Gravitational Physics, Golm, Germany; 2011-
- Associate of Indian Academy of Sciences, India; 2010-2013
- INSA Young scientist Award, Indian National Science Academy, India; 2010
- Ramanujan fellowship, Science and Engineering Research Council, India; 2010
- Essay [29] recieved Honorable mention in gravity essay contest by Gravity Research Foundation, USA; 2009
- Marie Curie International Incoming Fellowship 2006 (Deferred for 1 year); 2007 - 2009
- Max Planck Fellowship; 2006-2008
- James Hartle award, best student oral presentation at GR-16 conference, Durban; 2001
- Ph. D. Fellowship, University Grants Commission (UGC), India; 1997-2002

Research summary

- *Research interests:* Early universe cosmology, Black-holes, quantum gravity, Quantum phase transition
- *41 publications in peer-reviewed international journal;*
2 invited reviews (R1-R2); 10 conference proceeding contributions(C1-C10)
- *8 postdoctoral fellows supervised under DST and MPG grants;* 3 Ph.D. students;
6 undergraduate projects resulted in 5 publications; *Full list in Page (6).*
- *5 invited talks at international meetings;*
talk at 24th Mid-year Meeting of Indian Academy of Sciences, Bangalore

- *Publications in pages (4-7)* have 1100⁺ citations; h-index 17 (*Source: Inspire*); 100⁺ citations: [6], [5]; 50⁺ citations: [26], [24], [19], [8], [7]

Funding

- *Center for Computation, Modeling and Simulation, FAST, MHRD; Amount: ₹ 40 Million; 08/2014-* Coprincipal investigator along with 6 other faculty members at IISER, Trivandrum
- *Max Planck-India Partner group; 05/2011-* Principal investigator, IISER-TVM; Amount: ₹ 13 Million
- *Ramanujan Fellowship, DST-India; 02/2010-* Principal investigator, IISER-TVM; Amount: ₹ 7.3 Million
- *European Commission FP6 project MC-IIF-2006-039205; 10/2007-07/2009* Principal investigator, ICG, Portsmouth; Amount: € 160,000
Project title: Probing quantum gravitational physics via inflation

Group members

Ph.D. Students

Santosh Kumar (01/2011 -) ([37])
 Jose Mathew (08/2011 -)
 Debottam Nandi (08/2012 -)

Post-doctoral fellows

Jozef Skakala (08/2013 -) ([36],[38], [40], [S2])
 Abhishek Basak (09/2013 -) ([33])
 Swastik Bhattacharya (08/2014 -)
 Abhishek Majhi (08/2014 -)

Group Alumni

Suman Ghosh, PDF (03/2011 - 06/2013) ([32], [34], [37] [C1])
 Currently: PDF, S. N. Bose Institute, Kolkata

Kinjal Banerjee, PDF (10/2012 -04/2013)
 Currently: Assistant Professor, BITS, Goa

Pramod Dominic, PDF (06/2013 - 11/013)
 Currently: Assistant Professor, Jain University, Bengaluru

Sanil Unnikrishnan, PDF (08/2012 -01/2014) ([39])
 Currently: Assistant Professor, LNM Information Technology Institute, Jaipur

Rakesh Tibrewala, PDF (11/2011 - 05/2014) ([41])
 Currently: PDF, I.I.Sc., Bangalore

Teaching

- *Quantum Mechanics-2*, Forth year Integrated BS-MS program, IISER, Trivandrum; Fall, 2014
- *General Relativity*, Forth year Integrated BS-MS program, IISER, Trivandrum; Fall 2011 & Spring, 2014
- *Introduction to Quantum Mechanics*, III year Integrated MS program, IISER-TVM; Fall, 2012 & 2013
- *Atomic and Molecular Physics*, IV year Integrated MS program, IISER-TVM; Spring, 2013
- *Introduction to Quantum Field Theory*, IV year Integrated MS program, IISER-TVM; Spring, 2011
- *Applied Physics*, II year Integrated MS program, IISER-TVM; Spring, 2011
- *Statistical mechanics*, II year Integrated MS program, IISER-TVM; Spring, 2010 & 2011

- *Mathematical methods in Physics*, III year Integrated MS program, IISER-TVM; Fall, 2010
- *Classical mechanics*, I year Integrated MS program, IISER-TVM; Fall, 2009
- *Mathematical methods for Physicists*; Graduate course, ICG, Portsmouth; Spring, 2009

Conference organized

- 4th Biannual meeting of Heads of Max Planck Partner Groups; April, 2013
- Workshop on Algebraic methods in quantum theory; March, 2013
- Astronomical Society of India Meeting-2013; February, 2013
- Field theory and Gravity; April, 2012
- AstroCosmo @ Trivandrum; November, 2011

Membership

- Member, Astronomical Society of India; 2013-
- Member, Indian Physics Association; 2012-
- Member, Indian Association for General Relativity and Gravitation; 2011-
- Member, International society on general relativity and gravitation; 2001-

Contributions to IISER-TVM

- Coordinator, School of Physics; 2013-
- Coordinator, Doctoral programmes; 2011-2012
- Local coordinator, JEST; 2010-
- Joint Admissions Committee for BS-MS degree program; 2010-2012
- Chairman, Institute Colloquium committee; 2009-2011

List of publications

Submitted to Journals

- S1 An approach to the quantization of black-hole quasi-normal modes, Soham Pal, Karthik Rajeev and S. Shankaranarayanan, arXiv:1312.5689
- S2 Black hole thermodynamics as seen through a microscopic model of a relativistic Bose gas, Jozef Skákala and S. Shankaranarayanan, Submitted to *Class. Quant. Grav.*, arXiv:1406.2477

In peer-reviewed journals

41. Zero modes and divergence of entanglement entropy, Krishnand Mallaya, Rakesh Tibrewala, S. Shankaranarayanan and T. Padmanabhan, To appear in *Phys. Rev. D*, arXiv:1404.2079
40. No minimally coupled scalar hair in Lanczos-Lovelock gravity, Jozef Skákala and S. Shankaranarayanan, *Class. Quant. Grav.* **31** 175005 (2014) [arXiv:1402.6166]
39. Consistency relation in power-law G-inflation, Sanil Unnikrishnan and S. Shankaranarayanan, *J. Cosm. Astro-phys.* **07**, 003 (2014) [arXiv:1311.0177]

38. Black hole hair in Lovelock gravity, Jozef Skákala and S. Shankaranarayanan, *Phys. Rev. D* **89** 104003 (2014) [arXiv:1312.4347]
37. Entanglement entropy in non-zero genus topologies, Santhosh Kumar, Suman Ghosh, and S. Shankaranarayanan, *Phys. Rev. D* **89** 065019 (2014), [arXiv:1401.2839]
36. Horizon spectroscopy in and beyond general relativity, Jozef Skákala and S. Shankaranarayanan, *Phys. Rev. D* **89**, 044019 (2014) [arXiv:1311.4255]
35. Entanglement entropy in all dimensions, S. Braunstein, S. Das and S. Shankaranarayanan, *JHEP* **1307**, 130 (2013) arXiv: 1110.1239,
34. 5D non-symmetric gravity and geodesic confinement, Suman Ghosh and S. Shankaranarayanan, *Gen. Relat. Gravi.*, (2013) [arXiv: 1210.4361]
33. Attractor behavior in Einstein-Elko system, Abishek Basak, Jitesh Bhat, S. Shankaranarayanan and K. V. P. Varma, *J. Cosm. Astrophys.* **04**, 025 (2013) [arXiv: 1212.3445]
32. Entanglement signatures of phase transition in higher-derivative quantum field theories, Suman Ghosh and S. Shankaranarayanan, *Phys. Rev. D* **86**, 125011 (2012) [arXiv: 1211.2043]
31. Corrections to Bekenstein-Hawking entropy – quantum or not-so quantum?, *Entropy* **13**, 11-16 (2011) [arXiv: 1101.0030] (Special issue on *Entropy in quantum gravity*)
30. The Cosmological constant and Horava-Lifshitz gravity, Corrado Appignani, Roberto Casadio and S. Shankaranarayanan, *JCAP* **04** 006 (2010) [arXiv: 0907.3121]
29. A note on second-order perturbations of non-canonical scalar fields, Corrado Appignani, Roberto Casadio and S. Shankaranarayanan, *JCAP* **1003** 010 (2010) arXiv: 0905.4184
28. What-if inflaton is a spinor condensate? S. Shankaranarayanan, *Int. Journ. Mod. Phys. D* **18**, 2173 (2009) [arXiv: 0905.2573]
Received an Honorable Mention in 2009 Essay Competition of the Gravity Research Foundation, USA
27. Path integral duality modified propagators in spacetimes with constant curvature, Dawood Kothawala, L. Sriramkumar, S. Shankaranarayanan and T. Padmanabhan, *Phys. Rev. D* **80**, 044005 (2009) [arXiv: 0904.3217]
26. Gauge invariant cosmological perturbation equations with corrections from loop quantum gravity, Martin Bojowald, Golam Mortuza Hossain, Mikhail Kagan and S. Shankaranarayanan, *Phys. Rev. D* **79**, 043505 (2009), arXiv: 0811.1572
25. Consistency relation between the scalar and tensor spectra in spinflation, D. Gredat and S. Shankaranarayanan, *JCAP* **01**, 008 (2010) [arXiv: 0807.3336]
24. Anomaly freedom in perturbative loop quantum gravity, Martin Bojowald, Golam Mortuza Hossain, Mikhail Kagan and S. Shankaranarayanan, *Phys. Rev. D* **78**, 063547 (2008) [arXiv: 0806.3929]
23. Do subleading corrections to Bekenstein-Hawking entropy hold the key to quantum gravity?, S. Shankaranarayanan, *Mod. Phys. Lett. A* **23**, 1975 (2008) [arXiv: 0805.4531]
22. Quantum gravitational corrections to the stress-energy tensor around the BTZ black hole Dawood A. Kothawala, S. Shankaranarayanan and L. Sriramkumar, *JHEP* **09**, 095 (2008) [arXiv: 0801.0225]
21. Sub-leading contributions to the black hole entropy in the brick wall approach, S. Sarkar, S. Shankaranarayanan and L. Sriramkumar, *Phys. Rev. D* **78**, 024003 (2008) [arXiv: 0710.2013]
20. Where are the degrees of freedom responsible for black hole entropy? Saurya Das, S. Shankaranarayanan and Sourav Sur, *Can. J. Phys.* **86(4)**, 653 (2008) [arXiv:0708.2098]
19. Power-law corrections to entanglement entropy of black holes, Saurya Das, S. Shankaranarayanan and Sourav Sur, *Phys. Rev. D* **77**, 064013 (2008) [arXiv: 0705.2070]

18. Where are the black hole entropy degrees of freedom? Saurya Das and S. Shankaranarayanan, *Class. Quant. Grav.* **24**, 5299 (2007) [arXiv: gr-qc/0703082]
17. Entanglement as a source of black hole entropy, Saurya Das and S. Shankaranarayanan, *J. Phys. : Conf. Ser.* **68**, 012015 (2007) [arXiv:gr-qc/0610022]
16. Path integral duality and Planck scale corrections to the primordial spectrum in exponential inflation, L. Sriramkumar and S. Shankaranarayanan, *JHEP* **12**, 050 (2006) [arXiv:hep-th/0608224]
15. How robust is entanglement entropy-area relation? Saurya Das and S. Shankaranarayanan, *Phys. Rev. D* **73**, 121701(R) (2006) [arXiv: gr-qc/0511066]
14. High frequency quasi-normal modes for black-holes with generic singularities II: Asymptotically non-flat space-times, Archisman Ghosh, S. Shankaranarayanan and Saurya Das, *Class. Quant. Grav.* **23**, 1851 (2006) [arXiv: hep-th/0510186]
13. Is entanglement entropy proportional to area? Morteza Ahmadi, Saurya Das, and S. Shankaranarayanan, *Can. J. Phys.* **84**, 1-7 (2006) [arXiv: hep-th/0507228]
12. Gauge-invariant perturbation theory for trans-Planckian inflation, S. Shankaranarayanan and Musongela Lubo, *Phys. Rev. D* **72**, 123513 (2005) [arXiv: hep-th/0507086]
11. High frequency quasi-normal modes for black-holes with generic singularities, Saurya Das and S. Shankaranarayanan, *Class. Quant. Grav.* **22**, L7 (2005) [arXiv: hep-th/0410209]
10. Trans-Planckian corrections to the primordial spectrum in the infra-red and the ultra-violet, S. Shankaranarayanan and L. Sriramkumar, *Phys. Rev. D* **70**, 123520 (2004) [arXiv: hep-th/0403236]
9. Non-singular black-holes on the brane, S. Shankaranarayanan and Naresh Dadhich, *Int. Journ. Mod. Phys. D* **13**, 1095 (2004) [arXiv: gr-qc/0306111]
8. Temperature and Entropy of Schwarzschild-de Sitter space-time, S. Shankaranarayanan, *Phys. Rev. D* **67**, 084026 (2003) [arXiv: gr-qc/0301090]
7. Is there an imprint of Planck scale physics on inflationary cosmology? S. Shankaranarayanan, *Class. Quant. Grav.* **20**, 75-83 (2003) [arXiv: gr-qc/0203060]
6. Hawking radiation in different coordinate settings: Complex paths approach, S. Shankaranarayanan, T. Padmanabhan and K. Srinivasan, *Class. Quant. Grav.* **19**, 2671-2688 (2002) [arXiv: gr-qc/0010042]
5. Method of complex paths and general covariance of Hawking radiation, S. Shankaranarayanan, K. Srinivasan and T. Padmanabhan, *Mod. Phys. Lett. A* **16**, 571-578 (2001) [arXiv: gr-qc/0007022]
4. Hypothesis of path integral duality: Applications to QED, S. Shankaranarayanan and T. Padmanabhan, *Int. Journ. Mod. Phys. D* **10**, 351 - 365 (2001) [arXiv: gr-qc/0003058]
3. Vanishing of the cosmological constant in nonfactorizable geometry, T. Padmanabhan and S. Shankaranarayanan, *Phys. Rev. D* **63**, 105021 (2001) [arXiv: hep-th/0011159]
2. Probing the BLR in AGNs using time variability of associated absorption lines, R. Srianand and S. Shankaranarayanan, *Astro. Phys. J.* **518**, 672 - 675 (1999) [arXiv: astro-ph/9901091]
1. Hydrogen solubility and thermodynamics of dissolved hydrogen in $\text{Pd}_{1-x}\text{Tb}_x$ ($x = 0.05$ & 0.08) solid solution alloys, S. Shankaranarayanan and S. Ramaprabhu, *Berichte Bunsen-Gesellschaft* **101**, 1986 (1997)

Review articles

- R1 Quantum corrections to Bekenstein-Hawking entropy, S. Shankaranarayanan, **Invited review** for the edited book *Vignettes in gravitation and cosmology*, Editors: T. R. Seshadri and L. Sriramkumar, World Scientific (2011)

R2 Black hole entropy from entanglement: A review, Saurya Das, S. Shankaranarayanan and Sourav Sur, **Invited review** for the edited book Horizons in World Physics Vol: 268, Editors: M. Everett and L. Pedroza, Nova publishers (2009) [arXiv: 0806.0402]

Conference proceedings

- C1 Linear higher derivative field theories, entanglement entropy and quantum phase transition, Suman Ghosh and S. Shankaranarayanan, J. Phys.: Conf. Ser. **405**, 012016 [Proceedings of Cosgrav-12 Meeting]
- C2 Quantum gravitational corrections to the propagator in spacetimes with constant curvature, D. Kothawala, S. Shankaranarayanan and L. Sriramkumar, To appear in the proceedings of 12th Marcel Grossman meeting, arXiv: 1002.1132
- C3 Ambiguities in second-order cosmological perturbations for non-canonical scalar fields, C. Appignani, R. Casadio and S. Shankaranarayanan, To appear in the proceedings of 12th Marcel Grossman meeting, arXiv: 1002.1130
- C4 Entanglement and corrections to Bekenstein-Hawking entropy, Saurya Das, S. Shankaranarayanan and Sourav Sur, To appear in the proceedings of 12th Marcel Grossman meeting, arXiv: 1002.1129.
- C5 Dark spinor driven inflation, S. Shankaranarayanan, To appear in the proceedings of 12th Marcel Grossman meeting, arXiv: 1002.1128.
- C6 Corrections to the Bekenstein-Hawking entropy in the brick wall approach, Sudipta Sarkar, S. Shankaranarayanan and L. Sriramkumar, Proceedings of Science(BHs, GR and Strings) 035 (2008)
- C7 Power-law corrections to black-hole entropy via entanglement, Saurya Das, S. Shankaranarayanan and Sourav Sur, Proceedings of II Milan workshop on black-holes, Ed: M. Francaviglia and G. Magli. See the URL <http://www.mate.polimi.it/bh2> [arXiv:0711.3164]
- C8 Planck scale effects and the suppression of power on the large scales in the primordial spectrum, S. Shankaranarayanan and L. Sriramkumar, Proceedings of PASCOS-2004, Eds: G. Alverson, E. Barberis, P. Nath and M. T. Vaughan, Pg. 38 - 42 (World Scientific, Singapore, 2005) [hep-th/0410072]
- C9 Probing the imprint of Planck scale physics in inflationary cosmology using CMBR observations, Proceedings of the XVIII IAP Colloquium 'On the nature of dark energy' (Paris, July, 2002)
- C10 Vanishing of Λ in non-factorizable geometry, GR: Proceedings of the 16th International Conference, Ed: Nigel T Bishop and Sunil D Maharaj (World Scientific, Singapore, 2002); Page 418 – 421.

Projects Supervised

- R. Karthik, V year BSMS student, IISER-TVM;08/2014- Master's thesis project
- P. J. Joseph, V year BSMS student, IISER-TVM;05/2014- Master's thesis project
- Sake Sunil Kumar, Undergraduate student, IIT-Madras ;05 - 07/2014 Entanglement entropy of 2-mode squeezed states (Summer Project)
- Soham Bhattacharya, Int. Ph.D. Student, IISER-TVM; 05 - 07/2014 Quasinormal modes and dissipative system (Summer Project)
- *Niyor Borah, IV year BSMS Student, IISER-TVM; 05/2013- Symmetries in Time-dependent Harmonic Oscillator (Minor thesis)*
- *Krishnand Mallaya, V year BSMS student, IISER-TVM; 05/2013- Master's thesis project* resulting in the publication [41]
- *R. Karthik, IV year BSMS Student, IISER-TVM; 05/2013-07/2013* resulting in the publication [S4]

- *P. J. Joseph, Undergraduate student, IISER-TVM; 05/2013-07/2013*
Singular potentials and Renormalization in quantum mechanics (Summer Project)
- *Sonakshi Sachdev, B.Sc. Student, Chennai Mathematical Institute; 05/2013-07/2013*
Relation between Elkos and teleparallel gravity theories (Summer Project)
- *Soham Pal, M.Sc. Student, BITS-Hyderabad; 01/2013-05/2013*
Master's thesis resulting in the publication [S4]
- *Phani Raj, IV year BSMS student, IISER-TVM; 01/2013-04/2013*
Quantization of dissipative Harmonic Oscillator (Minor thesis)
- *K. V. P. Varma, IV year BSMS, IISER-TVM; 01/2012-08/2012*
resulting in the publication [33] (Minor thesis)
- *M. V. Vishal, Undergraduate student, IIT-Bombay; 05/2011-07/2011*
Particle production in external electric field backgrounds
- *Harish Lingan, KVPY fellow, IISER-TVM; 05/2011-07/2011*
A method for computation of target Score in interrupted T20 Cricket Matches
- *Darshan Kakkad, Academy fellow, Delhi University; 06/2011-08/2011*
PT-Symmetric quantum mechanics
- *N. Vigneshwar, KVPY fellow, IISER-TVM; 05/2010-07/2010*
Restricted three body problem
- *Damien Gredat, Master's student, Universiti Paris-Sud; 04/2008-08/2008*
resulting in the publication [26]
- *Archisman Ghosh, M. Sc. student, IIT-Kanpur; 06/2006-09/2006*
resulting in the publication [14]

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