CURRICULUM VITAE — V. SREENATH

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PERSONAL INFORMATION

- **Gender:** Male
- **Date of Birth:** October 26, 1985
- **Nationality:** Indian
- **Marital Status:** Married

PRESENT POSITION

- Assistant Professor, Department of Physics, National Institute of Technology Karnataka, Surathkal, India, 25.09.2019–Present.

EDUCATION (in reverse chronological order)

Degree	Institution	Month and year
Ph.D. Physics	Indian Institute of Technology Madras, Chennai, India	June, 2015
M. Sc. Physics	Sree Krishna College, Guruvayur, India	December, 2008
B. Sc. Physics	St. Thomas College, Thrissur, India	June, 2006

RESEARCH EXPERIENCE (in reverse chronological order)

Sl. No.	Positions held	Name of the institute	Period
1.	Postdoctoral fellow	Inter-University Centre for Astronomy and Astrophysics, Pune, India	August, 2017 – September, 2019
2.	Postdoctoral researcher	Louisiana State University, Baton Rouge, USA	Augugst, 2015 – August, 2017
3.	Junior Research Fellow	Indian Institute of Space Science and Technology, Thiruvananthapuram, India	March, 2009 – December, 2009

RESEARCH INTERESTS

My research is focused on investigating various primordial scenarios such as inflation, loop quantum cosmology and other bouncing scenarios. I am primarily interested in studying perturbations generated in these scenarios and investigating imprints of these perturbations in various observables. My research interests include but is not limited to:

- Primordial non-Gaussianity
- Evolution of perturbations in an anisotropic background
- Features in primordial power spectrum
- Primordial black holes
- Relation between CMB anomalies and primordial physics
- Imprints of scale dependent primordial non-Gaussianity on CMB and LSS
- Model Comparison and constraining models using data
- Quantum to classical transition and measurement problem in Cosmology

I am also interested in various aspects of structure formation and the possibility of dark matter being a Bose-Einstein condensate.

Ph. D. THESIS

Thesis topic: Computation and characteristics of inflationary three-point functions

Thesis supervisor: Prof. L. Sriramkumar

Primordial non-Gaussianities and, in particular, the scalar bi-spectrum can provide a powerful handle to arrive at a much smaller class of viable inflationary models. Such an expectation has been corroborated to a substantial extent by the strong constraints that have been arrived at from the Planck data on the three non-Gaussianity parameters, *viz.* ($f_{\rm NL}^{\rm loc}$, $f_{\rm NL}^{\rm eq}$, $f_{\rm NL}^{\rm ortho}$), that are commonly used to characterize the scalar bi-spectrum. While a considerable amount of effort has been dedicated to understanding the generation and imprints of the scalar bi-spectrum, a rather limited amount of attention has been paid to investigating the three-point functions involving the tensor perturbations. My Ph. D. thesis was aimed at the numerical computation of all the three-point functions and their properties in the squeezed limit (where in one wavenumber is much smaller than the other two). In particular, the thesis focused on the following three problems. Firstly, we studied the scalar bi-spectrum for an arbitrary configuration of wavenumbers generated in three models which leads to features in the power spectrum due to deviation from slow roll. We showed, by certain examples, that the consistency relations between the non-Gaussianity parameter, $f_{\rm NL}$, and the scalar spectral index, $n_{\rm s}$, in the squeezed limit holds even away from slow roll. Secondly, utilizing Maldacena formalism for calculating three-point functions, we constructed a numerical procedure to evaluate the three-point scalar-tensor cross-correlations as well as the tensor bi-spectrum in single field inflationary models involving the canonical scalar field. We illustrated the robustness of the numerical procedure by comparing with the analytical results for power law inflation, slow roll inflation and Starobinsky model (involving a linear potential with a sudden change in its slope.) We then utilized the code we have developed to evaluate the three-point correlation functions of interest (and the corresponding non-Gaussianity parameters that we introduce) for an arbitrary triangular configuration of the wavenumbers in three different classes of inflationary models which lead to features in the scalar power spectrum, as have been recently considered by the Planck team. We also showed that the contributions to the three-point functions during preheating in inflationary models with a quadratic minimum is small. Finally, after writing down the consistency relation obeyed by three-point functions involving tensors in terms of the tensor non-Gaussianity parameter $h_{\rm NL}$ and the two parameters $C_{\rm NL}^{\mathcal{R}}$ and $C_{\rm NL}^{\gamma}$ which were earlier introduced by us to characterize the cross-correlations, we showed that these consistency relations are valid away from slow roll.

PUBLICATIONS AND PREPRINTS (in reverse chronological order)

All my papers can be accessed electronically in the following link .

1. I. Agullo, D. Kranas and **V. Sreenath**, *Large scale anomalies in the CMB and non-Gaussianity in bouncing cosmologies* arXiv:2006.09605 [astro-ph.CO]. Accepted for publication in Classical and Quantum Gravity.

2. I. Agullo, J. Olmedo and **V. Sreenath**, *xAct Implementation of the Theory of Cosmological Perturbation in Bianchi I Spacetimes* Mathematics 8 (2020) 2, 290 [arXiv:2006.03397 [gr-qc]].

3. I. Agullo, J. Olmedo and **V. Sreenath**, *Observational consequences of Bianchi I spacetimes in loop quantum cosmology* Phys. Rev. D 102, 043523 (2020) [arXiv:2006.01883 [gr-qc]].

4. I. Agullo, D. Kranas and **V. Sreenath**, *Anomalies in the CMB from a cosmic bounce*, General Relativity and Gravitation **53**, 17 (2021) [arXiv:2005.01796 [astro-ph.CO]].

5. I. Agullo, J. Olmedo and **V. Sreenath**, *Hamiltonian theory of classical and quantum gauge invariant perturbations in Bianchi I spacetimes* Phys. Rev. D 101, 123531 (2020) [Phys. Rev. D 101, 123531 (2020)].

6. I. Agullo, J. Olmedo and **V. Sreenath**, *Predictions for the CMB from an anisotropic quantum bounce*, Phys. Rev. Lett. 124, 251301 (2020) [arXiv:2003.02304 [gr-qc]].

7. A. Ashtekar, B. Gupt, D. Jeong and **V. Sreenath**, *Alleviating the Tension in the Cosmic Microwave Background using Planck-Scale Physics*, Phys. Rev. Lett. **125**, 051302 (2020) [arXiv:2001.11689 [astro-ph.CO]].

8. **V. Sreenath**, I. Agullo and B. Bolliet, *Computation of non-Gaussianity in loop quantum cosmology*, arXiv:1904.01075 [gr-qc].

9. **V. Sreenath**, *Spherical collapse of fuzzy dark matter*, Phys. Rev. D **99**, 043540 (2019) [arXiv:1808.08219 [astro-ph.CO]].

10. I. Agullo, B. Bolliet and **V. Sreenath**, *Non-Gaussianity in Loop Quantum Cosmology*, Phys. Rev. D **97**, 066021 (2018) [arXiv:1712.08148 [gr-qc]].

11. D. Jaffino Stargen, **V. Sreenath** and L. Sriramkumar, *Quantum-to-classical transition and imprints of wavefunction collapse in bouncing universes* , arXiv:1605.07311 [gr-qc].

12. Debika Chowdhury, **V. Sreenath** and L. Sriramkumar, *The scalar-scalar-tensor inflationary three-point function in the axion monodromy model*, JCAP **1611**, 041 (2016) [arXiv:1605.05292 [astro-ph.CO]].

13. Debika Chowdhury, **V. Sreenath** and L. Sriramkumar, *The tensor bi-spectrum in a matter bounce*, JCAP **1511**, 002 (2015) [arXiv:1506.06475 [astro-ph.CO]].

14. **V. Sreenath**, D. K. Hazra and L. Sriramkumar, *On the scalar consistency relation away from slow roll*, JCAP **1502**, 029 (2015) [arXiv:1410.0252 [astro-ph.CO]].

15. **V. Sreenath** and L. Sriramkumar, *Examining the consistency relations describing the three-point functions involving tensors*, JCAP **1410**, 021 (2014) [arXiv:1406.1609 [astro-ph.CO]].

16. **V. Sreenath**, R. Tibrewala and L. Sriramkumar, *Numerical evaluation of the three-point scalar-tensor cross-correlations and the tensor bi-spectrum*, JCAP **1312**, 037 (2013) [arXiv:1309.7169 [astro-ph.CO]].

17. G. Santhosh, **V. Sreenath**, A. Lakshminarayan and R. Narayanan, *Localized zero-energy modes in the Kitaev model with vacancy disorder*, Phys. Rev. B **85**, 054204 (2012) [arXiv:1106.2385 [cond-mat.str-el]].

DEVELOPMENT OF NUMERICAL CODES

- I wrote a Mathematica code using the package xAct to compute second-order Hamiltonian of gauge invariant perturbations in Bianchi I spacetimes. The code is available at this URL: https://bitbucket.org/jolmedo/bianchii-perts/src/master/.
- I have actively contributed to the development of a C code based on the infrastructure provided by CLASS to calculate scalar non-Gaussianity generated in Loop Quantum Cosmology. The code is available at this URL: https://github.com/borisbolliet/class_lqc_public.
- I have written a Fortran code to evaluate inflationary three-point functions involving scalars and tensors for an arbitrary canonical single field inflationary model. The code is available at this URL: https://github.com/v-sreenath/itpfit.

COMPUTATIONAL SKILLS

- I have worked with cosmological codes such as CLASS, CAMB, COSMOMC and Healpy.
- I am familiar with Mathematica package known as xAct which is helpful in performing tensor computer algebra.
- I am familiar with the following programing languages: C, Fortran, Python and Mathematica.
- I have completed the following online courses on machine learning :
  - *Structuring Machine Learning Projects* offered by deeplearning.ai on Coursera. Certificate earned on 22 October, 2020.
  - *Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization* offered by deeplearning.ai on Coursera. Certificate earned on 23 September, 2020.
  - *Neural Networks and Deep Learning* offered by deeplearning.ai on Coursera. Certificate earned on 25 July, 2020.
  - *Machine Learning* offered by Stanford University on Coursera. Certificate earned on 07 June, 2019.

PARTICIPATION IN WORKSHOPS AND CONFERENCES (in reverse chronological order)

1. *Less Travelled Path of Dark Matter: Axions and Primordial Black Holes*, held online at International Centre for Theoretical Sciences, Bengaluru, India, November 09 - 13, 2020.
2. *Physics of the Early Universe - An Online Precursor*, held online at International Centre for Theoretical Sciences, Bengaluru, India, August 31 to September 03, 2020.
3. *Regional Astronomers Meeting V on Astronomy Research : Opportunities and Challenges*, Department of Physics, Cochin University of Science and Technology, Ernakulam, India, February 08–09, 2019.
4. *The 30$^{\text{th}}$ Indian Association of General Relativity and Gravitation meeting*, BITS Pilani Hyderabad campus, Hyderabad, India, January 03–05, 2019.

5. *The 15$^{\text{th}}$ Marcel Grossmann meeting*, Sapienza Universitá di Roma, Rome, Italy, July 01–07, 2018.
6. *Post-Planck Cosmology : Enigma, Challenges and Visions*, The Inter-University Centre for Astronomy and Astrophysics, Pune, India, Oct 09–12, 2017.
7. *Quantifying and Understanding the Galaxy–Halo Connection*, Kavli Institute for Theoretical Physics, Santa Barbara, United States of America, May 15–19, 2017.
8. *APS April meeting 2017*, Washington, DC, United States of America, January 28–31, 2017.
9. *21st International Conference on General Relativity and Gravitation*, Columbia University, New York, United States of America, July 10–15, 2016.
10. *APS April meeting 2016*, Salt Lake City, United States of America, April 16–19, 2016.
11. *Particle Cosmology after Planck*, DESY, Hamburg, Germany, September 23–26, 2014.
12. *Aspects of Cosmology*, Indian Institute of Astrophysics, Bengaluru, India, April 9–11, 2014.
13. *Post Planck Cosmology*, Ecole De Physique de Houches, Les Houches, France, July 8–August 2, 2013.
14. *Twenty-Seventh Meeting of the Indian Association for General Relativity and Gravitation*, Department of Physics, H. N. Bahuguna Garhwal University, Srinagar (Garhwal), Uttarakhand, India, March 7–9, 2013.
15. *Present Observational Constraints on Cosmological Parameters*, Department of Physics and Astrophysics, University of Delhi, Delhi, India, January 28–February 1, 2013.

RECENT TALKS (in reverse chronological order)

1. *"Spherical Collapse of fuzzy dark matter"* at Department of Physics, Indian Institute of Technology Madras, Chennai, India, May 29, 2019.
2. *"Inflationary cosmology"* in The Regional Astronomers Meeting V on Astronomy Research: Opportunities and Challenges, Department of Physics, University of Science and Technology, Ernakulam, India, February 08–09, 2019.
3. *"Spherical Collapse of fuzzy dark matter"* in The 30$^{\text{th}}$ Indian Association of General Relativity and Gravitation meeting, BITS Pilani Hyderabad, Hyderabad, India, January 03–05, 2019.
4. *"Spherical Collapse of fuzzy dark matter"* at Virtual Institute of Astroparticle Physics, Paris, France, September 28, 2018.
5. *"Non-Gaussianity in loop quantum cosmology"* in The 15$^{\text{th}}$ Marcel Grossmann meeting, Sapienza Universitá di Roma, Rome, Italy, July 01–07, 2018.
6. *"Primordial non-Gaussianity in loop quantum cosmology"* in Post-Planck Cosmology : Enigma, Challenges and Visions, The Inter-University Centre for Astronomy and Astrophysics, Pune, India, October 09–12, 2017.
7. *"Evolution of perturbations in anisotropic loop quantum cosmology"* in APS April Meeting 2017, Washington, DC, United States of America, January 28–31, 2017.
8. *"Evolution of perturbations through an anisotropic quantum bounce"* seminar at Raman Research Institute, Bengaluru, India, 01 August 2016.

9. *"Evolution of perturbations in anisotropic loop quantum cosmology"* in 21st International Conference on General Relativity and Gravitation, Columbia University, New York, United States of America, July 10–15, 2016.

10. *"The tensor bi-spectrum in a matter bounce"* in APS April Meeting 2016, Salt Lake City, United States of America, April 16–19, 2016.

11. *"Computation and characteristics of inflationary three-point functions"* seminar at Louisiana State University, 26 August 2015.

12. *"Computation and characteristics of inflationary three-point functions"* seminars at The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy on 30 September, 2014, The Institut d'astrophysique de Paris, Paris, France on 09 October, 2014 and The Centre for Cosmology and Particle Physics Phenomenology - CP^3 Origins, Odense, Denmark on 13 October, 2014.

13. *"On the consistency relations describing the three-point functions involving tensors"* in Particle Cosmology after Planck, DESY, Hamburg, Germany, September 23–26, 2014.

14. *"Non-Gaussianity parameters for three point scalar-tensor cross correlations and tensor bi-spectrum"* in Post Planck Cosmology, Ecole De Physique de Houches, Les Houches, France, July 8–August 2, 2013.

15. *"Scalar-tensor cross correlations and tensor bi-spectra in models involving deviations from slow roll"* in Twenty-Seventh Meeting of the Indian Association for General Relativity and Gravitation, Department of Physics, H. N. Bahuguna Garhwal University, Srinagar (Garhwal), Uttarakhand, India, March 7–9, 2013.

FELLOWSHIPS

- Junior and Senior Research Fellowships, UGC-CSIR NET, India, 2009–2014.
- Grant for participating in "Les Houches School of Physics session C Post-Planck cosmology" held from July 09 – August 02, 2013 from Ecole De Physique des Houches, Les Houches, France.

TEACHING

I enjoy teaching and interacting with students. At National Institute of Technology Karnataka, Surathkal, I have taught the following courses:

1. Physics (for first year engineering students)
2. Computational physics (for M. Sc. students)
3. General theory of relativity (for M. Sc. students)

MENTORING

Master Thesis (at National Institute of Technology Karnataka)

- *Generation of Primordial Gravitational Waves during Inflation* by DivyaRani C. G.
- *Cosmological Parameter Estimation from Type Ia Supernovae* by Amrutha Devi M. M.

Other student projects

- *Late time acceleration of universe: A Bayesian analysis of data from Supernova Ia* by Kishan Hasmukhbhai Sankharva, Indian Institute of Technology Kanpur (as part of Visiting Students Programme at IUCAA, Pune).

OUTREACH ACTIVITIES (in reverse chronological order)

1. *How to model our universe?* a webinar at Zamorin's Guruvayurappan College, Kozhikode, India, December 05, 2020.
2. *An Invitation to Cosmology* a webinar at Carmel College, Thrissur, India, November 28, 2020.
3. *General Relativity, Expanding Universe and Big Bang* as part of International Physics Colloquia held online at Mar Thoma College, Tiruvalla, India, September 10, 2020.
4. Two lectures on "Introduction to Cosmology", as part of "Mini-School on Gravitation and Cosmology" held at Providence College, Calicut, India, February 07-10, 2019.
   Target audience : College students
5. *Story of our universe : Standard model of cosmology*, as part of seminar on "Space Science and Nano Science" held at Little Flower College, Guruvayur, India, October 11, 2018.
   Target audience : College students
