Raghav Govind Jha

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| Date of Birth: January 23, 1989, Citizenship: Indian

Research Experience after Ph.D.

- **Jefferson Lab (JLab)** *September 2022 -*
  Postdoctoral Researcher Newport News, VA, USA

I am member of the Co-design Center for Quantum Advantage (C2QA) which is one of the five National Quantum Information Science (QIS) Research Centers funded by the U.S. DOE (Department of Energy) Office of Science. The goal of this initiative is to develop quantum algorithms and methods to study problems in high energy theory on near-term quantum devices. We are currently exploring digitization in scalar field theories and $O(3)$ non-linear sigma model.

- **Perimeter Institute for Theoretical Physics** *September 2019 - August 2022*
  Postdoctoral Fellow, Mentor: Pedro Vieira. Waterloo, ON, Canada

I was postdoc in the Quantum Fields and Strings group and was also partly supported by Simons Bootstrap Collaboration. As part of this appointment, I conducted independent research with students and collaborators in addition to working on aspects of how bootstrap can be used to solve matrix models. Another (ongoing) project is to understand the behaviour of S-matrix from real-time analysis of field theories in two (Euclidean) dimensions.

Education

- **Doctor of Philosophy (Ph.D.) Physics**, Syracuse University, NY, USA — August 2013 - May 2019
  [Advisor: Simon Catterall. Thesis defense date: April 02, 2019]
  Thesis title: Holography, large N, and supersymmetry on the lattice
- **M.Sc. Physics**, St. Xavier's College & Bose Institute, Kolkata, INDIA — August 2011 - May 2013
- **M.S. in Nanomaterials**, Sorbonne Université, Paris, FRANCE — September 2010 - July 2011
- **B.Sc. Physics (Honours)**, St. Stephen's College, Delhi, INDIA — July 2007 - May 2010

PUBLICATIONS

Total citations[1] (as per iNSPIRE HEP): 190, h-index: 9
Google Scholar, iNSPIRE HEP

19. Non-perturbative phase structure of the bosonic BMN matrix model
    arXiv:2201.08791, JHEP 05 (2022) 169
    N. S. Dhindsa, R. G. Jha, A. Samlodia, A. Joseph, and D. Schaich

18. Thermal phase structure of dimensionally reduced super-Yang–Mills
    arXiv:2201.03097
    D. Schaich, R. G. Jha, A. Joseph

17. Tensor renormalization of three-dimensional Potts model
    arXiv:2201.01789
    R. G. Jha

16. Introduction to Monte Carlo for Matrix Models
    arXiv:2111.02410, SciPost Phys. Lect. Notes 46 (2022)
    R. G. Jha

[1] For paper-wise citation, please refer to iNSPIRE

15. Large-N limit of two-dimensional Yang–Mills theory with four supercharges
arXiv:2109.01001
N. S. Dhindsa, R. G. Jha, A. Joseph, and D. Schaich

14. Tensor renormalization group study of the $3d$ $O(2)$ model
arXiv:2105.08066, Phys. Rev. D 104, 094517 (2021)
J. Bloch, R. G. Jha, R. Lohmayer, M. Meister

13. Three-dimensional super-Yang–Mills theory on the lattice and dual black branes
arXiv:2010.00026, Phys. Rev. D 102, 106009 (2020)
S. Catterall, J. Giedt, R. G. Jha, D. Schaich, T. Wiseman

12. Positive geometries for all scalar theories from twisted intersection theory
arXiv:2006.15359, Phys. Rev. Research 2, 033119 (2020)
R. G. Jha, N. Kalyanapuram

11. Critical analysis of two-dimensional classical XY model
arXiv:2004.06314, J. Stat. Mech. (2020) 083203
R. G. Jha

10. Thermal phase structure of a supersymmetric matrix model
arXiv:2003.01298, PoS LATTICE2019 (2020) 069
D. Schaich, R. G. Jha, A. Joseph

9. Finite N unitary matrix models
arXiv:2003.00341
R. G. Jha

8. Tensor renormalization group study of the non-Abelian Higgs model in two dimensions
arXiv:1901.11443, Phys. Rev. D 99, 114507 (2019)
A. Bazavov, S. Catterall, R. G. Jha, J. U-Yockey

7. Lattice quantum gravity with scalar fields
arXiv:1810.09946, PoS LATTICE2018 (2019) 043
R. G. Jha, J. Laiho, J. U-Yockey

6. The properties of $D1$-branes from lattice super Yang–Mills theory using gauge/gravity duality
arXiv:1809.00797, PoS LATTICE2018 (2019) 308
R. G. Jha

5. Removal of the trace mode in lattice $\mathcal{N} = 4$ super Yang-Mills theory
arXiv:1808.04735, Phys. Rev. D 98, 095017 (2018)
S. Catterall, J Giedt, R. G. Jha

4. Nonperturbative study of dynamical SUSY breaking in $\mathcal{N} = (2, 2)$ Yang-Mills
arXiv:1801.00012, Phys. Rev. D 97, 054504 (2018)
S. Catterall, R. G. Jha, A. Joseph

3. Truncation of lattice $\mathcal{N} = 4$ super Yang-Mills
EPJ Web of Conferences 175, 11008 (2018)
S. Catterall, J Giedt, R. G. Jha

2. Testing the holographic principle using lattice simulations
arXiv:1710.06398, EPJ Web of Conferences 175, 08004 (2018)
R. G. Jha, S. Catterall, D. Schaich, T. Wiseman

1. Testing holography using lattice super-Yang-Mills on a 2-torus
arXiv:1709.07025, Phys. Rev. D 97, 086020 (2018)
S. Catterall, R. G. Jha, D. Schaich, T. Wiseman

Invited Talks/Lectures

24. Classical computation using tensor networks and quantum computation with qubits and qumodes (November 14, 2022) at Jefferson Lab, USA [Online] [Slides]
23. Application of tensor methods to real-space renormalization and real-time study of field theories (October 31, 2022) at Brookhaven National Lab (BNL), USA [Online] [Slides]
22. New tools for old problems in spin and gauge models on the lattice (October 12, 2022) at IIT Hyderabad, India [Online] [Slides]
21. Some old problems on the lattice using tensors (August 26, 2022) at ICTS, Bangalore, India during NUMSTRINGS 2022 conference [YouTube]
20. Introduction to Quantum Computation using QISKIT (June 22 and 23, 2022) - Two lectures for Summer School 2022 at Rensselaer Polytechnic Institute, USA [Online] [Lecture 1 & 2]
19. New approach to continuous spin models in two and three dimensions (May 17, 2022) at Numerical Methods in Theoretical Physics conference, APCTP, Pohang, South Korea [Online] [Slides]
18. Holography with large matrices on the lattice (March 24, 2022) at Institute of Nuclear Sciences, Universidad Nacional Autónoma de México, Mexico City, Mexico [Slides]
17. Large N matrix models using Monte Carlo and Bootstrap (February 22, 2022) at University of Surrey, Surrey, UK [Online] [Slides]
16. Introduction to tensor networks and spin systems (January 11, 2022) at Azim Premji University, Bengaluru, India
15. Tensor networks and spin models (December 7, 2021) at Indian Institute of Science Education and Research (IISER), Mohali, India [Slides]
14. Real-space tensor renormalization for spin models in three dimensions (November 19, 2021) at Perimeter Institute, Waterloo, Canada
13. Solving matrix models at large and finite N (June 28 and 29, 2021) - Two lectures for Summer School 2021 at Rensselaer Polytechnic Institute, USA [Online] [Lecture 1 & 2]
12. Holographic gauge theories on the lattice at (June 23, 2021) [Online] at Dublin Institute for Advanced Studies, Dublin, Ireland [Slides] [YouTube]
11. Old and new methods for new and old problems in Physics (March 8, 2021) [Online] at Indian Institute of Technology (IIT) Madras, India [Slides]
10. Probing holographic dualities with lattice supersymmetric Yang-Mills theories (February 25, 2021) [Online] at Massachusetts Institute of Technology, Boston, USA [Slides] [YouTube]
9. New tool for old problems - Tensor network approach to spin models and gauge theories (October 14, 2020) [Online] at University of Liverpool, Liverpool, UK [Slides]
8. Tensor Networks: Algorithm & Applications (June 10 and 11, 2020) - Two lectures for CyberTraining Summer School 2020 at Rensselaer Polytechnic Institute, USA [Online due to COVID-19 pandemic] [Lecture 1 & 2]
7. Numerical Approaches to Holography (August 28, 2019) at Ashoka University, Sonepat, India [Slides]
6. Numerical Approaches to Holography (August 8, 2019) at Indian Institute of Science Education and Research (IISER) Mohali, India
5. Holographic dualities and tensor renormalization group study of gauge theories (March 11, 2019) at Perimeter Institute, Waterloo, Canada [Video (PIRSA, 19030108)]
4. Supersymmetry breaking and gauge/gravity duality on the lattice (April 6, 2018) at UC Boulder, Colorado, USA [Slides]

3. Recent results from lattice supersymmetry in $2 \leq d < 4$ dimensions (January 31, 2018) at ICTS, Bangalore, India [YouTube]
2. Testing holography through lattice simulations (April 4, 2017) at Yukawa Institute for Theoretical Physics, Kyoto, Japan [Slides]
1. Supersymmetry on the lattice (April 17, 2016) at April Meeting 2016 - Salt Lake City, Utah, USA [Slides]

Teaching Experience

- Recitation Instructor for PHY 216 (General Physics II for Honors and Majors) and Grader for PHY 662 (Quantum Mechanics II) Spring 2019
- Recitation Instructor for PHY 215 (General Physics I for Honors and Majors) and Grader for PHY 312 (Relativity & Cosmology) Spring 2018
- Grader for PHY 424 (Electromagnetism) and PHY 360 (Waves and Oscillations) Fall 2016
- Recitation Instructor for PHY 212 General Physics II Spring 2016
- Grader for PHY 641 (Statistical Mechanics) and PHY 731 (Electromagnetic theory) Fall 2015
- Recitation Instructor for PHY 211 General Physics I Spring 2014
- Lab Instructor for PHY 101 General Physics Fall 2013

Awards

- Henry Levinstein Fellowship for Outstanding Senior Graduate Student - Department of Physics, Syracuse University [USD 2000] 2017
- College of Arts and Sciences Fellowship for best performance in introductory Graduate Courses - Syracuse University [USD 1700] 2014
- CSIR/UGC-NET - Junior Research Fellowship (JRF) by Government of India 2013
- Erasmus Mundus Scholarship for pursuing M.S at UPMC, University of Paris VI [EUR 12000] 2010
- National Top 25 Students (out of 5153 students) in National Graduate Physics Examination (NGPE) conducted by Indian Association of Physics Teachers (IAPT) 2009
- KVPY (Kishore Vaigyanik Protsahan Yojana) Scholarship by Department of Science & Technology, Government of India [about USD 3500 in two years] 2008
- Merit certificate by University of Delhi (11^{th} in the university out of $\approx$ 1200 students) 2008
- NIUS (National Initiative on Undergraduate Sciences) Fellowship by Tata Institute of Fundamental Research (TIFR), Mumbai 2008

Technical Skills

- **Programming and Softwares:** C/C++, Python, Julia, Matlab, Bash, CUDA, Mathematica, LaTeX, PyTorch, TensorFlow
- **Quantum Programming:** QisKit (IBM), Cirq (Google)
- **Tools & OS:** Git, Jupyter, Google Colab, Linux, Mac OS, Windows

Professional Services and Grants

– Quantum Fields and Strings Seminar Organizer at Perimeter Institute [January 2020 - March 2021].

– Referee for Physical Review D and Physical Review Letters (since 2020), European Physical Journal (EPJ) (since 2022), IOP Machine Learning: Science and Technology (since 2021)

– Awarded DiRAC computing grant in 2022 for ≈ 24M core-hours with D. Schaich, T. Wiseman, A. Joseph

– Awarded USQCD computing grants of ≈ 12M core-hours on Fermilab pi0 machine each year in 2017 & 2018 with S. Catterall, D. Schaich, and J. Giedt.

Mentorship Experience

1. Nikhil Kalyanapuram (Perimeter Scholar International (PSI) at Perimeter Institute, now PhD candidate at Penn State) 2019-2020

   • We co-authored a paper which discussed the positive geometries for calculating amplitudes in scalar field theory which is an alternative to the standard techniques.

2. Navdeep Singh Dhindsa (PhD student at IISER Mohali) 2020-

   • We co-authored one paper and conference proceedings (including other collaborators) on bosonic phase structure of the BMN model. I came up with the idea of this project and assisted Navdeep at various stages of the work.

3. Vamika Longia (PhD student at IISER Mohali) 2021-

   • We are working on a paper which will be part of the PhD thesis submitted by Vamika at IISER Mohali. I have planned and directed the project since none of the authors have any previous experience in tensor network computations.

4. Abhishek Samlodia (BS-MS IISER Mohali, now PhD candidate at Syracuse University) 2021-

   • We have co-authored one paper on phase structure of the bosonic BMN matrix model. I planned and led this project. I am mentoring Abhishek on another project related to GPU acceleration in tensor network computations.

5. Nikhil Bansal (BS-MS IISER Mohali) 2022-

   • Nikhil did a short reading project with me on bootstrapping matrix models. This was survey of the recent developments in this numerical approach.

Work in Progress

– Phase transition in $\mathcal{N} = (2, 2)$ SYM at large N and finite temperatures [Expected in 2022]

– Scattering in Ising Field Theory using Matrix Product States [Expected in 2023]

– Tensor network study of generalized XY model [Expected in 2023]

– Phase diagram of BMN matrix model at finite couplings at large N [Expected in 2023]

– Parallel MILC-based software for large N supersymmetric gauge theories [Expected in 2023]

References

1. Simon Catterall - Professor of Physics, Syracuse University, NY, USA
   smcatter@syr.edu +13154435978

2. Toby Wiseman - Professor of Theoretical Physics, Imperial College, London, UK
   t.wiseman@imperial.ac.uk +442075947832

3. Pedro Vieira - Faculty at Perimeter Institute, Waterloo, Canada and ICTP-SAIFR, São Paulo, Brazil
   pedrogvieira@gmail.com +15195697600 (8611)

4. Joel Giedt - Associate Professor, Rensselaer Polytechnic Institute, Troy, NY, USA
   giedtj@rpi.edu +15182766455

5. David Schaich - Lecturer in Theoretical Particle Physics, University of Liverpool, Liverpool, UK
david.schaich@liverpool.ac.uk +447568168895

6. A. P. Balachandran - Emeritus Professor of Physics, Syracuse University, NY, USA
balachandran38@gmail.com

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