ASHMEET SINGH

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Current Research Interests

Quantum Mechanics, Cosmology, Quantum Gravity, Emergent Spacetime, Statistical Physics, Quantum Information, and Foundations of Quantum Mechanics

PROFESSIONAL EXPERIENCE

Whitman College *August 2022 - present*
Assistant Professor of Physics

California Institute of Technology *July 2020 - July 2022*
Postdoctoral Research Scholar Associate in Physics
Cosmology Group of Dr. Olivier Doré
Research focuses on the study of novel quantum signatures in early universe cosmology, understanding the quantum-to-classical transition in our universe, and the role played by quantum mechanics in cosmological evolution.

Jet Propulsion Labratory (JPL), NASA *August 2020 - present*
Visiting Affiliate
Working with a NASA Innovative Advanced Concepts (NIAC) team planning a space mission aimed at direct detection of dark energy and other fundamental physics. My role focuses on studying possible signatures of the quantum nature of gravity using space-based atom interferometric tests.

University of Illinois at Urbana-Champaign *Sep 2019 - Dec 2020*
Visiting Scholar
Multi-hazard Approach to Engineering (MAE) Center
Department of Civil and Environmental Engineering
Research collaboration with Prof. Paolo Gardoni's group focusing on using techniques in statistical physics, quantum physics, and information theory to Bayesian inference problems in engineering.

EDUCATION

California Institute of Technology *Sep 2015 - June 2020*
Ph.D in Theoretical Physics
Advisor: Prof. Sean M. Carroll
Thesis Title: Quantum Mechanical Vistas on the Road to Quantum Gravity

California Institute of Technology *Sep 2015 - June 2018*
Masters in Physics

Indian Institute of Technology Roorkee, India *July 2010 - May 2015*
Integrated Masters in Physics
Cumulative GPA: 9.41/10
Institute Silver Medal Award (Department Rank: 1)
Thesis Title: Precision Emulation of Statistics of the Lyman-alpha Forest using a Gaussian Process-based Machine Learning Model
Research conducted at the Max Planck Institute for Astronomy, Heidelberg, Germany

NOTABLE HONOURS, AWARDS AND ACHIEVEMENTS

Innovation in Education Grant Award 2020
Center for Teaching, Learning, and Outreach (CTLO) at Caltech
For launching an online course on Ph2a: Vibrations and Waves

R. Bruce Stewart Prize for Excellence in Physics Teaching 2019
Department of Physics, California Institute of Technology

ASCIT Excellence in Teaching Award 2018
By the Associated Students of the California Institute of Technology (ASCIT)

FQXi's Physics Essay Contest on "What is Fundamental" 2018
Third Prize for the paper, Mad-Dog Everettianism: Quantum Mechanics at its Most Minimal

Commonwealth Fellowship by the Govt. of United Kingdom 2015
For pursuing a doctorate at University of Oxford (Declined)

Institute Silver Medal for Academics 2015
Indian Institute of Technology Roorkee

Annual Excellence Award 2013 and 2014
Indian Institute of Technology Roorkee - Heritage Foundation

Kishore Vaigyanik Proysahan Yojna (KVPY) Fellowship 2010-2015
All India Rank - 4, National pre-PhD fellowships for Excellence in Basic Sciences

Working Internship for Science and Engineering (WISE) 2013
DAAD - German Academic Exchange Service (Max Planck Institute for Astrophysics, Garching, Germany)

National Graduate Physics Examination 2012 2012
National Top 25

O P Jindal Engineering and Management Scholarship 2012
National Top 100

SCIMIND INDIA - National Science Quiz Contest 2010
National Rank-3 *Organised by Dept. of Science & Technology (DST), India*

National Bal Shree Honor 2007
Highest National Honour for creative excellence below 16 years for Creative Scientific Innovations

· Conferred by H.E. Smt. Pratibha Devisingh Patil, President of India on June 10th, 2008.

Chacha Nehru Scholarship for Artistic and Innovative Excellence 2008-2010
Creative Scientific Innovations *Govt. of India*

TEACHING AT WHITMAN

Phys347: Classical Mechanics Fall 2022
Junior/senior class; engaging 2 lectures a week, including "flipped" problem solving sessions

Phys156: General Physics - II (Electromagnetism & Waves) Fall 2022
Freshmen/sophomore class; engaging 3 lectures a week, including "flipped" problem solving sessions

TEACHING AT CALTECH

Physics Teaching Fellow 2019-2020
Resource for TAs, to coordinate and further build and improve the TA culture at Caltech

Ph-1a: Introduction to Newtonian Mechanics Fall 2016
Freshmen class; engaging 2 recitations per week, including a flipped section format

Ph-1b Practical Track: Introduction to Electromagnetism Winter 2016 & 2017
Freshmen class; engaging 3 recitations per week, including a flipped section format

Ph-1c Practical Track: Electromagnetism & Special Relativity Spring 2016
Freshmen class; engaging 3 recitations per week, including a flipped section format

Ph-2a: Vibrations & Waves Fall 2017, 2018, 2019
Sophomore/junior class; engaging 2 lectures per week; also acting as Head TA

Online Course on Ph2a: Vibrations and Waves (publicly released, June 2020)

Ph-2b: Introduction to Quantum Mechanics Winter 2018 & 2020
Sophomore/junior class; engaging 2 lectures per week; also acting as Head TA

Ph-2c: Statistical Mechanics & Thermodynamics Spring 2018
Sophomore/junior class; engaging 2 lectures per week

Ph-12a: Advanced Vibrations & Waves Winter 2017
Sophomore/junior class; grading TA

Ph - 125c: Advanced Quantum Mechanics Spring 2017
Senior class; Discussion & Grading TA, including formulating homeworks and exams

TALKS AND PRESENTATIONS

Observational Cosmology Seminar, Caltech Invited, June 2022
A Quantum-Fueled Universe: Lessons from Quantum Mechanics for Cosmological Expansion

French L'Action Dark Energy Seminar Series Invited, April 2022
Toolkit for Scalar Fields in Universes with Finite-Dimensional Hilbert Space

University College London: Foundations Seminar Invited, February 2022
Toolkit for Scalar Fields in Universes with Finite-Dimensional Hilbert Space

NTT Workshop on Quasiclassicality in Many-Body Systems Invited, December 2021
Quantum State Reduction: Generalized Bipartitions from Algebras of Observables

The Quantum & The Gravity Invited, April 2021
Fun with Finite-Dimensional Quantum Theory Informed by Gravity

Indian Physics Association, Roorkee Chapter Invited, November 2020
Fun with Finite-Dimensional Quantum Theory Informed by Gravity

Philosophy of Physics Group, Rotman Institute of Philosophy Invited, October 2020
Quantum Mereology: Factorizing Hilbert Space into Sub-Systems with Quasiclassical Dynamics

Dark Sector Meeting, JPL, NASA Invited, August 2020
Fun with Finite-Dimensional Quantum Theory Informed by Gravity

Physics Webinar, Indian Institute of Technology Roorkee Invited, September 2019
Demystifying Quantum Mechanics: From Matrices to Quantum Gravity

Caltech Physics TA Training Workshop Invited, September 2019
The Joys of Teaching

High Energy Physics Seminar, KU Leuven Invited, March 2019
Fun with Finite-Dimensional Quantum Theory Informed by Gravity

Strings Seminar, University of British Columbia Invited, September 2018
Quantum Mereology: Factorizing Hilbert Space into Sub-Systems with Quasiclassical Dynamics

Boulder School on Quantum Information, University of Colorado, Boulder Poster, July 2018
Quantum Mereology: Factorizing Hilbert Space into Sub-Systems with Quasiclassical Dynamics

SoCal Grad Strings and Fields, UC Santa Barbara Contributed, May 2018
Quantum Mereology: Factorizing Hilbert Space into Sub-Systems with Quasiclassical Dynamics

APS March Meeting: Quantum Foundations Contributed, March 2018
Quantum Mereology: Factorizing Hilbert Space into Sub-Systems with Quasiclassical Dynamics

Galaxy Coffee, Max Planck Institute for Astronomy Invited, July 2015
Precision emulation of the statistics of the Lyman-alpha Forest

Argelander-Institute for Astronomy, Bonn Invited, July 2014
Relativistic Corrections to the Central Force Problem in a generalized potential approach

Astronomical Society of India Annual Meeting Poster, March 2014
The cold mode: A phenomenological model for the evolution of density perturbations in the intracluster medium

COMPUTATIONAL SKILLS

MATLAB, Python, and Mathematica

PEER-REVIEW FOR ACADEMIC JOURNALS

- *Quantum*
- *Quantum Studies: Mathematics and Foundations*
- *Advances in Theoretical & Mathematical Physics*
- *Modern Physics Letters A*
- *Foundations*
- *Indian Journal of Physics*

POSITIONS HELD

Caltech Department of Physics California Institute of Technology
Physics Teaching Fellow *2019-2020*

34th Pacific Coast Gravity Meeting (PCGM) California Institute of Technology
Organizer and Session Chair *March 2018*

Graduate Student Journal Club on High Energy Physics California Institute of Technology
Organizer *2016-17*

SINTIS - Students' Initiative for Nurturing Talent in Schools 2013-2014
Panelist *Indian Institute of Technology Roorkee*

Astronomy Section — Indian Institute of Technology Roorkee
Secretary — *2013-2014*

Physics Journal Club — Indian Institute of Technology Roorkee
Co-founder and Organizer — *2012-2015*

PUBLICATIONS: REFEREED AND SUBMITTED

1. Friedrich, O., **Singh, A.** & Doré, O. *Toolkit for Scalar Fields in Universes with Finite-Dimensional Hilbert Space*, accepted for publication in Class. Quant. Gravity, arXiv:2201.08405 [gr-qc] .
2. **Singh, A.**, *Probing the Quantum Nature of Gravity in the Microgravity of Space*, White Paper written for the National Academies' Decadal Survey on Biological and Physics Sciences (BPS) Research in Space 2023-2032, arXiv:2111.01711 [quant-ph] .
3. **Singh, A.** & Doré, O. *Does Quantum Physics Lead to Cosmological Inflation?*, arXiv:2109.03049 [gen-ph] .
4. Pandey, A., **Singh, A.** & Gardoni, P., *A Review of Information Field Theory for Bayseian Inference of Random Fields*, Structural Safety 99 (2022) 102225, https://doi.org/10.1016/j.strusafe.2022.102225.
5. Carroll, S. M., & **Singh, A.**, *Quantum Mereology: Factorizing Hilbert Space into Subsystems with Quasi-classical Dynamics*, Phys. Rev. A 103, 022213 (2021), arXiv:2005.12938 [quant-ph].
6. **Singh, A.**, *Quantum Space, Quantum Time, and Relativistic Quantum Mechanics*, Quantum Stud.: Math. Found. 9, 3553 (2022), arXiv:2004.09139 [quant-ph] .
7. Kabernik, O., Pollack, J., & **Singh, A.**, *Quantum State Reduction: Generalized Bipartitions from Algebras of Observables*, Phys. Rev. A 101, 032303 (2020), arXiv:1909.12851 [quant-ph].
8. Cao, C., Chatwin-Davies, A., & **Singh, A.**, *How Low can Vacuum Energy go when your Fields are Finite-Dimensional*, Int. J. Mod. Phys. D Vol. 28, No. 14, 1944006 (2019), arXiv:1905.11199 [hep-th] .
9. Pollack, J., & **Singh, A.**, *Towards Space from Hilbert Space: Finding Lattice Structure in Finite-Dimensional Quantum Systems*, Quantum Stud.: Math. Found. 6, 181 (2019), arXiv:1801.10168 [quant-ph] .
10. **Singh, A.**, & Carroll, S. M., *Modeling Position and Momentum in Finite-Dimensional Hilbert Spaces via Generalized Pauli Operators*, arXiv:1806.10134 [quant-ph] .
11. Carroll, S. M., & **Singh, A.**, *Mad-Dog Everettianism: Quantum Mechanics at Its Most Minimal*, What is Fundamental?, Springer International Publishing, 95 (2019) arXiv:1801.08132 [quant-ph] .
12. **Singh, A.**, & Carroll, S. M., *Quantum Decimation in Hilbert Space: Coarse-Graining without Structure*, Phys. Rev. A 97, 032111 (2018), arXiv:1709.01066 [quant-ph] .
13. Bao, N., Carroll, S. M., & **Singh, A.**, *The Hilbert Space of Quantum Gravity is Locally Finite Dimensional*, Int. J. Mod. Phys. D 26, 1743013 (2017), arXiv:1704.00066 [hep-th] .
14. **Singh, A.**, *Physics from Angular Projection of Rectangular Grids*, Eur. J. Phy - 36, 025001 (2015), arXiv:1502.01207 [gen-ph] .
15. **Singh, A.** & Sharma, P., *The cold mode: A phenomenological model for the evolution of density perturbations in the intracluster medium*, Mon. Not. R. Astr. Soc. (MNRAS) 2014 446 (1): 1895-1906, arXiv:1409.1220 [astro-ph].
16. **Singh, A.** & Patra, B. K., *Relativistic corrections to the central force problem in a generalized potential approach*, Accepted for publication in Can. J. Phy.; DOI: 10.1139/cjp-2014-0261, arXiv:1404.2940 [class-ph].
17. **Singh, A.**, *A simplistic pedagogical formulation of a thermal speed distribution using a relativistic framework*, Pramana, 81, 1 (2013), 143-156, arXiv:1208.3897 [gen-ph].

REFERENCES

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