Arghya Chattopadhyay

C2W Postdoctoral Fellow

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Research identity

My research exploration starts from 0 dimensions with matrix models and continues to 1 dimensional matrix quantum mechanics as well as SYK models. In 2 dimensions I am involved with Jackiew-Titelboim gravity theory as well as two dimensional conformal field theory and their integrable deformations. I have also recently started working on 3 and 4 dimensional higher spin gravity theories. My work with fluid/gravity duality can be thought of as my contribution towards 5 dimensional theories. On the opposite spectrum of 10 dimensional theories, I am interested in both the mathematical and phenomenological effects of Calabi-Yau compactifications. I am actively working on dualities enjoyed by blackholes in supergravity. Coming to the Phenomenological aspects I am currently working with machine learning approach towards gaining a Ricci flat metric using Ricci flow among others. Additionally I am involved in different projects on p-adic holography and applications of padic mathematics in string theory.

Keywords: **Matrix Models** | **JT gravity** | **Deformed CFT** | **Complexity** | **Higher spin gravity** | **Holography** **Fluid/Gravity** | **Freudenthal Duality** | **p-Adic Analysis** | **Machine learning**

Education

Indian Institute of Science Education and Research Bhopal — *Bhopal, MP, India*

PhD in Theoretical Physics — *2014-2019*

- **Advisor:** Prof. Suvankar Dutta
- **Thesis Title:** Emergent Phase Space Description of Unitary Matrix Models and its Applications

Visva-Bharati — *Shantiniketan, WB, India*

MSc in Physics — *2012 - 2014*

- **Special paper:** Particle Physics
- **Thesis Supervisor:** Prof. Biplab Raychaudhuri
- **Masters Thesis Title:** Conventionality of Simultaneity and Relativistic Transformations

Visva-Bharati — *Shantiniketan, WB, India*

BSc (Honours) in Physics — *2009 - 2012*

- Placed in first class with distinction

Postdoctoral positions

Université de Mons — *Mons, Belgium*

Connect With(Come to) Wallonia Postdoctoral Fellow — *Oct 2022 - Present*

- **Project title:** Topological toolkit and complexity in higher spin gravity (ToTCHty)
- **Funding Source:** European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska Curie grant agreement number 101034383

University of the Witwatersrand — *Johannesburg, South Africa*

Postdoctoral Fellow — *Jun 2020 - Oct 2022*

- **Funding Source:** South African Research Chairs Initiative of the National Research Foundation grant number 78554 and Simons Foundation Grant Award ID 509116

The Institute of Mathematical Sciences — *Chennai, TN, India*

Postdoctoral Fellow — *May 2019 - May 2020*

- **Funding Source:** The Institute of Mathematical Sciences

Publications

Book Chapter

Hitchhikers guide to AI, Machine Learning and Career Oppurtunities

Chattopadhyay Arghya

Book: Career Guidance : Choices Before You (2024). ISBN:9788196669386, 2024

Peer Reviewed

Weyl formula and thermodynamics of geometric flow
Parikshit Dutta, Arghya Chattopadhyay
Phys. Rev. D 109.10 (2024) p. 105010. 2024

Generalized Freudenthal duality for rotating extremal black holes
Arghya Chattopadhyay, Taniya Mandal, Alessio Marrani
JHEP 03 (2024) p. 170. 2024

Spread complexity as classical dilaton solutions
Arghya Chattopadhyay, Arpita Mitra, Hendrik J. R. Zyl
Phys. Rev. D 108 (2 July 2023) p. 025013. American Physical Society, 2023

Near-extremal Freudenthal duality
Arghya Chattopadhyay, Taniya Mandal, Alessio Marrani
JHEP 08 (2023) p. 014. 2023

Flow of shear response functions in hyperscaling violating Lifshitz theories
Arghya Chattopadhyay, Nihal M, Debangshu Mukherjee
Eur. Phys. J. C 83.8 (2023) p. 771. 2023

Freudenthal duality of near-extremal black holes and Jackiw-Teitelboim gravity
Arghya Chattopadhyay, Taniya Mandal
Phys. Rev. D 105.4 (2022) p. 046014. 2022

From 2d droplets to 2d Yang-Mills
Arghya Chattopadhyay, Suvankar Dutta, Debangshu Mukherjee, Neetu
Nucl. Phys. B 974 (2022) p. 115648. 2022

Quantum mechanics of Plancherel growth
Arghya Chattopadhyay, Suvankar Dutta, Debangshu Mukherjee, None Neetu
Nucl. Phys. B 966 (2021) p. 115368. 2021

Chern-Simons Theory on Seifert Manifold and Matrix Model
Arghya Chattopadhyay, Dutta Suvankar, Neetu
Phys. Rev. D 100.12 (2019) p. 126009. 2019

Matrix Model for Riemann Zeta via its Local Factors
Arghya Chattopadhyay, Parikshit Dutta, Suvankar Dutta, Debashis Ghoshal
Nucl. Phys. B 954 (2020) p. 114996. 2020

From Phase Space to Integrable Representations and Level-Rank Duality
Arghya Chattopadhyay, Parikshit Dutta, Suvankar Dutta
JHEP 05 (2018) p. 117. 2018

Emergent Phase Space Description of Unitary Matrix Model
Arghya Chattopadhyay, Parikshit Dutta, Suvankar Dutta
JHEP 11 (2017) p. 186. 2017

arXiv Submissions / In Communication

Krylov complexity of deformed conformal field theories
Arghya Chattopadhyay, Vinay Malvimat, Arpita Mitra
(May 2024). 2024

Talks and lectures

Selected talks

Spread complexity as classical dilaton solutions

- Bel day mini workshop 2023, KU Leuven, Belgium

Probing Freudenthal Duality through JT gravity

- IISER Mohali, India

Quantum Mechanics of Plancherel Growth

- Chennai String Meeting 2019, IMSc, India

Chern-Simons Theory on Seifert Manifold and Matrix Model

- Indian String Meeting 2018, IISER Thiruvananthapuram, India
- Visitor talks, ICTP, Italy
- Visitor talks, IMSc, India

Level-Rank Duality and Constraint on Large N representations for Chern-Simons Theory on $S^2 \times S^1$

- National String Meeting 2017, NISER Bhubaneswar, India
- Visitor talks, Nagoya University, Japan

From Phase Space to Integrable Representations and Level-Rank Dualty

- Visitor talks, IPMU, Japan

Consequesnces of Integrable Representations on Chern-Simons Theory

- Visitor talks, ICTS, India
- Visitor talks, IMSc, India

Lecture Series

Hitchhiker's guide for Matrix Models

- **Number of Lectures:** 3
- **Organised through:** Student Talks on Trending Topics in Theory 2019

How (and why) to train your machine

- **Number of Lectures:** 2
- **Organised through:** Low energy talks in high energy physics 2022

Online presence

How (and why) to train your machine

- **Youtube Channel:** LETHEP Seminar
- **Hyperlinks:** youtube.com/lect1, youtube.com/lect2

Probing Freudenthal Duality through JT gravity

- **Youtube Channel:** HEP Journal Club, IISER Mohali
- **Hyperlink:** youtube.com/iisermohali

In person workshops and conferences

Emergent Geometries from Strings and Quantum Fields

Florence, Italy, July 2- 16, 2023

SYK models: from strongly correlated systems to quantum gravity

Brussels, Belgium, June 27- 28, 2023

Chennai String Meeting

Chennai, India, November 23-24, 2019

Spring School on Superstring Theory and Related Topics

Trieste, Italy, March 28-April 5, 2019

Third Mandelstam Theoretical Physcis School and workshop

Durban, South Africa, January 9 - 19, 2019

Indian String Meeting

IISER Trivandrum, India, December 16 - 21, 2018

Supersymmetric Localization and Exact Results

IHES, France, July 16 - July 27, 2018

Strings 2018

OIST, Japan, June 25 - 29, 2018

Nonperturbative and Numerical Approaches to Quantum Gravity, String Theory and Holography

ICTS, Bangalore, India, January 27 - February 3, 2018

Kavli Asian Winter School (KAWS) on Strings, Particles and Cosmology

ICTS, Bangalore, India, January 8 - 18, 2018

National String Meeting

NISER Bhubaneswar, India, December 5 - 10, 2017

School and Workshop on Modular Forms and Black Holes

NISER Bhubaneswar, India, January 5 - 14, 2017

Indian String Meeting

IISER Pune, India, December 15 - 21, 2016

National String Meeting
IISER Mohali, India, December 6 - 11, 2015

SERC Main School in Theoretical High Energy Physics
BITS-Pilani, Pilani, India, November 16 - December 5, 2015

SERC Preparatory School in Theoretical High Energy Physics
IISER Bhopal, India, June 29 - July 25, 2015

Teaching experience

Project Supervision

Membrane at the Horizon

- **Course:** Master's Internship Project from 1^{st} February to 1^{st} March 2024
- **Institute:** Université de Mons
- With Loris Cavenaile

As Lecturer or tutor

SERC Preparatory School on Theoretical High Energy Physics

- **Tutor for:** General Relativity
- 28^{th} October - 9^{th} November at Tezpur, Assam, India

Student Talks on Trending Topics in Theory

- **Lecturer for:** Matrix models
- 17^{th} - 25^{th} July, 2019 at Bhopal, MP, India

Teaching Assistantship

Classical Mechanics 1

- **Instrustor:** Prof. Sudhendu Rai Chaudhary & Dr. Ambar Jain
- **Sessions:** Aug - Dec 2014 & Aug - Dec 2015 at IISER Bhopal

General Laboratory

- **Instrustor:** Prof. Sudhendu Rai Chaudhary
- **Sessions:** Jan - Jul 2015 & Jan - Jul 2016 at IISER Bhopal

Condensed Matter Physics

- **Instrustor:** Prof. Suvankar Dutta
- **Sessions:** Aug - Dec 2016 & Aug - Dec 2017 at IISER Bhopal

Statistical Mechanics 1

- **Instrustor:** Prof. Subhash Chaturbedi
- **Session:** Jan - Jul 2017 at IISER Bhopal

Quantum Physics

- **Instrustor:** Dr. Bhargava Ram Niraghatam
- **Session:** Jan - Jul 2018 at IISER Bhopal

Quantum Mechanics 1

- **Instrustor:** Prof. Suvankar Dutta
- **Session:** Aug - Dec 2018 at IISER Bhopal

Computer skills

Programming Language	C | C++ | Fortran | Python | Haskell | Machine Language
Frameworks & Libraries	Scikit-learn | PyTorch | Tensorflow
Scripting Language	Bash Shell Script | LaTeX | HTML | CGI programming

Outreach activity

Career Counselling and Training programme 2022-24

- 9^{th} March 2022, 11^{th} February 2023, 11^{th} January 2024
- **Organiser:** Asutosh College, Kolkata, WB, India
- **Role:** Resource person
- **Talk title:** Guide to machine learning and getting a career out of it

Extra academic interests

Music Writing, composing and recording music and playing string instruments like guitar, ukulele, violin, dotara.

Linux Since 2010, I have been using Linux. I recently switched to Mac OS, which feels like linux barring the open-source freedom.

Cooking From the time of pandemic I have become fond of trying newer recipes in kitchen.