Dr. Arpith Kumar, PhD

CURRICULUM VITAE

Postdoctoral Fellow, 9417, Institute of Particle Physics,
Central China Normal University, Wuhan,
152 Luoyu Road, 430079, Hubei, China
Email: arpithk@ccnu.edu.cn · *Webpage:* arpithkphy.github.io
Phone: +86-18372112542 · *Nationality*: Indian
Last updated: January 20, 2026

RESEARCH INTERESTS

- Lattice Field Theory
- Lattice QCD at finite T, eB, μ_B, μ_I
- Stochastic quantization and complex Langevin method for complex actions
- Machine Learning and Diffusion Models for config. generation

My research focuses on the non-perturbative structure of QCD and the sign problem, using primarily first-principles lattice simulations and modern computational techniques. I study QCD thermodynamics in strong magnetic fields—relevant to the early universe, neutron-star interiors, and heavy-ion collisions—by exploring fluctuations of conserved charges and equation of state at nonzero baryon chemical potentials. I also work on the applicability and reliability of complex Langevin dynamics to field-theoretic systems plagued by sign problem, relevant to lattice QCD studies at high baryon densities.

I have actively published in major scientific journals relevant for high energy physics:
(orcid: 0000-0002-5887-3803, INSPIRE HEP id: 1763612)

Journal publications: 7
Physical Review Letters — 1
Physical Review D — 4
Journal of High Energy Physics — 1
International Journal of Modern Physics A — 1
Conference proceedings: 7
including recent major conferences: Quark Matter 2025, XQCD 2025, and Lattice 2024.
Unpublished articles: 2
recently submitted to Journal of High Energy Physics — 1

ACADEMIC TIMELINE

(Sep 2023 - Present) POSTDOCTORAL FELLOW at the Central China Normal University Wuhan, China

- Supervisor: PROF. HENG-TONG DING, Institute of Particle Physics, CCNU Wuhan
- Initial appointment of 2 years, extended to 3rd year in recognition of contributions

(Apr 2023 - Jun 2023) VISITOR at the Tata Institute of Fundamental Research Mumbai, India

- Supervisor: PROF. NILMANI MATHUR, Department of Theoretical Physics, TIFR Mumbai

(Jul 2018 - Mar 2023) PHD at the Indian Institute of Science Education and Research Mohali, India

- Dissertation: Non-Perturbative Simulations of Quantum Field Theories using Complex Langevin Dynamics
- Supervisor: DR. ANOSH JOSEPH, Department of Physical Sciences, IISER Mohali
  Currently at University of the Witwatersrand, Johannesburg

(Aug 2012 - Jun 2017) BS-MS at the Indian Institute of Science Education and Research Bhopal, India

- Major: Physical Sciences, BS-MS (Dual Degree) CGPA: 8.26/10
- Dissertation: CMB Spectral Distortions from Thermal Sunyaev-Zel'dovich Effect
- Supervisor: DR. RAJIB SAHA, Department of Physical Sciences, IISER Bhopal

Numerical and Computational Skills

I have strong proficiency in programming languages/environments and data analysis skills relevant to lattice field theory:

- C/C++, Python, Bash Script, Jupyter-Lab, GNU Octave, MATLAB, Mathematica, Gnuplot
- CPU+GPU parallel programming on supercomputing clusters (NSC3 Wuhan, ParamSmriti Mohali, TIFR Mumbai, etc.) primarily using MPI+CUDA
- Large datasets analysis skills, including biased and unbiased estimators, bootstrap resampling, spline interpolations, continuum limit, rational polynomial fits, etc.

Fellowships and Fundings

(Sept 2023 - Present) Postdoctoral Fellowship: partly supported by CCNU Wuhan and grants under National Natural Science Foundation in China

(Jul 2020 - Jul 2023) CSIR-SRF: Senior Research Fellowship offered by Council of Scientific and Industrial Research, India

(Jul 2018 - Jul 2020) CSIR-JRF: Junior Research Fellowship offered by Council of Scientific and Industrial Research, India (*secured all India 70th rank*)

(Dec 2017 - Dec 2018) Provisional INSPIRE Fellowship: Innovation in Science Pursuit for Inspired Research fellowship for graduate research offered by the Department of Science and Technology, India

(Aug 2012 - Apr 2017) INSPIRE Scholarship: Innovation in Science Pursuit for Inspired Research scholarship for undergraduate study offered by the Department of Science and Technology, India
(*secured all India 99.3 percentile in IIT-JEE entrance examination*)

Seminar Talks

I recently delivered seminar talks on our current strong magnetic field research program:

3. *QCD in strong magnetic fields: conserved charges and EoS*,
CHEP Seminar at the Indian Institute of Science Bangalore, India (19 Nov 2025)

2. *QCD in strong magnetic fields: fluctuations of conserved charges and equation of state*,
Free Meson Seminar at the Tata Institute of Fundamental Research Mumbai, India (12 Nov 2025)

1. *QCD in strong magnetic fields: fluctuations of conserved charges and equation of state*,
MITP Seminar at the University of the Witwatersrand, Johannesburg, South Africa (24 Oct 2025)

Talks at International Conferences and Workshops

I have actively participated in and delivered talks at major international conferences and workshops.
Lattice Symposium — 4 in 2025, 2024, 2022, 2021
Quark Matter — 1 in 2025
XQCD — 2 in 2025, 2024
Hot Quarks — 1 in 2025
ECT Workshop* — 1 in 2024

13. *QCD in strong magnetic fields: fluctuations of conserved charges and equation of state*,
Lattice 2025: The 42nd International Symposium on Lattice Field Theory
hosted by Tata Institute of Fundamental Research Mumbai, India (2-7 Nov 2025)

12. (invited talk) *Thermodynamic Diagnostics for Complex Langevin Simulations: The Role of Configurational Temperature*,
The 1st International Workshop on Advances in Lattice QCD
hosted by Institute of Modern Physics, Huizhou, China (12–15 Oct 2025)

11. (invited talk) *Leading-Order QCD Equation of State in Strong Magnetic Fields at Nonzero Baryon Chemical Potential*,
The QCD Phase Diagram: From Theory to Experimental Signatures
hosted by Dalian University of Technology, Dalian, China (7–12 Oct 2025)

10. *QCD in strong magnetic fields: Conserved charges and EoS*,
XQCD 2025: The 21st International Conference on QCD in Extreme Conditions
hosted by University of Wroclaw, Poland (02–04 Jul 2025)

9. *QCD Equation of State in Strong Magnetic Fields at Non-zero Density*,
Hot Quarks 2025: X International Workshop on Physics of Ultra-relativistic
Nucleus–Nucleus Collisions hosted in Hefei, Anhui, China (11–17 May 2025)

8. *Baryon–Electric Charge Correlation as a Magnetometer of QCD*,
Quark Matter 2025: XXXI International Conference on Ultra-Relativistic
Nucleus–Nucleus Collisions hosted by Goethe University Frankfurt, Germany (06–12 Apr 2025)

7. (invited talk) *QCD EoS in strong magnetic fields and non-zero baryon density*,
New developments in studies of the QCD phase diagram
hosted by ECT* Trento, Italy (09–13 Sep 2024)

6. *QCD EoS in strong magnetic fields and non-zero baryon density*,
Lattice 2024: The 41st International Symposium on Lattice Field Theory
hosted by The University of Liverpool, UK (28 Jul–03 Aug 2024)

5. (invited talk) *Complex Langevin Study of Spontaneous SO(10) Symmetry Breaking in Euclidean IKKT Matrix Model*,
The Sixth Mandelstam Theoretical Physics School and Workshop
hosted by University of the Witwatersrand, Johannesburg, South Africa (10–16 Jan 2024)

4. (invited talk) *Complex Langevin Study of Spontaneous SO(10) Symmetry Breaking in Euclidean IKKT Matrix Model*,
Numstrings 2022: Nonperturbative and Numerical Approaches to Quantum Gravity, String Theory and Holography 2022 hosted by ICTS–TIFR, Bengaluru, India (21 Aug - 02 Sep 2022)

3. *Complex Langevin study of spontaneous symmetry breaking in IKKT matrix model*,
Lattice 2022: The 39th International Symposium on Lattice Field Theory
hosted by University of Bonn, Germany [online] (8-13 Aug 2022)

2. *Complex Langevin simulations for $\mathcal{PT}$-symmetric models*,
Lattice 2021: The 38th International Symposium on Lattice Field Theory
hosted by Massachusetts Institute of Technology, Cambridge, USA [online] (26-30 Jul 2021)

1. *Complex Langevin Simulations of Low-dimensional Supersymmetric QFTs*,
APLAT 2020: Asia-Pacific Symposium for Lattice Field Theory
co-hosted by KEK Theory Center, Japan [online] (4-7 Aug 2020)

Poster at International Conferences

1. *QCD EoS in non-zero baryon density and strong magnetic field*,
XQCD 2024: The 20th International Conference on QCD in Extreme Conditions
hosted in Lanzhou, China (17–19 Jul 2024)

Teaching and Mentoring Experience

I have got opportunities to gain teaching and mentoring experience, as listed below.

IISER Mohali
Department of Physical Sciences, Mohali, India

Teaching Assistant

2021 Spring: PHY212 — Modern Physics Lab
2020 Monsoon: PHY401 — Nuclear and Particle Physics
2020 Spring: PHY212 — Modern Physics Lab
2019 Monsoon: PHY411 — Nuclear Physics Lab

Course Grader

2022 Spring: PHY304 — Statistical Mechanics
2021 Monsoon: PHY635 — Gravitation and Cosmology
2021 Spring: PHY304 — Statistical Mechanics

Mentoring summer students

I worked closely with master's students and summer interns, offering tutorials and example codes on the fundamentals of lattice field theory and the CLM.

Summer 2022

- Ujjwal Basumatary, BS Physics, 2nd year, IISc Bengaluru, India — project on *Investigations of the Mini BMN Matrix Model using Complex Langevin Dynamics*

- Saikat Ghosh, BS-MS Physics, 3rd year, IISER Kolkata, India — project on *Severity of the Sign Problem in Zero-dimensional Supersymmetric QFTs*

Summer 2021

- Piyush Kumar, BS-MS Physics, 4th Year, IISER Mohali, India — project on *Complex Langevin Method for SO(4) Symmetric Matrix Model*

- Ashutosh Tripathi, BS-MS Physics, 4th year, IISER Mohali, India — project on *Non-lattice Simulation of Supersymmetric Anharmonic Oscillator*

- Gaurav Dadwal, BS-MS Physics, 4th year, IISER Mohali, India — project on *Sign Problem and Complex Langevin Method*

Summer 2020

- Piyush Kumar, BS-MS Physics, 3rd year, IISER Mohali, India — project on *Complex Langevin Dynamics for Complex Actions*

Co-mentoring master's projects

2022-2023

- Gaurav Dadwal, BS-MS Physics, IISER Mohali, India — project on *Complex Langevin Method and Its Validity in Removing the Sign Problem*

- Piyush Kumar, BS-MS Physics, IISER Mohali, India — project on *Investigating Spontaneous Symmetry Breaking in IKKT Matrix Model*

- Ashutosh Tripathi, BS-MS Physics, IISER Mohali, India — project on *Non-lattice Simulations of Supersymmetric Yang-Mills Theories*

CCNU Wuhan
Institute of Particle Physics, Wuhan, China

Mentoring and collaborating with PhD students

I actively collaborate with PhD students, and I believe our work has become increasingly productive and enjoyable through many fruitful discussions spanning physics, computational techniques, and cultural exchange. More recently, I have had the opportunity to mentor a master's student heading to PhD track, introducing QCD physics in magnetic fields with HRG baselines, performing measurements of observables and careful analysis of lattice data, as well as detailed note-making.

Aug 2025–Present

Jia Ni, Master's student to PhD track, CCNU Wuhan, China
QCD in presence of strong magnetic fields
Hadron Resonance Gas model calculations w and w/o strong magnetic fields
Introduction to lattice QCD data and susceptibilities computations

Sept 2023–Present

Jin-Biao, PhD student, CCNU Wuhan, China
QCD in presence of strong magnetic fields
Collaborated in three published works and four proceedings

Organizational Engagement as a graduate student

Co-organizer, (Online) MPI Workshop, IISER Mohali, India

April 26–29, 2021, IISER Mohali

Organizer and lecturer of a four-day parallel programming MPI workshop. I designed the curriculum and hands-on exercises, delivered lectures, and provided one-to-one tutorials. (Workshop link with lecture materials: sites.google.com/view/mpi-workshop/)

- *Volunteer*, XXV DAE-BRNS HEP Symposium 2022
  hosted by IISER Mohali, India (12–16 Dec 2022)
- *Coordinator*, High Energy Physics Journal Club (HEPJC),
  Department of Physical Sciences, IISER Mohali, India (Jan 2020−Dec 2021)
- *Local Coordinator*, (Hybrid) Shivalik HEPCATS Meeting Winter 2021
  hosted by IISER Mohali, India (18 Dec 2021)
- *Local Coordinator*, (Online) Shivalik HEPCATS Meeting Winter 2020
  hosted by IISER Mohali, India (30 Jan 2021)
- *Local Coordinator*, (Online) Shivalik HEPCATS Meeting Summer 2020
  hosted by IISER Mohali, India (30−31 Jul 2020)
- *Volunteer*, International Conference on Gravitation & Cosmology 2019
  hosted by IISER Mohali, India (10−13 Dec 2019)
- *Local Coordinator*, Shivalik HEPCATS Meeting Winter 2019
  hosted by IISER Mohali, India (7 Dec 2019)