Curriculum Vitae

Personal information

Name: Dr. Kumar Abhinav

Date and place of birth:
1st of September, 1982 in Jorhat, India (39 years old)

Family status: Married.

Current web-page: https://na.mahidol.ac.th/nas2020/kumar-abhinav-page/

Current Position: Lecturer

Affiliation: Nakhonsawan Studiorum for Advanced Studies – NAS, Mahidol University, Nakhonsawan Campus, Thailand

Phone: +66(0)864456406 (O), +66(0)623876062 (M)

E-mail: kumar.abh@mahidol.ac.th, gokuabhinav@gmail.com

Present Address: Nakhonsawan Studiorum for Advanced Studies – NAS, Mahidol University, Nakhonsawan Campus, 402/1 Moo 5, Khao Thong, Phayuha Khiri, Nakhonsawan 60130, Thailand

Permanent Address: C/o Mr. Nani Dutta, Nakari Road, Digambar Chuck, Jorhat-785001, Assam, India.

Professional record

Mar. 2021-
Present Lecturer at Nakhonsawan Studiorum for Advanced Studies – NAS, Mahidol University, Nakhonsawan Campus, Thailand

Oct. 2019-
Feb. 2021 Lecturer at The Institute for Fundamental Study (IF), Naresuan University, Thailand.

June 2018-
Sep. 2019 Overseas Specialist Lecturer at The Institute for Fundamental Study (IF), Naresuan University, Thailand.

Sep. 2017-

May 2018 TUBITAK 2216 Postdoctoral Fellow of Turkish Government at Department of Physics, University of Bilkent, Ankara, Turkey.

Feb. 2016-
Sep. 2017 Post-Doctoral Research Associate - 1 in S. N. Bose National Centre for Basic Sciences, Kolkata, India.

May 2009-
Nov. 2015 PhD, Indian Institute of Science Education and Research (IISER) Kolkata, India.

Aug. 2007-
Aug. 2008 Junior Research Fellow in Harish-Chandra Research Institute, Allahabad, India.

Jul. 2006-
Feb. 2007 Lecturer (Ad-Hoc) in Department of Physics and Electronics, Jagannath Baruah College, Jorhat, India.

Academic record

Mar. 2021 – Present

Lecturer at Nakhonsawan Studiorum for Advanced Studies – NAS, Mahidol University, Thailand.

Independent appointment (Tenure-Track).

Research Direction: As a researcher faculty, working in effective gravity and topological gauge theories. Also pursuing deformed Integrable structures, nonlinear dynamics-related neural networks and pseudo-Hermitian topological systems.

Jun. 2018 – Feb. 2021

Overseas Specialist Lecturer and then Lecturer at The Institute for Fundamental Study (IF), Naresuan University, Thailand.

Independent appointment.

Research Direction: As an independent researcher, working in effective gravity and topological gauge theories. Also pursuing deformed Integrable structures. Additional responsibility of teaching Field Theory and related topics at Graduate, Post-Graduate and PhD levels.

Sep. 2017 - May. 2018

Postdoctoral Associate in Department Physics, University of Bilkent, Ankara, Turkey under TUBITAK 2216 fellowship.

Host: Prof. Balazs Hetenyi.

Research Direction: Transport properties in Topological Condensed Matter systems with effective Abelian and Non-Abelian gauge structures.

Feb. 2016 – Aug. 2017

Post-doctoral Research Associate in Department of Theoretical Sciences, S N Bose National Centre for Basic Sciences, Kolkata, India.

Host: Prof. Partha Guha and Prof. Samir K Paul.

Research Directions: Topological field theories, Gauge theory of gravity, Integrable Models, Conformal field theories.

Work Summary:

Generalized Weyl Invariance: A massive Abelian gauge theory with $U(1)_R$ coupling to scalar-tensor theory gravity was analyzed. It yields a non-trivial conserved current under extended Weyl-gauge symmetry and is quantized under the BRST formalism with extended diffeomorphism and generalized Weyl gauges.

Quasi-Supersymmetric Integrable Model: N=2 Supersymmetric extension to quasi-integrable (QI) sine-Gordon model was obtained, with extended algebraic structure. QI deformation of Mixed Fermi-Pasta-Ulam and Frenkel-Kontorova models with Bäcklund transformation, KdV system and comparison of QI and non-holonomic (NH) nonlinear Schrödinger (NLS) systems are achieved. Also, inhomogenous Heisenberg spin chain is identified with particular NH NLS system.

Chern-Simons Theory and CFT: Non-Abelian Chern-Simons theory with a finite boundary is shown to be gauge-invariant only in the presence of a scalar mode. The latter is identified as a CFT on the boundary.

May. 2009 – Oct. 2016

Doctoral fellow, Dept. Of Physical Sciences, Indian Institute of Science Education and Research (IISER) Kolkata, India.

Dissertation: *Investigation of Lower Dimensional Field-theoretical and Quantum mechanical Systems with Broken Parity having Topological Non-perturbative Characteristics.*

Supervisor: Prof. Prasanta K Panigrahi

My thesis included treatment of PT-symmetric quantum systems, wherein supersymmetric techniques have been used to identify two distinct sectors of the Hilbert space, corresponding to PT-broken and unbroken phases. Further, scattering properties of generic PT-symmetric systems are analyzed to obtain novel boundary conditions, which already have experimental realization in the coherent perfect absorber and in proposed PT-CPA laser. An analysis of PT-symmetric non-linear quantum system has also been carried out. In a field-theoretic treatment, gravitational KdV solitons of topological origin are realized in the boundary of the planar system, like graphene, resulting in resistance-less spin transport of curvature-induced excitation. Further, a novel topological spin-1 exciton is obtained in planar QED, realizable in graphene and topological insulators. Stability of the same against quantum and thermal fluctuations are analyzed. An effective first quantized treatment of the same system yields non-trivial local extension to the angular momentum of the gauge sector, akin to parity anomaly in 2+1 dimensions, resulting in Efimov-like resonances.

Though outside of the thesis, during my PhD, I had analyzed strongly coupled quasi-one-dimensional BECs, wherein two sectors were identified, characterized with soliton with finite threshold momentum and soliton trains. Also, I have worked in linear N-body systems, of

Calogero-type, with scaling symmetry, leading to novel 'omega' modes, based on inherent correlation and symmetry.

PhD Coursework
Quantum Field Theory: Bosonic and Fermionic fields, Wick expansion, Scattering matrix and amplitude calculation, Gauge fields, Quantum Electrodynamics, Loop calculation and regularization.
Advanced Quantum Mechanics: Angular momentum, SU(2) and SO(3) groups, Quantum scattering, Klein-Gordon Equation , Dirac Equation, Quantum vacuum, Klein's paradox, Relativistic square well.
General Relativity: Tensor calculus, Metric and curvature, parallel Transport, Geodesic equation, Riemann tensor, Einstein's equation, Schwarzschild solution, Black holes, Killing vectors, Gravitational waves.
Advanced Mathematical Methods: Differential equations, Non-linear dynamics, Matrix algebra, Group theory, Topology and manifolds.
Research Methodology: Data analysis, statistical weights, Mathematica, MatLab, Wavelet analysis, Error estimation.

Aug. 2007 – Aug. 2008

Junior Research Fellow in Harish-Chandra Research Institute, Allahabad, India .

Summary: During this period, I attended two semesters of course-work, including subjects like Quantum Mechanics, Mathematical Methods, Classical dynamics, Electrodynamics, Quantum mechanics, Introductory quantum field theory, Statistical mechanics, Advanced Quantum mechanics and General relativity. Additionally, a seminar project in accelerated electromagnetic potentials was undertaken.

Jul. 2006 – Feb. 2007

Lecturer (Ad-Hoc) in Department of Physics and Electronics, Jagannath Baruah College, Jorhat,

India.

Summary: Taught both Minor and Major (Hons.) courses at Bachelor-level including Quantum mechanics, Classical Mechanics, Special relativity, Electrodynamics, Nuclear physics, Statistical mechanics, Optics, Thermodynamics and Electronics.

Jan. 2004 – Dec. 2005

MSc in Physics, Dibrugarh University, India (Ranked 2nd, 69.13%).

Topics studied included
Nuclear and Particle Physics: Models of nuclei, nuclear spectrum and radiation, fission and fusion mechanisms, nuclear detectors and reactors, standard model, SU(3) group and eight-fold way, quark model, neutrinos.
Atomic and molecular physics: Atomic spectra, spin-orbit interaction, fine and hyperfine structure, Zeeman and Paschen-Beck effects, Molecular orbital, LCAO, Molecular spectra, Raman spectra, Effective models of molecules.
Quantum Mechanics: Ideas of Matrix mechanics, Schrödinger equation, Born interpretation, Plane waves, Square Well, 1-D scattering, Harmonic Oscillator, Double well, Landau levels, Spherical well, Scattering and Harmonics, Dirac and Klein-Gordon Equations.

Statistical Mechanics: Distribution laws and ensemble approach, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics, partition functions, Thermodynamic potentials, Bose-Einstein Condensates, Fermi Level.
Classical Mechanics: Lagrangian approach, Hamiltonian approach, Phase-space, Action-angle variables, Orbits and open systems.
Mathematical Physics: Ordinary and partial differential equations, Matrices, Group theory, Differential calculus and geometry, Infinite and finite series, Special functions.

Jul. 2000 – Jun. 2003

BSc in Physics, Jagannath Baruah College, Dibrugarh University, India (Ranked 4th, 67.50%).

Majored in Physics [Classical Mechanics, Waves and oscillations, Optics, Special Relativity, Quantum Mechanics, Electrodynamics, Thermodynamics, Statistical Mechanics, Atomic Physics, Nuclear Physics, Mathematical Physics]
Minored in Mathematics and Statistics.

Short Scientific Autobiography

Following the motivation from schooldays, my dream of becoming a theoretical physicist was sustained during my Bachelor and Master degrees, through the choice of subjects like Advanced Mathematical Physics, Quantum Mechanics, Relativity and Particle Physics. Although not being able to pursue a proper research project during the period, I self-prepared with advanced topics like Quantum Field Theory and General Relativity.
During my PhD, I had a few good-quality publications, including 6 peer-reviewed publications (5 first author) in leading international journals (e.g., Annals of Physics, J Phys. A and Journal of High Energy Physics), 2 Conference proceedings (1 first author) at national level, 1 book chapter published at international level, and 1 study material for IIT Kanpur. Though I started working in the area of the supersymmetric structure of PT-symmetric quantum systems, scale-invariant many-body systems and strong-coupling BECs, I quickly moved into core topics like topological field theory, especially Chern-Simons theory, and gravity; wherein crucial topics like bound state problem and gravitational solitons were addressed.
After my PhD, I have worked in conformal gravitational field theory (2 peer-reviewed publications) and in integrable systems (2 peer-reviewed publications). I have further worked in gauge theories with gravity, quantization of higher-dimensional topological models and generic topological models with conformal boundary modes. Deformed non-linear models and their geometrical representation are also under investigation. Their application into neuural networks and rellated topics are studied also. Lately, study of pseudo-Hemiitian topological field theories is underway.

Corresponding pre-prints are available in ArXiv.

Immediate Research goals

I am currently pursuing a few interesting research topics. Firstly, **the effect of induced Chern-Simons (C-S) interaction on vortex states through fermion-induced fluctuations** is of interest. This borrows from my earlier work on topological excitons and can potentially lead to novel realization of bound vorteces that can be observed in planar condensed matter systems. Given the extensive interest and utility of vortex dynamics in various branches of physics, including black hole solutions in planar gravity.

Secondly, **massive gauge models in various effective gravity theories, including FRW-based conformal models** are being persued. Such models are expected to explain the early behavior of of the Universe as well as to bring out novel possibilities in the present epoch. A **dynamical system treatment** is actively considered for concrete predictive results.
Thirdly, **deformation of non-local nonlinear integrable models, specifically of KdV and NLS type**, are being studied. They represent physical systems more closely than their undeformed counterparts and are applied to various fields like hydrodynamics and atmospheric sciences. Further, **a general geometric construction of such deformations** is being sought-after. Also, **application of neural networks into such deformed systems** is being studied.
Fourthly, we are trying to obtain **an effective field theory (low energy) model of Drude weight with an original (not induced) Peierls phase**. This should explicate conductivity structures in low-dimensional materials, **including topological insulators**, possibly leading to novel stable phases. A generalization of such systems having **pseudo-Hermitian nature** is also under consideration. Subsequently, studies about **PT-symmetric gauge theories** are in continuation.

I expect that these works will lead to a body of good quality papers in a couple of years in leading international journals. Though I have a few active collaborators, mostly in India and Turkey, for efficient outcome I am willing to work with new people who can improve the quality of the output.

Publications

In Peer-reviewed Journals

Citation indices updated to 18th February, 2022:
Google Scholar: 141 citations, **h-index** 8, **i10 index** 4. **INSPIRE, h_{HEP} index** 2**.**

1. *"Non-Holonomic and Quasi-Integrable Deformations of the AB Equations"*, **K. Abhinav**, I. Mukherjee and P. Guha, Physica D : Nonlinear Phenomena **433**, 133186 (2022). *Both non-holonomic and quasi-integrable deformations of the AB system, that models geophysical and atmospheric fluid motion and ultra-short pulses in nonlinear optics, are obtained for the first time. Particular localized solutions are obtained, some unique to the deformation, with similarities to physically observed excitations.*

2. *"Analysis and comparative study of non-holonomic and quasi-integrable deformations of the nonlinear Schrödinger equation"*, **K. Abhinav**, P. Guha and I. Mukherjee, Nonlinear Dyn **99**, 1179 (2020). *The non-holonomic deformation for the NLS system was obtained by both bi-Hamiltonian and Lax methods for the first time. It is comapared with the corresponding quasi-integrable deformation. Their local coincidence is subjected to a space discontinuity of the NLS solution yielding a definite phase-modulus coupling. They are gauge non-equivalent and are graphically distict too, though the solutions converge asymptotically. A non-integrable deformation, due to locally scaled amplitude, is also compared.*

3. *"Study of quasi-integrable and non-holonomic deformation of equations in the NLS and DNLS hierarchy",* **K. Abhinav**, P. Guha and I. Mukherjee, Jour. Math. Phys. **59**, 101507 (2018)*. Both non-holonomic (NH) and quasi-integrable (QI) deformations are performed for NLS and DNLS hierarchies. The equations of motion are free from QI anomaly, suggesting dynamical integrabiliy. NH deformation is further applied to the coupled KdV type NLS and also to Kaup-*

Newell and Chen-Lee-Liu DNLS systems and different aspects of the results are discussed.

4. *"Inhomogeneous Heisenberg Spin Chain and Quantum Vortex filament as Non-Holonomically Deformed NLS Systems",* **K. Abhinav** and P. Guha, Eur. Phys. J. B **91**, 52 (2018). *The continuum limits of two physically different systems, namely the Heisenberg XXX spin chain with site-dependent (inhomogeneous) coupling and the Quantum Vortex filament in a superfluid with drag are shown to be specific non-holonomic deformations of the usual NLS system. The generic spectral selection and phase-amplitude coupling of these systems along with the inherent scaling of general non-holonomic deformation of the NLS system were analyzed.*

5. *"Bäcklund Transformation and Quasi-Integrable Deformation of Mixed Fermi-Pasta-Ulam and Frenkel-Kontorova Models",* **K. Abhinav**, A. Ghose Choudhury and P. Guha, Disc. Nonlin. Complex. **7**, 31 (2018). *In this work, it is shown that the mixed Fermi-Pasta-Ulam and Frenkel-Kontorova Models, represented by a generalized semi-discrete equation, models non-linear dislocation waves in the crystal lattice, with a mixed generalized potential KdV and sine-Gordon equation being the continuum limit. Single soliton solutions were obtained by Bäcklund transformation and its quasi-integrable deformation is obtained by exploiting the underlying sl(2) loop algebra.*

6. *"Heisenberg Symmetry and Collective Modes of One Dimensional Unitary Correlated Fermions",* **K. Abhinav**, B. Chandrasekhar, V. M. Vyas and P. K. Panigrahi, Phys. Lett. A **381**, 457 (2017). *In this work, dimers in a one-dimensional, unitary, cold Fermi gas are found to possess underlying Heisenberg symmetry, with an exact algebraic map from the interacting to the non-interacting regimes. A ground state energy-shift, proportional to the scaling exponent, is accompanied by novel breathing modes, at integral values of the driving frequency ω, are predicted, with possible exclusion statistics.*

7. *"Novel Symmetries in Weyl-invariant Gravity with Massive Gauge Field",* **K. Abhinav**, A. Shukla and P. K. Panigrahi, Eur. Phys. J. C **76**, 639 (2016). *Herein, quadratic Lagrangian is obtained from a theory of scalar-tensor gravity coupled with massive gauge field, through background field expansion. The theory is quantized through (anti-)BRST method, by identifying actual degrees of freedom, through modified gauge fixing for both diffeomorphism and Abelian sectors, yielding a 'scalar-infused' graviton and a massive $U(1)_R$ photon.*

8. *"Quasi-Integrability in Supersymmetric Sine-Gordon Models",* **K. Abhinav** and P. Guha, EPL **116**, 10004 (2016). *In this paper, quasi-integrability of the supersymmetric sine-Gordon equation has been established, by obtaining a finite number of conserved and an infinite number of non-conserved charges. In the asymptotic limit, the latter type of charges also becomes conserved, leading to complete integrability. The additional presence of supersymmetry yields unique sub-algebraic extension to the characteristic sl(2) loop algebra.*

9. *"Conservation Law for Massive Scale-Invariant Photons in Weyl-Invariant Gravity",* A. Shukla, **K. Abhinav** and P. K. Panigrahi, Class. Quantum Grav. **33**, 235008 (2016). *In this work, it was shown that a massive photon can couple to scalar-tensor gravity, provided gauge and Weyl invariance are combined indistinguishably through proper identification. This leads to a non-vanishing current, unlike the Weyl-invariant theory, making the theory genuine. Under the global approximation, the symmetry reduces to a shift-type one and leads to a Goldstone-like mode.*

10. *"Quantum and Thermal Fluctuations and Pair-breaking in Planar QED"*, **K. Abhinav** and P. K. Panigrahi, JHEP **03**, 032 (2016). *In this paper, the effects of both vacuum and thermal*

fluctuations are analyzed on fermion-antifermion bound state (exciton) of Chern-Simons topological origin in 2+1 space-time dimensions. This effective gauge excitation is topologically stable against a threshold due to gauge dynamics, whereas it melts smoothly with rising temperature. Such a state can be observed in graphene-like systems.

11. *"Solitons and Spin Transport in Graphene Boundary"*, **K. Abhinav**, V. M. Vyas and P. K. Panigrahi, Pramana-journal of physics **85**, 1023 (2015). *It was shown, through the dynamic equivalence of Chern-Simons theory and gravity in 2+1 space-time, that overall gauge invariance of a finite system demands a chiral scalar mode at the boundary. This mode eventually represents solitonic transport of spin connections without resistance.*

12. *"Conserved Correlation in PT-symmetric Systems: Scattering and Bound States",* **K. Abhinav**, A. Jayannavar and P. K. Panigrahi, Annals of Physics **331**, 110 (2013). *In this generic treatment of scattering by PT-symmetric systems, the conserved 'charge' is found to be a non-local correlation depending on boundary values. This correctly leads to unique scattering states for such systems, seen in Coherent Perfect absorbers (CPAs) and proposed in PT-CPA lasers.*

13. *"Gapped solitons and periodic excitations in strongly coupled BEC ",* U. Roy, B. Shah, **K. Abhinav** and P. K. Panigrahi, J. Phys. B: At. Mol. Opt. Phys. **44**, 035302 (2011)*. In this body of work, it was shown that strongly coupled BECs, in quasi-one-dimension, show two distinctive classes in the repulsive domain. One is a soliton without background, requiring finite wave-number for excitation. In presence of background, a W-type periodic soliton train exists. Both these structures are localized, stable and controllable in the trap.*

14. *"Comment on 'Comment on Supersymmetry, PT-symmetry and spectral bifurcation' ",* **K. Abhinav** and P. K. Panigrahi, Annals of Physics, **326**, 538 (2011). *In this comment, it was shown that in Scarf-II type PT-symmetric systems, additional SL(2,R) symmetry identifies the two sectors of the bifurcated Hilbert space in the PT-broken phase.*

15. *"Supersymmetry, PT-symmetry and Spectral Bifurcation",* **K. Abhinav** and P. K. Panigrahi, Annals of Physics, **325**, 1198 (2010). *In this first-ever algebraic treatment of PT-symmetric systems, supersymmetric techniques were used to show bifurcation of the corresponding Hilbert space over the breaking of PT-symmetry. This property is shown to be generic to all solvable PT-symmetric systems.*

In Conference Proceedings

1. "*A study of PT-symmetric Non-linear Schrödinger Equation*", K. N. Reddy, S. Modak, **K. Abhinav**, P. K. Panigrahi, Proceedings of National Seminar on "Recent Advances in Physics", North Orissa University, pp 18-16 (2014). *In this extensive work, PT-symmetric nonlinear Schrödinger equations, with a PT-symmetric trap, are found to support only the PT-unbroken solitonic phase. The PT-broken phase corresponds to uncorrelated decay that cannot be balanced by the non-linearity. An exhaustive class of systems was shown to follow this property.*

2. *"Supersymmetry and PT-Symmetric Spectral Bifurcation",* **K. Abhinav** and P. K. Panigrahi, Proceedings of "Photonics and Quantum Structures", Narosa Publishing House, pp 151-156 (2012). *In this work, as a follow-up to the best poster award earlier in the corresponding conference in 2009, the supersymmetric structure of PT-symmetric quantum systems is analyzed,*

depicting a phase-transition in the Hilbert-space over PT-symmetry breaking. This effect is parameterized by numerical parameters in the PT-symmetric potential, whereas non-PT-symmetric systems do not show such a phase-transition.

Invited Book Chapter

1. "*Bose-Einstein Condensates in a Harmonic Trap and Optical Lattice*", P. K. Panigrahi, R. Atre, S. Sree Ranjani, P. Das and **K. Abhinav**, "Atomic and Molecular Physics: Introduction to Advanced Topics", Narosa Publishing House, pp 183-202 (2012). *In this collected body of work, based on the authors' published works in peer-reviewed journals, various topics of BECs with strong and weak coupling in one, two and three dimensions are considered. Dark, bright and grey solitons were obtained, both with and without background, and shown to be stable, both analytically and numerically. The effect of background is considered extensively, also in the context of multi-soliton profiles. Such models, realizable in cold atoms and optical lattices, are shown to be controllable dynamically, through Feshbach resonance and other dynamical properties of the traps.*

Invited Book Material

1. "*Mathematical Methods for Physics*", P. K. Panigrahi and **K. Abhinav**, Digital Book Material, Indian Institute of Technology, Kanpur, India [To appear digitally]. *In this course-material, topics in undergraduate mathematical physics were compiled based on teaching experiences of the authors. The main topics included matrices and determinants, finite and infinite series expansions, special functions and distributions, special integrals, differential geometry, ordinary and partial differential equations, continuous groups and wavelets. The material is aimed to be problem-based and was compiled to be suitable for visual presentations, with additional slides for each chapter.*

Grants and Projects

2021-Present Research Grant numbered MRC-MGR 04/2565 of Thai Government at Mahidol University, Thailand.

Honours and Awards

2017-2018 TUBITAK 2216 Postdoctoral Research Fellowship of the Turkish Government at the University of Bilkent, Ankara, Turkey.

2016-2017 Post-Doctoral Research Associate Fellowship, SNBNCBS, Kolkata, India.

2011-2015 Senior Research Fellowship, IISER Kolkata, India.

2013 International travelling grant from ICTP, Trieste, Italy, following Invitation to attend "Workshop in Ultra-cold Atoms and Gauge Theories" in ICTP, Trieste, Italy.

2012 Selected to attend 27th SERC-THEP main school held in SINP, Kolkata, India.

2012 DST-ITS grant of the Dept. of Science and Technology, India, for attending "Innovations in Strongly Correlated Electronic Systems: School and Workshop" in ICTP, Trieste, Italy.

2009-2011 Junior Research Fellowship, IISER Kolkata, India.

2009 Best Poster Award in "National Conference in Quantum Optics" in Tezpur University, India.

2009 All India Rank 67 in the Joint Entrance Screening Test (JEST), 2009, SERB, India.

2007-2008 Junior Research Fellowship, HRI, Allahabad, India.

2007 Cleared the CSIR National Eligibility Test (NET), India, held in December, 2006, in the Lectureship category.

2007 All India Rank 39 in the Joint Entrance Screening Test (JEST), 2007, SERB, India.

2006 2nd rank in MSc in Physics (69.13%) under Dibrugarh University, Assam, India.

2003 4th rank in BSc in Physics (67.50%) under Dibrugarh University, Assam, India.

Teaching University Courses and Mentoring

University Courses

2020-2021 Co-instructor for the course titled "Differential Equations and Dynmical Systems" at the graduate level in the Institute for Fundamental Studies for one semester. Therein, I took regular classes and graded tests.

2020-2021 Co-instructor for the course titled "Waves and Fluid Dynamics" at the graduate level in the Institute for Fundamental Studies for one semester. Therein, I took regular classes and graded tests.

2020 Instructor for the course titled "Advanced Statistical Mechanics" at the PhD level in the Institute for Fundamental Studies for one semester. Therein, I took regular classes and graded tests

2019-2020 Instructor for the course titled “Statistical Field Theory” at the PhD level in the Institute for Fundamental Studies for one semester. Therein, I am taking regular classes and grading tests.

2019 Instructor for the course titled “Non-Relativistic Quantum Mechanics” at the graduate level in the Institute for Fundamental Studies for one semester. Therein, I took regular classes and graded tests.

2019 Instructor for the course titled “Relativistic Quantum Fields II” at the postgraduate level in the Institute for Fundamental Studies for one semester. Therein, I took regular classes and graded tests.

2018-2019 Instructor for the course titled “Mathematical Methods of Physics” at the graduate level in the Institute for Fundamental Studies for one semester. Therein, I took regular classes and graded tests.

2018 Co-instructor for the course titled “Particles and Fields” at the postgraduate level in the Institute for Fundamental Studies for one semester. Therein, I took regular classes and graded tests.

2014-2015 Teaching assistantship of fifth-year undergraduate course titled “Research Methodology” for one semester. Therein, I took a few classes and regular tutorials and graded on tests.

2013-2014 Teaching assistantship of third-year undergraduate course titled “Physics III: Nuclear and Particle Physics” for one semester. Therein, I took a few classes and regular tutorials and graded on tests.

2012-2013 Teaching assistantship of fifth-year undergraduate course titled “High Energy Physics” for one semester. Therein, I took a few classes and regular tutorials and graded on tests.

2011-2012 Teaching assistantship of second-year undergraduate course titled “Waves and Sound” for one semester. Therein, I took regular tutorials and graded on tests.

2011-2012 Teaching assistantship of fifth-year undergraduate course titled “Advanced Mathematical Methods” for one semester. Therein, I took few classes and regular tutorials.

2010-2011 Teaching assistantship of second-year undergraduate course titled “Quantum Mechanics 1” for one semester. Therein, I took a few classes and regular tutorials, in addition to grading on tests.

2010-2011 Teaching assistantship of second-year undergraduate course titled “Electricity and Magnetism” for one semester. Therein, I took a few classes and regular tutorials and graded on tests.

2009-2010 Teaching assistantship of second-year undergraduate course titled “Electricity and Magnetism” for one semester. Therein, I took a few classes and regular tutorials, along-with setting question papers and grading on tests.

2009-2010 Teaching assistantship of first-year undergraduate course titled “Mathematical Analysis” for one semester. Therein, I took a few classes and regular tutorials, and graded on tests.

2006-2007 Lecturer at J B College, Jorhat, India. Therein, I taught theory courses, took practical classes, conducted and graded tests. These include Quantum mechanics (undergraduate third-year Hons.), Classical Mechanics (undergraduate first year Hons.), Special relativity (undergraduate first-year Hons.), Electrodynamics (undergraduate third-year Hons.), Nuclear physics (undergraduate third-year Hons.), Statistical mechanics (undergraduate third-year Hons.), Optics (undergraduate first-year Hons.), Thermodynamics (undergraduate first-year Hons.), Electronics (undergraduate second,third-year), Mechanics (undergraduate first year) in theory courses. Practical courses included experiments in Electronics (undergraduate first-year Hons.), Electricity and Magnetism (undergraduate second-year Hons.), Mechanics (undergraduate first-year).

Mentoring/tutoring of graduate/undergraduate students

2020 Mr. Harikrishnan S V, third year undergraduate student of IISER Trivandrum, on *Effective Gravity and Scalar Fields* at IF, Naresuan University. He is about to complete completed his master’s degree from IISER Trivandrum.

2017 Taught selected topics in Introductory Quantum Field Theory, Topological Gauge Theory and Conformal Field Theory to Graduate students in the Department of Physics, Bilkent University.

2015 Mr. Sriram Sundaram, fifth-year undergraduate student of IISER Kolkata, on *Topological loop amplitudes in planar quantum electrodynamics*. He completed his master’s degree from IISER Kolkata.

2013 Taught a voluntary course on *Introductory Quantum Field Theory* to graduate students of 2012 PhD batch of IISER Kolkata, India. Therein, topics like scalar and fermion fields, Wick expansion, tree-level Feynman diagrams were discussed.

2012 Mr. K. Nireekshan Reddy, project student at IISER Kolkata from University of Hyderabad, India, on *Stability of soliton solutions of PT-symmetric, complex non-linear quantum systems under breaking of PT-symmetry* [Work published as a conference proceeding]. He is currently pursuing his PhD in the Tel Aviv University, Israel.

2011 Mr. Phillip Cherian, project student at IISER Kolkata from St. Stephens College, University of Delhi, India, on *Algebraic map of a new class of real potentials to PT-symmetric systems through Isospectral deformation*. He is currently pursuing his PhD in Ecole Polytechnique, Paris, France.

2011 Mr. Ujjal Saikia, project student at IISER Kolkata from ISM, Dhanbad, on *Supersymmetric techniques applied to scattering by complex Coulomb potential and Regge poles*. He is currently pursuing his PhD in Institute of Advanced Study in Science and Technology, Guwahati, India.

Organization of scientific meetings/courses

2022 Convener of the 'Khao Tong Seminar', the official lecture series of NAS, Mahidol University, Nakhon Sawan Campus since January, 2022.

2020 Organized and taught in a school on "Applied Machine Learning with Python" in Institute for Fundamental Study, Naresuan University, Thailand during 7-8 March, 2020.

2019 Organized and taught in a school on "*Introductory Vedic Mathematics"* in Institute for Fundamental Study, Naresuan University, Thailand during 1-5 April, 2019.

2015 Organized the conference on "*Recent Developments in Field Theory (RDFT) 2015"* in Institute of Physics, Bhubaneswar, India, in joint collaboration with IISER Kolkata and Utkal University, Orissa, India, in celebration of the 60^{th} birthday of Prof. Ashok Das, University of Rochester, USA.

2013 Organized the "*Workshop in Field Theory: Recent Trends and Applications (FTRTA) 2013"* in IISER Kolkata. This was the second edition of the workshop.

2013 Organized " *AD 65",* a HEP symposium commemorating 65^{th} Birthday of Prof. Amitava Datta, of IISER Kolkata, in IISER Kolkata. This also was the first edition of annual meet of the department of physics, IISER Kolkata.

2013 Served as advisor to the second journal club of the department of physical sciences, IISER Kolkata, for a year.

2012 Organized the first "*Inter IISER Physics Meet*", in IISER Kolkata. This is an annual summit of Physics researchers in all the five IISERs in India.

2011 Organized the "*Workshop in Field Theory: Recent Trends and Applications (FTRTA) 2011"* in IISER Kolkata.

2010 Initiated and served as convenor of the first journal club of the department of physical sciences, IISER Kolkata, for a year.

Scientific Skills/Services

- Extensive training and hands-on analytic experience in Quantum Field Theory, including Path Integral formalism, Non-perturbative techniques and Finite Temperature formalisms.
- Detailed training and analytic experience in General Relativity and Many-body Theory.

- Formidable experience with Mathematical Methods in Physics.
- Considerable experience in Integrable Models and solitonic systems.
- Expertise in supersymmetric techniques in Quantum Mechanics, PT-symmetric and non-Hermitian systems and mean-field non-linear systems.

Reviewing service

1. Three manuscripts for *Annals of Physics*, NY, USA between 2011 and 2014.
2. Thirteen manuscripts for Classical and Quantum Gravity, IOP Publishing since 2017.
3. One manuscript for Journal of Physics Communication, IOP.
4. One manuscript for Nonlinear Dynamics, Springer.

Technical packages/programming/systems

- Mathematica, Matlab, Fortran 77.
- LaTex, Microsoft Word and Powerpoint.
- Linux and Windows.

Potential Referees

- *Prof. Dr. Prasanta K Panigrahi, Dean (International Relations and Outreach), Department of Physics, Indian Institute of Science Education and Research (IISER) Kolkata, West Bengal, India. E-mail: pprasanta@iiserkol.ac.in*
- *Prof. Dr. Partha Guha, Khalifa University of Science and Technology, Abu Dhabi, UAE. E-mail:* partha.guha@ku.ac.ae
- *Prof. Dr. Burin Gumjudpai*, Director, Centre for Theoretical Physics & Natural Philosophy (NAS), Mahidol University, Nakhonsawan Campus, Thailand. E-mail: burin.gum@mahidol.ac.th
- *Asst. Prof. Dr. Seckson Sukhasena*, Former Director, The Institute for Fundamental Study (IF), Naresuan University, Phitsanulok, Thailand. E-mail: secksons@nu.ac.th
- *Assoc. Prof. Dr. Samir K Paul*, Department of Theoretical Sciences, S N Bose National Centre for Basic Sciences (SNBNCBS), Kolkata, India. E-mail: smr@bose.res.in
- *Assoc. Prof. Dr. Indranil Mukherjee*, Depatment of Management, Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal. E-mail: imukh@wbut.ac.in

Declaration

I hereby declare that the details furnished above are true and correct to the best of my knowledge and belief and I undertake to inform the concerned of any changes therein immediately. I am aware that I may be held liable for the same.

With regards,

[Kumar Abhinav], Lecturer,
NAS, Mahidol University,
Nakhonsawan Campus,
Nakhonsawan 60130, Thailand