Dr. Manoranjan Samal

Curriculum Vitae

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Personal Information

Date of Birth: **17th Feb 1990**

Nationality: **Indian**

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Education

2013–2019 **Doctor of Philosophy (Ph.D.)**, *Indian Institute of Technology Kharagpur* ,
Broad research area: String Theory
Thesis Title: Classical Strings in Deformed AdS: Finite Size Effect and Chaos

2012–2010 **Master of Science(M.Sc.)**, *National Institue of Technology Rourkela*,
Subject: Physics, First division

2007–2010 **Bachelor of Science(B.Sc.)**, *Utkal University, Bhubaneswar*, Subject: Physics(Hons.), First division

2005–2007 **Higher Secondary Education**, *Banki College, Banki*, First division,

2005 **Secondary Education**, *Board of Secondary Education, Odisha*,
First division.

Achievements and Rewards

2012 **CSIR-UGC NET-JRF**,
All India Rank-236

2013 **Graduate Aptitude Test in Engineering (GATE)**,
All India Rank-242

2013 **Joint Entrance Screening Test**,
All India Rank-146

Computer Skills

Operating Systems: **Linux, Windows**

Languages: **Python, Mathematica, C++**

Document Formatting: **LaTeX, MS Office, Libre Office**

Work Experiences

May-2022–Present **Lecturer in Physics**, *Rayagada Autonomous College, Rayagada*

Feb-2022–May-2022 **Associate Professor in Physics**, *Capital Engineering College, Khurdha*

2021–2022 **Faculty in Physics**, *OPS Mohavidyalaya, Dhenkanal*

2015–2016 **Teaching Assistant for B.Tech students**, *IIT Kharagpur*

2017–2018 **Lab Instructor for B.Tech. Physics Lab**, *IIT Kharagpur*

2017–2018 **Lab Instructor for M.Sc. Physics Lab**, *IIT Kharagpur*

School/ Conference /Workshop attended

2018 **String Meeting, NISER Bhubaneswar**

2017 **Student Talks on Trending Topics in Theory, Chennai Mathematical Institute**

2017 **Advanced String School , Puri**

2016 **Research Scholar Day, IIT Kharagpur**

2015 **National String Meeting , IISER Mohali**

2015 **SERC Main School , BITS Pilani Rajsthan**

2014 **Indian Strings Meeting , Puri**

2014 **SERC Prep. School on Theoretical High Energy Physics , BITS Pilani Hyderabad**

2013 **National Strings Meeting , IIT Kharagpur**

List of Publications

- Kamal L. Panigrahi and **Manoranjan. Samal**, "Finite Size Effect from Classical Strings in deformed $AdS_3\times S^3$", **JHEP 1809, 162 (2018)**, arXiv:1807.04601

- Sorna Prava Barik, Kamal L. Panigrahi and **Manoranjan. Samal**, "Spinning pulsating strings in $(AdS_3\times S^3)_\varkappa$", **Eur. Phys.J.C. 78, no. 4, 280 (2018)**, arXiv:1801.04248

- Sorna Prava Barik, Kamal L. Paingrahi, **Manoranjan Samal**, "Perturbation of Pulsating Strings", **Eur. Phys. J. C. 78, no. 11, 882 (2018)**, arXiv: 1708.05202.
- Kamal L. Panigrahi, **Manoranjan Samal**, "Chaos in Classical String Dynamics in $\hat{\gamma}$ Deformed $AdS_5 \times T^{1,1}$", **PLB 2016.08.021**, arXiv:1605:05638.
- Aritra Banerjee, Kamal L. Panigrahi, **Manoranjan Samal**, "A note on oscillating strings in $AdS_3 \times S^3$ with mixed three form fluxes", **JHEP 1511,133(2015)**, arXiv:1508.03430.
- Pabitra. Pradhan, Kamal L. Panigrahi, **Manoranjan Samal**, "Pulsating String in $(AdS_5 \times S^5)_\varkappa$", **JHEP 1503 010(2015)**, arXiv:1412.6936.

Research Statement

My research work is mainly based on the study of classical strings in the context of integrability, and AdS/CFT correspondence in $AdS_5 \times S^5$ and its integrable deformed backgrounds. My work also includes studying the world-sheet fluctuation of classical string. I am also interested in the application swampland criteria in string inspired cosmology. I would also like to work in the field of entanglement entropy.

One of the most successful example of the gauge/gravity duality is AdS/CFT correspondence. According to the AdS/CFT dictionary, the spectrum of the theory comprises the energies of its string states, each of which must be equal to the scaling dimensions of its dual gauge theory operator. Though solving the full string spectrum is quite non trivial due to non-linear string sigma model, classical strings give some interesting results, where the energy spectrum in string theory side is mapped to anomalous dimension of certain gauge invariant operators. In order to improve the understanding of the relationship between integrability and the amount of global symmetries preserved by the target space-time, one should explore possibilities of various deformations of the string target space time that preserve the integrability of the two-dimensional quantum field theory on the world sheet. Integrable deformations of $AdS_5 \times S^5$ can be achieved by a combination of T- duality and shift transformations. This geometric approach results in a new class of deformations which can be described in terms of original string theory and the deformations result into quasi-periodic but keeping the integrability intact. The other way is an algebraic approach based on q-deformations of the world sheet S-matrix. Recent studies about the integrable deformation of $AdS_5 \times S^5$ motivate whether the duality holds in these deformed backgrounds. In this context we have studied rigidly rotating strings, folded spinning strings which have been mapped to spin chain excitations of the gauge theory side. We construct the scaling relations between energy and charges in various limits and compare the results with the undeformed results. We also have computed the finite size scaling relation for giant magnon, single spike and GKP string which correspond to the correction to the dispersion relation due to classical wrapping effect in strongly coupled gauge theory side.

In general, the string dynamics in curved space are described by the help of 2D-sigma models where equations of motion in general are non-linear. Integrability plays an major role in finding out the classical solutions of the non linear equations, correlation functions, scattering amplitudes and spectrum. A system is said to be integrable if the number of degrees of freedom is same as the number of conserved charges. String sigma model in two dimensions has infinite number of degrees of freedom and the system is integrable on arbitrary backgrounds only when it has infinite number of conserved charges which happens to be the case in $\mathrm{AdS}_5 \times \mathrm{S}^5$. The standard way to show the integrability of 2D-sigma model in arbitrary background is to construct a Lax pair which generates infinite number of conserved charges. But to show the existence of Lax pair is quite cumbersome. In fact the necessary condition for a system to be integrable is when all of its subsystem are integrable. In other words, a system is said to be non-integrable if at least one of its subsystem is non-integrable. Therefore the general proof of the non integrability of a two dimensional sigma model in arbitrary background can be done by first reducing it to a 1D subsystem and then showing the 1d subsystem is non-integrable. This can be done either by doing numerical analysis of string motion in phase space or by analytic method using Normal Variational Equation(NVE). This numerical approach has been particularly useful in various cosmological and black hole backgrounds. We have explicitly showed through the appearance of chaos that the string motion in the $\hat{\gamma}$ deformed $AdS_5 \times T^{1,1}$ geometry is not integrable. We study numerically the motion of the system and found it to be chaotic. Non-integrability does not, necessarily, imply the chaotic motion. However, the appearance of chaos is evidence of the breakdown of integrability. In our study the chaotic motion of the strings is first seen in the Poincaré sections and also in the phase space trajectories. We have taken the example of a particular type of circular string and showed that numerically that the motion is chaotic. We have shown further that as soon as the strings are replaced with point particles the integrability restores back. Hence one can conclude that while the point like solutions are integrable, the extended string equations of motion are not. We have further support of this result by looking at the Lyapunov exponent and proved that the string equations of motion are non integrable while the point like equations are integrable.

References

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