Amitabha Lahiri

Professor
Theoretical Sciences
amitabha@bose.res.in

Professor Amitabha Lahiri did his PhD in theoretical high energy physics from Syracuse University, followed by post-docs at Los Alamos National Laboratory and University of Sussex at Brighton. He joined SNBNCBS in 1996. His research interests are quantum field theory, general relativity, and mathematical physics.

Supervision of Research / Students

Ph.D. Students

(All `ongoing' as of 31/03/2017)

1. Debmalya Mukhopadhyay (External)
2. Subhasish Chakrabarty
3. Ishita Dutta Choudhury
4. Ambalika Biswas
5. Karan Fernandes
6. Ritam Basu

Teaching activities at the Centre

1. Spring 2016; Electromagnetic Theory; PHY 203; 7
2. Autumn 2016; Classical Dynamics; PHY 101; 9

Publications in Journals

1. Saikat Chatterjee, **Amitabha Lahiri** and Ambar N. Sengupta; *Construction of categorical bundles from local data;* Theory and Applications of Categories; 2016; **31;** 388.
2. Ambalika Biswas and **Amitabha Lahiri;** *Alignment, reverse alignment, and wrong sign Yukawa couplings in two Higgs doublet models;* Phys. Rev. D; 2016; **93;** 115017.
3. Saikat Chatterjee, **Amitabha Lahiri** and Ambar N. Sengupta; *Connections on decorated path space bundles;* J. Geom. Phys.; 2017; **112;** 147.
4. Karan Fernandes, Suman Ghosh and **Amitabha Lahiri;** *Constrained field theories on spherically symmetric spacetimes with horizons;* Phys. Rev. D; 2017; **95;** 045012 .

Other Publications

1. Ambalika Biswas and **Amitabha Lahiri,** *Various perspectives of Two Higgs Doublet models and Naturalness criteria,* (talk delivered by A. Biswas) in the Proceedings of the 38th International Conference on High Energy Physics (ICHEP 2016), Chicago, USA 3-10 Aug, 2016, Published in **PoS (ICHEP 2016)** 710.

Lectures Delivered

1. Topological mass generation and confining potential, Keio University, Hiyoshi, Kanagawa, Japan, Nov 2016
2. Quark confinement and magnetic monopoles, Presidency University, Kolkata, Mar 2017.

Membership of Committees

Internal Committee

Director's Advisory Board; Consultative Advisory Committee; Admission Committee; Students' Curriculum and Research Evaluation Committee; Students Advisory Committee ***(ex officio as Dean (AP) till 31st January, 2017);*** Complaints Committee (till Aug 2016); Computer Services Cell (Working Group & Advisory Committee); Conferences, Workshops and Extension Programmes Committee; Medical Committee.

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

1. Sl. No. 1, 3, 4

International

1. Sl. No. 1, 3

Significant research output / development during last one year

General research areas and problems worked on

Quantum Field Theory and Particle Physics:

Two Higgs doublet models (2HDM) as a possible source of Dark Matter;

General Relativity:

Gauge systems near a horizon;

Mathematical Physics:

Construction of fiber bundles on the path space of a manifold, and of connections on those bundles.

Interesting results obtained

1. and 3. The space of paths on a manifold is a mathematical object called a category. We are interested in dynamics on this space because that can describe the dynamics of charged strings on ordinary spacetime. We constructed a fiber bundle on this space, and found that it required a novel way of describing the action of a categorical group on the categorical bundle. Later we also constructed a connection on this bundle, i.e.,a derivative operator compatible with the category structure. These constructions should be useful, in the long run, in finding a description of QCD strings for example.
2. 2HDMs with a softly broken U(1) symmetry have two uncharged CP-even scalars. We imposed a very basic criterion that infinities coming from quadratic divergences cancel at the lowest order, and calculated the masses of the new scalar particles which arise in the model. We have shown that the heavier CP-even scalar in these 2HDMs cannot be the observed Higgs particle. For the case when the lighter CP-even scalar is the observed Higgs particle, and fermions couple to it with the wrong sign Yukawa coupling, we have calculated the rate of decay of the Higgs to two photons (Fig.1). This may be a way to test 2HDMs in ongoing and future LHC experiments.

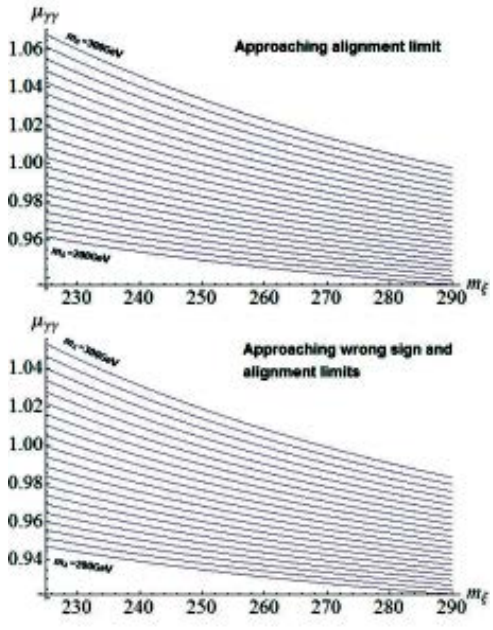

Fig.1: Diphoton decay width of the SM-like Higgs particle (normalized to SM) as a function of the charged Higgs mass in GeV for (a) the same sign and (b) the wrong sign, of down-type Yukawa couplings.

4. We studied gauge theories on spacetimes with a black hole under less restrictive, and more physical, assumptions about gauge transformations than have been done before, and found that gauge constraints are modified in previously unknown ways. In particular, we found the remarkable and counterintuitive result that for a charged black hole, the horizon carries an equal and opposite charge which is not visible from outside. This will clearly have a significant impact on our understanding of dynamics on black hole spacetimes, and also on quantization of gauge fields near black holes.

Proposed research activities for the coming year

i) Mathematical Physics: I plan to investigate the local description of the connection on categorical fiber bundle, in particular, how to relate it to gauge fields on the base manifold, and to investigate gauge transformations of these fields. These fields may be expected to mediate interactions between charged strings.

ii) Quantum Field Theory: I plan to work on a followup of an earlier work, in which a non-local interaction between fermions and a 2-form field was proposed. Since a 2-form field typically arises in string theory, I plan to investigate if stringlike obejcts are present in the non-local model in question.

iii) Particle Physics: I plan to look into the possibility of Higgs-Higgs bound states in 2HDMs. These, being uncharged and weakly interacting with other fields, may provide viable candidates for Dark Matter.

iv) General Relativity: I plan to follow up on the problem of gauge theories on black hole spacetimes, and try to extend it to stationary black holes and to quantum gauge theories.

Any other matter

He was Dean (Academic Programme) till Jan 31, 2017.