CEFIPRA HEPNET: IN2 Presentation

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TIFR, Mumbai

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Outline

On a personal note

- I would like to start by expressing my sincere gratitude to CEFIPRA for funding two projects that I was an investigator on.
- It helped me seed and sustain professional and personal ties with French colleagues. The exiguity of my contributions was matched only by their generosity towards me.
- In this brief recounting of my gratitutde to CEFIPRA, I believe I speak for several members on the Indian side.
- I look forward to revisiting old ties and forming new ones in the course of this new Indo-French network.

The IN2 Node

- Herein I will present an overview of the research activities of the members of the IN2 node indicative of the kind of directions they are likely to explore in the course of the activities of the present network.
- Two sites in the IN2 node: the Tata Institute of Fundamental Research (TIFR), Mumbai and the Indian Institute of Science Education and Research (IISER), Pune.
- This presentation will also briefly touch upon research programmes pursued in these sites which are relevant to but not presently covered by our proposal. This is being done in an attempt to envisage the future of the network.

Outline

Site 1: TIFR

- The Tata Institute of Fundamental Research (TIFR) is one of the leading science reseearch institutions in India with a stated commitment to pursuing pure research in all areas of science.
- The TIFR has played a major role in shaping science in post-independent India, at the level of practice and policy.

HEP@TIFR

- Throughout its 70-year history, High Energy Physics has been one of the thrust areas of the TIFR.
- The Institute has played a pioneering role in high energy physics research on the theoretical and experimental fronts.
- In the following, I will speak in some more detail about the areas of research in HEP relevant to the present network that are pursued in TIFR.

Site 2: IISER, Pune

- The IISERs, like the one in Pune, are relatively new institutions with a commitment to teaching and training students in areas of pure science and to set up programmes of internationally competitive research.
- IISER, Pune which is one of the most established of the IISERs has already made remarkable strides in research and education.
- A small but potentially important experimental high-energy physics programme is getting concretized in IISER, Pune and it bodes well for the future of this area of science in terms of its practice in India.

Outline

Node Members

1. R. Bhalerao
2. S. Dube
3. R. Gavai
4. M. Guchait
5. S. Gupta
6. G. Majumder
7. S. Raychaudhuri
8. S. Sharma
9. K. Sridhar

The Paradigm

- The current paradigm of High-Energy Physics is the Standard Model (SM) which is the very well-tested theory of electromagnetic, strong nuclear and weak nuclear interactions.
- Research Programmes in High-Energy Physics fall into three classes:
  1. **RP1**: Progress in theoretical calculations in the SM and to discover expected, but not yet observed, aspects of the SM.
  2. **RP2**: Theoretical and experimental studies of already observed processes in the SM at higher precision.
  3. **RP3**: Theoretical and experimental studies of searches for new phenomena not contained in the SM, the motivation for which come largely from theoretically unpleasing features of the SM.

RP1: Quark Gluon Plasma

- One difficult and unsolved issue within the SM is the understanding of parton confinement: why do quarks and gluons remain confined within the proton?
- It is now understood that, at high temperatures, deconfinement occurs and a deconfined state called the Quark-Gluon Plasma can be produced.
- The high-temperature environment can be produced in the collisions of heavy nuclei – a major research programme at the LHC.
- How does one search for the QGP and other important features of high-temperature/high-density strong interaction physics?

RP1: Quark Gluon Plasma

- Members of the IN2 Node have made very important contributions to our present understanding of the quark-gluon plasma.
- Lattice studies of the dynamics of strong interactions at finite temperature and the phenomenology of heavy-ions collisions have been carried out.
- Members of the node involved in these studies: R. Gavai, S. Gupta and R. Bhalerao.
- Members have been part of two CEFIPRA collaborations.
- Major Conference organized: Asian Triangular Conference in Heavy Ion Collisions in 2016.

RP2: Top, Higgs, Dileptons, Electroweak Tests

- These kind of studies involve studying SM observables at high precision both in experiment and in theory.
- Some of these studies allow for a better understanding of masses, couplings and other aspects of the SM like a precise determination of parton distributions.
- Also, more precise measurements of the parameters of the SM may provide a way of hint of new physics.

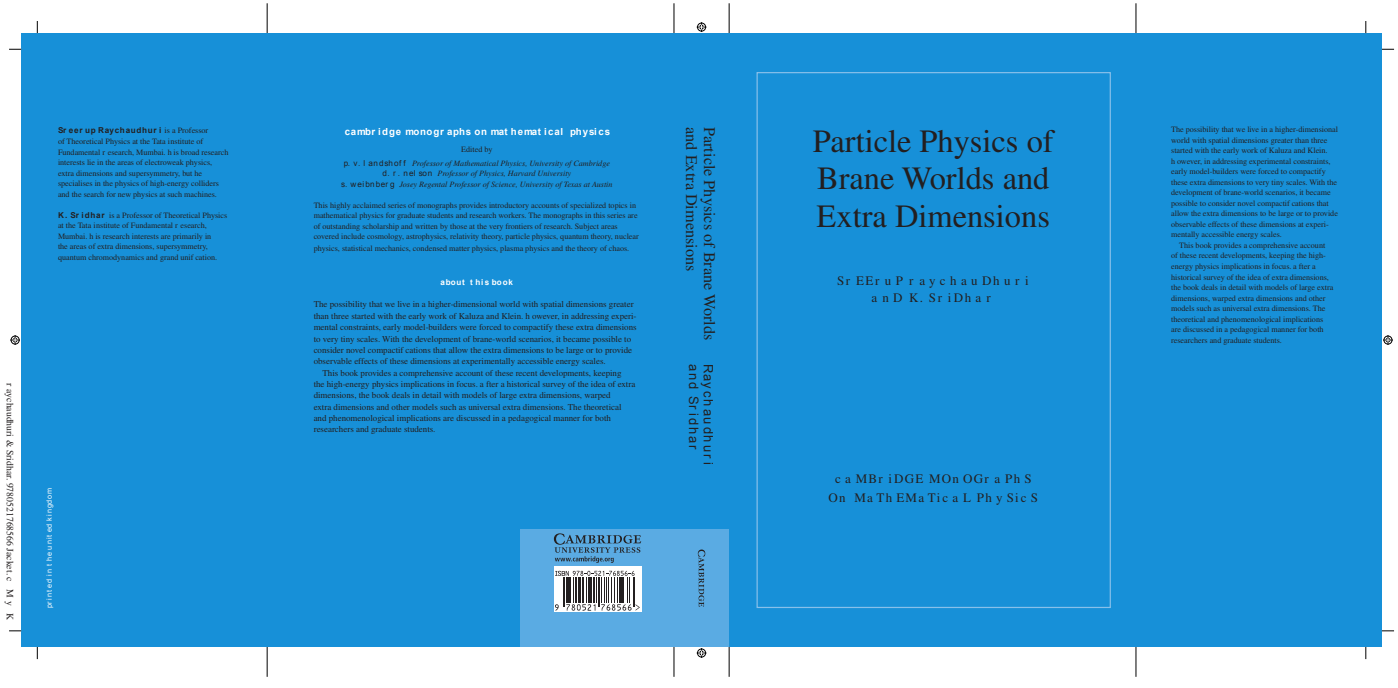
RP3: SUSY, Extra-Dimensions, Exotics

- There are theoretical reasons to believe that even if the SM is in agreement with extant data, it cannot be the full story.
- These suggest the possibility of new theories:
  1. Supersymmetry: A class of theories where every SM particle is partnered by a particle of a different spin.
  2. Extra Dimensions: A class of theories where spatial dimensions more than 3 are invoked to address the theoretical issues within the SM.
  3. Exotics: New physics models which may not possess the grammar of the above mentioned theories but still suggest interesting phenomena.
- Members of the node have made very important contributions to these studies in terms of both theoretical and experimental analyses.

RP2 and RP3

- Members of the IN2 node involved in the studies listed in RP2 and RP3: S. Dube, M. Guchait, G. Majumder and S. Sharma (experimental) M. Guchait, S. Raychaudhuri and K. Sridhar (theoretical).
- Some of these members have been involved in three CEFIPRA projects and have long-standing collaborations with members on the French side.
- A series of meetings entitled *From Strings to LHC* was organised by members of this node which was initiated after discussions with French physicists. The fourth meeting in this series is planned for 2017.

Book



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about this book

The possibility that we live in a higher-dimensional world with spatial dimensions greater than three started with the early work of Kaluza and Klein. h owever, in addressing experimental constraints, early model-builders were forced to compactify these extra dimensions to very tiny scales. With the development of brane-world scenarios, it became possible to consider novel compactif cations that allow the extra dimensions to be large or to provide observable effects of these dimensions at experimentally accessible energy scales.

This book provides a comprehensive account of these recent developments, keeping the high-energy physics implications in focus. a fter a historical survey of the idea of extra dimensions, the book deals in detail with models of large extra dimensions, warped extra dimensions and other models such as universal extra dimensions. The theoretical and phenomenological implications are discussed in a pedagogical manner for both researchers and graduate students.

Particle Physics of Brane Worlds and Extra Dimensions

Raychaudhuri and Sridhar

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Particle Physics of Brane Worlds and Extra Dimensions

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Other activities

- Neutrino physics
- Flavour physics
- Jet physics