

**PROF. G. RAJASEKARAN FEST @ CMI**

Day I (19, August 2016)

**Session I: (10.00am - 11.30am)**

*Chairperson: Nita Sinha*

1. D. P. Roy (30m)

Title:

Basic Constituents of Matter and Their Interactions

Abstract:

I shall first introduce the basic constituents of matter and their interactions, i.e. the matter fermions and gauge bosons. Then I shall discuss the high energy accelerators leading up to the the LHC, and the role they played in the discovery of these particles.

2. R. P. Malik (30m)

Title:

Higher p-Form Gauge Theories & Strings: BRST Approach

Abstract:

In our presentation, we shall discuss about the BRST analysis of Abelian 3-form gauge theory and bosonic string theory. Some of the novel results, obtained by our group, would be highlighted. The impact and influence of Rajaji's articles and lectures on gauge theories and strings would be pointed out as far as our-research works at BHU are concerned.

3. M. Sivakumar (30m)

Title:

Higher Spin theories: From Dirac to Vasiliev

Abstract:

This talk will give a non-technical survey on Higher spin theories, since the days of early quantum theory to the present status as a potential theory of quantum gravity owing to Higher spin gravity equations due to Vasiliev and point out future prospects.

BREAK (15m)

**Session II: (11.45am - 12.45PM)**

*Chairman: Romesh Kaul*

4. J. Maharana (30m)

Title:

High Energy Scattering in Higher Dimensions

Abstract:

I consider scattering of massive, spinless neutral particles in D-dimensional

spacetime. Assuming the polynomial boundedness of the amplitude in energy and analyticity inside an analog Lehmann ellipse, it is possible to derive stronger bounds on the amplitude. I also discuss consequences of this bound.

5. G. Krishnaswami (30m)

Title:

Higgs mechanism and the Added Mass Effect

Abstract:

We report on a new physical analogy between the added mass effect in fluid mechanics and the Higgs mechanism for generation of vector boson masses. The correspondence turns the gauge Lie algebra into the flow domain with the body at its origin. It encodes the pattern of gauge symmetry breaking in the shape of an associated rigid body accelerated through potential flow. This is joint work with Sachin Phatak.

LUNCH

**Session III: (2.00pm - 3.30PM)**

*Chairman: H. S. Mani*

6. J. Samuel (30m)

Title:

Wick Rotation in the Tangent Space

Abstract:

Wick rotation is usually performed by rotating the time coordinate to imaginary values. In a general curved spacetime, the notion of a time coordinate is ambiguous. We note that within the tetrad formalism of general relativity, it is possible to perform a Wick rotation directly in the tangent space using considerably less structure: a timelike, future pointing vector field, which need not be Killing or hypersurface orthogonal. This method has the advantage of yielding real Euclidean metrics, even in spacetimes which are not static. When applied to a black hole exterior, the null generators of the event horizon reduce to points in the Euclidean spacetime. Requiring that the Wick rotated holonomy of the null generators be trivial ensures the absence of a 'conical singularity' in the Euclidean space. To illustrate the basic idea, we use the tangent space Wick rotation to compute the Hawking temperature by Euclidean methods in a few spacetimes including the Kerr black hole.

7. R. Rajaraman (30m)

Title:

The S-Matrix Formulation of Statistical Mechanics and Issues of Elementarity

Abstract:

We will give a thumbnail introduction to the S-Matrix formulation of Statistical Mechanics invented by Dashen and Ma in the late sixties. They did this profound construction at a time when it looked like one may never know the fundamental degrees of freedom or the Hamiltonian of strong interactions, to

be able to use the standard Boltzmann formula for the Partition Function  $Z = \text{Tr} [\exp(-H/kT)]$ . All that experiments gave us were the S-matrix elements. At the same time, it was felt that one may need to do the thermodynamics of relativistic hadronic systems in astrophysics and cosmology. The formulation was forgotten after QCD came but remains correct and valid even today. Besides it has helped clarify some long standing issues about the elementarity of elementary particles.

In the time available for the talk we can only state the central formula of the S-matrix theory of Stat Mech and explain how it avoids having to know which particles are elementary and which are not. We will also briefly discuss an application: to decide whether it is correct to use the famous  $\rho$ -resonance as an elementary degree of freedom in neutron star calculations.

8. G. Rajasekaran (30m)

Title:

My Inward Bound Journey (or) How I got Enlightenment

**Session IV: (3.30pm - 4.15PM)**

*Chairman: R. Karandikar*

1. Felicitation by CMI
2. Seshadri (...min)
3. Balaji, Sridharan, Shiva Shankar, Madhavan and others from CMI.
4. High Tea (4.30pm onwards)

Day II (20, August 2016)

**Session I: (10.00am - 11.30am)**

*Chairman: M. V. N. Murthy*

1. Sudarshan Ananth (30m)

Title:

Relating the forces of Nature

Abstract:

I review a formalism that allows us to derive interacting field theories based entirely on symmetry considerations. I highlight three research directions that relate to our search for a consistent quantum theory of gravitation.

2. Amitava Raychaudhuri (30m)

Title:

A4 as a symmetry for neutrino mass models

Abstract:

We begin with a discussion of the discrete A4 Group and the pioneering contribution of Professor Rajasekaran in applying it to particle physics model building. We also elaborate on a more recent A4-based neutrino mass model which has

testable predictions relating neutrino mass ordering with CP-violation in the lepton sector.

3. Vivek Datar (30m)

Title:

Some novel physics with ICAL at INO and a possible cryogenic Indium detector for solar neutrinos Abstract:

I will discuss some of the sensitivity studies of the Iron Calorimeter (ICAL) detector at the India based Neutrino Observatory for magnetic monopoles, dark matter decay to muons and active-sterile neutrino mixing using atmospheric neutrinos. Finally I will also discuss a possible indium based detector for real time solar neutrino spectral measurements at high energy resolution.

BREAK (15m)

**Session II: (11.45am - 12.45pm)**

*Chairman: R. Ramachandran*

4. R. Adhikari (30m)

Title:

Leptogenesis in supersymmetric models

Abstract:

Soft leptogenesis is a mechanism which generates the matter- antimatter asymmetry of the Universe via the out-of-equilibrium decays of heavy sneutrinos in which soft supersymmetry breaking terms play two important roles: they provide the required CP violation and give rise to the mass splitting between otherwise degenerate sneutrino mass eigenstates within a single generation. This mechanism is interesting because it can be successful at lower temperature regime  $T10^9$  GeV in which the conflict with the overproduction of gravitinos can possibly be avoided. In earlier works the leading CP violation is found to be nonzero only if finite temperature effects are included. By considering generic soft trilinear couplings, we find two interesting consequences: 1) the leading CP violation can be nonzero even at zero temperature realizing nonthermal CP violation and 2) the CP violation is sufficient even far away from the resonant regime allowing soft supersymmetry breaking parameters to assume natural values at around the TeV scale. We discuss phenomenological constraints on such scenarios and conclude that the contributions to charged lepton flavor violating processes are close to the sensitivities of present and future experiments.

Finally we discuss that in  $R$ -parity violating Minimal Supersymmetric Standard Model (MSSM), both TeV scale leptogenesis and sub-eV neutrino mass are possible after considering three body decay of next to lightest neutralino with only first order lepton number violating interactions in Feynman diagrams for leptonic asymmetry.

5. Saurabh Gupta (30m)

Title:

A natural explanation for large neutrino mixing

Abstract:

The origin of small mixing among quarks and a large mixing in the neutrino sector poses an intriguing open question. Among many approaches to answer this question the high scale mixing unification (HSMU) hypothesis is a natural one. The central idea of HSMU hypothesis is that the quark and leptonic mixing angles can be unified at some high scale, typically at GUT scale, either due to some quark-lepton symmetry or some other underlying mechanism. The large leptonic mixing angles are obtained through the renormalization group evolution of the corresponding mixing parameters from the unification scale to the low scale. This hypothesis nicely explains the mixing pattern in the neutrino sector including the recent observation of nonzero but small value of  $\theta_{13}$ . I will try to elaborate the HSMU hypothesis in the context of both Dirac as well as Majorana neutrinos and discuss the phenomenology of various parameters.

LUNCH

**Session III: (2.00pm - 3.00pm)**

*Chairman: Rahul Sinha*

6. M. K. Parida (30m)

Title:

Sterile Neutrino Assisted Non-canonical Seesaw Mechanisms

Abstract:

7. Ravindran (30m)

Title:

Infrared structure of Gauge theory

Abstract:

Infrared structure of gauge theory amplitudes provides vital clue to resum soft gluons to all orders in perturbation theory to make sensible predictions. We demonstrate how resummation of threshold logarithms can be done using the universality of IR singularities and factorisation properties of scattering cross sections.

BREAK (15m)

**Session IV: (3.15pm - 4.30pm)**

*Chairman: A. P. Balachandran*

Reminiscences: Manjari Bagchi, Shrihari Gopalakrishna, Bala Sathiapalan, Baskaran, Prafulla Behera, B. Satyanarayana, Date, TRG, SVM Satyanarayana, P.M. Mathews, and others.

Concluding Remarks: V.V. Sreedhar.