TIFR Annual Technical Report (2014-15)

Department of Theoretical Physics

1 HIGHLIGHTS

Cosmology and Astroparticle Physics

Basudeb Dasgupta (joined December 2014), and Subhabrata Majumdar.

- Prospects for looking for missing baryons in the Universe were examined by studying Sunyaev-Zel'dovich distortion of the cosmic microwave background radiation from extensive circum-galactic gas in massive galactic haloes.
- Plausible dark energy models, parametrized by multiple candidate equations of state, were tested using the recently published Cosmic Microwave Background data from Planck, together with the WMAP-9 low-ℓ polarization data, and data from low redshift surveys.

Condensed Matter and Statistical Physics

Mustansir Barma, Kedar S. Damle, Deepak Dhar, Rajdeep Sensarma, and Vikram Tripathi.

- Conditions for condensate formation were specified in terms of randomness and interactions, and the distribution of critical densities was found.
- A nonequilibrium system of particles sliding down a fluctuating surface was shown to exhibit algebraic relaxation to the steady state, much faster than the logarithmic behavior found in other systems which exhibit strong phase separation.
- A model of fragmentation of glaciers by branching and merging cracks was solved exactly. New results were obtained for the classical problem of 2×2 hard squares on a square lattice, establishing that it shows critical exponents of the Ashkin-Teller model.

- A perturbative renormalization group formalism was developed for driven interacting quantum systems.

High Energy Physics

Rajeev Bhalerao, Saumen Datta, Amol Dighe, Rajiv Gavai, Sourendu Gupta, Nilmani Mathur, Sreerup Raychaudhuri, Tuhin S. Roy (joined September 2014), Rishi Sharma, and K. Sridhar.

- A complete set of multiparticle correlation observables was presented, which provides a multipronged probe of the physics of flow fluctuations in ultrarelativistic heavy-ion collisions.
- Significant enhancement in the capabilities of the ICAL detector at INO, with the addition of information on the hadron energy in the detector, was demonstrated through simulations.
- A method was proposed to facilitate the use of lattice quark fields with superior chiral properties for QCD critical point investigations.
- The method for evading the fermion-sign problem invented earlier was extended to compute the equation of state of strongly interacting matter at finite chemical potential and temperature.
- From Lattice QCD calculation the mass splitting between B_c^* and B_c meson was predicted to be about 80 ± 8 MeV. This result can help in the discovery of B_c^* meson.
- The Higgs boson signal strengths as measured at the LHC were used to put constraints on a minimal model with a universal extra dimension. Taking into account constraints on the model from stability of the Higgs vacuum, this led to a new lower bound of 1.3 TeV on the size parameter of the extra dimension.
- A formalism for understanding/calculating statistical stability in the "Qjets" procedure was developed. The technique of Qjets had been invented by the same authors in order to handle ambiguities in jet-reconstruction in hadron colliders, such as the LHC at CERN.
- A new framework of electroweak scale supersymmetry, namely "Generalized Supersoft Supersymmetry" was proposed.
- Bulk Randall-Sundrum Models were studied in the context of Electroweak precision observables.
- It was shown that vector channel current correlator in fluctuation-dissipation theorem needed to be modified due to the effective interaction in the model Lagrangians. This proved that the inclusion of implicit parameter dependences were consistent with the field theoretic point of view.

String Theory and Mathematical Physics

Gautam Mandal, Shiraz Minwalla, Sandip P. Trivedi, and Spenta R. Wadia

- It was argued that the usual text book rules of crossing symmetry are modified in Chern Simons matter theories because the scattering particles are effectively anyonic and enjoy a duality between bosons and fermions. The S matrix of the corresponding theories was exactly computed in the t' Hooft large N limit to all orders in the coupling constant in several classes of such theories, and the conjectured crossing properties verified.

- It was demonstrated that the dynamics of black holes simplifies considerably in the limit in the large D limit, where D is the number of dimensions of spacetime in which the black hole lives. It was demonstrated that the dynamics of black holes in the appropriate limit is completely determined by the solutions to an auxiliary problem; the motion of a membrane together with a velocity field on its surface. The equations of motion of this membrane were determined to leading order, and demonstrated to reproduce known solutions including rotating black holes and quasinormal modes about static black holes.

- An example of a stable Bianchi attractor in gauged supergravity was constructed.

- A geometric dual for a large class of entangled quantum states was found.

- A definition for the entanglement entropy of a region in a lattice gauge theory was proposed, and demonstrated to enjoy several desirable properties.

- Model independent constraints on the three point function of the scalar field were derived assuming only that the inflationary background had the isometries of DeSitter space perturbed by a slow role parameter. The constraints were obtained by first determining Ward Identities in exactly DeSitter backgrounds and using those to constrain the three point functions in slow role models.