

TIFR Annual Report (2012-13) - Department of Theoretical Physics

HIGHLIGHTS

- A new solution concept called co-action equilibrium was proposed for analysing stochastic strategies for minority games.
- Studies of a nano-electromechanical system (NEMS) fashioned out of an incommensurate charge density wave material, $NbSe_3$, revealed an unexpectedly large modification of the apparent elastic properties associated with a pinning-depinning transition.
- It was pointed out that the indirect constraints on the branching ratio of $B_s \rightarrow \tau\tau$ allow it to be orders of magnitude more than its Standard Model prediction.
- Two of the most constrained models of low energy supersymmetry (cMSSM and NUHM) were analyzed in the light of the most recent data from the LHC.
- The reach of the ICAL detector at INO for measurements of neutrino oscillation parameters was determined through detailed detector simulations.
- Several new results have been obtained in the formalism of the relativistic dissipative fluid dynamics.
- Estimate of the location of the QCD Critical point was shown to be robust by computing it on finer lattices with lower sized cut-off and its agreement with earlier coarser lattice results. Viability of the earlier proposed faster method for obtaining even better estimates of the critical point was demonstrated.
- Excited state spectra were calculated using lattice QCD for N , Δ , Λ , Σ , Ξ and Ω families of baryons. The resulting lattice spectra have bands of baryonic states with well-defined total spins up to $J = 7/2$, and the low lying states remarkably resemble the expectations of quantum numbers from $SU(6) \times O(3)$ symmetry.

- Hadron spectra containing one or more charm quarks as well as the ratio of leptonic decay constants, $f_{D_s^*}/f_{D_s}$, were calculated by using overlap valence quarks on configurations with improved gluons and staggered sea quarks.
- A direct calculation of the mixed-action parameter, Δ_{mix} , with valence overlap fermions on a domain-wall fermion sea, was performed.
- Optimization of gauge link smearing was investigated by observing its effects on the infrared and ultraviolet components of gluon and quark fields and it was found that smearing improves taste symmetry at finite temperature.
- Screening of nucleonic charges in hot strongly interacting matter is studied which indicates a precursor of chiral symmetry restoration below T_c .
- An analysis of the constraints on the minimal supergravity-mediated model of supersymmetry (the cMSSM), made just before the Higgs boson discovery, showed that most of the parameter space was quite unconstrained even if the best combination of experimental parameters was taken.
- Asymmetries in the azimuthal angle distribution of jets at the proposed LHeC were suggested as a direct probe of the newly-found Higgs boson's coupling to a W boson pair, measuring CP properties which cannot be done easily at the main LHC.
- Apart from the discovered Higgs-like boson, if there exist multiple Higgs bosons lighter than the Z boson – as is possible in a CP-Violating version of the MSSM – it was shown that they can be detected efficiently using recently-invented boosted jet techniques.
- It was shown that in minimal models with a universal extra dimension, a 125 GeV Higgs boson leads to a very compressed spectrum for the Kaluza-Klein excitations of the Standard Model fields, rendering most of the LHC signals for such models unviable.
- The amount of AGN feedback in galaxy cluster cores was estimated using the observed ‘entropy profiles’ of clusters from the REXCESS survey, the first estimate of the total, as well as radial, non-gravitational energy deposition for a large, nearly flux-limited, sample of clusters. Various correlations of the non-gravitational feedback energy with other integrated cluster properties were calculated. These observationally determined energy profiles provide crucial inputs to hydrodynamic cluster simulations.
- The first detailed MCMC likelihood study of cosmological constraints that are expected from some of the largest, ongoing and proposed, cluster surveys in different wave-bands was done. These were compared with prevalent Fisher Matrix forecasts, showing its prospects and pitfalls. The usefulness of joint analysis of multiple cluster datasets was shown.

- Two different probes of the expansion history of the Universe was compared using a Bayesian interpretation of Crossing statistic. The cosmic duality relation was assumed to search for inconsistencies between the two probes and hence look for underlying systematics.
- The phase-space distribution of the Dark Matter (DM) particles in our Milky way was studied. Using the rotation curve of the Galaxy, the velocity distribution function (VDF) of the DM was determined, which is a crucial input in the interpretation of direct DM detection experiment event rates. A parametrized, non-Maxwellian, form of the derived local VDF was given.
- An R-parity violating supersymmetric explanation was provided for the Tevatron forward-backward asymmetry.
- Bulk models of warped extra dimensions were studied in the light of the Higgs discovery at the Large Hadron Collider.
- The partition function of Chern Simons theories with vector matter were determined exactly in the large N limit and the results were used to predict and confirm strong weak coupling dualities between bosonic and fermionic theories.
- Vasiliev's equations of higher spin gravity were demonstrated to emerge as a limit of string theory in a supersymmetric context.
- The constitutive relations of hydrodynamics were systematically constrained using the requirement that fluids equilibrate.
- The thermal N=2 Supersymmetric Chern-Simons theory was studied in the large N limit using a generalization of the standard Huddard-Stratanovich technique for arbitrary polynomial interactions.
- It was found that in quantum quenches in matrix models, equilibration happens with the memory of an infinite number of conserved charges.