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THEORETICAL PHYSICS

String Theory and Mathematical Physics

Tachyon Condensation and Black Hole Entropy

Condensation of tahcyons in closed string theory was analyzed and its connection with the computation of the black hole entropy was pointed out. The entropy computed in this manner was found to be in precise agreement with the the Bekenstein-Hawking Entropy. [Atish Dabholkar]

Tachyon Potential and C-function

A tachyon potential with the appropriate critical points was proposed in terms of an effective c-function of the worldsheet theory and it was determined as a solution of certain integrable equations. [Atish Dabholkar and C. Vafa of Harvard University]

D-branes in PP-wave Backgrounds

Dirichlet branes in the background of a PP wave were constructed and the open string spectrum was in agreement with the gauge theory spectrum. [Atish Dabholkar and Sharoukh Parvizi]

Loop Equation and Wilson Line Correlators in Non-commutative Gauge Theories

Loop equations for correlators of Wilson line operators in non-commutative gauge theories were derived. Unlike what happens for closed Wilson loops, the joining term survives in the planar equations. This fact was used to obtain a NEW loop equation which relates the correlation function of an arbitrary number of Wilson lines to a set of closed Wilson loops, obtained by joining the individual Wilson lines together by a series of well-defined cutting and joining manipulations. For closed loops, we showed that the non-planar contributions do not have a smooth limit in the limit of vanishing non-commutativity and hence the equations do not reduce to their commutative counterparts [Avinash Dhar and Y. Kitazawa of National Laboratory of High Energy Physics, Japan]

Non-commutative Gauge Theory, Open Wilson Lines and Closed Strings

It was suggested that reparametrization invariance of a Wilson line is the principle which determines the coupling of non-commutative gauge theory/matrix model to the modes of the closed string. An analogue of the level matching condition on the gauge theory/matrix model operators emerges quite naturally from the cyclic symmetry of the straight Wilson line. It was shown that the generating functional of correlation functions of these operators has the space-time gauge symmetry that one expects to find in closed string field theory. We also identified an infinite number of conserved operators in gauge theory/matrix model, the first of which is known to be the conserved stress tensor [Avinash Dhar and Y. Kitazawa of National Laboratory of High Energy Physics, Japan]

Thermality in AdS Spacetimes

In anti-de-Sitter spacetimes uniformly accelerated observers perceive the invariant vacuum as a thermal bath provided the acceleration exceeds a critical value. It was shown that the holograms of such accelerated objects on the boundary consist of extended profiles which expand in time as the object receeds further away from the boundary. The holographic analog of observers comoving with the object in the bulk is then the class of observers on the boundary according to whom the profile is time independent. It was found that the transformation to such comoving coordinates on the boundary leads to nontrivial Bogoliubov transformations only when the accleration exceeds the critical value. Acceleration radiation in the bulk is then interpreted as radiation detected by observers in a cosmological spacetime defined on the boundary. [Sumit Das and A. Zelnikov of University of Alberta]

Holographic Signature of Thermality in de-Sitter Spacetime

In de-Sitter spacetimes geodesic observers perceive the invariant vacuum as a thermal bath. Assuming that there is a duality between de Sitter and an euclidean conformal field theory on the future or past boundary, we obtain the hologram of such geodesic objects as the one point function of dual operators. After an analytic continuation on the boundary we then find a coordinate transformation which renders this one point function constant. This coordinate transformation mixes up modes of fields in the CFT with nontrivial Bogoliubov coefficients leading to a thermal state with the expected temperature. Thus cosmological radiation becomes interpreted as acceleration radiation in the boundary theory. [Sumit Das]

Penrose Limits and Symmetry Breaking

The Penrose limit of $AdS \times S$ spacetimes which lead to pp-wave backgrounds is shown to correspond to a spontaneous breaking of the original isometries. The broken generators

obey a Heisenberg algebra which acts on the transverse plane. The single particle states were shown to correpsond to Nambu-Goldstone particles of the broken symmetry. This leads to a natural holographic interpretation in terms of a theory living on whole or part of the transverse space. [Sumit Das, C. Gomez of C-XVi Universidad Autonoma, Madrid, and S.J. Rey of Seoul National University]

Noncommutative Gauge Theories, Ramond Couplings and Seiberg-Witten Map

The couplings of noncommutative D-branes to spatially varying Ramond-Ramond fields were derived. These couplings are expressed in terms of open Wilson lines, which play an important role in ensuring gauge invariance. An exact expression for the Seiberg-Witten map from commutative to noncommutative gauge fields was obtained. [Sunil Mukhi and Nemani Suryanarayana]

Noncommutativity and Open String Theory Actions

An infinite subset of the higher-derivative corrections to the actions of open-string theory were determined using noncommutativity. (Sumit Das, Sunil Mukhi and Nemani Suryanarayana).

A boundary-state computation was performed at large magnetic field, to obtain derivative corrections to the Chern-Simons coupling between a p-brane and certain gauge potentials. The result was seen to confirm a prediction based on noncommutativity. [Sunil Mukhi]

PP-wave Limit of IIB String Theory in Anti-deSitter Spacetime

It was observed that the pp wave limit of Anti-deSitter compactifications of type IIB string theory is universal and maximally supersymmetric under certain conditions. The correspondence between gauge theory operators and string oscillators was obtained for a class of examples. [Sunil Mukhi and Nissan Itzhaki, Igor Klebanov of Princeton University]

W-geometry and Permutation Symmetry

Consequences of permutation symmetry in W-geometry were completed. A study of an exactly solvable model of exotic atoms was made. [Ashok Raina]

Ghost Sector of Vacuum String Field Theory and the Projection Equation

The ghost sector of vacuum string field theory where the BRST operator Q is given by the midpoint insertion was studied. Using a convenient basis of half-string modes in terms of which Q takes a particularly simple form was used. A field redefinition reduces the ghost sector field equation to a pure projection equation for string fields satisfying the constraint that the ghost number is equally divided over the left- and right halves of the string. When this constraint is imposed, vacuum string field theory can be reformulated as a $U(\infty)$ cubic matrix model. Ghost sector solutions can be constructed from projection operators on half-string Hilbert space just as in the matter sector. The ghost sector equivalent of various well-known matter sector projectors such as the sliver, butterfly and nothing states were constructed. [Joris Raeymaekers and R. Potting of Universidade do Algarve, Portugal]

Generating Potentials in String Theory via Fluxes

Understanding string compactifications with few moduli is an important problem in string theory. Typical string compactifications studied so far have several flat directions. Physical parameters like the fine structure constant or Newton's Gravitational Constant vary along these directions. One needs to understand how a potential is generated along these flat directions and where the resulting minima lie in order to bring string theory in closer conact with phenomenology.

The basic idea of the work has been to consider compactifications where various RR and NS fluxes are turned on. These fluxes can be thought of as generalisations of the Magnetic field in Maxwell theory. One example of a compactifications with flux in a simple IIB orientifold was studied in detail. The general superpotential was written down and vacua with $N = 3, 2, 1$ supersymmetry were found. By appropriately choosing fluxes, it was shown that the number of flat directions reduces from about 70 to 3 in this example. [Sandip Trivedi and S. Kachru, M. Schulz of Stanford University]

A subsequent paper showed that vacua with different amounts of supersymmetry can be connected by spherical domain walls which have a tension small compared to the string scale. The results suggest that in time dependent situations like cosmology also transitions between vacua with different amounts of supersymmetry might be allowed. Understanding such transitions is crucial, in the long run , in understanding how string theory picks out a vaccum like the one seen in nature. [Sandip Trivedi and Kachru, Liu, Schulz of Stanford University]

Various duals of these flux compactifications have also been explored. Some duals have been constructed and various resulting features are being explored. [Sandip Trivedi and Prasanta Tripathi]

Matrix Dynamics of Fuzzy Spheres

A matrix model that describes the quantum mechanics of D0-branes in the presence of Ramond-Ramond flux was studied. It was known earlier that this model has classical solutions representing fuzzy spheres (dielectric 2-branes). The energy landscape of the space of N D0-branes with k RR-flux was investigated, and the instability of smaller spheres towards fusing into the largest allowed sphere was exhibited. A rich structure of deformations of each critical point which describe pulling various spheres from each other and the onset of instabilities. The supergravity manifestation of the solutions was also discussed. [Gautam Mandal, Spenta Wadia and K.P.Yogendran]

Subtleties of the Large N Limit in Noncommutative Field Theories

A regularized noncommutative field theory is carefully defined as a large-N matrix model. The importance of this consideration is underlined particularly in the context of noncommutative solitons found earlier in the context of large noncommutativity (θ). Unless the two limits — large N and large θ — are defined carefully in relation to each other, the solitons are destabilized by large quantum corrections. [Gautam Mandal, Spenta Wadia and S.-J. Rey of Seoul National Unversity, Korea]