YTF 12

Wednesday, 18 December 2019 - Thursday, 19 December 2019

Centre for Particle Theory, Durham

Book of Abstracts

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Parallel Session 3 / **38**

Recursion Relations for Anomalous Dimensions in the 6d (2,0) Theory

Author: Theresa Abl[None]

M-theory in AdS7xS4 is dual to a six-dimensional superconformal field theory with (2,0) supersymmetry and it reduces to 11d supergravity at low energies. Higher-derivative corrections to tree-level supergravity are encoded in the anomalous dimensions of double-trace operators occurring in the conformal partial wave expansion of four-point stress tensor correlators in the 6d (2,0) theory. I will describe recursion relations for these anomalous dimensions which are derived using conformal bootstrap methods.

Parallel Session 3 / **46**

The abelian duality web in 2+1 dimensions

Author: Mohammad Akhond[1]

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I will give an overview of dualities between non-supersymmetric gauge theories in 2+1 dimensions and describe a "gauging" procedure to derive new dualities assuming the validity of a "seed" dual pair. We will mainly demonstrate these ideas through example, focusing on a duality between QED3 and free fermions. If there is any time left I will mention some work in progress in using the gauging procedure to relate this to a duality derived from string theory.

Parallel Session 4 / **48**

A bogomol'nyi equation for magnetic skyrmions

Author: Brunno Barton-Singer[1]

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In the field of topological solitons, the bogomol'nyi trick is a method that can be used to find non-trivial minima of the energy functional where the Euler-Lagrange equations are generally too hard to solve. In the field of condensed matter, magnetic skyrmions are one of the few real-life examples of topological solitons, with potential applications in memory storage. In this talk I will introduce both the bogomol'nyi trick and the magnetic skyrmion model, and describe how the former has been used to find an infinite family of exact solutions to the latter (ref: arXiv:1812.07268).

Parallel Session 2 / **59**

High Energy Jets

Author: Emmet Byrne[1]

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In high energy particle collisions, large logarithms appear at all
orders in the coupling of fixed-order perturbative calculations.
I will introduce the High Energy Jets formalism which incorporates these large logarithms to all orders in the coupling. In particular, I will talk about our current effort to match this prediction to next-to-leading order accuracy.

Parallel Session 3 / 52

Introduction to non-equilibrium QFT, and the 2PI effective action

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With the developments of modern measurement techniques we are able to test Physics at a vast range of scales, ranging from collider experiments to single-atom detection. Apart from being Quantum Theories, the description of these systems also share that a clear understanding of the non-equilibrium dynamics is not fully established. Also missing is a clear understanding of how systems thermalize. In this talk I focus on one approach to formulate out-of-equilibrium QFT using the N-PI effective action, a natural extension of the 1PI effective action, within the Keldysh formalism. Explicitly considering the 2PI approach, I aim to present a general framework for understanding non-equilibrium dynamics, as well as motivate future research in this area across topics, as this framework finds applications across scales. Some of these applications, past and future, will be summarized at the end of my talk.

Parallel Session 2 / 36

Grand Covariance in Quantum Gravity

Authors: Kieran Finn[1]; Sotirios Karamitsos[1]; Apostolos Pilaftsis[1]

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The laws of physics should not depend on how we choose to describe them, and we should not be able to change the physical predictions of our theory just by changing notation. However, this is exactly what happens in the standard formulation of quantum field theories. The effective action receives different quantum corrections depending on how we parametrise our fields. Even Feynman diagrams, a fundamental building block for QFT calculations, yield results that depend on the definition of the fields we choose to work with. In this talk I will rectify these problems by introducing the notion of grand covariance, in which the quantum fields are treated as coordinates on a manifold, known as the grand field space. Field redefinitions are then simply diffeomorphisms of this manifold and thus we can impose reparametrisation invariance using well-known techniques from differential geometry. I show how we can apply this formalism to scalar-tensor theories of quantum gravity. This talk is based on arXiv:1910.06661.

Parallel Session 4 / **47**

Resurgence and Picard-Lefschetz theory in Quantum Field Theory

Author: Philip Glass[1]

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Finding a non-perturbative formulation of Quantum Field Theory (QFT) is an important outstanding problem in physics and mathematics. In mathematics it is needed to put QFT on rigorous footing. In physics it is needed to explain many phenomena observed in nature, particularly at strong coupling, for example the confinement of quarks. Resurgence and Picard-Lefschetz theory are tools that provide a way of calculating non-perturbative contributions from perturbative ones, and thus look like a promising route to unravelling some of the mysteries of non-perturbative QFT. Resurgence does this through analysing asymptotic series. Picard-Lefschetz gives a complementing picture from a path-integral perspective. I will give an introductory talk to one or both of these topics, with some basic examples, to give a flavour of how they work.

Parallel Session 4 / **55**

Detecting Gravitational Waves from the Early Universe

Author: Chloe gowling[None]

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Around 10 picoseconds after the Big Bang it is thought a cosmological electroweak phase transition occurred. In certain BSM theories such a transition can occur via a first order phase transition, which would lead to the production of gravitational waves. Such a source would form a stochastic background observable with the upcoming LISA mission. I will discuss this signature and the methods currently being developed to extract information relating to BSM physics from LISA data.

Parallel Session 3 / **35**

Hasse Diagrams for Higgs Branches

Author: Julius Grimminger[1]

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The partial order of partial Higgsings of a gauge theory with 8 supercharges matches the partial order of inclusion of closures of the symplectic leaves that make up its Higgs branch. The Hasse diagram is a graphical depiction of a partial ordering and as such a central tool in studying Moduli spaces of quantum field theories with 8 supercharges. We will use brane constructions in Type II String Theory to identify the Higgs branch of various theories in different dimensions and derive their Hasse diagram. How the moduli space and it's Hasse diagram change at a conformal fixed point of the theory will be discussed.

Parallel Session 2 / **42**

QCD coherence and how it fails

Author: Jack Holguin[1]

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QCD coherence is a non-Abelian generalisation of the statement that short wavelength physics is largely independent of long wavelength physics. The evolution of hadronic parton densities is accounted for using the equations of Dokshitzer, Gribov, Lipatov, Altarelli, and Parisi (DGLAP). It is often assumed that, as a result of QCD coherence, this hadron evolution can be factorised from any wide-angle, soft-gluon emissions. However, the build up of quantum interference can destroy coherence and break factorisation. My talk will discuss coherence quite generally; when and why it breaks. I will stress why this result is counter-intuitive and fundamentally non-Abelian.

Parallel Session 2 / 51

Probing Black Hole Microstates

Author: Marcel Hughes[1]

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The fuzzball proposal provides one possible resolution to Hawking's information loss paradox within the framework of string theory by conjecturing the existence of a large number of microstates describing a classical black hole. With the goal of gaining a better understanding of the physics in these individual pure states, explicit correlation functions of the D1D5 system are studied. An example of physics that can be studied holographically in these systems is high energy scattering in the presence of an individual microstate.

Parallel Session 3 / 37

Twistor action for gamma-deformed SYM

Authors: Tim Adamo[1]; Sumer Jaitly[None]

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Twistor space has proved to be a useful tool in the study of space-time field theory. Field theories may be formulated in terms of actions on twistor space, just as in space-time; their enhanced gauge symmetry provides a powerful edge over the space-time description. We find a new result that a gamma-deformation of the well known N=4 SYM theory may be formulated in terms of a twistor action. This in turn leads to a twistor description of the simple 'conformal fishnet theory'. No previous experience with twistors required!

Parallel Session 1 / 41

Can you regularise gravity on a supermanifold?

Author: Matthew Kellett[1]

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In this talk, we take inspiration from studies of using SU(N|N) to construct a manifestly gauge invariant renormalisation procedure and attempt to apply this to gravity, preserving diffeomorphism invariance and incorporating allowing us to fit gravity into the renormalisation group (a rather well-known problem in physics). This means introducing a supermanifold and attempting to find the degrees of freedom by looking at the second order action.

For this to work like gauge theory, we are required to break the supersymmetry and be left with the normal diffeomorphism invariance. Fortunately, a mass very naturally appears in the superfield formalism, however we find that it doesn't act like a mass at the level of the propagator. Nonetheless, we find many interesting and useful results about gravity on a supermanifold and offer ways which this approach may yet work.

Parallel Session 3 / 60

SO(10) at the LHC

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We study and compare various Zmodels arising from SO(10), focussing in particular on the Abelian subgroup U(1)R × U(1)B–L, broken at the TeV scale to Standard Model hypercharge U(1)Y. The gauge group U(1)R × U(1)B–L, which is equivalent to the U(1)Y × U(1)χ in a different basis, is well motivated from SO(10) breaking and allows neutrino mass via the linear seesaw mechanism. Assuming supersymmetry, we consider single step gauge unification to predict the gauge couplings, then consider the detection and characterisation prospects of the resulting Zat the LHC by studying its possible decay modes into dileptons as well as into Higgs bosons. The main new result here is to analyse in detail the expected leptonic forward-backward asymmetry at the high luminosity LHC and show that it may be used to discriminate the U(1)R ×U(1)B–L model from the usual B –L model based on U(1)Y ×U(1)B–L.

Parallel Session 2 / 57

Application of the eigenfunctions of the Dirac operator on spheres to de Sitter QFT

Author: Vasileios Letsios[1]

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Studying field theory in de Sitter spacetime is important because of its relevance to inflationary cosmology. N-dimensional de Sitter space can be obtained by analytic continuation of the N-sphere. In this talk, I will discuss how one can construct spinor fields in de Sitter spacetime by analytically continuing the eigenfunctions of the Dirac operator on the N-dimensional sphere. Furthermore, I will explain how to obtain mode expansions for the free Dirac field operator and discuss how these modes are connected with unitary SO(N,1) representations.

Parallel Session 4 / 49

Sub-Planckian ϕ^2 Inflation with an R^2 term in the Palatini formalism

Authors: Amy Lloyd-Stubbs[1]; John McDonald[1]

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We discuss a model of inflation with a minimal Image potential. There are two main problems with conventional Image chaotic inflation: the tensor to scalar ratio is generally unacceptably large, and it requires a super-Planckian inflaton field in order to inflate. It has been shown recently that a minimal Image inflation model with an Image term in the context of Palatini gravity is able to solve the problem of a large tensor to scalar ratio while maintaining the successful prediction of the scalar spectral index. In this work we seek to answer the following questions: can the inflaton in this model remain sub-Planckian and remain consistent for Planck-suppressed potential corrections, and can this model produce a viable post-inflation cosmology? We show that for large enough values of the dimensionless coupling alpha on the Image term, it is possible for the relevant inflaton in the Einstein frame to be sub-Planckian and for the scalar spectral index to be unaffected by Planck-suppressed potential corrections. In addition, we show that the reheating temperature is large enough for a viable post-inflation cosmology, and that the model conserves unitarity during inflation. We discuss some specific reheating mechanisms and the evolution of the inflaton field after inflation, including the possibility of condensate fragmentation.

Parallel Session 1 / 40

Leptoquark Pair Production at Future Colliders

Author: Maeve Madigan[1]

Co-authors: Benjamin Allanach [1]; Tyler Corbett [2]

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As new physics continues to evade detection at the LHC, proposals have been made for future colliders with the aim of extending the mass reach and improving sensitivity to physics beyond the standard model. The scalar leptoquark provides a particularly interesting new physics candidate. At tree-level, leptoquark-mediated transitions may account for the hints at lepton flavour universality violation observed by experiments such as Belle and LHCb. I will present estimates of the sensitivity of the high luminosity and high energy modes of the LHC and of a 100 TeV future circular collider to these leptoquarks, focusing on their pair production and decay into the dimuon dijet channel.

Parallel Session 2 / 54

Scattering Amplitudes Soft Anomalous Dimension in QCD

Author: Niamh Maher[1]

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The aim is to explain what the soft anomalous dimension is and its relevance to computing cross sections. Scattering amplitudes can be factorised into hard, soft and jet functions. The soft function renormalisation group equation defines the soft anomalous dimension and the its constrains will be discussed.

Parallel Session 1 / **43**

A novel approach to perturbatively renormalizable quantum gravity

Author: Alex Mitchell-Lister[1]

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In this talk we review current research into a novel approach to creating a perturbatively renormalizable theory of quantum gravity. This is based on a treatment of Einstein's GR under the exact renormalization group leading to the discovery of operators with negative scaling dimension which resolve the issue of irrelevant operators in interacting gravity. The restriction of these operators to those that are diffeomorphism invariant and the consequences of this are also discussed.

Parallel Session 3 / **61**

Non-Lorentzian Descriptions for the M5-brane

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I will give an overview of some recent progress in capturing aspects of the non-Abelian dynamics of M5-branes through non-Lorentzian worldvolume descriptions.

Parallel Session 4 / **62**

Classification of N=1 heterotic string vacua and towards N=0 classification

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In this talk the key results from the last 15 years of work in heterotic string vacua classification in the free fermionic formulation will be reviewed. The latest work on fertility condition in the Left-right symmetric models will be explored as well as the ongoing project towards a classification of Non-SUSY models.

Parallel Session 1 / **45**

Quantum Gravity - No Strings Attached!

Author: Axel Polaczek[1]

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The marriage of quantum theory and gravity is a notoriously difficult problem. While the most popular approach is string theory, it is by no means the only game in town. In this talk I will give a bird's eye view on a selection of other approaches to quantum gravity.

Parallel Session 1 / 53

Muon and electron g-2 in a Z' model with vector-like fermions

Authors: Sam Rowley[1]; Steve King[1]; Huchan Lee[1]; Antonio Carcamo Hernandez[2]

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We consider a simple renormalisable and gauge-invariant model in which a massive new Z′ boson has couplings only to the electron and muon and their associated neutrinos, arising from mixing with a heavy vector-like fourth family of leptons. Within this model, we discuss the contributions to the electron and muon anomalous magnetic moments from Z′ exchange, subject to the constraints from $\mu \to e\gamma$ and neutrino trident production. Using analytic and numerical arguments, we find that such a Z′ model can account for either the electron or the muon g−2 anomalies while remaining consistent with the experimental constraints from $\mu \to e\gamma$ and neutrino trident production, but not both simultaneously.

Parallel Session 4 / 50

Resurgence in the Bi-Yang-Baxter model

Author: Lucas Schepers[1]

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In this talk, a taster is given of preliminary results obtained with my collaborators. We study the integrable Yang-Baxter deformations of the Principal Chiral Model and its on-shell "uniton" solutions. By dimensionally reducing the theory on the world-sheet we obtain an effective quantum mechanics. Using techniques from resurgence we try to interpret the non-perturbative physics as uniton effects. Moreover, the WKB curve of the quantum mechanics is the same as that of N=2 Seiberg-Witten theory with 4 flavours, which opens doors to a whole range of interesting speculations.

Parallel Session 3 / 56

Scalar Fields in 2D de Sitter Space

Author: Lasse Schmieding[1]

[1] *University of York*

Unlike higher dimensional de Sitter spaces, two dimensional de Sitter space is not simply connected. The behaviour of the fields on making a full rotation of the spatial direction must therefore be specified. Previously, Epstein and Moschella have shown that anti-periodic real scalar fields have no analogue of a Bunch-Davies vacuum state. For complex scalar fields, more general behaviour is possible. I will discuss complex scalar field theories in two dimensional de Sitter space and then comment on the existence of de Sitter invariant and Hadamard states for these theories.

Parallel Session 1 / 58

Lifetimes of charmed hadrons

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