Nonpeturbative QFT: Methods and Applications

Tuesday, 24 September 2013 - Friday, 27 September 2013

DESY Hamburg

Book of Abstracts

Contents

Parallel Session 3: Strings & Mathematical Physics / **2**

Large N Volume Independence and an Emergent Fermionic Symmetry

Author: Aleksey Cherman[1]

[1] *FTPI, University of Minnesota*

Corresponding Author: cherman@physics.umn.edu

Large-N volume independence in circle-compactified QCD with Nf ≥ 1 adjoint Weyl fermions implies the absence of any phase transitions as the radius is dialed to arbitrarily small values. This class of theories are believed to possess a Hagedorn density of hadronic states. These properties are in apparent tension with each other, because a Hagedorn density of states typically implies a phase transition at some finite radius. This tension is resolved if there are degeneracies between the spectra of bosonic and fermionic states, as happens in the Nf=1 supersymmetric case. Resolution of the tension for Nf>1 then suggests the emergence of a fermionic symmetry at large N, where there is no supersymmetry. The Coleman-Mandula theorem can be escaped since the N=∞ theory is free, with a trivial S-matrix. I will show an example of such a spectral degeneracy in a non-supersymmetric toy example which has a Hagedorn spectrum.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / **5**

Gravitino DM and a Healthy EDM in D3/D7 mu-Split Supersymmetry

Author: Aalok Misra[1]

Co-author: Mansi Dhuria [1]

[1] *Indian Institute of Technology Roorkee*

Corresponding Author: aalokfph@iitr.ernet.in

We present a phenomenological model which could possibly be obtained as a local Swiss-Cheese Calabi-Yau string-theoretic compactification in the large volume limit with a mobile D3-brane restricted to a nearly special Lagrangian cycle in the Calabi-Yau and fluxed stacks of wrapped D7-branes. The model provides a natural realization of mu-Split SUSY with a high SUSY-breaking scale wherein the gravitino(LSP), squarks, sleptons, gauginos, Higgsino and one Higgs are very heavy and with fine tuning, one is able to obtain a 125-GeV light Higgs. By explicitly calculating the lifetimes of decays of the co-NLSPs –the squarks/sleptons and a neutralino –to the LSP –the gravitino –as well as gravitino decays, we verify that BBN constraints relevant to the former as well as the requirement of the latter to be (more than) the age of the universe, are satisfied. For the purpose of calculation of the gravitino relic density in terms of the neutralino/slepton relic density, we evaluate the former to be around 0.1 by evaluating the neutralino/slepton annihilation cross sections and hence show that the former satisfies the requirement for a dark matter candidate. We also show that it is possible to obtain the electron/neutron EDM "d/e" to two loops to be around 10^{-28}cm for diagrams with SM vertices and 10^{-33}cm for diagrams with BSM vertices.

Parallel Session 3: Strings & Mathematical Physics / **6**

Connecting superconformal indices in various dimensions

Author: Ilmar Gahramanov[1]

[1] *Humboldt-University Berlin*

Corresponding Author: ilmar.gh@gmail.com

By reduction of a single letter index a natural connection is found between superconformal indices of even-dimensional supersymmetric theories. We find that the superconformal index of the 4d N=2, 4 theory reduces to the superconformal index of the N=(2,2), (4,4) theory in the certain limit of the superconformal fugacities. The proposed reduction procedure could also help to extract information about the four-dimensional index from the six-dimensional index, we discuss some examples related to this relationship.

Parallel Session 3: Strings & Mathematical Physics / 10

Computing knot invariants with topological recursion

Authors: Albrecht Klemm[1]; Hans Jockers[1]; Jie Gu[1]; Masoud Soroush[1]

[1] *Universität Bonn*

Corresponding Author: jiegu@th.physik.uni-bonn.de

It's been conjectured that the Chern-Simons theory with SU(N) group on S3 in the large N limit can be described by closed topological string. When a Wilson line operator along some knot is inserted in the Chern-Simons theory, some brane appears in the topological string. We give support to the second half of the conjecture by computing the instanton numbers in B-model, using the topological recursion in the spirit of Eynard-Orantin and the spectral curves associated with torus knot insertion proposed by Aganagic and Vafa, and compare with the results in the Chern-Simons theory.

Parallel Session 3: Strings & Mathematical Physics / 11

Refined BPS invariants on del Pezzo and half K3 Calabi-Yau manifolds

Author: Maximilian Poretschkin[1]

Co-authors: Albrecht Klemm [1]; Min-xin Huang [2]

[1] *Bethe Center for Theoretical Physics*

[2] *Interdisciplinary Center for Theoretical Study*

Corresponding Author: poretschkin@th.physik.uni-bonn.de

The most detailed information about rigid $\mathcal{N} = 2$ supersymmetric theories in $\mathbb{R}^4 \times S^1$ is contained in a supersymmetric index counting refined BPS states. They fall into representations of $\mathrm{SU}(2)_L \times \mathrm{SU}(2)_R$, the little group in $5d$, which has an induced action on the cohomology of the moduli space of stable pairs.

I will present the computation of refined BPS state multiplicities associated to M-theory reductions on local Calabi Yau manifolds, which are given by the total space of the canonical bundle over del Pezzo surfaces. The identification of the integer cohomology lattice with the root lattice of exceptional Lie groups plays a key role in this discussion.

The results provide not only a better understanding of Seiberg Witten theory with matter but have also interesting implications for the stable degeneration limit of F-theory compactifications and zero-sized instantons in heterotic string theory.

This talk is based on

M.~X.~Huang, A.~Klemm, M.~Poretschkin “Refined BPS invariants on del Pezzo and half K3 Calabi Yau manifolds” - to appear soon.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 12

Minimal Decaying Dark Matter and the LHC

Author: Giorgio Arcadi[1]

[1] *University of Göttingen*

Corresponding Author: arcadi@theorie.physik.uni-goettingen.de

Decaying Dark Matter is an interesting and viable alternative to the common paradigm of stable Dark Matter. We consider a simple extension of the Standard model with two states, a Dark Matter Majorana fermion and a colored or only electroweakly charged scalar, without introducing any symmetry to stabilize the DM state. We identify the parameter region accounting for an Indirect Dark Matter signal in the reach a of future observations and which can, at the same time, be probed by collider searches. Among the possible scenarios particulary promising is the case in which the DM is produced by the Freeze-in and SuperWimp mechanisms. We point out the different collider signals of this scenario and how it will be possible to measure the relevant couplings in case of a combined Indirect and collider detection.

Parallel Session 2: Cosmology & Astroparticle Physics / 14

No-scale D-term inflation with stabilized moduli

Authors: Clemens Wieck[1]; Valerie Domcke[1]; Wilfried Buchmüller[1]

[1] *DESY Hamburg*

We study the effects of coupling hybrid inflation to moduli stabilization as employed in certain type IIB string compactifications with D-branes and fluxes. In a scenario with a single Kahler modulus stabilized in a racetrack potential, F-term hybrid inflation is unfeasible due to either a large inflaton mass or a tachyonic direction. However, we present a working model of D-term hybrid inflation with stabilized moduli. We discuss how the supersymmetric Minkowski vacuum at the end of inflation can be uplifted to a dS vacuum with TeV-scale gravitino mass without spoiling moduli stabilization or inflation. Moreover, we show that the considered model is equivalent to superconformal D-term inflation. The latter reproduces the Starobinsky model in the large-field regime, which makes it phenomenologically appealing in view of the recently published Planck data.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 15

Laboratory tests of leptogenesis and fine tuning

Author: Marco Drewes[1]

[1] *TU München*

I discuss leptogenesis in the type I seesaw model with Majorana masses below the electroweak scale and the perspectives to test this scenario in the laboratory. It is often stated that it can only be realised if either two Majorana masses are highly degenerate or new degrees of freedom in addition to the right handed neutrinos are added to the Standard Model. This is, however, only true in models with two right handed neutrinos. We show that three or more right handed neutrinos with non-degenerate masses in the GeV range can generate the observed baryon asymmetry of the universe without any other new particles. This is possible due to the interplay of flavour and thermal effects.

Parallel Session 3: Strings & Mathematical Physics / 16

A Systematic Study of Instanton Moduli Spaces

Author: Noppadol Mekareeya[1]

[1] *Max Planck Institute for Physics*

Corresponding Author: n.mekareeya@gmail.com

In this talk, I will present a method for a systematic study of the moduli spaces of Yang-Mills instantons in a simple gauge group. For a classical group, the moduli space can be studied via the ADHM construction, which can be realised from the Lagrangian of a certain quiver gauge theory with 8 supercharges. Such a construction is, however, not available for instantons in exceptional gauge groups and all known string theoretic constructions of the latter so far do not admit a perturbative Lagrangian description. I will demonstrate how to study the moduli spaces in these cases using a partition function that counts holomorphic functions on the moduli space, also known as the Hilbert series. The connections between Hilbert series, Nekrasov's partition functions and superconformal indices will be discussed in detail.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 18

The Weyl Consistency Conditions and Standard Model Vacuum Stability

Author: Marc Gillioz[1]

Co-authors: Esben Mølgaard [1]; Francesco Sannino [1]; Jens Krog [1]; Oleg Antipin [1]

[1] *CP3-Origins, University of Southern Denmark*

Corresponding Author: marc.gillioz@gmail.com

The conformal symmetry plays an important role in quantum field theories, even when it is explicitly broken by a renormalization group flow. The Weyl consistency conditions reflect its presence in the renormalized theory. They provide relations among the beta functions of the theory at different loop orders. As an example, we show how the Weyl consistency conditions affect the computation of the vacuum stability in the Standard Model.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 19

Electroweak vacuum stability in the inflationary cosmology

Author: Kohei Kamada[1]

[1] *DESY*

Recent LHC results suggest the electroweak vacuum metastability. Although its lifetime is longer than the cosmic age in almost all the parameter space, quantum tunneling to the unwanted true vacuum in the quasi-de Sitter background may occur during inflation. This, in turn, constrains severely high-scale inflation models. In this talk, we discuss how to avoid such tunneling during high-scale inflation and give new constraints on parameters of inflation models, such as reheating temperature.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 20

Analytic solutions of multi-parton ʻt-Hooft equations

Author: Jacek Wosiek[1]

[1] *Jagellonian University*

Corresponding Author: wosiek@th.if.uj.edu.pl

After explaining the role of generalized, i.e. multi-parton, ʻt Hooft equations in QCD, their numeric and analytic solutions will be discussed. The intriguing localization property, together with stringy interpretation will be demonstrated. Finally, we will derive analytically the complete basis of localized solutions satisfying appropriate, infrared safe, boundary conditions in all parton sectors. Their linear spectrum, together with calculable degeneracies provide rather transparent interpretation of, otherwise complicated, multi parton spectra. The entropy of above solutions is readily available and reveals the Hagedorn behaviour.

Parallel Session 2: Cosmology & Astroparticle Physics / 23

Non-relativistic leptogenesis (Cancelled)

Author: Mirco Wörmann[1]

[1] *Universität Bielefeld*

Corresponding Author: mwoermann@physik.uni-bielefeld.de

Parallel Session 2: Cosmology & Astroparticle Physics / 24

New Light on an Old Idea: The Starobinsky Model from Superconformal D-term Inflation

Authors: Kohei Kamada[1]; Valerie Domcke[1]; Wilfried Buchmüller[1]

[1] *DESY*

A remarkable feature of the recently published Planck data is that one of the oldest models of inflation, the R^2 inflation model proposed by Starobinsky, fits the data strikingly well. In this talk, I show how the Starobinsky model arises asymptotically in the large field limit of a supergravity D-term

hybrid inflation model based on an approximate superconformal symmetry. This superconformal symmetry implies a remarkably simple structure in the Jordan frame, leading to a well-motivated and highly predictive class of models.

Parallel Session 3: Strings & Mathematical Physics / 25

Calculating amplitudes in the multi-Regge regime of strongly coupled N=4 SYM

Author: Martin Sprenger[1]

Co-authors: Jochen Bartels [2]; Volker Schomerus [1]

[1] *DESY*

[2] *II. Institute for Theoretical Physics, Hamburg University*

Corresponding Author: martin.sprenger@desy.de

In this talk, I will present results for the 6- and 7-point amplitude in strongly coupled N=4 super Yang-Mills theory in the multi-Regge regime. I will review the calculation of scattering amplitudes in strongly coupled N=4 SYM, where calculating the amplitude corresponds to calculating a specific minimal surface embedded into AdS5.

The leading order solution of this problem is determined by a set of non-linear integral equations, which, however, do not allow an analytic solution for arbitrary kinematics.

We therefore study this problem in the multi-Regge regime, in which the equations simplify and where explicit solutions can be obtained.
I will present a general algorithm for the calculation of amplitudes in this kinematic regime and show new results for the 6- and 7-point amplitude as specific examples.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 26

The minimal curvaton-higgs model

Author: Rose Lerner[1]

[1] *Helsinki University*

The curvaton is only a spectator field during inflation, but produces the observed curvature perturbation when it decays after inflation. We present a simple "realistic" model for the curvaton mechanism, where the curvaton is a real scalar coupled to the standard model Higgs Boson. This coupling to the higgs results both in interesting stochastic behaviour of the field during inflation, and in thermal blocking of curvaton (p)reheating. Curvaton decay in most cases is through gravitational-strength interactions. The model is particularly interesting because the coupling to the standard model allows the curvaton field dynamics to be determined, and the model can be constrained by current and future data.

Parallel Session 3: Strings & Mathematical Physics / 27

WZ term in Permutation Cosets

Author: Cagnazzo Alessandra[1]

Co-author: Zarembo Konstantin [2]

[1] *DESY*

[2] *Nordita*

Corresponding Author: alessandra.cagnazzo@desy.de

The study of Superstring Theories on AdS backgrounds is important in the context of Gauge/Gravity correspondence. These theories can be reduced, under certain assumptions, to Sigma Models on semi-symmetric super-cosets. For a peculiar class of these cosets one can also introduce a WZ term. This correspond to study a Superstring Theory on a background supported by a mixture of RR and NSNS fluxes, as can happen for theories on $AdS_3 \times S^3 \times M_4$. I will show the effect of this term on Integrability, Kappa symmetry and conformality of the theory, computing also the BMN spectrum in some relevant case for AdS_3/CFT_2 correspondence.

Parallel Session 3: Strings & Mathematical Physics / 28

U(1) Symmetries in Global F-Theory Compactifications with GUTs

Authors: Christoph Mayrhofer[1]; Eran Palti[1]; Jan Borchmann[1]; Timo Weigand[1]

[1] *Heidelberg University*

Corresponding Author: c.mayrhofer@thphys.uni-heidelberg.de

In this talk we will describe the construction of F-Theory GUT models for elliptically fibred Calabi-Yau fourfolds admitting a non-trivial Mordell-Weil group. We work out the matter spectrum and Yukawa couplings, including singlets, for these geometries and present the fluxes corresponding to the U(1) symmetries.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 29

(1+1) QCD & Transverse Quark States in a Flux Tube

Author: Andrew Koshelkin[1]

Co-author: Cheuk-Yin Wong [2]

[1] *Moscow Institute for Physics and Engineering*

[2] *Physics Division, Oak Ridge National Laboratory*

Corresponding Author: and.kosh59@gmail.com

In order to describe the dynamics of particle production and hadron spectrum in a flux tube, we start with an action integral in QCD4 in (3+1)dimensional space-time with a confining scalar transverse interaction. Under the dominance of longitudinal motion of the valence quark-antiquark pair, the four dimensional space-time QCD4 can be compactified into QCD2 in (1+1) dimensional space-time [1]. The obtained action integral is found to govern massive fermion and gluon fields, with a relation between the coupling constant g(2D) in QCD2 and g(4D) in QCD4. The contribution to the quark and gluon masses due to the flux tube are derived. The

coupling constants and the masses depend crucially on the excitation of the partons in the transverse degrees of freedom. The spectrum of transverse degrees of freedom in the flux tube are studied in detail. On basis of the obtained quark eigenstates of a tube, the gluon and fermion masses as well as 2D coupling constants, g(2D), are calculated. The relation of the obtained gluon mass to the spectrum of observable hadrons will be considered.

References

[1] A. V. Koshelkin and C. Y. Wong, Phys. Rev. v.D86, 125026 (2012).

Parallel Session 3: Strings & Mathematical Physics / 30

Wilson Lines and Entanglement Entropy in Higher Spin Gravity

Author: Martin Ammon[1]

[1] *Friedrich-Schiller University Jena*

Corresponding Author: martin.ammon@uni-jena.de

Holographic entanglement entropy provides a direct connection between classical geometry and quantum entanglement; however the usual prescription does not apply to theories of higher spin gravity, where standard notions of geometry are no longer gauge invariant. We present a proposal for the holographic computation of entanglement entropy in field theories dual to higher spin theories of gravity in AdS3. These theories have a Chern-Simons description, and our proposal involves a Wilson line in an infinite-dimensional representation of the bulk gauge group. In the case of spin-2 gravity such Wilson lines are the natural coupling of a heavy point particle to gravity and so are equivalent to the usual prescription of Ryu and Takayanagi. For higher spin gravity they provide a natural generalization of these ideas. We work out spin-3 gravity in detail, showing that our proposal recovers many expected results and computes thermal entropies of black holes with higher spin charge, finding agreement with previous expressions in the literature.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 31

Gluino decay in natural supersymmetry

Author: Masaki Asano[1]

[1] *University of Hamburg*

Natural supersymmetric spectra require light Higgsinos, light stops and sbottom to achieve the correct electroweak symmetry breaking without a fine tuning. Furthermore, taking into account two loop contribution to the Higgs mass squared term, gluino would not be very heavy. We study the gluino decay signal in natural supersymmetric spectra at the LHC. It would be different from simplified models and we also discuss the difficult signal to search at the LHC considering R-parity breaking terms.

Parallel Session 1: Phenomenology / 32

An asymptotic safety scenario for gauged chiral Higgs-Yukawa models

Authors: Holger Gies[1]; Luca Zambelli[1]; Michael Scherer[2]; Stefan Rechenberger[3]

[1] *TPI, Friedrich-Schiller-Universität Jena*

[2] *Universität Heidelberg*

[3] *Radboud University Nijmegen*

Corresponding Author: luca.zambelli@uni-jena.de

We investigate chiral Higgs-Yukawa models with a non-abelian gauged left-handed sector reminiscent to a sub-sector of the standard model. We discover a new weak-coupling fixed-point behavior that allows for ultraviolet complete RG trajectories which can be connected with a conventional long-range infrared behavior in the Higgs phase. Despite the weak coupling properties, the system exhibits non-Gaußian features which are distinctly different from its standard perturbative counterpart: e.g., on a branch of the line of fixed points, we find linearly instead of quadratically running renormalization constants.

Parallel Session 3: Strings & Mathematical Physics / 33

CFT and Hermitian Symmetric Superspaces

Author: Václav Tlapák[1]

Co-authors: Constantin Candu [2]; Volker Schomerus [1]

[1] *DESY*

[2] *ETH Zürich*

Corresponding Author: vaclav.tlapak@desy.de

Replacing the regular Lie groups in the coset construction of Goddard-Kent-Olive (GKO) with Lie supergroups yields conformal but non-unitary 2-dimensional QFTs. We extend previous studies of exactly marginal deformations in such superspace coset models to hermitian symmetric superspaces. In this case we obtain several families of N=2 superconformal field theories with continuously varying exponents.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 35

Time Evolution of the Large-Scale Tail of Primordial Magnetic Fields

Authors: Andrey Saveliev[1]; Günter Sigl[1]; Karsten Jedamzik[2]

[1] *University of Hamburg*

[2] *University 2 Montpellier*

Corresponding Author: andrey.saveliev@desy.de

We present our results from semi-analytic computations on the time evolution of the energy content for primordial magnetic fields and the accompanying turbulent flows in the general framework of an expanding Universe with homogeneous and isotropic turbulence. In particular we include the back-reaction of the turbulent medium on the magnetic field and point out the effect of helicity compared to the non-helical case.

Parallel Session 1: Phenomenology / 38

3D N=4 lattice gauge theory with fundamental matter

Author: Anosh Joseph[1]

[1] *DESY Zeuthen*

Corresponding Author: anoshjoseph@gmail.com

We construct lattice action for three-dimensional N=4 supersymmetric gauge theory with matter fields in the fundamental representation. We also discuss the construction of N=4 U(N_1)xU(N_2) quiver lattice gauge theory with bi-fundamental matter fields. Some issues such as flat directions, fine tuning and sign problem appearing in these theories are also briefly discussed.

Parallel Session 3: Strings & Mathematical Physics / 39

N=2 vacua in electrically gauged N=4 supergravities

Author: Christoph Horst[1]

[1] *University of Hamburg*

Corresponding Author: christoph.horst@desy.de

We study N=2 vacua in gauged N=4 supergravity theories in four-dimensional spacetime. Using the embedding tensor formalism that describes general consistent magnetic gaugings of an ungauged N=4 matter-coupled supergravity theory in a symplectic frame with SO(1,1) x SO(6,n) off-shell symmetry we formulate necessary conditions for partial supersymmetry breaking and find that the Killing spinor equations can be solved for the embedding tensor components. Subsequently, we show that the classification of theories that allow for vacua with partial supersymmetry amounts to solving a system of purely algebraic quadratic equations. Then, we restrict ourselves to the class of purely electric gaugings and explicitly construct a class of consistent super-Higgs mechanisms and study its properties. In particular, we find that the spectrum fills complete N=2 supermultiplets that are either massless or BPS. Furthermore, we demonstrate that (modulo an abelian Lie algebra) arbitrary unbroken gauge Lie algebras can be realized provided that the number of N=4 vector multiplets is sufficiently large. Finally, we compute the relevant terms of the effective action below the scale of partial supersymmetry breaking and argue that the special Kaehler manifold for the scalars of the N=2 vector multiplets has to be in the unique series of special Kaehler product manifolds. This talk is based on work done in collaboration with Jan Louis and Paul Smyth (JHEP 1303 (2013) 144).

Parallel Session 1: Phenomenology / 40

Electroweak Corrections to Drell Yan in the POWHEG BOX

Author: Christian Weiss[1]

Co-authors: Alexander Mück [1]; Michael Krämer [1]

[1] *Institute for theoretical particle physics and cosmlogy, RWTH Aachen University*

Precision calculations for hadron colliders require numerous computational methods, among others the simulation of parton showers. They provide a good description of collinear radiation, i.e. the internal structure of jets. However, to better describe the production of jets, NLO matrix elements are needed. Their interface to parton showers involves problem, leading to the loss of NLO accuracy.

The POWHEG method overcomes these problems by modifying the parton shower. To provide an easy way to create events according to this method, a computer program, the POWHEG BOX was created.

Up to recently, the POWHEG BOX was only suited for QCD calculations. We present an implementation of electroweak corrections to Drell Yan in this program. Drell Yan processes are easy to detect because of two final-state leptons. Electroweak corrections have a significant effect on the kinematics of those leptons, and the POWHEG BOX is able to describe them.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 41

Propagating Ultra-High Energy Cosmic Rays in the Universe with CRPropa

Author: Rafael Alves Batista[1]

[1] *II. Institute for Theoretical Physics, University of Hamburg*

Corresponding Author: rafael.alves.batista@desy.de

The origin, chemical composition, and mechanisms of acceleration of the ultra-high energy cosmic rays (UHECRs) are not yet well understood. Aiming for a better interpretation of the available experimental data, these data have to be confronted with theoretical models. In this sense, the development of numerical tools to propagate UHECRs is essential to constrain astrophysical parameters. CRPropa 3 is a software package to simulate the propagation of UHE nuclei through the large scale structure of the universe. It accounts for all relevant interactions with the photon backgrounds, as well as deflections due to galactic and extragalactic magnetic fields.

Parallel Session 3: Strings & Mathematical Physics / 42

Orbifolds and topological defects

Author: Daniel Plencner[1]

[1] *LMU Munich*

Corresponding Author: daniel.plencner@physik.uni-muenchen.de

Orbifolding a 2-dimensional quantum field theory by a symmetry group admits an elegant description in terms of defect lines and their junction fields. This perspective offers a natural generalization of the concept of an orbifold, in which the role of the symmetry group is replaced by a defect with the structure of a (symmetric) separable Frobenius algebra. In this talk I will focus on the case of Landau-Ginzburg models, in which defects are described by matrix factorizations. After introducing the generalized twisted sectors and discussing topological bulk and boundary correlators in these sectors, I will present a simple proof of the Cardy condition and discuss some further consistency checks on the generalized orbifold theory. This talk is based on arXiv:1307.3141 with Ilka Brunner and Nils Carqueville.

Parallel Session 3: Strings & Mathematical Physics / 43

Tensor Towers and (2,0) Theories

Author: Federico Bonetti[1]

[1] *MPI Munich*

Corresponding Author: bonetti@mpp.mpg.de

A five-dimensional approach to six-dimensional tensor theories is discussed, which makes use of towers of massive five-dimensional tensors in a Kaluza-Klein inspired fashion. The relation to Chern-Simons theories in five dimensions is considered at the quantum level. A five-dimensional supersymmetric Lagrangian with tensor towers is proposed to furnish a description of non-Abelian (2,0) theories.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 44

The Scale of Dark QCD

Author: Pedro Schwaller[1]

Co-author: Yang Bai [2]

[1] *CERN*

[2] *UW Madison*

Corresponding Author: pedro.schwaller@gmail.com

Most of the mass of ordinary matter has its origin from quantum chromodynamics (QCD). A similar strong dynamics, dark QCD, could exist to explain the mass origin of dark matter. Using infrared fixed points of the two gauge couplings, we provide a dynamical mechanism that relates the dark QCD confinement scale to our QCD scale, and hence provides an explanation for comparable dark baryon and proton masses. Together with a mechanism that generates equal amounts of dark baryon and ordinary baryon asymmetries in the early universe, the similarity of dark matter and ordinary matter energy densities can be naturally explained. For a large class of gauge group representations, the particles charged under both QCD and dark QCD, necessary ingredients for generating the infrared fixed points, are found to have masses at one to two TeV, which sets the scale for dark matter direct detection and novel collider signatures involving visible and dark jets.

Parallel Session 3: Strings & Mathematical Physics / 45

Target space unitarity in string theory

Author: Tobias Hansen[1]

[1] *Universitaet Hamburg*

Corresponding Author: tobias.hansen@desy.de

Tree level unitarity relates the residues of N-point amplitudes of scalars to lower point amplitudes of all particles in the spectrum of a theory. I will explain in the case of open bosonic string theory how to exploit this relation, in which one has to sum over all particles that are on-shell at the residue in question and all its possible polarizations. In contrast to Yang-Mills theory, here the spectrum contains an infinite amount of massive states, which are irreducible tensor representations of the little group SO(D-1). Along the way, we will come across a simple way to derive the restrictions that the no-ghost theorem poses on the parameters α_0 and D. This talk is based on work with Rutger Boels.

Parallel Session 3: Strings & Mathematical Physics / 46

Two-dimensional S-matrices from unitarity cuts

Authors: Ben Hoare[1]; Lorenzo Bianchi[1]; Valentina Forini[1]

[1] *Humboldt-Universität zu Berlin*

Corresponding Author: bdhoare@gmail.com

In this talk we will discuss recent developments in the application of unitarity techniques to 2-d integrable field theories. After outlining the general construction (mainly focussing on one loop, but with some comments on two), we will apply the method to various integrable theories, finding evidence that the one-loop S-matrix is cut-constructible. The final part of the talk will focus on the world-sheet theory for the light-cone gauge-fixed AdS_5 x S^5 superstring, where at one-loop we reproduce the S-matrix known from integrability techniques. To conclude I will make some brief comments on other integrable string backgrounds and related open questions.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 47

Non-perturbative QFT for the calculation of collider processes embedded in the intense electromagnetic fields at the Interaction Point

Author: Anthony Hartin[1]

[1] *DESY*

Corresponding Author: anthony.hartin@desy.de

A non-perturbative QFT - the Furry picture - which treats the interaction of particles with each other perturbatively and with intense electromagnetic fields exactly, is already used routinely in the calculation of the beamstrahlung and coherent pair production. The current implementation of the theory for existing calculations requires the approximation of ultra-relativistic, co-linear initial and final states and takes into account the field of only one of the intense charge bunches colliding at the IP. In this talk will be presented theoretical developments to make existing calculations more exact by obtaining solutions of the minimally coupled Dirac equation in two external, constant crossed fields for general kinematics. These solutions are applied to the beamstrahlung and the more exact transition probability is compared numerically to the standard one. The next generation of colliders will involve such intense electromagnetic fields that these exact solutions must be applied to all collider processes so as to obtain corrected cross-sections. Such a program of work is outlined and the application to general second order processes is described in detail.

Parallel Session 3: Strings & Mathematical Physics / 49

Closed formulae for superstring tree amplitudes: Multiple zeta values and the Drinfeld associator

Author: Oliver Schlotterer[1]

[1] *AEI Potsdam*

Corresponding Author: oliver.schlotterer@web.de

We discuss tree level scattering of massless open superstring states on a worldsheet of disk topology – for any number of external legs. The entire state dependence of these disk amplitudes can be expressed in terms of gauge theory subamplitudes from the point particle limit. The string corrections entering through momentum dependent integrals over the disk boundary can be disentangled from the Yang-Mills seeds and analyzed separately. Their power series expansion in the string length and momenta involves multiple zeta values (MZVs). We briefly review some mathematical background on MZVs and the network of relations between them.

As the main result of the talk, the explicit form of any tree level string correction to YM theory is derived from the generating function of MZVs – the Drinfeld associator. It interpolates between the worldsheet integrals in N-point and (N-1)-point scattering and leads to a recursive formula for the momentum expansion of any disk amplitude. The analysis is valid for any number of spacetime dimensions or supersymmetries and chosen helicity configurations.

Plenary Session / **50**

t t* geometry in 3 and 4 dimensions

Plenary Session / **51**

Resurgence and quantum field theory

Corresponding Author: gerald.dunne@uconn.edu

"Resurgent" semiclassical analysis, a systematic unification of perturbative and non-perturbative sectors, can be applied to resolve fundamental problems in quantum theories with degenerate minima. Expansions about different saddle points are quantitatively related to one another in a precise manner. Illustrations include double-well and periodic potentials in QM, and asymptotically free QFTs such as CPN and Yang-Mills, where this resurgent approach yields a new semiclassical interpretation of IR renormalons.

Plenary Session / **52**

Lattice QCD: Successes and Challenges

Corresponding Author: wittig@kph.uni-mainz.de

Plenary Session / **53**

N=4 super Yang-Mills on a lattice

Plenary Session / **54**

RG Flows, Entanglement and Holography

Corresponding Author: rmyers@perimeterinstitute.ca

Plenary Session / **55**

On Scale and Conformal Invariance in Four Dimensions

Corresponding Author: zohar.komargodski@weizmann.ac.il

Plenary Session / **56**

Non-pertutbative effects in large N theories and strings

Corresponding Author: marcos.marino@unige.ch

Plenary Session / **57**

Supersymmetric dualities and partition functions

Corresponding Author: razamat@ias.edu

Plenary Session / **58**

SUSY Musings

Corresponding Author: jjaeckel@thphys.uni-heidelberg.de

Plenary Session / **59**

Volume (in) - dependence in Large N gauge theories

Corresponding Author: antonio.gonzalez-arroyo@uam.es

HEINRICH HERTZ LECTURE / **60**

The String Magic

Plenary Session / **61**

Flux-tube S-matrix and Spacetime S-matrix in planar N=4 SYM theory

Plenary Session / **62**

The quark-antiquark potential in N=4 SYM and other observables from integrability

Corresponding Author: nadav.drukker@kcl.ac.uk

Plenary Session / **63**

Weyl symmetry and the structure of 4D RG flows

Corresponding Author: riccardo.rattazzi@epfl.ch

Plenary Session / **64**

The gradient flow and the determination of \alpha_s

Corresponding Author: alberto.ramos@desy.de

Plenary Session / **65**

Infrared conformal gauge theories on the lattice

Corresponding Author: kari.rummukainen@helsinki.fi

Plenary Session / **66**

Energy flow at colliders: from QCD to N=4 SYM and back

Plenary Session / **67**

The disk entanglement entropy of 3d Maxwell theory

Plenary Session / **68**

Scale Invariance Implies Conformal Invariance in 4D Quantum Field Theory

Plenary Session / **69**

Two-dimensional models on the world sheet of non-Abelian strings

Corresponding Author: shifman@umn.edu

70

tba

71

Closing

72

(no title)

73

(no title)

74

(no title)

75

(no title)

76

(no title)

77

(no title)

78

(no title)

79

(no title)

80

(no title)

81

(no title)

82

(no title)

83

(no title)

84

(no title)

85

(no title)

86

(no title)

Parallel Session 3: Strings & Mathematical Physics / 87

Resurgence at work in the Principal Chiral Model

Author: Daniele Dorigoni[1]

[1] *DAMPT Cambridge*

Corresponding Author: daniele.dorigoni@gmail.com

Also in theories without instantons non-perturbative saddle points play a crucial role. Using the example of the 2d principal chiral model we show how resurgence theory, which unifies perturbative and non-perturbative physics, predicts the existence of several types of non-perturbative saddles: the fractons. With these new saddles is possible to understand the quantum interpretation of unstable classical solutions called unitons. We explain also how these fractons lead to a semi-classical realization of IR renormalon and yield the generation of the mass gap. We will conclude with some remarks on integrability and localization.

88

(no title)

89

(no title)

90

(no title)

Parallel Session 1: Phenomenology / 91

Composite quark partners in composite Higgs models at LHC

Author: Thomas Flacke[1]

[1] *Korea Advanced Institute of Science and Technology (KAIST)*

Composite Higgs models represent an attractive extension of the Standard Model of particle physics, providing a solution to the hierarchy problem. The Higgs-like particle is realized as a bound state of a strongly coupled sector. This implies the existence of further bound states at the TeV scale, which can be searched for at the LHC. In this talk we focus on the composite quark partners, i.e. fermionic SU(3) charged states which mix with the Standard Model quarks. We show how the partners of the first,second, and third family quarks are produced at the LHC, and how they decay. Thus, we identify the best search channels for the composite quarks in composite Higgs models.
We find that those channels strongly differ for first, second, and third family partners. To obtain bounds on the model, we combine several recent ATLAS and CMS searches.
We find that up- and top-partners are stronger constrained by the current ATLAS and CMS analyses, whereas the mass bound on charm-partners lies at only 550 GeV.

Parallel Session 1 + 2: Particle Phenomenology and Cosmology & Astroparticle Physics / 92

Strong Electroweak Phase Transition in the MSSM-like Parameter Space

Author: Germano Nardini[1]

[1] *Bielefeld*

Corresponding Author: germano@ifae.es

In order to explain the observed baryon asymmetry of the Universe, electroweak baryogenesis requires that the electroweak symmetry breaking occurred via a strong first-order phase transition. As proven more than a decade ago for a (lighter CP-even) Higgs mass m_h <~ 100 GeV, such a condition is fulfilled in the MSSM if the right-handed stop is very light. Recently, the same conclusion was reached for the case m_h ~ 126 GeV by means of two different approaches: lattice simulations and perturbation theory. In this talk we will review these results. Some brief comments on the experimental status of the model will be also provided.

93

Nekrasov backgrounds from N=2 string amplitudes

Author: Ioannis Florakis[1]

[1] *MPI Physik*

I will present a new class of N=2 amplitudes in string theory, generalizing the well-known F-terms which compute the topological string theory partition function. These generalized F-terms involve, in addition to the standard anti-self-dual graviphoton background, additional insertions of self-dual vertices. The latter can be identified, using the non-trivial constraint that the correct N = 2

gauge theory partition function be recovered in the field theory limit, both perturbative and non-perturbatively. The structure of the amplitudes opens up the possibility of expressing them as correlators in a topological string theory, hence leading to a worldsheet definition of the refined topological string.

Parallel Session 3: Strings & Mathematical Physics / 94

Nekrasov backgrounds from N=2 string amplitudes

Author: Ioannis Florakis[1]

[1] *MPI Physik*

Corresponding Author: florakis@mppmu.mpg.de

I will present a new class of N=2 amplitudes in string theory, generalizing the well-known F-terms which compute the topological string theory partition function. These generalized F-terms involve, in addition to the standard anti-self-dual graviphoton background, additional insertions of self-dual vertices. The latter can be identified, using the non-trivial constraint that the correct N = 2 gauge theory partition function be recovered in the field theory limit, both perturbative and non-perturbatively. The structure of the amplitudes opens up the possibility of expressing them as correlators in a topological string theory, hence leading to a worldsheet definition of the refined topological string.

95

welcome address