YTF 21

Thursday, December 16, 2021 - Friday, December 17, 2021

Centre for Particle Theory, Durham

Book of Abstracts

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Introductory address

Corresponding Author: ryan.i.moodie@durham.ac.uk

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Plenary speaker talk

Author: Ruth Gregory[None]

Corresponding Author: connor.armstrong@durham.ac.uk

Return of the String

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Goodbye address

Corresponding Author: dorian.w.praia-do-amaral@durham.ac.uk

Full-length talks / 122

$Hb\bar{b}$ production as an example of modern amplitudes calculations

Authors: Heribertus Bayu Hartanto[1]; Jakub Krys[2]; Simon Badger[3]; Simone Zoia[3]

[1] *University of Cambridge*

[2] *IPPP Durham*

[3] *Università di Torino*

Corresponding Author: jakub.m.krys@durham.ac.uk

In this talk, I present some of the modern techniques used in computation of scattering amplitudes. Using $Hb\bar{b}$ production as an example, I give an overview of the method and describe how computational bottlenecks can be overcome by using finite field reconstruction to obtain analytic expressions from numerical evaluations. I also show how the method of differential equations allows us to express the answers using a basis of special functions whose numerical values can be readily obtained at any point in phase space. Finally, I discuss the obstacles of loop computations and potential advances in the field.
This talk is based on arXiv:2107.14733

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Amplitudes

Full-length talks / **123**

Chiral models of composite axions and accidental Peccei-Quinn symmetry

Author: Filippo Revello[1]

[1] *University of Oxford*

Corresponding Author: filippo.revello@physics.ox.ac.uk

The QCD axion, based on the existence of the anomalous Peccei-Quinn (PQ) symmetry, realizes a remarkably simple and elegant solution to the strong CP problem, and is also a well-motivated dark matter candidate. However, hiding behind the apparent simplicity, explicit realizations are extremely sensitive to PQ-violating effects in the UV, which can destabilize the axion potential and spoil the original mechanism. Since global symmetries are always expected to be broken by Quantum Gravity, such effects appear rather generically: this is known as the axion quality problem. In this talk, we introduce a class of composite axion models where the PQ symmetry is not only accidental, but also naturally protected from higher dimensional operators by the gauge dynamics. The axion emerges as the NGB of a strongly-interacting, chiral sector with no fundamental scalars, where all mass scales are generated dynamically. The models can be easily embedded in a Grand Unified Theory; we shall discuss the case of non-supersymmetric SU(5), and possibly SO(10). From a wider perspective, we also clarify the selection-rules under which higher dimensional PQ violating operators can generate a potential for the axion in the IR, which can be of general interest for composite axion models based on a QCD-like confining gauge group.

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Phenomenology

Full-length talks / **124**

Quantum computing approaches for simulating parton showers in high energy collisions

Author: Simon Williams[1]

[1] *Imperial College London*

Corresponding Author: s.williams19@imperial.ac.uk

The interpretation of measurements from high energy collisions at experiments like the Large Hadron Collider (LHC) relies heavily on the performance of full event generators, specifically their accuracy and speed in simulating complex multi-particle final states. With the rapid and continuous improvement in quantum computers, these devices present an exciting opportunity for high energy physics. Dedicated quantum algorithms are needed to exploit the potential that quantum computers can provide. In this talk, I will present general and extendable quantum computing algorithms for the simulation of the parton shower in a high energy collision. The algorithms utilise the quantum nature of the parton shower calculation, and the quantum device's ability to remain in a quantum state throughout the computation, to efficiently perform the simulation. Furthermore, it will be shown that reframing the parton shower in the quantum walk framework dramatically improves the performance of the parton shower simulation, increasing the number of shower steps that can be simulated, whilst reducing the required Quantum Volume on the device. These algorithms are the first step towards simulating a full and realistic high energy collision event on a quantum computer.

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QCD

Full-length talks / **125**

A stochastic approach to scalar correlators in cosmological de Sitter

Authors: Archie Cable[1]; Arttu Rajantie[1]

[1] *Imperial College London*

Corresponding Author: archie.cable18@imperial.ac.uk

The study of scalar correlation functions in de Sitter spacetime is important to develop our understanding of the inflationary epoch. However, the standard procedure of QFT in a curved spacetime can only be used in a regime where the fields are sufficiently massive. This is because light self-interacting scalar fields cause perturbation theory to break down due to infrared divergences. This leads us to develop effective theories, one of which - the stochastic approach - will be the subject of this talk. In a nutshell, the stochastic approach approximates quantum behaviour as a statistical correction to the classical equations of motion. This allows the theory to be cast as a purely statistical problem, leading to statistical correlation functions. The question that I will pose and attempt to answer is: are these stochastic correlators an appropriate replacement for their quantum counterparts?

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Cosmology

Full-length talks / **126**

Constructing The Standard Model from String Theory

Author: Thomas Harvey[1]

Co-authors: Andrei Constantin [1]; Steve Abel [2]; Andre Lukas [1]

[1] *University of Oxford*

[2] *University of Durham*

Corresponding Author: thomas.harvey@balliol.ox.ac.uk

The oldest, and one of the most promising, attempts of connecting string theory to low energy physics has been the compactification of $E_8 \times E_8$ Heterotic string theory on Calabi-Yau 3-folds.

In this talk I will (attempt to) give a pedagogical overview of such constructions, and string model building in general. The talk will then finish with a discussion of recent work, where modern computational methods (specifically reinforcement learning and genetic algorithms) have been applied to finding realistic models within these environments.

https://inspirehep.net/literature/1906415
https://inspirehep.net/literature/1953720

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Strings

129

2-Group Symmetries in 6d

Authors: Dewi Gould[1]; Fabio Apruzzi[None]; Lakshya Bhardwaj[None]; Sakura Schafer-Nameki[None]

[1] *University of Oxford*

Corresponding Author: gouldd@maths.ox.ac.uk

2-group symmetries arise when the discrete 1-form symmetry and continuous flavor symmetry group of a theory mix with each other. We uncover such symmetries in 6d superconformal field theories and carry out a classification.

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Strings

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Full-length talks / **130**

Indirect detection of long-lived particles via a less-simplified dark Higgs portal

Author: Krzysztof Jodlowski[1]

[1] *National Centre for Nuclear Research*

Corresponding Author: krzysztof.jodlowski@ncbj.gov.pl

Simplified models of light new physics are an important theoretical and experimental benchmark. Models that extend minimal scenarios by introducing other degrees of freedom are well motivated ways to go beyond the Standard Model (SM). In this talk, I will focus on the light dark Higgs portal that connects the dark sector consisting of, e.g., TeV-scale secluded dark matter (DM) with the SM. I will illustrate the phenomenology of this model, focusing on the signatures of DM and long-lived particles (LLP) in complementary experimental searches. These include i) the intensity frontier searches for light new physics, ii) indirect detection (ID) of secluded WIMPs, and iii) future CMB radiation surveys. Finally, I will highlight the important role of non-local effects present in the ID of LLPs which significantly affects the detection strategies, usually tailored to WIMPs. These effects include a) an additional contribution to the photon flux due to the "GC diffusion" effect, b) a linear flux decrease in the long-lived regime due to finite DM density support, and c) a faster flux decrease with LLP decay length for observations focused on small regions of interest, compared to large ones.

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Astroparticle

131

Indirect detection of long-lived particles via a less-simplified dark Higgs portal

Author: Krzysztof Jodlowski[1]

[1] *National Centre for Nuclear Research*

Corresponding Author: krzysztof.jodlowski@ncbj.gov.pl

In this poster I will present recent paper dedicated to indirect detection of long-lived particles in a light dark Higgs portal. I will illustrate the phenomenology of this model, focusing on the signatures of DM and long-lived particles (LLP) in complementary experimental searches. These include i) the intensity frontier searches for light new physics, ii) indirect detection (ID) of secluded WIMPs, and iii) future CMB radiation surveys. Finally, I will highlight the important role of non-local effects present in the ID of LLPs which significantly affects the detection strategies, usually tailored to WIMPs. These effects include a) an additional contribution to the photon flux due to the "GC diffusion" effect, b) a linear flux decrease in the long-lived regime due to finite DM density support, and c) a faster flux decrease with LLP decay length for observations focused on small regions of interest, compared to large ones.

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Astroparticle

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The following fields are only relevant for spoken talks (not poster presentation).:

Full-length talks / 132

Primordial black hole formation with full numerical relativity

Authors: Eloy de Jong[1]; Eugene Lim[1]; Josu C. Aurrekoetxea[1]

[1] *King's College London*

Corresponding Author: eloy.dejong@kcl.ac.uk

I will talk about studying the formation of black holes from subhorizon and superhorizon perturbations in a matter dominated universe with 3+1D numerical relativity simulations. We find that there are two primary mechanisms of formation depending on the initial perturbation's mass and geometry – via direct collapse of the initial overdensity and via post-collapse accretion of the ambient dark matter. In both cases, the duration of the formation the process is around a Hubble time, and the initial mass of the black hole is $M_{BH}\ 10^{-2}H^{-1}M_{\rm Pl}$. Post formation, we find that the PBH undergoes rapid mass growth beyond the self-similar limit $M_{BH} \propto H^{-1}$, at least initially. We argue that this implies that most of the final mass of the PBH is accreted from its ambient surroundings post formation.

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Gravity

Full-length talks / **133**

EW Sudakov logarithms and their implementation in OpenLoops

Author: Lorenzo Mai[None]

Corresponding Author: l.mai@sussex.ac.uk

In the energy range above the electroweak (EW) scale the leading contributions coming from EW radiative corrections have a logarithmic nature: they can be both double (DL) or single (SL) logs and they are generally known as Sudakov logarithms. These terms increase with energy and they can provide corrections of order 10% or larger for scales of 1 TeV and beyond; therefore, it is crucial to take them properly into account for precise studies and predictions.
For processes which are not mass-suppressed at high energies, these corrections are universal and factorize, i.e. they can be associated with external lines. In this talk I will explain how in my research project I am working to implement such corrections in the OpenLoops framework, starting from a tree amplitude and generating the corresponding one with double pseudo-counterterms insertions which can account for the Sudakov factors.

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Phenomenology

Full-length talks / **134**

Gravity at the Tip of the Throat

Author: Bruno Bento[1]

[1] *University of Liverpool*

Corresponding Author: bruno.bento@liverpool.ac.uk

Warped throats have been a major tool in trying to connect string theories with our 4d Universe, in particular for their ability to suppress high energy scales.
An explicit description of such a throat (the deformed conifold) can be used to perform explicit computations to determine how the throat affects gravity in 4d.
In this talk I will briefly show how a tower of massive graviton modes arises in the 4d theory and describe some effects of warping on gravity were we to live on a 3 dimensional brane at the tip of the throat, focusing on corrections to the Newtonian gravitational potential.

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Gravity

Full-length talks / **135**

Light inflaton model in a metastable Universe

Authors: Abigail Keats[1]; Fedor Bezrukov[1]

[1] *University of Manchester*

Corresponding Author: abigail.keats@postgrad.manchester.ac.uk

We minimally extend the Standard Model (SM) with a Z_2 symmetric potential containing a single scalar field, serving as our inflaton with a quartic self-coupling. In the model we have symmetry breaking in both sectors, and with the addition of an inflaton-Higgs portal, the Universe is able to efficiently reheat via 2-2 inflaton-Higgs scattering. Assuming that the Universe with a positive cosmological constant should be metastable, only one particular symmetry breaking pattern in the vacuum is possible, without the need to finely-tune the Higgs quartic self-coupling. Inflatons with masses in the range $O(10^{-3}) \leq m_\chi \leq m_h$ and mixing angles that span $\theta_m^2 = O(10^{-11} - 10^{-2})$

evade all current cosmological, experimental and stability constraints required for a metastable electroweak (EW) vacuum. Upgraded particle physics experiments may be able to probe the parameter space with $\theta_m^2 \geq O(10^{-4})$, where we would observe trilinear Higgs couplings suppressed by up to 2% compared to the SM value. However to access the parameter space of very weakly-coupled inflaton, we rely on the proposals to build experiments that target the hidden sector.

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Beyond the Standard Model

Full-length talks / **136**

A comparison of spectral reconstruction methods applied to non-zero temperature NRQCD meson correlation functions

Author: Thomas Spriggs[1]

Co-authors: Chris Allton [1]; Ben Page [1]; Gert Aarts [2]; Timothy Burns [1]; Rachel Horohan D'Arcy [3]; Benjamin Jäger [4]; Seyong Kim [5]; Maria-Paola Lombardo [6]; Sam Offler [1]; Sinead Ryan [7]; Jon-Ivar Skullerud [3]

[1] *Department of Physics, Swansea University*

[2] *Department of Physics, Swansea University and European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT*) & Fondazione Bruno Kessle*

[3] *Department of Theoretical Physics, National University of Ireland Maynooth, County Kildare, Ireland*

[4] *CP3-Origins & Danish IAS, Department of Mathematics and Computer Science, University of Southern Denmark*

[5] *Department of Physics, Sejong University*

[6] *INFN, Sezione di Firenze,*

[7] *Trinity College Dublin*

Corresponding Author: 996870@swansea.ac.uk

We present results from the fastsum collaboration's programme to determine the spectrum of the bottomonium system as a function of temperature. Three different methods of extracting spectral information are discussed: a Maximum Likelihood approach using a Gaussian spectral function for the ground state, the Backus Gilbert method, and the Kernel Ridge Regression machine learning procedure. We employ the fastsum anisotropic lattices with 2+1 dynamical quark flavours, with temperatures ranging from 47 to 375 MeV.

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Lattice QCD

Gong show talks / **137**

Dynamics of Non-Supersymmetric Chiral Gauge Theories and Duality

Author: Kaan Onder[1]

[1] *University of Cambridge*

Corresponding Author: kaan@onder.net

With no Monte Carlo safety net, a proper understanding of the strong coupling dynamics of chiral gauge theories remains elusive. I will present some possible non-supersymmetric dualities between chiral/vector-like theories and comment its implications.

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Non-Peturbative QFT

Full-length talks / **138**

A Good and Fun way to lift Supergravity Moduli

Author: George Smith[1]

[1] *Imperial College London*

Corresponding Author: grs19@ic.ac.uk

Moduli in Supergravity compactifications are fields which parameterise properties of the compactificaiton space such as its volume or the size of its cycles. If the effective field theory potential is degenerate in the moduli directions then these moduli appear as massless scalars in the effective theory for which there is no experimental evidence. More seriously if the moduli have no VEV the

theory cannot be used to make any predictions at all. Most concrete compactification results come from setting the theories fluxes to zero and so produce effective theories with a large number of massless scalars. Allowing the flux to be non-zero produces a potential for the moduli and a more phenomenologically realistic effective theory. In this talk we produce a more natural and rigorous way to calculate the number of remaining moduli which involves flows on infinite dimensional spaces.

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Strings

Full-length talks / **139**

Type II Calabi-Yau compactifications in general spacetime signature

Author: Maxime Médevielle[1]

Co-authors: Giacomo Pope ; Thomas Mohaupt [1]

[1] *University of Liverpool*

Corresponding Author: maxmedevielle@gmail.com

String Theory is a web of perturbatively defined 10 dimensional theories related to each other by various dualities such as “T-duality”. When considering a “timelike” T-duality we uncover theories that realize all spacetime signatures.

In this talk, I will motivate the study of dynamic spacetime signature in a quantum gravity context and present the theories obtained in 4 dimensions when compactifying these exotic theories on a Calabi-Yau manifold, as well as the web of dualities relating them.

I will also give an introduction to the “Special geometry” of the scalar sector and, if time permits, I will describe how this formalism allows one to relate certain black hole solutions to cosmological ones.

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Strings

Full-length talks / **140**

Cosmological and quantum gravity applications of quantum Riemannian geometry on polygons

Author: Julio Narciso Argota Quiroz[1]

[1] *Queen Mary University of London*

Corresponding Author: julio.argota@gmail.com

The idea that space-time could be better modeled due to quantum gravity effects by non-commutative coordinates or 'quantum spacetime' is widely accepted as a possibility and is a cornerstone of the formalism of Quantum Riemmanian Geometry (QRG). This formalism allows to address issues related to unification of quantum theory and gravity in a systematic way. Using the QRG approach we fully solve the quantum geometry of Z_n as a polygon graph with arbitrary metric square-length on the edges. The quantum cotangent bundle is 2-dimensional and a generic metric has curvature. The correlation functions for small n of the Euclanized quantum gravity are given for this model. As another toy application, we develop a FLRW model on RxZ_n finding the same radial expansion as in the classical 1+2 model. Finally, we use the adiabatic approximation in order to find the conditions under which there is no cosmological particle creation.

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Cosmology

Full-length talks / **141**

Hilbert series techniques in quantum field theory

Author: Mohammad Akhond[1]

[1] *Swansea University*

Corresponding Author: akhondmohammad@gmail.com

I will say some general things about the Hilbert series associated to the moduli space of a supersymmetric QFT. I will then discuss the physical information one can extract from the Hilbert series.

The following fields are only relevant for spoken talks (not poster presentation).:

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SUSY

Full-length talks / **142**

Scheme Dependence in pQCD at the Four Loop Level

Author: Robert Mason[None]

Corresponding Author: robert.mason@liverpool.ac.uk

Explaining data from particle colliders relies on understanding the underlying quantum field theories, such as Quantum Chromodynamics (QCD) for processes involving the strong force. Measurable quantities in perturbative QCD are represented by series in the interaction coupling constant. The renormalization process introduces an ambiguity into calculations leading to multiple schemes for calculating the same measurable. Each scheme should result in the same ultimate value for the physical observable, however in practice the series is truncated to a finite order meaning each scheme expression is only an approximation of the true quantity. Therefore an error must be constructed to describe the uncertainty introduced through truncation. This talk discusses the use of scheme dependence as a measure of error at the four-loop level in massless pQCD concentrating on the R-Ratio and the Bjorken sum rule in various kinematic schemes and in particular the symmetric MOM schemes.

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QCD

Full-length talks / **143**

Fifth forces in scalar-tensor theories and how to avoid them

Author: Sergio Sevillano Muñoz[1]

Co-authors: Peter Millington [1]; Ed Copeland [1]

[1] *University of Nottingham*

Corresponding Author: ppyss8@nottingham.ac.uk

The Einstein-Hilbert action is well known as the standard choice when model-building theories of gravity. However, couplings between scalar fields and the space-time curvature regularly arise in string theory and cannot be avoided when RG running standard theories of gravity in the presence of additional scalar fields. The resulting theories are usually referred to as scalar-tensor theories and generally exhibit fifth forces. In this talk, I will show that, by treating the symmetries of the modified action consistently, we can perturb the gravitational sector in the weak-field limit and calculate scattering amplitudes directly in the so-called Jordan frame. By studying the linearised Lagrangian, we can then understand the origin of fifth forces and show the pivotal role that scale symmetries play in determining the strength of their couplings to matter, thereby allowing certain models to evade experimental tests of gravity.

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Phenomenology

Full-length talks / **144**

Cosmology of a new class of massive vector fields

Author: VICTOR POZSGAY[1]

[1] *Imperial College London*

Corresponding Author: v.pozsgay19@imperial.ac.uk

I will start by presenting existing classes of massive vector fields before moving on to the new Extended Proca-Nuevo, a non-linear theory of a massive spin-1 field that enjoys a non-linearly realized constraint that distinguishes it among other generalized vector models. I will show how this theory builds a (partial) bridge between the equivalent Generalized Proca and Proca Nuevo while exploring a new portion of the space of massive vector models. I will then prove that the theory may be covariantized in models that allow for consistent and ghost-free cosmological solutions. This model describes the correct number of dynamical variables in the presence of perfect fluid matter. I will finally exhibit, in a specific set-up, explicit hot Big Bang solutions featuring a late-time self-accelerating epoch, and which are such that all the stability and subluminality conditions are satisfied and where gravitational waves behave precisely as in General Relativity.

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Cosmology

145

SM Effective Field Theory analyses of LHC processes

Authors: Marion Thomas[1]; Claudio Severi[1]

[1] *University of Manchester*

Corresponding Authors: claudio.severi@postgrad.manchester.ac.uk, marion.thomas-3@postgrad.manchester.ac.uk

The Standard Model Effective Field Theory (SMEFT) is an almost model-independent extension of the Standard Model. The only assumptions are that the new physics is heavy and consistent with known symmetries. This poster presents two examples of SMEFT analyses relevant to LHC experiments. In particular, we focus on modifications of the tth vertex in gg > ZZ, a process relevant in Higgs/top physics. We also study anomalous top spin correlations induced by a top dipole moment.

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Beyond the Standard Model

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Full-length talks / 146

Fueling the search for light dark matter-electron scattering

Authors: Christopher McCabe[1]; Louis Hamaide[None]

[1] *King's College London*

Corresponding Author: louis.hamaide@kcl.ac.uk

Dark matter (DM) detectors employing a Spherical Proportional Counter (SPC) have demonstrated a single-electron detection threshold and are projected to have small background rates. We explore

the sensitivity to DM-electron scattering with SPC detectors in the context of DarkSphere, a proposal for a 300 cm diameter fully-electroformed SPC. SPCs can run with different gases, so we investigate the sensitivity for five targets: helium, neon, xenon, methane, and isobutane. We use tools from quantum chemistry to model the atomic and molecular systems, and calculate the expected DM induced event rates. We find that DarkSphere has the potential to improve current exclusion limits on DM masses above 4 MeV by up to five orders of magnitude. Neon is the best all-round gas target but using gas mixtures, where methane and isobutane constitute 10% of the gas, can improve the sensitivity, especially when combined with helium. Our study highlights the currently untapped potential of SPCs to search for DM-electron scattering in the MeV-to-GeV DM mass range.

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Could you please give the most relevant category for your talk?:

Phenomenology

Gong show talks / **148**

QED real corrections in Sherpa

Author: Lois Flower[1]

[1] *IPPP*

Corresponding Author: lois.flower@durham.ac.uk

In this talk I will present my work implementing QED real corrections in the Sherpa event generator. Using the Catani-Seymour dipole formalism, a kT-ordered QED parton shower was constructed. The correct radiation pattern was obtained by applying negative weights to same-charge dipoles using the existing framework for applying analytic weights in the veto algorithm. Results are presented for an interleaved QCD+QED shower.

The following fields are only relevant for spoken talks (not poster presentation).:

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Phenomenology

Full-length talks / 149

Searching for dark-matter waves with pulsar polarimetry

Author: Jorge Terol Calvo[1]

[1] *Instituo de Astrofísica de Canarias (IAC)*

Corresponding Author: jorgetc@iac.es

In this talk I will explain how the polarization of photons emitted by astrophysical sources might be altered as they travel through a medium of dark matter composed of ultra light axion-like particles (ALPs). I will describe a new, more robust, analysis we delevoped to search for this effect. Afterwards, I will show the resulting strong limits on the axion-photon coupling for a wide range of masses. Finally, I will comment on possible optimal targets and the potential sensitivity to axionic dark-matter in this mass range that could be achieved using pulsar polarimetry in the future.

The following fields are only relevant for spoken talks (not poster presentation).:

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Astroparticle

Full-length talks / 150

Three-loop helicity amplitudes for diphoton production in gluon fusion

Author: Piotr Bargiela[1]

[1] *University of Oxford*

Corresponding Author: piotr.bargiela@physics.ox.ac.uk

We present a calculation of the helicity amplitudes for the process $gg \to \gamma\gamma$ in three-loop massless QCD. We employ a recently proposed method to calculate scattering amplitudes in the 't Hooft-Veltman scheme that reduces the amount of spurious non-physical information needed at intermediate stages of the computation. Our analytic results for the three-loop helicity amplitudes are remarkably compact, and can be efficiently evaluated numerically. This calculation provides the last missing building block for the computation of NNLO QCD corrections to diphoton production in gluon fusion.

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Amplitudes

Full-length talks / **151**

Unoriented dualities from brane tiling

Author: Salvatore Mancani[1]

Co-authors: Andrea Antinucci [2]; Massimo Bianchi [3]; Fabio Riccioni [4]

[1] *Università di Roma La Sapienza*

[2] *SISSA*

[3] *INFN Roma2, Università di Roma Tor Vergata*

[4] *INFN Roma1, Università di Roma La Sapienza*

Corresponding Author: mancanisalvo@gmail.com

In the context of AdS/CFT, brane tiling allows us to construct the dual gauge theories associated with toric geometries. Studying the orientifold projection of such gauge theories and their conformal points via a-maximization, we show that for three infinite families of theories the projection reduces the degrees of freedom by more than a half and that these families are related by a web of dualities.

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Strings

Full-length talks / **153**

Holomorphic Modular Bootstrap

Authors: Arpit Das[1]; Chethan N. Gowdigere[2]; Jagannath Santara[2]

[1] *Durham University*

[2] *National Institute of Science Education and Research*

Corresponding Author: arpit.das@durham.ac.uk

In this talk, we shall discuss a classification scheme, called holomorphic modular bootstrap, for classifying Rational Conformal Field Theories (RCFTs) using the Modular Linear Differential Equations (MLDEs) their characters (which are the holomorphic factors of their torus partition functions) satisfy. This is a classification scheme based on two parameters (n,l) where n is the number of linearly independent characters of the RCFT (which is also the order of the MLDE) and l is related to the order of the zeros of the Wronskian of the MLDE. We shall see how almost all known RCFTs (say for example the Ising model at criticality) can be classified in this scheme. In particular, we will present some new results on (3,0) RCFTs. Furthermore, we shall also discuss some simple novel results concerning WZW CFTs.

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Could you please give the most relevant category for your talk?:

Non-Peturbative QFT

Gong show talks / 154

Higher-form symmetry, chiral magnetohydrodynamics, and holography

Authors: Arpit Das[1]; Nabil Iqbal[1]; Ruth A. W. Gregory[2]

[1] *Durham University*

[2] *King's College London*

Corresponding Author: arpit.das@durham.ac.uk

In this talk, we shall discuss the finite temperature physics of a magnetohydrodynamic chiral plasma. This can be understood as a system with an axial $U(1)_A$ current that is afflicted by an Adler-Bell-Jackiw (ABJ) anomaly, where the corresponding vector $U(1)_V$ current has been coupled to dynamical electromagnetism. In modern language, the system has a 1-form global symmetry associated with the conservation of magnetic flux and the global axial 0-form symmetry is broken by the ABJ anomaly. We will study this problem by analyzing a holographic model with the above symmetry structure.

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Holography

Full-length talks / **155**

Precision Calculation in Theoretical Predictions

Author: Hang Yu[1]

[1] *University of Liverpool-Theoretical Physics*

Corresponding Author: louis287@liverpool.ac.uk

The precision-imporved theoretical prediction plays a crucial rules in matching with the experiment result and test new physics. Our project is currently computing the 3-loop QCD correction to neutral kaon oscillation $\bar{s}d \to s\bar{d}$ amplitude, which helps with testing the CP violation about in kaon decays. The process and some techniques (e.g. tetrahedron symmetries) are applied for dealing with huge number ($\sim 10^4$) of 3-loop diagrams. Some future plan about precision in $g-2$ is also presented in the end.

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Amplitudes

Full-length talks / **156**

Theoretical Frontiers in Neutrinoless Double-Beta Decay

Author: Graham Van Goffrier[1]

[1] *University College London*

Corresponding Author: vangoffrier@gmail.com

Neutrinoless double beta ($0\nu\beta\beta$) decay is a hypothetical process of crucial interest due to its sensitivity both to the neutrino mass scale and to lepton-number violation. The precision of searches for the

decay is largely constrained by disagreement between different many-body models for their nuclear matrix elements (NMEs), due in part to the large nuclei involved and the presence of correlated nucleon states. This talk will give an overview of two parallel strands of research: 1) a computational study of the impact of correlated NME errors on future $0\nu\beta\beta$ searches, via Bayesian methodologies; and 2) an analysis of corrections to a known leading-order contact contribution (in chiral EFT) to the $0\nu\beta\beta$ transition operator, including from the gluon vacuum condensate and from inelastic intermediate nuclear states.

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Non-Peturbative QFT

Full-length talks / **157**

Decomposition of Triple Collinear Splitting Functions

Authors: Nigel Glover[1]; Oscar Braun-White[2]

[1] *IPPP, Durham University*

[2] *IPPP Durham University*

Corresponding Author: oscar.r.braun-white@durham.ac.uk

In the kinematic region where three particles are collinear, the multi-parton scattering amplitudes factorise into a product of a triple collinear splitting function and a multi-parton scattering amplitude with two fewer particles. These triple collinear splitting functions contain both iterated single unresolved contributions, and genuine double unresolved contributions. We make this explicit by rewriting the known triple collinear splitting functions in terms of products of two-particle splitting functions, and a remainder that is explicitly finite in all single unresolved limits.

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QCD

Full-length talks / 158

Improved Constraints on Effective Top Quark Interactions using Edge Convolution Networks

Authors: Oliver Atkinson[1]; Akanksha Bhardwaj[1]; Stephen Brown[1]; Christoph Englert[1]; David J. Miller[1]; Panagiotis Stylianou[1]

[1] *University of Glasgow*

Corresponding Author: p.stylianou.1@research.gla.ac.uk

Reinterpreting the LHC results as bounds on the Wilson Coefficients (WCs) of the Standard Model Effective Field Theory (SMEFT) allows studying new-physics effects in a model-independent way. However the large number of effective interactions along with theoretical and experimental uncertainties often result in poor constraints on WCs that motivate the use of alternative techniques with more comprehensive extraction of information from data. In this presentation I will talk about constructing physics-inspired graphs from the final states of $pp \to t\bar{t}$ production with semi-leptonic top decays, and using Edge Convolution Neural Networks in order to condense the multidimensional phase space information. When a signal region is identified from the output of the neural network such that the SM contribution is minimised, the approach yields improvements on the bounds of WCs, compared to analyses on inclusive collision data employing differential distributions to measure deviations from the SM.

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Machine Learning

159

A Tale of Orientifolds: new unoriented dualities in the infrared

Author: Salvatore Mancani[1]

Co-authors: Andrea Antinucci [2]; Fabio Riccioni [3]; Massimo Bianchi [4]

[1] *Università di Roma La Sapienza*

[2] *SISSA*

[3] *INFN Roma1, Università di Roma La Sapienza*

[4] *INFN Roma2, Università di Roma Tor Vergata*

Corresponding Author: mancanisalvo@gmail.com

We study the orientifold projection of toric theories that can also be realised on elliptic models. From the prototypical cases of the orientifold of C^2/Z_3xC and SPP, we show that for three infinite

families of theories the projection reduces the degrees of freedom by more than a half and that these families are related by a web of dualities.

Could you please give the most relevant category for your talk?:

Strings

The following fields are only relevant for spoken talks (not poster presentation).:

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Full-length talks / **160**

Introduction to the Cosmic Neutrino Background

Author: Jack Shergold[1]

[1] *Durham University*

Corresponding Author: jack.d.shergold@durham.ac.uk

In the early universe, neutrinos are produced in equilibrium with the Standard Model plasma. As the universe cools these neutrinos freeze-out, and exist today as a thermal relic that we call the Cosmic Neutrino Background (CnuB). In this talk I will attempt to introduce the CnuB and derive its important properties, before giving a brief introduction to CnuB detection proposals.

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Astroparticle

Gong show talks / **161**

Energy transport by dark matter scattering in the Sun

Author: Hannah Banks[None]

Corresponding Author: hmb61@cam.ac.uk

Asymmetric dark matter (ADM) that is captured in the Sun can act as an efficient conductor of heat, causing observable modifications to properties of the Solar interior. The two formalisms commonly used to parametrise this phenomenon were developed over 30 years ago, and calibrated on single set of simulations. In this talk, I will present the results of new state-of-the-art Monte Carlo simulations of ADM mediated energy transport, including the first ever numerical exploration of interaction cross sections with velocity and momentum dependence. Based on simulation results, updated recommendations on the parametrisation of DM heat transport for inclusion in stellar evolution models will be given.

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Astroparticle

Full-length talks / **162**

Energy transport by dark matter scattering in the Sun

Author: Hannah Banks[None]

Corresponding Author: hmb61@cam.ac.uk

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Astroparticle

Full-length talks / 163

Lattice simulations of early universe first order deconfinement phase transitions

Author: David Mason[1]

[1] *University of Swansea*

Corresponding Author: 2036508@swansea.ac.uk

The detection of gravitational waves has opened an entirely new route to constrain new physics beyond the standard model. A promising direction of investigation is the analysis of gravitational waves produced by first order phase transitions in the early universe. The determination of the expected signatures requires precise measurements of the thermodynamic observables of the transition, such as the latent heat, which can be obtained in principle with numerical calculations on a lattice. In these calculations, a major challenge is the metastable dynamics near the phase transition, which leads to large and often uncontrolled numerical errors. In this talk, as a prototype lattice calculation, I will discuss the first order deconfinement transitions in the strong Yang-Mills sector of the standard model. I will use a novel lattice method, the logarithmic linear relaxation method, which provides a determination of the density of states of the system with exponential error suppression.This enables us to rebuild thermodynamic observables with a significantly smaller and controlled error, providing a promising direction for accurate model predictions.

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Lattice QCD

164

Charting the fifth force landscape

Author: Hannah Banks[None]

Corresponding Author: hmb61@cam.ac.uk

In recent years particle physics research has undergone somewhat of a phase transition, looking increasingly towards hidden sectors and the feebly interacting frontier. We introduce a new approach to parameterising dark sector forces, underpinned by the Källén-Lehman representation, in which the effects of any general scalar fifth force are captured by a single positive-definite spectral function. Using this language, we demonstrate how the effects of loop-level forces can be simply obtained,

without needing to explicitly perform loop calculations. We show how experimental observables can be expressed in completely general terms, facilitating the straightforward extraction of limits to any specific model. Finally, we see how this framework opens the possibility to speculatively probe violations of unitarity, causality or locality within hidden sectors.

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Beyond the Standard Model

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Gong show talks / **165**

Journeys through the moduli space using generalised geometry

Author: Stephanie Baines[1]

[1] *Imperial College London*

Corresponding Author: seb21@ic.ac.uk

The aim of this talk is to give the audience some understanding of Generalised Geometry and how it helps with the study of supergravity backgrounds in string theory and M-theory. I will set the stage by looking at a toy model of a 2 dimensional background spacetime with a GL(2, R) structure group before discussing a more realistic supergravity background with a non-trivial NS – NS flux. I will focus in particular on a simple application of Generalised Geometry in the context of the AdS distance conjecture proposed Lüst, Palti and Vafa in [1] to give the audience a flavour of how powerful this geometric approach can be.

[1] Dieter Lüst, Eran Palti, and Cumrun Vafa. Ads and the swampland. Physics Letters B, 797, 2019

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Gravity

166

Friday welcome

Corresponding Author: dorian.w.praia-do-amaral@durham.ac.uk

Gong show talks / **167**

Scattering Equations and Amplitudes in (Anti) de Sitter

Author: Connor Armstrong[1]

[1] *Durham University*

Corresponding Author: connor.armstrong@durham.ac.uk

We can use the scattering equations to describe and relate amplitudes from different theories, exposing hidden relations between them such as the double copy. These have now been generalised to describe some amplitudes outside flat space, in particular in de Sitter and Anti-de Sitter. I will briefly highlight and motivate some of these developments and talk about the parallels to flat space amplitudes.

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Amplitudes

Gong show talks / **168**

Primordial black holes in braneworld scenarios

Author: Itziar Aldecoa Tamayo[1]

[1] *University of Sussex*

Corresponding Author: ia318@sussex.ac.uk

Primordial black holes (PBHs) are not only a fascinating dark matter candidate, but, if detected, they would also be a probe of the very early universe. For these reasons, PBHs have been an object of study for decades and have been considered in multiple scenarios. We are currently studying their properties and evolution in braneworlds. PBHs with masses below a critical value differ from their (3+1)-dimensional counterparts in what refers to their geometry, accretion, spin and evaporation. Understanding these processes and how the current cosmological and astronomical constraints are affected by the introduction of extra dimensions and branes is the objective of our study.

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Cosmology

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Gong show talks / **169**

An Introduction to Causal Set Theory

Author: Ansh Bhatnagar[1]

[1] *IPPP*

Corresponding Author: ansh.bhatnagar@durham.ac.uk

Causal Set Theory (CST) is an approach to quantum gravity which asserts that spacetime is fundamentally a locally finite partially ordered set that encodes a causal ordering between elements. In this theory, the continuous manifold is simply an emergent phenomenon, with the discreteness of spacetime becoming significant at the Planck scale. In this talk I will review the causal sets programme, discuss the motivation for a discrete spacetime, and go through key developments such as potential mechanisms for causal set growth as well as the Benincasa-Dowker-Glaser action for causal sets.

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Gravity

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171

Introduction to Toric Geometry

Author: Richie Dadhley[None]

Corresponding Author: richie.s.dadhley@durham.ac.uk

Toric geometry is a part of algebraic geometry that often allows us to turn highly complicated geometric notions into almost trivial combinatoric games on a lattice. This poster aims to introduce the

very basics of toric geometry, in particular the notion of a fan, and show its usefulness when considering Calabi-Yau hypersurfaces in projective spaces. These Calabi-Yau hypersurfaces are typically quite tedious to compute from a differential geometry point of view, but, as we highlight, they are simple counting games in the realms of toric geometry.

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Strings

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172

test

Author: Guillaume Rostagni[1]

[1] *IPPP, Durham University*

Corresponding Author: guillaume.rostagni@durham.ac.uk

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