21st STRING PHENOMENOLOGY Conference

LIVERPOOL | 4 - 8 JULY 2022

	Monday	Tuesday	Wednesday	Thursday	Friday
08:15	Registration & Welcome				
Chair	Weigand	Hardy	Ruehle	Special Session	Bianchi
09:00	Shiu	Lüst	Taylor	In Memory of Graham Ross	Heckman
09:30	Grimm	Goodsell	Dudas		Wrase
10:00	Gray	Percival	Martucci		Basile
10:30	Coffee Break				
Chair	Tatar	Shiu	Nilles	Special Session	Abel
11:00	McAllister	Van Riet	Halverson	In Memory of Costas Kounnas	Zadeh
11:30	Cicoli	Sethi	Mavromatos		Zavala
12:00	Valenzuela	Acharya	Graña		Moritz
12:30	Lunch				
13:00					
13:30					
Chair	Groot Nibbelink		Dudas		Faraggi
14:00	Montero	Parallel Session I	Bianchi	Parallel Session III	Padilla
14:30	Ruehle		Conlon		Westphal
15:00	Weigand		Ovrut		Blumenhagen
15:30	Coffee Break				
Chair	Parameswaran		Sethi		
16:00	Hebecker	Parallel Session II	Soler	Parallel Session IV	
16:30	Groot Nibbelink		Andriot		
17:00	Marchesano		Schafer-Nameki		
17:30	Quevedo				
18:00	Welcome Reception	Refreshments			
18:30		Sustainability & Inclusion Panel Discussion			
19:00			Conference Dinner		
19:30					
20:00					

In Memory of Graham Ross	
Chair	Mavromatos
09:00	Ibáñez
09:30	Nilles
10:00	Lukas

In Memory of Costas Kounnas	
Chair	García Etxebarria
11:00	Antoniadis
11:30	Partouche
12:00	Cvetič

Parallel Session I				
Room	Theatre A	Theatre B	Theatre C	Theatre D
Chair	Van Riet	Blumenhagen	Quevedo	McAllister
14:00	Pellín	Angius	Apers	Oehlmann
14:20	Tascon	Makridou	Wiesner	Médevielle
14:40	Piantadosi	Huertas	Pasquarella	Ma
15:00	Brinkmann	Delgado	Saraswat	Kneissl

Parallel Session II				
Room	Theatre A	Theatre B	Theatre C	Theatre D
Chair	Valenzuela	Wrase	Cicoli	Angelantonj
16:00	Scalisi	Bernardo	Bento	Choi
16:20	Mora	Leedom	Villa	Friedrich
16:40	Etheredge	Rajaguru	Muia	Matyas
17:00	Lanza	Kokorelis	Stout	Nutricati
17:20	Kläwer	Schachner	Panizo	Tonioni
17:40	Calderon Infante		Laliberte	Tarazi

Parallel Session III				
Room	Theatre A	Theatre B	Theatre C	Theatre D
Chair	Hebecker	Padilla	Taylor	Heckman
14:00	Schreyer	Podo	Liu	Carta
14:20	Venken	Hughes	Li	Hosseini
14:40	Küspert	Mehta	Bies	Mininno
15:00	Emelin	Marsh	Turner	Gendler

Parallel Session IV				
Room	Theatre A	Theatre B	Theatre C	Theatre D
Chair	Martucci	Lukas	Zavala	Zadeh
16:00	Cribiori	Maiti	Anguelova	Svanes
16:20	Aalsma	Constantin	Kulkarni	Hurtado
16:40	Heidenreich	Harvey	Ruiz Garcia	Parra de Freitas
17:00	Collazuol	van de Heisteeg	Revello	Schlechter
17:20	Rodriguez	Monnee	Angus	Obied
17:40	Gonzalo	Herraez	Masias	Brodie

Scientific Programme

Monday 4^{th} July

Registration & Welcome – CTL & Theatre A

08:15 | Registration

08:45 | **Karl Coleman** – University of Liverpool

Opening Address

Plenary Session – Theatre A — Weigand

09:00 | **Gary Shiu** — University of Wisconsin

Amplitudes meet the Swampland

Unitarity and causality constraints on the S-matrix have led to a set of positivity bounds which constrain the Wilson coefficients of the low energy EFTs. I'll discuss how such positivity bounds when extended to gravitational theories can be used to substantiate swampland conjectures. I'll also show how we can turn the argument around and use swampland constraints to obtain new gravitational positivity bounds that are not known at present with amplitude techniques. I'll then present evidence for the axionic weak gravity conjecture using known positivity bounds. Finally, I'll show that axionic Euclidean wormholes, which have been used for setting the axionic weak gravity bound, are perturbatively stable. This settles a 25 year debate on whether such wormholes contribute as saddle points of the Euclidean path integral.

09:30 | **Thomas Grimm** — Utrecht University

Tameness and finiteness of string theory effective actions

In this talk I will introduce a generalized notion of finiteness and argue that it appears in all well-understood string theory effective theories and in perturbative QFTs. The underlying mathematical foundation is described by the tame geometry that is built from o-minimal structures. These remarkable structures originated in logic and have recently been used to prove many longstanding mathematics conjectures. I will propose a Tameness Conjecture that claims that consistent effective theories that can be coupled to gravity have to be tame. I sketch how tameness strengthens other swampland conjectures.

10:00 | **James Gray** — Virginia Tech

Target space duality and small instanton transitions between the gauge and (Co-)tangent bundles

I will discuss a spacetime perspective on target space duality, which relates seemingly rather disparate vacua of the heterotic string. I will present a geometrical view point wherein the link between dual pairs of compactifications entails small instantons being transferred between the gauge and the cotangent bundles of the string backgrounds. This somewhat exotic physics allows us to extend the duality to theories with M5 branes that would be rather hard to study directly from the original GLSM point of view.

Plenary Session – Theatre A — Tatar

11:00 | **Liam McAllister** — Cornell University

Flux Vacua and the Cosmological Constant

I will present a construction of vacua of string theory in which all moduli are stabilized and the magnitude of the cosmological constant is exponentially small. The vacua are supersymmetric AdS_4 solutions in type IIB compactifications on orientifolds of Calabi-Yau hypersurfaces. The vacuum energy is small because we ensure the exact cancellation of all perturbative contributions, through an explicit choice of integer parameters determined by the topology and quantized fluxes. The nonperturbative contributions that remain are exponential in these integers. I will comment on the difficult open problem of extending this approach to positive cosmological constants.

11:30 | **Michele Cicoli** — University of Bologna

String Theory and the Darkness

I will discuss recent developments in the understanding of the late-time dynamics of the dark side of string compactifications, focusing on dark matter, dark radiation and dark energy.

12:00 | **Irene Valenzuela** — IFT UAM-CSIC Madrid

Where do we live in the string landscape?

In this talk I will discuss the possibility that we live in an asymptotic region of the field space, corresponding to an infinite distance limit in which the cosmological constant goes to zero. I will present the motivation and implications of such a scenario, leading to a light infinite tower of states. The mass of this tower is correlated to the cosmological constant in a way that could differ from EFT naturalness expectations. I will also present ongoing work in which we analyse the possibility of having accelerated expansion at parametric control in the asymptotic limits of 4d $\mathcal{N} = 1$ flux compactifications. We identify some ways in which accelerated expansion might occur, unlike what previous works suggested.

Plenary Session – Theatre A — Groot Nibbelink

14:00 | **Miguel Montero** — Harvard University

A dark dimension and a new string theory

In the first part of the talk I will outline how, motivated by Swampland principles, the assumption that one is in an asymptotic region of moduli space leads to a unique corner of the string landscape, with one large extra dimension. I will discuss the experimental predictions of the scenario. In the second part of the talk, I will describe ongoing work on a new string theory with 16 supercharges, which lives in a new, separate component of moduli space.

14:30 | **Fabian Ruehle** — Northeastern University

Kähler Moduli Spaces, Geodesics, and Flops

We study geodesics in Kähler Moduli spaces of Calabi-Yau manifolds, flops, and relations to the swampland distance conjecture.

15:00 | **Timo Weigand** — University of Hamburg

The Tower Weak Gravity Conjecture and Weak Coupling Limits

We revisit the Tower Weak Gravity conjecture in four-dimensional $\mathcal{N} = 1$ supersymmetric string compactifications.

Plenary Session – Theatre A — Parameswaran

16:00 | **Arthur Hebecker** — Heidelberg University

Challenges and Phenomenological Opportunities for the LVS

After recalling the singular-bulk problem of KKLT, I will discuss why the LVS is facing a related challenge of parametric control. An in principle well-defined escape route is characterized by the "LVS parametric tadpole constraint". I will also discuss recent progress in understanding alpha-prime and loop corrections as well as some exciting observational opportunities related to the QCD axion and dark radiation. Finally, I will comment on a new idea concerning the measure problem of string landscape cosmology.

16:30 | **Stefan Groot Nibbelink** — Rotterdam UAS

Heterotic T-duality orbifolds

Investigations of the landscape of string vacua is an ongoing fascinating endeavour. An overwhelming portion of this research has focussed on geometrical compactifications. However, string theory admits various non-geometric constructions which defy a simple direct geometrical interpretation though they might constitute a large part of the landscape. Asymmetric orbifolds, where specific elements of the T-duality groups of the underlying tori are modded out, are particular useful examples in this direction as they admit exact CFT descriptions. In this talk connections of this approach with double field theory are discussed from worldsheet

and target space points of view. Various simple examples of T-duality orbifolds are considered in the heterotic setting from which some instructive lessons can be drawn.

17:00 | **Fernando Marchesano** — IFT UAM-CSIC Madrid

Progress in AdS_4 orientifold vacua

TBA

17:30 | **Fernando Quevedo** — University of Cambridge

TBA

TBA

Tuesday 5^{th} July

Plenary Session – Theatre A — Hardy

09:00 | **Dieter Lüst** — MPI Munich

Distance Conjectures and Primordial Black Holes as Dark Matter

Very recently, it was suggested that combining the Swampland program with the smallness of the dark energy leads to the prediction of the existence of a single extra-dimension with characteristic length-scale in the micron range. We show that the rate of Hawking radiation slows down for black holes perceiving the dark dimension and discuss the impact of our findings in assessing the dark matter fraction that could be composed of primordial black holes, demonstrating that an all-dark-matter interpretation in terms of primordial black holes should be indeed feasible.

09:30 | **Mark Goodsell** — LPTHE - CNRS Paris

Automating the link between strings and BSM

There are a handful of experimental anomalies that might have an explanation in terms of physics Beyond the Standard Model (BSM), and there are a huge number of experimental searches that can be used to constrain the same models. Those searches typically publish limits on not only specific models, but specific scenarios within a model. For a string phenomenologist to compare their favourite model to the data therefore requires a whole chain of tools and calculations. With the immense range of possible models and measurements this begs for automation and genericity. I will give an overview of the state of the art of this toolchain and describe my recent efforts to facilitate it, in particular regarding recasting long-lived particle searches, computations of the Higgs and W masses, an improved computation of the muon magnetic moment, and using active learning to

automate parameter space exploration.

10:00 | **Benjamin Percival** — University of Liverpool

Non-Supersymmetric Heterotic String Classification and Asymmetric Orbifolds

Within the free fermionic classification methodology of $\mathbb{Z}_2 \times \mathbb{Z}_2$ heterotic strings, different avenues towards Non-Supersymmetric models are discussed. The analysis of phenomenological criteria relating to the observable spectrum is aided by the novel application of SAT/SMT solvers which vastly improve on random generation methods of classification. Notably, these sophisticated solvers are capable of demonstrating no-go results relating to contradictory criteria. The adaptation of the classification tools to a class of Flipped SU(5) models with asymmetric shifts is further explained. It is shown how moduli fixing is realised and how different asymmetric shifts impact phenomenological features, such as having 3 particle generations. Distributions of the one-loop cosmological constant at the free fermionic point for samples of models are shown, with an eye towards a broader analysis across the moduli space of the one-loop potential.

Plenary Session – Theatre A — Shiu

11:00 | **Thomas Van Riet** — KU Leuven

Comments on AdS/KK scale separation

I will review some basic results of the last year(s) concerning the possibility of moduli stabilisation in scenarios where we can separate the AdS scale from the KK scale.

11:30 | **Savdeep Sethi** — University of Chicago

String solutions without supersymmetry

The first part of the talk will briefly overview some no-go results on the string landscape. The second part of the talk will describe a way to potentially evade those no-go results by building non-classical string solutions. Specifically, I will outline a strategy to construct non-supersymmetric string solutions. I will also describe an explicit AdS solution where various swampland conjectures can be examined.

12:00 | **Bobby Acharya** — ICTP Trieste

TBA

TBA

Parallel Session – Theatre A — Van Riet

14:00 | **Joan Quirant Pellín** — IFT UAM-CSIC Madrid

A tale of two non-SUSY DGKT vacua

Some aspects of non-SUSY massive type IIA compactifications on CY orientifold with fluxes will be studied. We focus on the AdS Instability conjecture and present some properties of the would-be CFT duals.

14:20 | **Andres Rios-Tascon** — Cornell University

Convergence of Worldsheet Instanton Corrections in AdS Flux Vacua

Constructing AdS flux vacua requires a variety of tools to find the appropriate flux data and validate the resulting vacuum. Among these, it is important to be able to enumerate non-perturbative corrections, which require the computation of Gopakumar-Vafa (GV) invariants. Our recent AdS construction relies on a racetrack formed by exponentially-suppressed contributions to the superpotential, where GV invariants play a key role. Furthermore, as part of our validation, we check the convergence of worldsheet instantons corrections to the Kahler potential. This is a difficult task to perform, as it requires the computation of GV invariants for models with a large number of moduli. In this talk I will discuss how we achieved this and justify why our construction is under good control.

14:40 | **Pellegrino Piantadosi** — University of Bologna

Effects of F^4-corrections on string inflation

In this talk I will discuss the higher-order F^4-corrections to the scalar potential in the context of type IIB string theory considering divisor topologies suitable for the ralization of the LVS model for moduli stabilization. I will focus on the effects that such corrections have on string inflationary models and, in particoular, on Fiber and Blow-up inflation. The results obtained will be compared with phenomenological observations and the conditions on the parameters of the model will be studied in order to preserve inflationary dynamics and make the picture consistent.

15:00 | **Max Brinkmann** — INFN Padua

Stringy quintessence models in the swampland

The embedding of accelerated expansion, in particular our past and present cosmology, in string theory remains an open problem in string phenomenology. Certain swampland conjectures place stringent bounds on such models. In this talk I will focus on multifield quintessence in the late universe, and the search for transients close to the cosmological parameters today. I will conclude that typical stringy models do not have observationally compatible trajectories, if one starts with matter-dominated initial conditions. I will also describe universal, compatible trajectories starting from early phases of kinetic domination, however these favorable initial conditions are harder to justify.

Parallel Session – Theatre B — Blumenhagen

14:00 | **Roberta Angius** — IFT UAM-CSIC Madrid

Dynamical Cobordisms in String Theory

At topological level the Cobordism conjecture states that the whole set of different backgrounds in Quantum Gravity is completely networked through interpolating configurations. This includes end-of-the world configurations in which the theory spacetime simply ends at a codimension 1 boundary, defining a Cobordisms to Nothing. In this talk, I will describe dynamical realizations of such configurations following an effective field theory approach in String Theory, where they appear as spacetime running solutions of a d-dimensional Einstein gravity coupled to scalars and showing a Singularity at a finite distance in spacetime at which scalars go to infinity. Following this approach, it seems natural to identify the source of the singularity with an extended object, an End of The World (ETW) brane, localized at the boundary of the running direction. I will provide a Local Universal description of the theory near the ETW-brane, where the solutions simplify dramatically and the dynamics, as well as scaling relations among the spacetime distance to the singularity, the field space distance, and the spacetime curvature, are controlled by just one critical exponent. I will show some explicit examples of different setups in String Theory satisfying this Local Analysis, hence showing a dynamical realization of a Cobordism to Nothing.

14:20 | **Andriana Makridou** — MPI Munich

Dynamical Cobordism of a Domain Wall and its Companion Defect 7-brane

The Cobordism Conjecture postulates that the cobordism classes in a consistent theory of quantum gravity should be trivial, possibly predicting new stringy defects. In this light, I will discuss the Dynamical Cobordism induced by the backreaction of a 9-dimensional non-supersymmetric, positive tension domain wall in string theory. Breaking the cobordism symmetry requires a 7-brane defect capping off spacetime. I will provide an explicit description of this defect, in terms of a new non-isotropic solution of the dilaton gravity equations of motion.

14:40 | **Jesús Huertas Castellanos** — IFT UAM-CSIC Madrid

Quantum Tunneling: From Bubbles of Nothing to String Theory Dynamical Cobordism

Codimension one singularities in solutions of Einstein-dilaton gravity in arbitrary dimensions are shown to exhibit an strikingly universal behaviour when the dilaton goes to infinity. These singularities are studied with a method recently developed to analytically treat Coleman-de Luccia quantum tunneling. This universal behaviour near singularities have allowed us to study Dynamical Cobordisms in String Theory from a bottom-up perspective. Besides, they also provide us the tools to study the nucleation of Witten's Bubbles of Nothing, to characterize generalizations of them and to find several analytical examples.

15:00 | **Matilda Delgado** — IFT UAM-CSIC Madrid

Dynamical Cobordism via tachyon condensation in supercritical strings

Dynamical Cobordism in a nutshell describes dynamical realizations of the Cobordism Conjecture. It provides a general framework for spacetime-dependent solutions that depict walls/bubbles of nothing as well as interpolating solutions between different theories of quantum gravity. In the former case, one can show that the solutions exhibit common scaling relations reminiscent of other swampland conjectures. In this talk I will revisit some setups developed nearly 20 years ago by Hellerman and Swanson where the condensation of the closed-string tachyon in supercritical theories was shown to source bubbles of nothing and dimension-changing bubbles. I will detail how these exotic processes can be seen as stringy realizations of cobordisms and show how they fit in the scaling relations put forth by dynamical cobordism.

14:00 | **Fien Apers** — University of Oxford

AdS flux vacua, swampland and holography

I will discuss some interesting aspects of the holographic duals of scale separated AdS vacua, focussing on DGKT AdS_4 flux vacua, and recently constructed related AdS_3 vacua. These vacua are suspected to be in the swampland, and the hope is that a study of the holographic duals will provide more clarity on their consistency.

14:20 | **Max Wiesner** — Harvard University

Holography and the KKLT scenario

The KKLT scenario, one of the few ideas to realize dS vacua in string theory, consists of two steps: the first involves the construction of a supersymmetric AdS vacuum with a small negative cosmological constant, whereas the second involves breaking supersymmetry and uplifting the energy to achieve dS. In this talk I use conventional holography to argue why it is not possible to complete the first step, i.e. to obtain supersymmetric AdS vacua with small cosmological constant in type IIB/F-theory flux compactifications. Holography identifies the radius of the AdS flux vacuum with the IR central charge of the worldvolume theory on 5-branes wrapping special Lagrangian cycles in CY fourfolds dual to the flux. I will show that, as a consequence of tadpole cancellation, the central charge of this worldvolume theory is bounded by the Euler characteristic of the fourfold. Since the species scale is also set by the Euler characteristic of the fourfold, the AdS scale is at best of the order of the species scale such that one can only obtain highly curved AdS vacua beyond the validity of the EFT.

14:40 | **Veronica Pasquarella** — University of Cambridge

2D Vacuum Transitions and their holographic interpretation

We show that the behaviour of 2D vacuum transitions is reminiscent of the CFT_2/CFT_1 correspondence. In doing so, we perform the calculation in Euclidean (CDL, BT) and Lorentzian (FMP) methods. In absence of conical deficits, the total action is proportional to the central charge of the defect, thereby signalling that the spacetimes involved are extremal. The total action in the Hamiltonian method is also shown to be proportional to the difference of the entanglement entropy, S_{EE}, of 2 $T\bar{T}$-deformed CFT_2 s. Generalisations of the c-theorem imply that the action diverges upon taking the flat limit, thereby showing an analogous behaviour to the information loss paradox, that first motivated the island proposal. This divergence can be cured by adding a non-extremal black hole, and, consequently, an island. Our findings therefore agree with the proposal made by Maldacena that false vacuum decay to a portion of AdS is allowed by the AdS/CFT correspondence. In all cases, the total action is proportional to the difference of generalised entropies. For transitions involving pure AdS_2 and/or AdS_2 black hole spacetimes, our results agree with those obtained by Van Raamsdonk et al. within the context of mutual approximation between states belonging to different CFT_2 s separated by a 1D interface. We further extend these arguments to the case of dS_2. We conclude providing a wedge-holographic embedding of these processes.

15:00 | **Krishan Saraswat** — Perimeter Institute for Theoretical Physics

Black Hole Thermalization and Microstructure From Microstate Statistics

The detection of gravitational waves has opened up new observational windows into the physics of black holes and has the potential to shed light on how imposing unitary evolution modifies the near horizon dynamics. In this talk, I will present how recent developments in holography have provided a way of understanding the physics of black hole thermalization in terms of the spacing statistics of black hole microstates. Based on this, I will suggest that the issue of measuring the quantum aspects of black holes from their ringdown depends on the spectral statistics of their microstates. I will then suggest that certain microstate statistics lends to the possibility of deviations in the ringdown behaviour of black holes in the form of "echoes" which might be interpreted as being due to Planck-scale microstructure near the horizon.

Parallel Session – Theatre D — McAllister

14:00 | **Paul-Konstantin Oehlmann** — Uppsala University

Geometric Engineering of T-dual little string theories

Little string theories in six dimensions are decoupled from gravity and, unlike SCFTs can be T-dual upon circle compactification. Exploiting F/M-theory duality we systematically engineer novel LSTs where T-duality is manifestly build in the toric description of birational elliptic threefold. This allows us to explore fractionalizations of heterotic LSTs and NS5 branes probing ADE-type singularities with non-trivial $E_8/SO(32)$ flavor holonomies. We comment on the fibre-base duality, match of Coulomb Branches and 2-group symmetries across the T-duality.

14:20 | **Maxime Médevielle** — University of Liverpool

Type II Calabi-Yau compactifications in general spacetime signature

When applying a timelike T-duality to Type II A and B, one uncovers a web of theories that realize all spacetime signatures. I will present the 4D $\mathcal{N} = 2$ theories in all signatures we obtain when compactifying these exotic theories on a Calabi-Yau manifold, as well as the web of dualities relating them. I will also present the Special geometry of the vector multiplets and hypermultiplets and, if time permits, I will describe how this formalism allows one to relate cosmological solutions to black hole solutions in the timelike T-dual theory.

14:40 | **Chen-Te Ma** — APCTP

Cubic action in double field theory

We study target space theory on a torus for the states with $N_L + N_R = 2$ through Double Field Theory. The spin-two Fierz-Pauli fields are not allowed when all spatial dimensions are non-compact. The massive states provide both non-vanishing momentum and winding numbers in the target space theory. To derive the cubic action, we provide the unique constraint for $N_L \neq N_R$ compatible with the integration by part. We first make a correspondence of massive and massless fields. The quadratic action is gauge invariant by introducing the mass term. We then proceed to the cubic order. The cubic action is also gauge invariant by introducing the coupling between the one-form field and other fields. The massive states do not follow the consistent truncation. One should expect the self-consistent theory by summing over infinite modes. Hence the naive expectation is wrong up to the cubic order. In the end, we show that the momentum and winding modes cannot both appear for only one compact doubled space.

15:00 | **Christian Kneißl** — MPI Munich

Dimensional Reduction in Cobordism and K-theory

In this talk I will illustrate the close link between cobordism and K-theory under dimensional reduction and discuss its role for the conjectured absence of non-trivial cobordism classes in quantum gravity. By utilizing the Atiyah-Hirzebruch spectral sequence, I will demonstrate how to compute cobordism and K-theory groups of a compact manifold X. Finally, I will explain how the result matches precisely with the expected pattern of broken and gauged symmetries arising when compactifying a theory of quantum gravity on X and takes certain quantum mechanical effects, such as the cancellation of Freed-Witten anomalies, automatically into account.

Parallel Session – Theatre A — Valenzuela

16:00 | **Marco Scalisi** — MPI Munich

Scalar Potentials and the Swampland

The Swampland Distance Conjecture (SDC) implies that infinite scalar field variations necessarily correspond to the massless limit of, at least, one infinite tower of states. By requiring that such behaviour holds equally also in presence of a scalar potential, we derive an upper bound on its gradient in terms of the deviation angle from the geodesics in moduli space and decay rate of the tower. This has direct implications for the realization and consistency of multi-field scenarios in string theory. We focus our investigation mainly on hyperbolic geometries, as prototype of string compactification spaces. In the framework of $\mathcal{N} = 1$ supergravity, we show that the constraints are even more stringent thus setting a bound on the Kähler curvature.

16:20 | **Alberto Castellano Mora** — IFT UAM-CSIC Madrid

The Gravitino in the corners of Moduli Space

In this talk I will discuss the recent Swampland conjecture which proposes that in any consistent supergravity theory with non-vanishing gravitino mass, the limit $m_{3/2} \to 0$ lies at infinite distance. Such conjecture may be motivated from the Weak Gravity Conjecture as applied to strings and membranes and implies in turn the AdS Distance Conjecture. Several tests of this proposal are discussed. Time permitting, we will briefly discuss its main phenomenological implications.

16:40 | **Muldrow Etheredge** — University of Massachusetts Amherst

Sharpening the Distance Conjecture in Diverse Dimensions

The Distance Conjecture holds that any infinite-distance limit in the scalar field moduli space of a consistent theory of quantum gravity must be accompanied by a tower of light particles whose masses scale exponentially with the proper field distance. This exponential dependence depends on a constant that is order-one in Planck units. In this talk, I will discuss the recently released paper (2206.04063) where we propose a sharp lower bound for this constant for the lightest tower in a given infinite-distance limit in d-dimensions: namely that the lower bound is greater than or equal to $1/\sqrt{d-2}$. In support of this proposal, we show that (1) it is exactly preserved under dimensional reduction, (2) it is saturated in many examples of string/M-theory compactifications, and (3) it is saturated in many examples of minimal supergravity.

17:00 | **Stefano Lanza** — Utrecht University

Taming the Distance Conjecture

In any consistent effective field theory, it is expected that an infinite tower of massless states emerges along any path that leads to an infinite distance point in field space, as predicted by the Distance Conjecture. However, delivering generic, path-independent checks of the conjecture is a hard task. In this talk I will show how the predictions of the Distance Conjecture can be generally addressed by employing the recent Tameness Conjecture. The latter constrains the functional form of all the EFT couplings, requiring them to belong to a special class of "tame" functions, and I will display how such a feature allows one to decompose the field space into finitely many sectors in which path-independent statements for the emergent infinite towers of states can be established. I will further illustrate how the behavior of these tame couplings can be inferred by looking at how they behave on the backreaction of a discrete set of axion strings. This suggests that axion strings are prime candidates to test the physics near any infinite distance point.

17:20 | **Daniel Kläwer** — University of Hamburg

Membrane Limits in Quantum Gravity

Infinite distance limits in scalar field space are expected to be governed by a tower of exponentially light states. The emergent string conjecture sharpens this statement by identifying the lightest tower as either KK modes or string excitations. This raises the question of what could be the role of higher dimensional membranes in this picture. I will argue that these can never be as light as the KK or string states. We will see that this "membrane censorship" is implied by consistent dimensional reduction and illustrate it in a non-trivial example in $\mathcal{N} = 2$ hypermultiplet moduli space.

17:40 | **José Calderón Infante** — IFT UAM-CSIC Madrid

An Entropic Argument for the Swampland Distance Conjecture

In this talk I will present a bottom-up argument in support of the Swampland Distance Conjecture (SDC). It comes from applying the covariant entropy bound (CEB) to backgrounds with end of the world branes describing dynamical cobordisms to nothing. We show that, at the level of the EFT, there is one such a solution for any geodesic exploring infinite distance in moduli space. The CEB applied to this background predicts a quantum gravity cut-off that falls exponentially with the moduli space distance. Upon identifying this cut-off with the species scale of a tower of states this recovers the SDC with precise bounds on the exponential decay rate. We check that these bounds are respected (and often saturated) in string theory setups. If time permits, I will also discuss the introduction of a potential in this setup and how this line of reasoning recovers the asymptotic dS conjecture. Based on ongoing work in collaboration with A. Castellano, A. Herraez and L.E. Ibáñez.

Parallel Session – Theatre B — Wrase

16:00 | **Heliudson Bernardo** — McGill University

Energy Condition Inheritance

I will discuss sufficient conditions for certain energy conditions to follow from their higher-dimensional counter-

part. Then I will use these conditions to reformulate no-go theorems in supergravity, offering a new perspective on what ingredients are necessary to avoid them. This might be useful for obtaining four-dimensional cosmologies from string theory.

16:20 | **Jacob Leedom** — DESY

Non-perturative Effects & Heterotic String Vacua

I will discuss loopholes in existing de Sitter no-go results and arguments to address them in the context of Heterotic string compactifications. I will focus on toroidal orbifold models and incorporate non-perturbative effects in the superpotential and Kahler potential that depend on the overall Kahler modulus and dilaton. The rich interplay of target space modular symmetry and non-perturbative effects provide powerful handles to determine conditions for dS vacua. I will also discuss several variations, including general parametrizations of non-perturbative contributions, H-flux, and racetracks.

16:40 | **Muthusamy Rajaguru** — Lehigh University

Type IIB flux compactifications with $h^{1,1} = 0$

With the advent of the swampland program, it is becoming increasingly important to explore new parts of the string landscape. In this talk, we revisit an older, rather unexplored setup namely, Landau-Ginzburg orientifolds of type IIB with F_3 and H_3 fluxes turned on. In particular, we will present new infinite families of supersymmetric and non-supersymmetric anti-de Sitter vacua with gauge groups of potentially arbitrary rank as well as the existence of dS solutions. We also discuss these solutions in the context of some of the relevant swampland conjectures.

17:00 | **Christos Kokorelis** — American University of Malta

Sterile neutrinos from D-brane models

We describe the first appearance of the sterile neutrino (SN) candidate from D-brane Standard model like string models. We are using an intersecting D6-brane model, with gauged baryon number, which accommodates the Standard Model with right handed neutrinos. The same class of models has been shown that satisfies $b \to s\, l_+\, l_-$ anomalies seen by LHCb experiment. The SN interacts with the active neutrino and the right handed neutrino of a single family. The models predict a sterile neutrino mass in the sub-eV range in agreement with recent long-baseline measurements of muon-neutrino disappearance and muon-to-electron neutrino appearance at the T2K and NOvA experiments. Model predictions are independent of the RR tadpole conditions.

17:20 | **Andreas Schachner** — University of Cambridge

Type IIB at eight derivatives: insights from Superstrings, Superfields and Superparticles

In this talk, we study the non-linear structure of Type IIB eight-derivative couplings involving the metric and the complexified three-form G_3. We show that, at the level of five-point string amplitudes, the kinematics in the maximally R-symmetry-violating sector is fully matched by standard superspace integrals and by superparticle amplitudes in M-theory on a two-torus. The latter approach is used to determine the complete effective action in this sector and to verify its invariance under $\mathrm{SL}(2,\mathbb{Z})$ duality. We further comment on the general

structure of the higher-point kinematics. We verify that K3 reductions are fully consistent with the constraints of six-dimensional supersymmetry, and derive the four-dimensional flux scalar potential and axion kinetic terms at order $(\alpha')^3$ in Calabi-Yau threefold reductions.

Parallel Session – Theatre C — Cicoli

16:00 | **Bruno Bento** — University of Liverpool

Gravity at the Tip of the Throat

Warped throats have been used in countless works in the context of string theory compactifications, in particular for their ability to suppress high energy scales. The Klebanov-Strassler solution gives us an explicit description of the geometry of a warped throat which we can use to perform computations — my focus will be on the gravitational sector of the resulting 4d EFT, with its tower of Kaluza-Klein (KK) gravitons. By assuming that we live on a (3+1)-dimensional brane somewhere along the throat, we can study how the warping influences the effects of the tower on the brane. In particular, I will show how the tower corrects the Newtonian potential and discuss how gravitational experiments and observations may be used to test the possibility that our Universe corresponds to a brane living in a warped throat.

16:20 | **Gonzalo Villa** — University of Cambridge

Hidden sectors and the Cosmic Gravitational Wave Background

The Cosmic Gravitational Wave Background is an ensured background of gravitational waves produced by (pseudo)particle exchange in the early Universe plasma. Its existence does not require beyond the Standard Model physics, as Standard Model particles and interactions are sufficient to produce it. In this talk we will explore the deviations from the Standard Model prediction arising from the presence of hidden sectors in the early Universe.

16:40 | **Francesco Muia** — University of Cambridge

Primordial black holes from an early matter dominated era

I will present a scenario for fast growth of cosmological perturbations; $\delta(t) \sim a(t)^s$, where $a(t)$ is the scale factor, with $s > 10$. The basic ingredients of the scenario are an early matter dominated era and the dark fermion which experiences a scalar mediated force during the epoch. Both of these arise in string/supergravity models. The fast growth occurs for sub-horizon density perturbations of the dark fermion. The fast growth has a rich set of phenomenological implications. We outline implications for the formation of primordial black holes and the production of gravitational waves. Primordial black holes in the sub-lunar mass range (which are ideal dark matter candidates) can be produced. Gravitational waves can be produced in a wide range of frequencies due to second order scalar perturbations and due to evaporation and merger of primordial black holes. I will also comment on the detectability of gravitational waves from sub-solar primordial black holes.

17:00 | **John Stout** — Harvard University

Infinite Distances and Factorization

I will argue that infinite distance limits are those in which correlation functions or expectation values factorize. Unitarity dictates that this is the only way an infinite distance point can appear in the information metric and since this metric is proportional to the moduli space and Zamolodchikov metrics when appropriately restricted, they share this interpretation. This provides an explanation for why infinite distance points in moduli space always have a weakly-coupled "dual" description, as well as a bottom-up motivation for why these points should be associated with the appearance of many "light" degrees of freedom in a consistent quantum gravitational theory.

17:20 | **Daniel Panizo** — Uppsala University

Riding Bubbles

In the following talk, we will review the dark bubble model's most basic concepts. In this set-up, a 4D dS Universe is realised on a wall separating two different 5D AdS regions. We will also explore how bulk's features translate to 4D cosmological ones on the boundary. Finally, we will argue that the boundary conditions can fixed in 4D quantum cosmology point of view by making use of bubble's nucleation in 5D.

17:40 | **Samuel Laliberte** — McGill University

Emergent Cosmology From Matrix Theory

Matrix theory is a proposed non-perturbative definition of superstring theory in which space is emergent. Recently, it was shown that a 4-dimensional expanding universe can emerge in the IKKT matrix model, with another 6 spatial dimensions stabilized at the string scale. This scenario was also explored in the BFSS model, in which case the emerging phase yields a scale-invariant spectrum of scalar and tensor perturbations. In this talk, we will discuss recent progress in understanding these results. More precisely, we will discuss a possible way of obtaining the metric out of the matrices in the IKKT model, and ways to probe symmetry breaking in the BFSS model.

Parallel Session – Theatre D — Angelantonj

16:00 | **Kang Sin Choi** — Ewha Womans University

Connected vacua in string models

Global consistency condition of string theory plays important role in obtaining vacua of string theory. It does not only restrict possible vacua, but also suggest that many vacua are connected, if the systems are protected by SUSY. We visit some examples in heterotic orbifold and F-theory, focusing on the small instanton transitions and their duals.

16:20 | **Björn Friedrich** — Heidelberg University

The local Wheeler-DeWitt Measure: A measure for the multiverse

The measure problem (of eternal inflation) is a severe unresolved problem that naturally appears in the String Theory multiverse. Generically, "everything that can happen, will happen infinitely many times", such that the naive approach of counting becomes insufficient to define a probability measure for statistical predictions. Based on the Wheeler-DeWitt equation and the cosmological central dogma, we construct a quantum mechanical model of the multiverse and show how meaningful predictions can be made.

16:40 | **Viktor Matyas** — University of Liverpool

Non-SUSY Heterotic Strings via Free Fermions and Orbifolds

Fermionic worldsheet constructions are known to produce some interesting phenomenologically viable models. In this talk, I discuss how such a formalism can be used to explore the Non-SUSY heterotic landscape. I will describe the phenomenological features of these models and introduce methods with which we can examine their stability.

17:00 | **Luca Armando Nutricati** — Durham University

On the Running of Gauge Couplings in String Theory

String theories naturally give rise to infinite towers of states whose degeneracies grow exponentially as functions of mass. These infinite towers of states are ultimately responsible for many of the finite properties for which string theory is famous. Recently, a framework was developed in which the effects of all of these states can be incorporated in a self-consistent way when calculating quantities relevant for low-energy phenomenology. In this talk, we discuss how to apply this formalism to calculate the running of the gauge couplings within closed string theories specifying to the famous case of four-dimensional $\mathcal{N} = 2$ supersymmetric vacua coming from toroidal compactification of six-dimensional $\mathcal{N} = 1$ theories, first discussed by Dixon, Kaplunovsky, and Louis (DKL). This will enable us to determine not only the extent to which the classic DKL results are valid, but also the manner in which they are deformed when worldsheet modular invariance is fully maintained. While we find expected logarithmic running at certain energy scales, we also find a number of intrinsically stringy behaviors that transcend what might be expected within an effective field theory approach.

17:20 | **Flavio Tonioni** — University of Liverpool

Non-Supersymmetric Strings and Finiteness

A feature of supersymmetry is the cancellation of quantum corrections among specular contributions from bosons and fermions. For non-supersymmetric strings, even if the particle spectrum lacks a one-by-one matching between bosons and fermions, an infinite oscillation of their relative surpluses can still result in the absence of divergences without fixing a cutoff scale. For non-tachyonic closed strings, this is well-known to be equivalent to modular invariance. Despite a simpler structure, however, analogous cancellations can be observed for open strings too. I will outline their description in mathematical terms, supporting the heuristic interpretation of such a “misaligned supersymmetry” as a physically-intuitive way to visualise the finiteness of the one-loop cosmological constant for non-supersymmetric strings.

17:40 | **Houri Christina Tarazi** — Harvard University

TBA

TBA

Sustainability & Diversity Panel – Theatre A

18:30 | **Mariana Graña, Viraf Mehta, Peter Millington & Irene Valenzuela**

A panel discussion on practising a sustainable and inclusive science in a warming, exclusionary world

Wednesday 6^{th} July

Plenary Session – Theatre A — Ruehle

09:00 | **Washington Taylor** — MIT

Comparing F-theory Standard Model constructions

F-theory provides a powerful global perspective on the landscape of supersymmetric string compactifications. Several qualitatively distinct F-theory constructions can lead to theories with the gauge group and chiral matter content of the Standard Model. This talk describes some new developments on such constructions and focuses on some key questions such as which constructions are most natural (i.e. involve the least fine tuning), and which are most promising for reproducing more detailed aspects of observed physics.

09:30 | **Emilian Dudas** — Ecole Polytechnique Paris and CERN-TH

Causality constraints on nonlinear supersymmetry and inflation

Recently two specific problems of gravitino propagation were found in specific supergravities with nonlinear supersymmetry: potential acausality and vanishing sound speed during inflation. I will show that using the equivalence theorem, subluminality constraints are captured by positivity constraints in goldstino lagrangians. We argue that nontrivial causality constraints arise for lagrangians without a two-derivative UV completion. We propose minimal inflationary models with no causality constraints.

10:00 | **Luca Martucci** — University of Padua

EFT constraints from EFT strings

Perturbative regimes of gravitational $d = 4\,\mathcal{N} = 1$ effective field theories (EFTs) are characterised by special fundamental axion strings, dubbed EFT strings. These EFT strings are associated with infinite field distance limits and provide a purely EFT realisation of the Swampland Distance Conjecture. I will propose that EFT strings support a weakly-coupled world-sheet sector, and I will show how its quantum consistency requires non-trivial

constraints on the bulk four-dimensional theory. I will then discuss some microscopic tests of these bottom-up predictions in string theory.

Plenary Session – Theatre A — Nilles

11:00 | **James Halverson** — Northeastern University

Ricci Flow with Infinite Neural Networks

Ricci-flat metrics, such as Calabi-Yau and G2 metrics, are the endpoints of Ricci flow. Recently, it has been shown that these metrics can be well approximated by neural networks trained with gradient descent. A breakthrough by Perelman realizes Ricci flow as the gradient of a functional, which motivates the study of a connection between Ricci flow and neural networks. I will explain how current innovations in deep learning theory, known as neural tangent kernel techniques, can be used to study metric flows induced by gradient descent. Certain assumptions recover Perelman's formulation of Ricci flow.

11:30 | **Nikolaos Mavromatos** — King's College London

String-Inspired Cosmologies with Anomalies: Inflation, Primordial Black Holes and Gravitational Waves

I discuss a string inspired model of cosmology, characterised by gravitational anomalies and torsion at early eras, which may provide a geometric origin of the entire dark sector of the Universe, from a running-vacuum model inflation to axionic dark matter, the axion degrees of freedom being associated with torsion. During inflation, the model may, under some circumstances, lead to enhanced gravitational-wave perturbations as well as enhanced densities of primordial black holes produced during inflation. In the current era, such a model may contribute to observable in principle deviations from ΛCDM, and alleviation of the observed tensions in the cosmological data, provided, of course, the latter are not due to astrophysical/statistical uncertainties.

12:00 | **Mariana Graña** — IPhT Saclay

The tadpole menace

In flux compactifications, moduli get masses from fluxes wrapping non-trivial cycles on the manifold. Fluxes have an associated charge that has to satisfy tadpole cancelation conditions. The tadpole conjecture proposes that the charge induced by the fluxes needed to stabilise a large number of moduli grows linearly with the number of moduli. In this talk I will explain the conjecture and present (new) supporting evidence.

Plenary Session – Theatre A — Dudas

14:00 | **Massimo Bianchi** — University of Rome - Tor Vergata

BH and fuzzball perturbation theory from quantum Seiberg-Witten curves

After reviewing the role Quasi-Normal Modes (QNMs) play in the Gravitational Wave (GW) signals emitted in the ring-down phase of Black-Hole (BH) mergers, we present a novel efficient approach to compute QNMs of BHs, D-branes and fuzz-balls, based on quantum Seiberg-Witten (SW) curves for $\mathcal{N} = 2$ supersymmetric Yang-Mills (SYM) theories. We find remarkable agreement with numerical results obtained by means of Leaver's method of continuous fractions and with 'semi-classical' results obtained in the eikonal approximation, based on geodetic motion. Finally we discuss the extension to D3-branes and their bound states of Couch-Torrence (CT) conformal inversions, that exchange horizon and infinity, and show that they keep the photon-sphere (or photon-halo) fixed.

14:30 | **Joe Conlon** — University of Oxford

Two Aspects of String Compactifications

I describe recent work on two aspects of string compactifications: (i) holographic interpretations of moduli-stabilised vacua and (ii) the overshoot problem in string cosmology. This describes work in collaboration with Fien Apers, Sirui Ning and Filippo Revello.

15:00 | **Burt Ovrut** — University of Pennsylvania

FIMP Dark Matter in Heterotic M-Theory

Within the context of $\mathcal{N} = 1$ supersymmetric heterotic M-theory, we present a "freeze-in" mechanism for producing dark matter via a "moduli portal" between the observable and hidden sectors. It is assumed that the observable sector consists of the MSSM or some physically acceptable extension of it, while the hidden sector is chosen to satisfy all physical and mathematical constraints. The couplings of the dilaton and the "universal" modulus to all fields of the observable and hidden sectors are presented and analyzed. These interactions are then combined to produce a moduli portal from a thermal bath of observable sector particles to the hidden sector. It is shown that only the uncharged hidden sector matter scalars can play the role of dark matter. Finally, it is demonstrated, for a wide choice of vacua, that one can correctly predict the observed dark matter "relic density".

Plenary Session – Theatre A — Sethi

16:00 | **Pablo Soler** — IBS Daejeon

Axion wormholes with massive dilatons

If Euclidean wormholes contribute meaningfully to the path integral of quantum gravity they can have important implications for particle physics and cosmology. The dominant effects arise from wormholes whose sizes are comparable to the cut-off scale of effective field theory, for which ultraviolet corrections become relevant. I will discuss corrections to classical axion wormhole solutions in string motivated scenarios in which the dilaton partner of the axion becomes massive. Corrections arise near the neck region which are consistent with a recent version of the weak gravity conjecture for axions.

16:30 | **David Andriot** — LAPTh Annecy and CNRS

The landscape of 4d (anti-) de Sitter and Minkowski solutions of 10d supergravities

String theory backgrounds with a 4d maximally symmetric space-time are of prime importance: they appear in cosmological and particle physics models, as well as holography. Their properties are currently under scrutiny, leading to the formulation of various (swampland) conjectures, regarding their existence, stability (especially for non-supersymmetric ones), or the matter of scale separation. In this talk, I will present a classification of such solutions of 10d IIA/B supergravities. The interest is twofold: first, it reveals new of types solutions, potentially carrying different physics. Second, it allows to note generic properties among the variety of solutions. The latter led us to conjecture that a 4d effective theory with de Sitter solution is at most $\mathcal{N} = 1$ supersymmetric, and that a Minkowski compactification always admits a 4d flat direction. I will also discuss scale separation in anti-de Sitter solutions.

17:00 | **Sakura Schafer-Nameki** — University of Oxford

Non-Invertible Symmetries

In the past year it was uncovered that higher dimensional QFTs can have symmetries, which obey fusion-like product structure (as opposed to group like multiplication). I will present several constructions of such symmetries in QFTs in $d = 3, 4, 5, 6$.

Thursday 7^{th} July

Special Session in Memory of Graham Ross – Theatre A — Mavromatos

09:00 | **Luis Ibáñez** — IFT UAM-CSIC Madrid

IR/UV mixing, Towers of Species and Swampland Conjectures

We use holographic ideas to motivate some of the Swampland conjectures involving towers of species. Applying the Bekenstein holographic principle to an EFT in a box of size L, one obtains that the UV and IR cut-off's of the EFT are necessarily correlated. Identifying the UV scale with the gravity "species scale" one obtains an upper bound on the mass of the lightest species in terms of the IR cut-off of the form $M < 1/L^{\alpha}$, with alpha a computable quantity. Thus decreasing the infrared cut-off $1/L$ brings along a tower of species states becoming light. Identifying the IR cut-off with the curvature in an AdS background, reproduces and motivates the statement of the AdS Distance Conjecture, giving in addition explicit limit values for its exponent alpha. The reasoning seems to apply both to AdS and dS vacua. Similar arguments also give a heuristic understanding of the Swampland Distance conjecture, giving a range of possible values for its rate exponent lambda. We also comment on possible application of these ideas to the dS phase of our observed universe.

09:30 | **Hans Peter Nilles** — Bonn University

Modular flavor symmetry: a bridge between ultraviolet (UV) and infrared (IR)

String dualities lead to modular flavor symmetries in the low-energy effective action. They combine with traditional flavor symmetries to the eclectic flavor group which acts nontrivially in moduli space. We explain the concept of "Local Flavor Unification" with locally enhanced flavor groups. Modular symmetry connects the properties of string theory with symmetries of the low-energy effective action. This leads to an explanation for the absence of certain couplings ("stringy miracles") in the low energy theory that could not be understood otherwise.

10:00 | **Andre Lukas** — University of Oxford

Numerical Calabi-Yau Metrics from Machine Learning

Neural networks to compute numerical Ricci-flat CY metrics for complete intersection and Kreuzer-Skarke Calabi-Yau manifolds are introduced. These techniques are realised in the package cymetric. In particular, we discuss point sampling on these manifold, explain how the metric can be computed at given points in Kähler moduli space and apply these techniques to various manifolds. We also show how the results can be used to compute properties of line bundles.

Special Session in Memory of Costas Kounnas – Theatre A — García Etxebarria

11:00 | **Ignatios Antoniadis** — LPTHE - CNRS - Sorbonne University

Challenges of an accelerating universe in string theory

TBA

11:30 | **Hervé Partouche** — CNRS

Wavefunction of the universe: Diffeomorphism invariance and field redefinitions

We reconsider the wavefunction of the universe defined as a path integral by Hartle and Hawking, in the case of a homogenous and isotropic universe with a positive cosmological constant. We resolve old issues in the gauge fixing of time reparametrizations, and show that field redefinitions of the scale factor yield different diffeomorphism-invariant path-integral measures and thus wavefunctions. For each choice, we lift the long standing ambiguity in the form of the Wheeler-DeWitt equation. We also identify the correct inner products of the Hilbert spaces corresponding to all choices and show that they yield identical observable predictions, at least at the semi-classical level.

12:00 | **Mirjam Cvetič** — University of Pennsylvania

Gauge Symmetry Constraints in Consistent Quantum Gravity

We address the allowed gauge symmetry topology of consistent quantum gravity both from the top-down geometric constraints of consistent string compactifications and the bottom-up anomaly constraints due to the gauging of higher-form symmetries in 8D $\mathcal{N}=1$ supergravity theories. Furthermore, by refining the junction constructions we obtain all the allowed 8D and 9D $\mathcal{N}=1$ string vacua.

14:00 | **Simon Schreyer** — Heidelberg University

Field-theoretic loop corrections in IIB

To establish metastable de Sitter vacua or even scale-separated AdS, control over perturbative corrections to the 4d Lagrangian is crucial. In this talk I will mostly focus on loop corrections and how their scaling with the Kahler moduli can be obtained from the field-theoretic perspective. This is particularly interesting as the form of loop corrections is only conjectured (by Berg, Haack and Pajer) for a general Calabi-Yau. I will then compare the field-theoretic results with this conjecture.

14:20 | **Gerben Venken** — Heidelberg University

The impact of α'-corrections on de Sitter uplifting in LVS

In recent years, the conditions for and possibility of achieving de Sitter vacua in string theory have come under much scrutiny. In this talk I will discuss the impact of α' corrections on the possibility of achieving a controlled de Sitter vacuum in the Large Volume Scenario in IIB string theory. I will discuss, given these corrections, in which regime of parameter space it seems most likely that one can achieve controlled de Sitter vacua.

14:40 | **Ruben Küspert** — MPIK and Heidelberg University

Obtaining small Kinetic Mixing

Kinetic mixing between $U(1)$ gauge groups is a well-known possible interaction between our visible Standard Model sector and a hidden sector supposed to contain dark matter. Naturally, the mixing coupling must be very small for the hidden sector to remain "almost" completely hidden. We aim to follow up on the established literature and investigate how very small kinetic mixing can arise in string theory compactifications. In particular, we focus on the large volume scenario in type IIB. Small kinetic mixing can be attained by tuning the hidden gauge coupling to small values, embedding the $U(1)$ in non-abelian gauge groups or by sequestering the visible and hidden sector. We elaborate why tiny gauge couplings are unsatisfactory since they reduce the cutoff of the 4-dim. effective theory. Considering the large volume scenario, we show that the hidden gauge coupling is bounded from below, thus excluding kinetic mixing of $\chi \lesssim 10^{-12}$. Driven by phenomenology, we advocate a "minimal setup" for stringy kinetic mixing incorporating charged states and evading the issues related to tiny gauge couplings. In this minimal setup, small kinetic mixing is achieved: 1) by embedding the $U(1)$s in non-abelian gauge groups, 2) by sequestering the visible and hidden sector hosted on D-brane stacks. Surprisingly, it turns out that the naive approach by simply separating the visible and hidden D-branes over long distances in the Calabi-Yau manifold is not sufficient to achieve exponentially suppressed kinetic mixing.

15:00 | **Maxim Emelin** — University of Padua

Goldstino Condensates and Anti-Brane Instability

The low-energy description of anti-branes contains a goldstino sector, which realizes supersymmetry non-linearly and is governed by the Volkov-Akulov action. This action contains goldstino self-interaction terms which may allow for the formation of composite states, which can have important qualitative effects on the dynamics of the system. In this talk, we describe an exact renormalization group approach to investigate the formation

of such composite states of the goldstino. We proceed to show that the pure Volkov-Akulov model has an instability towards goldstino condensation and discuss the implications of this fact for string models involving spontaneous supersymmetry breaking via anti-brane uplifts.

Parallel Session – Theatre B — Padilla

14:00 | **Alessandro Podo** — Columbia University

Integer solutions to the anomaly equations for a class of chiral gauge theories

We find all the integer charge solutions to the equations for the cancellation of local gauge anomalies in a class of gauge theories which extend the Standard Model (SM) by a gauge group of the form $G \times U(1)$, where G is an arbitrary semisimple compact Lie group. The SM fermions are assumed to be neutral under $G \times U(1)$ gauge interactions, while the new fermions transform in non-trivial representations of both the new and the SM gauge groups. Our analysis is valid also when the latter is embedded in an arbitrary semisimple compact Lie group. Theories with this structure have been recently studied as models of composite axions based on accidental symmetries and can provide a field theory resolution to the axion quality problem.

14:20 | **Christopher Hughes** — University of Cambridge

Axions from Kähler moduli

Motivated by the potential applications of the String Axiverse for Cosmology, we consider the minimisation of the Kähler moduli sector of type IIB string theory, discuss the equations for finding 'non-trivial' stationary points of the potential and present numerical results found for Calabi-Yau threefolds with $h^{1,1} = 2, 3$ moduli in examples only 'trivially' minimised previously.

14:40 | **Viraf Mehta** — University of Göttingen

Vacua in the String Axiverse

We consider multi-axion potentials derived from compactifications of Type IIB string theory and analyse their vacuum structure. We find that, due to the intrinsic properties of this class of geometries, very few vacua are present in each potential. We also discuss implications for inflation and the CC problem.

15:00 | **David Marsh** — King's College London

Constraining the KS Axiverse with Astrophysics

I will summarise recent results that can be used rule out Type IIB Calabi Yau vacua using astrophysics. Firstly, I present black hole superradiance, that excludes up to 60% of 10^5 randomly sampled geometries close to the tip of the Kähler cone for $h^{1,1} < 200$, with no cosmological or visible sector assumptions. I will then briefly summarise preliminary work that suggests very strong exclusions can be made all the way up to $h^{1,1} = 491$ and at large volume, using x-ray spectra (no cosmological assumptions), and freeze in production of dark matter and dark radiation (with mild assumptions on reheating).

14:00 | **Muyang Liu** — Uppsala University

Revisiting Heterotic ALE Instantons: 2-groups and T-duality

In this talk, I will revisit the construction of heterotic ALE instantons and the corresponding T-dual systems in 6D little string theories (LSTs). Considering two heterotic $E_8 \times E_8$ and Spin(32)$/\mathbb{Z}_2$ string theory placed on various background singularities, we expect the heterotic NS5 instantons to fraction. The choice of flat connection at infinity for E_8 or Spin(32)$/\mathbb{Z}_2$ respectively captures the feature of the 6D conformal matter theory built on F-theory geometry. We propose that the matching of 5d coulomb branches plus the 2-group structure constants determined by the higher form symmetry of LSTs as criteria to predict heterotic T-dual candidates.The exploitation are generalized by picking non-trivial flat connections at the infinity to break E_8 and Spin(32)$/\mathbb{Z}_2$ into their subgroups and confirm these T-dualities by the matching of criteria aforementioned. In addition, distinct tensor branch data obtained from 6D theories with a single instanton inspire us to classify heterotic strings probing ADE singularities.

14:20 | **Shing Yan Li** — MIT

Flux breaking and natural Standard Model structure in F-theory

We discuss natural constructions of the Standard Model gauge group and chiral matter spectrum in 4D F-theory models. These constructions use vertical and remainder fluxes to break rigid E_7, E_6 gauge groups, which are ubiquitous in the 4D F-theory landscape. The number of generations of matter in these models is naturally as small as three. We give an explicit global example of such constructions.

14:40 | **Martin Bies** — University of Pennsylvania

Towards F-theory MSSMs

This talk summarizes recent developments aimed towards F-theory constructions of MSSMs, i.e. F-theory vacua with exactly one Higgs field and no vector-like exotics.

15:00 | **Andrew Turner** — University of Pennsylvania

Terminal singularities and U(1) factors in F-theory

We investigate Q-factorial terminal singularities in F-theory models with a U(1) gauge factor. The existence of such singularities indicates the presence of localized uncharged matter states, whose number are related to the associated Milnor numbers. By comparison with corresponding models with no U(1) factor, we find that the presence of the generating section alters the nature of the singularities over some loci, making them crepantly resolvable. This corresponds to charging the previously uncharged localized matter states at these loci. We demonstrate this phenomenon in a variety of models. We also advertise a recent proposal to read off the U(1) charges of localized matter in F-theory models without having to perform a resolution, analogous to the Katz–Vafa method for nonabelian charges.

14:00 | **Federico Carta** — Durham University

Divisor topologies of CICYs and applications

We present a classification for the divisor topologies of the projective complete intersection Calabi-Yau (pCICY) 3-folds. To our surprise we find that the whole pCICY database results in only 11 coordinate divisors of distinct topology and we classify those surfaces with their possible deformations inside the pCICY 3-fold. We also present a classification of the ample divisors for all the favorable pCICYs which can be useful for fixing all the (saxionic) Kähler moduli through a single non-perturbative term in the superpotential. We argue that this relatively unexplored pCICY dataset, equipped with the necessary model building ingredients, can be used for a systematic search of physical vacua. To illustrate this for model building in the context of type IIB CY orientifold compactifications, we present moduli stabilization with some preliminary analysis of searching possible vacua in simple models, as a template to be adopted for analyzing models with a larger number of Kähler moduli.

14:20 | **Saghar Hosseini** — Durham University

Symmetry TFTs from M/string theory

(d+1)-dimensional topological field theories (TFTs) encode the higher symmetries, 't Hooft anomalies, higher structures, and the BF theory of d-dimensional field theories. These theories may be geometrically engineered from M/string theory. I will discuss how the symmetry TFTs are obtained by constructing a Chern-Simons action for the effective supergravity action.

14:40 | **Alessandro Mininno** — University of Hamburg

Weak coupling limits and the tower Weak Gravity Conjecture

Following the talk by Timo Weigand, I will discuss weak coupling limits in F-theory compactification and some consequences for the tower Weak Gravity Conjecture.

15:00 | **Naomi Gendler** — Cornell University

Superpotentials from Singular Divisors

We study Euclidean D3-branes wrapping divisors in Calabi-Yau orientifold compactifications of type IIB string theory. Witten's counting of fermion zero modes in terms of the cohomology of the structure sheaf applies when the divisor is smooth, but we argue that effective divisors of Calabi-Yau threefolds typically have singularities along rational curves. We generalize the counting of fermion zero modes to such singular divisors by detailing compactifications in which the singularities can be unwound by passing through flop transitions. Analytically continuing the superpotential through the flops, we find that singular divisors whose normalizations are rigid can contribute to the superpotential. The examples that we present feature infinitely many isomorphic geometric phases, with corresponding infinite-order monodromy groups Γ. We use the action of Γ on effective divisors to determine the exact effective cones, which have infinitely many generators. The resulting nonperturbative superpotentials are Jacobi theta functions, whose modular symmetries suggest the existence of strong-weak coupling dualities involving inversion of divisor volumes.

16:00 | **Niccolò Cribiori** — MPI Munich

Weak Gravity versus Scale Separation

The existence of a separation of scales between the four observed spacetime dimensions and the yet unobserved additional ones is a minimal requirement for (string) phenomenology. Explaining its origin at the theoretical level is an open problem. I will present a general argument excluding scale separation in supersymmetric anti-de Sitter vacua of four-dimensional $\mathcal{N} = 2, 8$ supergravity as a consequence of the weak gravity conjecture. This suggests that $\mathcal{N} = 0, 1$ supersymmetry at the lagrangian level could be the most promising chances to obtain a truly four-dimensional effective description of quantum gravity.

16:20 | **Lars Aalsma** — University of Wisconsin

New Spins on the WGC

Extremal black holes play a key role in our understanding of various swampland conjectures and the WGC in particular. The mild form of the WGC states that higher-derivative corrections should decrease the mass of extremal black holes at fixed charge. Whether or not this conjecture is satisfied depends on the sign of the combination of Wilson coefficients that control corrections to extremality. Typically, these corrections need to be computed on a case-by-case basis, but in this talk I will present a universal derivation that can be applied to a wide class of black holes. As a particular application of interest, I will use this formalism to compute corrections to rotating extremal black holes and assess the possibility of a rotating WGC.

16:40 | **Benjamin Heidenreich** — University of Massachusetts Amherst

The Weak Gravity Conjecture and BPS Strings

In the context of M-theory compactified on a Calabi-Yau threefold, I discuss the connection between the Weak Gravity Conjecture, BPS strings, and novel geometric conjectures generalizing Morrison's cone conjecture. These geometric conjectures dictate how "tame" the asymptotic regions of the Kähler moduli space are, and also closely relate to the Swampland Distance Conjecture and the Emergent String Conjecture.

17:00 | **Veronica Collazuol** — IPhT Saclay

E_9 symmetry in the heterotic string on S^1 and the Weak Gravity Conjecture

I will show that compactifications of the heterotic string on a circle exhibit at the boundary of moduli space ($R \to 0$, or equivalently the decompactification limit $R \to \infty$) a tower of winding or momentum modes that enhance the $E_8 \times E_8$ or $SO(32)$ gauge algebras to the affine algebras $(E_9 \oplus E_9)/\sim$ (the identification means that the two copies of E_9 share the same central extension) and $\hat{D}_{16}$, respectively. These towers of modes also satisfy the Lattice Weak Gravity and Repulsive Force Conjectures.

17:20 | **David Prieto Rodríguez** — IFT UAM-CSIC Madrid

Type IIA Scale Separation and Moduli Stabilization

We analyse the flux-induced scalar potential for type IIA orientifolds in the presence of p-forms and geometric fluxes. The bilinear structure of the scalar potential, with a factorised dependence on axions and saxions, allows us to perform a systematic search for vacua. We classify the branches of supersymmetric and non-supersymmetric vacua extending the results from arxiv:2007.00672. Following the steps of arxiv:2107.00019, we find scale separation in massless type IIA compactified over more general settings.

17:40 | **Eduardo Gonzalo** — Lehigh University

A tower of right-handed neutrinos and the Swampland

Given the smallness of the vacuum energy of our Universe, it is reasonable to expect, from the point of view of the Swampland, that a tower either is becoming or became light in the not-so-distant past. We review the experimental constraints and take the first steps towards the construction of a viable model for a tower with $m_{\text{tow}} \sim \Lambda_{4d}^{1/4}$. Since this coincides with the scale of neutrino oscillations we focus on the case where the tower is made out of right-handed neutrinos. The model is consistent with current tests of sub-milimeter gravity, but predicts deviations from Newton's Law at scales $R \lesssim 0.1 - 20\mu m$. The extra dimensions induce additional wiggles on top of the standard 3-flavour neutrino oscillations. We argue that they are naturally suppressed in string theory models, where Yukawa couplings between the zero modes of the active neutrino and the Higgs and the n excited state of the tower depend on n. We illustrate this point by explicitly computing the Yukawa couplings in toroidal compactifications of $D = 10$ SYM with fluxes.

Parallel Session – Theatre B — Lukas

16:00 | **Anindita Maiti** — Northeastern University

Neural Network Field Theories

Neural Networks are the backbones of breakthroughs in Deep Learning. In this talk, I will explain how they describe non-perturbative non-Lagrangian field theories through their architectures. In certain infinite limits, these theories become generalized free field theories via the Central Limit theorem (CLT), and small violations of CLT, by proper tuning of the architectures, turn on weakly coupled interaction terms. The symmetries and correlation functions may be computed exactly even when the action is unknown. This correspondence between Neural Networks and field theories can be beneficial to both Deep Learning and physics.

16:20 | **Andrei Constantin** — University of Oxford

Intelligent Explorations of the String Theory Landscape

The goal of identifying the Standard Model of particle physics and its extensions within string theory has been one of the principal driving forces in string phenomenology. Recently, the incorporation of artificial intelligence in string theory and certain theoretical advancements have brought to light unexpected solutions to mathematical hurdles that have so far hindered progress in this direction. In this talk I will focus on model building efforts in the context of the $E_8 \times E_8$ heterotic string compactified on smooth Calabi-Yau threefolds and discuss several areas in which machine learning is expected to make a difference.

16:40 | **Thomas Harvey** — University of Oxford

Exploring the Heterotic Landscape with Genetic Algorithms and Reinforcement Learning

We present work where Genetic Algorithms (GA) and Reinforcement Learning (RL) have been used to construct string theory realisations of the standard model, in situations that defy a systematic scan. Specifically, we explore the space of compactifications of $E_8 \times E_8$ Heterotic String theory with Monad bundles, in search of configurations that lead to supersymmetric theories with the spectrum of the MSSM. Both methods are successful in systematically exploring this large class of constructions, and both lead to similar lists of new viable models.

17:00 | **Damian van de Heisteeg** — Utrecht University

Building new lampposts in moduli spaces

In this talk I explore boundaries in Calabi-Yau moduli spaces away from the large complex structure point. We construct general models for the asymptotic periods in these regimes, which encode the $N = 2$ vector sector and part of the $N = 1$ supergravity data in Type IIB Calabi-Yau (orientifold) compactifications. We then show how to compute the leading coefficients of these expansions from the singular CY geometry at the boundary.

17:20 | **Jeroen Monnee** — Utrecht University

Hodge Theory and Deformed WZW Models

In this talk I will present a recently uncovered relationship between one-parameter variations of Hodge structure and lambda-deformed Wess-Zumino-Witten models. In string theory settings, the latter serves as an auxiliary field theory on the moduli space whose solutions encode properties of the effective field theory. Our work suggests an interesting connection between the field of integrable models and the mathematical study of period mappings.

17:40 | **Alvaro Herraez** — IPhT Saclay

The Tadpole Conjecture in the Strict Asymptotic Regime

The Tadpole Conjecture puts severe constraints on the stabilization of a large number of moduli by claiming that in such settings the flux contribution to the tadpole grows at least linearly with the number of stabilized fields. In this talk we present the first conceptual argument that explains this linear scaling setting and clarifies why it sets in only for a large number of stabilized moduli. This is done in the strict asymptotic limits of moduli space, by using the tools of asymptotic Hodge theory, which make possible an explicit discussion of moduli stabilization and allow us to establish the relevant scaling constraints for the tadpole.

Parallel Session – Theatre C — Zavala

16:00 | **Lilia Anguelova** — INRNE - Bulgarian Academy of Sciences

Hidden Symmetries, Rapid Turns and Cosmic Acceleration

Hidden symmetries provide a powerful tool for finding exact solutions in multifield cosmological models. I will show how, using such symmetries, one can find inflationary solutions in two-field models, which lead to the generation of primordial black holes. I will also discuss an exact solution in a two-field cosmological model, which describes dark energy. This solution is obtained with the use of a hidden symmetry, although the latter is broken by a constant term in the scalar potential. All of the above solutions are characterized by field-space trajectories with rapid turns.

16:20 | **Dnyanesh Kulkarni** — Cornell University

Flavor structure in geometric engineering

Four dimensional $\mathcal{N} = 2$ superconformal field theories (SCFTs) form a distinguished class of well-studied string compactifications and many of their properties are readable directly from the string construction; the flavor structure instead can only be understood partially from it. In this talk, I will present how some of the recently developed tools such as central charge formulae and stratification, relying solely on the data directly extractable by the string construction, can be used to determine the flavor structure as well as characterize fully the Higgs branch of geometric engineered SCFTs. I will also comment on some interesting observations regarding the Schur indices and associated vertex operator algebras of these theories.

16:40 | **Ignacio Ruiz García** — IFT UAM-CSIC Madrid

Asymptotic accelerated expansion in String Theory

Using potentials obtained by working on the asymptotic limit of F-theory compactifications on Calabi-Yau fourfolds with 4-form fluxes, we systematically study of the trajectories through which these potentials send the complex structure moduli to infinity. Working within a quintessence scenario, we show that these potentials do not automatically rule out the existence of an accelerated Universe, and we discuss under which circumstances this might be possible. We relate this with the de Sitter Swampland Conjecture and also provide comments on the connections with the Swampland Distance and Weak Gravity Conjectures.

17:00 | **Filippo Revello** — University of Oxford

Catch-Me-If-You-Can: The Overshoot Problem and the Weak/Inflation Hierarchy

We study the overshoot problem in the context of post-inflationary string cosmology (in particular LVS). LVS features a long kination epoch where the volume rolls down the exponential slope towards the final minimum. This roll admits tracker attractor solutions, and if the field locates these then the overshoot problem is solved. We show that this is achieved in LVS provided the hierarchy between the inflationary scale and the weak scale is sufficiently large, as the seed radiation is able to grow sufficiently. The requirement of ending in a stable vacuum therefore gives a preference for high inflationary scales – an anthropic argument, if one likes, for a large inflation/weak hierarchy. We discuss various origins, both universal and model-dependent, of the initial seed radiation. A particularly interesting case is that of a fundamental string network arising from brane inflation – this may lead to an epoch where the universe energy density principally consists of gravitational waves.

17:20 | **Stephen Angus** — Asia Pacific Center for Theoretical Physics

Aligned natural inflation in the Large Volume Scenario

I will discuss an explicit string theory embedding of natural inflation which is consistent with the weak gravity conjecture. Compactifying type IIB string theory on a Calabi-Yau orientifold and stabilising moduli under the Large Volume Scenario, we use D7-brane stacks to generate a potential for bulk axions. This allows us to realise natural inflation via the Kim-Nilles-Peloso alignment mechanism, yielding predictions for inflation in terms of the underlying geometry. We find that constraints from the Kähler cone condition, the weak gravity conjecture, and the observed power spectrum of scalar perturbations can all be satisfied in a regime with relatively small bulk volume. Furthermore, by carefully differentiating between instanton charges and axion decay constants, we also clarify the statements of the weak gravity conjecture for axions and the KNP alignment scenario.

17:40 | **Joaquin Aurelio Masias Teves** — MPI Munich

Particle production during Inflation and the Swampland Distance Conjecture

The Swampland Distance Conjecture states that, at large distances in field space, the characteristic mass of an infinite tower of states becomes exponentially light. We apply this to cosmological inflation and consider the tower mass depending on the inflaton field. As these modes become light, they start being produced thus generating additional friction and slowing down the inflaton. We study the phenomenological implications of such a scenario and present its predictions for cosmological observables.

Parallel Session – Theatre D — Zadeh

16:00 | **Eirik Eik Svanes** — University of Stavanger

Partition Functions of Heterotic Potentials

We compute the one loop partition function of the superpotential and Kähler potentials of the geometric sector of six-dimensional heterotic compactifications. The results are interesting both from an ordinary mirror symmetry and heterotic (0,2) mirror symmetry point of view.

16:20 | **Martín Hurtado Heredia** — University of Liverpool

Spinor-vector duality in smooth heterotic compactifications

In this talk I explain the ongoing work in extending the spinor-vector duality (SVD) (where two models are related by the exchange of a number of spinorial plus anti-spinorial representations by the same number of vectorial representations of the underlying GUT group) to smooth compactifications of the heterotic string (i.e. over Calabi Yau manifolds with vector bundles). I will outline the main results for the 6D and 5D cases and the work in the 4D case, which focus the resolution of $T^6/\mathbb{Z}_2 \times \mathbb{Z}_2$ orbifolds and the study of discrete torsion using Gauged Linear Sigma Models therein. Furthermore I will outline how SVD can fit in a bigger picture due to its deep connections with other well-studied symmetries like Mirror Symmetry and T-duality.

16:40 | **Hector Parra De Freitas** — IPhT Saclay

Frozen singularities and moduli spaces in high dimensions

The moduli space of string vacua with sixteen supercharges for a given number of spacetime dimensions

d consists of various connected components labeled e.g. by the rank of the gauge groups and spacetime dimension. For $d = 7, 8, 9$, this space has been thoroughly explored, but as I will argue, there exist certain components which have been so far unidentified. This result follows naturally from the framework of singularity freezing in F-Theory of M-Theory on (elliptic) K3 surfaces by taking into account how this freezing acts on the respective middle cohomology lattices. In $d = 7$ there are three new components with small gauge group rank, one of which uplifts to $d = 8, 9$.

17:00 | **Lorenz Schlechter** — Utrecht University

Tameness of QFTs

Recently the tameness conjecture was proposed which states that effective field theories arising from quantum gravity should be formulated using a tame geometry. In this talk I will show that quantum corrections arising in perturbative QFTs respect this tameness by mapping the amplitudes to geometric periods. Moreover, in certain exactly solvable examples like 2d string theories and gauged linear sigma models the tameness can be seen to hold even non-perturbatively.

17:20 | **Georges Obied** — Harvard University

Inflation and light Dark Matter constraints from the Swampland

I will explore the interplay between Swampland conjectures and models of inflation and light Dark Matter. To that end, I will briefly review the weak gravity conjecture (WGC) and the related Festina Lente (FL) bound. These have implications for light darkly and milli-charged particles and can disfavor a large portion of parameter space. The FL bound also implies strong restrictions on the field content of our universe during inflation and presents an opportunity for inflationary model building. At the same time, it rules out some popular models like chromo-natural inflation and gauge-flation. Finally, I will review another Swampland conjecture related to Stückelberg photon masses and discuss its implications for astro-particle physics.

17:40 | **Callum Brodie** — Virginia Tech

Topology change in heterotic string theory as a small instanton transition between the gauge and gravitational sectors

I will discuss aspects of a newly-discovered geometric structure underlying target space duality, namely that a topology-changing process in heterotic string theory appears to be naturally described by a small instanton transition between the gauge and gravitational sectors. I will describe how the appropriate change in the gauge bundle is mediated by M5-branes which are intimately associated to the geometry of the transition, and how this brane picture gives an explanation of the match between the spectra of target space dual theories.

Friday 8^{th} July

Plenary Session – Theatre A — Bianchi

09:00 | **Jonathan Heckman** — University of Pennsylvania

Reflections on F-theory and the Swampland Cobordism Conjecture

F-theory famously geometrizes the SL(2,$\mathbb{Z}$) duality symmetry of IIB string theory. In this talk we discuss a subtle generalization of this to the full Pin$^+$ cover of GL(2,$\mathbb{Z}$), which allows for reflections in the F-theory torus directions. The corresponding spectrum of defects predicted by the Swampland cobordism conjecture of McNamara and Vafa recovers many known supersymmetric F-theory backgrounds, but also leads to the discovery of new non-supersymmetric objects, as well as a new class of 4D $\mathcal{N} = 1$ SCFTs.

09:30 | **Timm Wrase** — Lehigh University

Type IIB flux compactifications with $h^{1,1} = 0$

In this talk I will discuss a non-geometric class of type IIB string flux compactifications. The existence of AdS, Minkowski and dS vacua is studied and their properties will be compared to several swampland conjectures. Controlled Minkowski vacua exist at strong coupling and might be the first examples of fully stabilized Minkowski vacua from string theory.

10:00 | **Ivano Basile** — University of Mons

Non-supersymmetric strings: the good, the bad and the swamp

Breaking supersymmetry is a crucial step toward realistic string phenomenology. Swampland and naturalness arguments point to string-scale breaking, which however entails dramatic backreaction if unbalanced. We review the status of these constructions focusing on phenomenology. Despite breaking supersymmetry, compactifications remain unviable: de Sitter vacua and scale separation are obstructed in agreement with numerous swampland conditions. However, instabilities naturally lead to de Sitter braneworld cosmologies inside an anti-de Sitter bulk. This indicates that metastable vacua of this type may allow a novel approach to string phenomenology.

Plenary Session – Theatre A — Abel

11:00 | **Ida Zadeh** — ICTP Trieste

Heterotic Strings on $T^3/\mathbb{Z}_2$ and Nikulin involutions

I will discuss compactification of the heterotic string on the smooth, flat 3-manifold $T^3/\mathbb{Z}_2$, without supersymmetry. The low energy dynamics of the corresponding ten dimensional heterotic supergravity will be described. The semi-classical theory has both Coulomb and Higgs branches of non-supersymmetric vacua. An exact worldsheet description of the compactification will then be presented using the framework of asymmetric orbifolds of T^3, where the orbifold generator involves a Nikulin non-symplectic involution of the even self-dual lattice of signature (19,3). This construction gives a novel conformal field theory description of the semi-classical field theory moduli space and reveals a rich pattern of transitions amongst Higgs and Coulomb branches.

11:30 | **Ivonne Zavala** — Swansea University

Primordial black holes and induced gravitational waves in string inflation

I will discuss recent developments in multifield inflation in supergravity and string theory, focusing on mechanisms for primordial black hole production and induced gravitational waves, and prospects for detection at future gravitational wave experiments.

12:00 | **Jakob Moritz** — Cornell University

PQ Axiverse

In this talk I will show that the strong CP problem is solved in a large class of compactifications of string theory. The Peccei-Quinn mechanism solves the strong CP problem if the CP-breaking effects of the ultraviolet completion of gravity and of QCD are small compared to the CP-preserving axion potential generated by low-energy QCD instantons. We characterize both classes of effects. To understand quantum gravitational effects, we consider an ensemble of flux compactifications of type IIB string theory on orientifolds of Calabi-Yau hypersurfaces in the geometric regime, taking a simple model of QCD on D7-branes. We show that the D-brane instanton contribution to the neutron electric dipole moment falls exponentially in N^4, with N the number of axions. In particular, this contribution is negligible in all models in our ensemble with $N > 17$. We interpret this result as a consequence of large N effects in the geometry that create hierarchies in instanton actions and also suppress the ultraviolet cutoff. We also compute the CP breaking due to high-energy instantons in QCD. In the absence of vectorlike pairs, we find contributions to the neutron electric dipole moment that are not excluded, but that could be accessible to future experiments if the scale of supersymmetry breaking is sufficiently low.

Plenary Session – Theatre A — Faraggi

14:00 | **Tony Padilla** — University of Nottingham

Quintessence in string theory

We provide a discussion of the main theoretical and phenomenological challenges of quintessence model building in any numerically controlled regime of the moduli space of string theory. We argue that a working quintessence model requires a leading order non-supersymmetric (near) Minkowski vacuum with an axionic flat direction. This axion, when lifted by subdominant non-perturbative effects, could drive hilltop quintessence only for highly tuned initial conditions and a very low inflationary scale.

14:30 | **Alexander Westphal** — DESY

A Quantum-Mechanical Mechanism for Reducing the Cosmological Constant

We exhibit a mechanism which dynamically adjusts cosmological constant toward 0^+. The adjustment is quantum-mechanical, discharging cosmological constant in random discrete steps. It renders de Sitter space unstable, and triggers its decay toward Minkowski. Since the instability dynamically stops at $\Lambda = 0$, the evolution favors the terminal Minkowski space without a need for anthropics. The mechanism works for any QFT coupled to gravity.

15:00 | **Ralph Blumenhagen** — MPI Munich

K-theory, Corbordism and Tadpoles

Both K-theory and cobordism classify charges of global symmetries. In quantum gravity these must be either gauged or broken. The gauging of such symmetries in string theory suggests that there should exist a deep connection between the two, which is indeed known as the Hopkins-Hovey theorem. In fact, both charges appear in stringy Bianchi identities and their resulting tadpole cancellation conditions. In this talk, we describe how this work in more detail, presenting also some new yet unpublished results. Finally, studying the backreaction of a non-BPS D8-brane, we also provide a new example of a dynamical cobordism. The breaking of this global symmetry is due to an end-of-the-world 7-brane for which an explicit solution is shown.

Social Programme

Morning Coffee Break

10:30 Daily | **Central Teaching Hub** — *1st floor*

Coffee, tea and snacks will be served on the 1st floor of the Central Teaching Hub just outside the lecture theatres.

Lunch

12:30 Daily | **Central Teaching Labs** — *ground floor*

The conference lunch will be served daily, on the ground floor of the Central Teaching Labs. This is right next to the conference venue in the same building through a set of doors either on the ground or 1st floor. Please feel free to serve yourself and eat at any of the tables scattered around the building, or outside if weather permits. All food will have labels with allergens — if unsure do not hesitate to ask the catering staff present about any dietary requirements you may have.

Afternoon Coffe Break

15:30 Daily | **Central Teaching Hub** — *1st floor*

Coffee, tea and snacks will be served on the 1st floor of the Central Teaching Hub just outside the lecture theatres.

Welcome Reception

17:30 Monday | **Central Teaching Labs** — *ground floor*

We invite all participants for a glass of wine and light bites after the last talk on Monday. The venue for the reception will be the same as for the lunch in the Central Teaching Labs.

Conference Dinner

19:00 Wednesday | **Victoria Gallery & Museum** — *Waterhouse Cafe*

For participants who have booked the optional dinner during the registration process, we will serve the conference dinner in the historic building of Victoria Gallery & Museum.

Useful Information

Conference Venue

Main Talks Venue	Accommodation	Conference Dinner
Central Teaching Hub University of Liverpool 200 Brownlow Hill Liverpool L3 5UE	Crown Place University of Liverpool 202 Brownlow Hill Liverpool L3 5UE	Victoria Gallery and Museum University of Liverpool Ashton Street Liverpool L69 3DR

Conference Accommodation

Participants who booked accommodation through the conference organisers will be staying at Crown Place halls of residence. Towels are provided and there will be a Tea/Coffee making tray in your room. TV and iron/ironing board can be found in the kitchens and hairdryers are available from the Reception Desk.

Check-in is from 16:00 on your day of arrival. Please report to the Reception Desk at Crown Place upon arrival to collect your room key. Participants will need to vacate their room by 09:30 on the day of departure. Please check out and hand in your room key at the Reception Desk in Crown Place. Left luggage facilities are available at Crown Place, with overflow provision available in the Central Teaching hub using the lockers (can fit a cabin size suitcase).

Crown Place Catering

Breakfast | *7:30–9:00 Daily* | *Courtyard Restaurant, The Guild of Students*

For participants staying at Crown Palace, breakfast will be served in the Courtyard Restaurant on the ground floor of The Guild of Students from 7:30am — 9am. This is a short 2min walk from Crown Place.

Additional Information

Cash machines are available at The Guild, Crown Place and the nearby Tesco. There are several coffee shops and convenience stores also nearby. As the campus is in the city centre, taxis are plentiful and easy to flag down from the street.

Emergency procedures will be announced at housekeeping during the welcome. Information on accommodation emergency procedures can be found on all bedroom doors — please take a moment to read these.

Contact

If you have any questions or require assistance, please don’t hesitate to contact us via email at StringPheno2022@liverpool.ac.uk.

List of Participants

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