Introduction to the Swampland Program

Cumrun Vafa
Harvard University

TBA

The Kinematic Swampland Conjectures

Jacob McNamara
Caltech

TBA

The Landscape with High Supersymmetry (an overview)

Hector Parra de Freitas
Harvard University

In the first talk I will give an overview of the state of our knowledge regarding the landscape of string vacua with 32 and 16 supercharges, both from the top down and bottom up. I will present various open questions and puzzles.

In the second talk I will introduce various concepts and tools that are useful for characterizing the spectrum of these theories in a systematic way. These methods are based on manipulations of indefinite lattices which play the role of lattices of electric charges and underlie many critical aspects of the nonperturbative structure governing this branch of the Landscape. They can be used as well in many other setups with broken supersymmetry.

The landscape of less supersymmetric vacua

Severin Luest
U. Montpellier

This lecture will cover less supersymmetric vacua in the string theory landscape, in particular those with eight and four real supercharges. We will first review compactifications of type II string theory on Calabi-Yau three-folds, and the resulting effective description in terms of four-dimensional N=2 supergravity. We will then discuss supersymmetry breaking via orientifolding and N=1 supersymmetric flux vacua. Time permitting, I will also outline their relationship to F-theory and heterotic compactifications.

State of the art in moduli stabilization

Timm Wrase
Lehigh University

Moduli stabilization is one of the most interesting and important goals in string phenomenology. After lots of new constructions and ideas in the early 2000's we have entered a phase of careful checks and scrutiny. This led to swampland conjectures that call into question the existence of dS vacua as well as scale-separated AdS vacua in string theory. I will review the current status of well-known string compactification scenarios like KKLT, LVS and DGKT as well as other ideas to stabilize moduli in string compactifications. References or Resources: 2310.20559 Chapters 1-5 and 9

A journey through the non-geometric string landscape

Houri Tarazi
Chicago University

TBA

Early Universe: Inflation and Quantun Gravity

Gary Shiu
University of Wisconsin-Madison

TBA

The dark dimension and cosmology in the late universe

Georges Obied
Oxford
TBA

Swampland and Geometry

Kai Xu
Harvard CMSA

TBA

Quantum Cobordism and Higher Factorization

Jacob McNamara
Caltech
TBA

The black hole scale in quantum gravity

David Wu
Harvard University

In this talk, I will introduce a new scale called the black hole scale which marks the inverse length (or the temperature) of the smallest Schwarzschild black hole where the EFT of quantum gravity gives a correct description of its free energy. This new scale is motivated from Swampland principles and is hard to detect from the viewpoint of the EFT. In particular, the black hole scale gets related to the Gregory-Laflamme transition in the decompactification limit and to the Horowitz-Polchinski solutions in the light perturbative string limits. Then, motivated by the identification of the black hole scale in quantum gravity, I will discuss recent progress in finding higher-dimensional analogues of the Horowitz-Polchinski solutions.

Overarching structures underlies the Landscape with 16 supercharges

Hector Parra de Freitas
Harvard University

TBA

Holography and KKLT

Severin Luest
U. Montpellier

In this talk I discuss holographic constraints on scale separated, supersymmetric AdS vacua of IIB string theory and M-theory. Their dual CFTs should have very large central charges and rather unusual properties. I first describe brane configurations that source these would-be AdS flux compactifications. Subsequently, I identify certain UV AdS geometries in the near horizon limit of these branes. Lastly, I explain how to obtain bounds on the absolute values of the cosmological constants of the AdS vacua from the central charges of the dual CFTs.

Stabilizing all moduli in a Landau-Ginzburg model

Timm Wrase
Lehigh University

I will discuss non-geometric flux compactifications of string theory on Landau-Ginzburg models that are dual to rigid Calabi-Yau manifolds. Minkowski vacua can be analyzed even at strong

coupling, providing a rare window in this corner of the string theory landscape. We focus on the number of stabilized moduli to test the tadpole conjecture in this context. While the conjecture is confirmed, a refined version is violated and needs to be modified. We furthermore discuss the existence of Minkowski vacua in which all scalar fields are stabilized. For some of these vacua all scalars fields are massive, while others have also some massless but stabilized scalar fields.

Exploring exotic corners of the susy and non-susy string landscape

Houri Tarazi
Chicago University

In this talk I will discuss concrete examples of string theory compactifications that are non-geometric. From the susy perspective such examples provide us with a more complete understanding of the string theory landscape that does not come from geometry. I will also discuss the importance of such examples in connection to the Swampland program in an effort to avoid the geometric lamppost. Additionally, from the non-susy perspective moduli stabilization is an important problem. I will show that non-geometric models can provide non-susy tachyon-free examples with a single neutral scalar field, which are a source of instability.

The Weak Gravity Conjecture

Gary Shiu
University of Wisconsin-Madison

The Weak Gravity Conjecture was motivated by black hole physics, i.e., black holes, even if extremal, must decay unless there is a symmetry that warrants its stability. The conjecture has since been formulated in different forms. In this talk, I will present arguments for the Weak Gravity Conjecture and its various strong forms. I will further discuss recent computations of decay rate of extremal black holes in diverse spacetimes that may distinguish different formulations of the conjecture.

De Sitte space constraint on brane tension and couplings.

Georges Obied
Oxford

Extended objects are ubiquitous in string theory where they have special properties. Outside of string theory, there are relatively few insights into the nature of extended objects that are allowed by quantum gravity. In this talk, using the Festina Lente conjecture, I will argue for new universal bounds on the tension of branes coupled to gauge fields in de Sitter space. This bound is implied by cosmic censorship and can be derived by studying the evolution of large charged black holes in de Sitter space. Since this is a bottom-up argument, it should be obeyed by any de Sitter quantum gravity including stringy constructions. Finally, I will provide a heuristic check of these bounds against the properties of (wrapped) D-branes in Type II string theory in the weak coupling limit and show that they satisfy all these constraints.

Finite Landscape of 6d ${\cal N=}$(1,0) Supergravity

Kai Xu
Harvard CMSA

We present a bottom-up argument showing that the number of massless fields in six-dimensional quantum gravitational theories with eight supercharges is uniformly bounded.
Specifically, we show that the number of tensor multiplets is bounded by $T\leq 193$, and the rank of the gauge group is restricted to $r(V)\leq 480$. Given that F-theory compactifications on elliptic CY 3-folds are a subset, this provides a bound on the Hodge numbers of elliptic CY 3-folds: $h^{1,1}({\rm CY_3})\leq 491$, $h^{1,1}({\rm Base})\leq 194$ which are saturated by special elliptic CY 3-folds. This establishes that our bounds are sharp and also provides further evidence for the string lamppost principle. These results are derived by a comprehensive examination of the boundaries of the tensor moduli branch, showing that any consistent supergravity theory with $T\neq0$ must include a BPS string in its spectrum corresponding to a ``little string theory" (LST) or a critical heterotic string. From this tensor branch analysis, we establish a containment relationship between SCFTs and LSTs embedded within a gravitational theory. Combined with the classification of 6d SCFTs and LSTs, this then leads to the above bounds.
Together with previous works, this establishes the finiteness of the supergravity landscape for $d\geq 6$.
This is joint work with Hee-Cheol Kim and Cumrun Vafa.