Titles and Abstracts

Luigi Alfonsi (University of Hertfordshire)
Tilte: Towards Non-Perturbative BV-Theory via Derived Geometry and the Puzzle of Quantisation
Abstract: In this talk I will introduce and discuss a global geometric framework which allows one to encode a natural non-perturbative generalisation of classical Batalin–Vilkovisky (BV-)theory. First, I will set the stage by briefly describing the current state of the art of perturbative BV-theory. Then, I will introduce a concrete model of derived differential geometry, whose geometric objects are formal derived smooth stacks (i.e. stacks on formal derived smooth manifolds), and which is obtained by applying Töen-Vezzosi's homotopical algebraic geometry to the theory of derived manifolds of Spivak and Carchedi-Steffens. I will explain how derived differential geometry is able to capture non-perturbative classical BV-theory by means of examples: scalar field theory and Yang-Mills theory. Finally, I will discuss some open questions, most importantly on quantisation and on applications to global aspects of M-theory.

Chris Blair (Universidad Autonoma de Madrid, Spain)
Tilte: Geometry and Dualities of Decoupling Limits in String Theory and M-Theory
Abstract: Our understanding of M-theory is based on a duality web connecting different limits of the theory. I'll discuss the extension of this duality web to a wide variety of decoupling limits related by duality to the null reduction of M-theory (and hence to the proposal that M-theory can be described by Matrix theory). From a modern perspective, these limits involve non-relativistic geometries, leading to new variants of supergravity in 11- and 10-dimensions. I'll discuss how to systematically explore these corners of M-theory, following the roadmap of https://arxiv.org/abs/2311.10564

Grigorios Giotopulos (NYU Abu Dhabi)
Tilte: Towards Non-Perturbative Lagrangian Field Theory via the Topos of Smooth Sets
Abstract: Any notion of non-pertubative (pre)-quantization of classical field theories, as in particular expected in M-theoretic contexts, presupposes a convenient category within which non-pertubative classical field theory may be rigorously formalised. In this talk, I will describe smooth sets as a category of generalized smooth spaces, completely determined by `how they may be smoothly probed by finite dimensional manifolds'. Formally, this is the ``topos of sheaves over the site of Cartesian space''. I will then explain how the variational algorithm of (bosonic) classical field theory and the space of on-shell fields naturally take place in smooth sets, along with many more field theoretic concepts. Time permitting, I will indicate how the setting naturally generalizes to include the description of infinitesimal (pertubative) structure, fermionic fields, and (gauge) fields with internal symmetries.

Fei Han (National University of Singapore)
Tilte: Cubic Forms, Anomaly Cancellation and Modularity
Abstract: Freed and Hopkins developed an algebraic theory of cubic forms, which is an analogy to the theory of quadratic forms in topology. They are motivated by the Witten-Freed-Hopkins anomaly cancellation formula in M-theory, which equals a cubic form arising from an E8 bundle over a 12 dimensional spin manifold to the indices of twisted Dirac operators on the manifold. In this talk, we will first review the Witten-Freed-Hopkins anomaly cancellation formula and the algebraic theory of cubic forms, and then show that the cubic forms as well as the anomaly cancellation formula can be naturally derived from modular forms that we construct inspired by the Witten genus and the basic representation of affine E8. Following this approach, we obtain new cubic forms and anomaly cancellation formulas on non-spin manifolds and thus provide a unified way to obtain anomaly cancellation formulas of this type. This is based on our joint work with Prof. Ruizhi Huang, Prof. Kefeng Liu and Prof. Weiping Zhang.

Yang-Hui He (University of Oxford)
Tilte: The AI Mathematician
Abstract: We summarize how AI can approach mathematics in three ways: theorem-proving, conjecture formulation, and language processing. Inspired by initial experiments in geometry and string theory, we present a number of recent experiments on how various standard machine-learning algorithms can help with pattern detection across disciplines ranging from algebraic geometry to representation theory, to combinatorics, and to number theory.

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Titles and Abstracts

Olaf Hohm (Humboldt University of Berlin)
Tilte: Double Copy, Double Field Theory & Homotopy Algebras
Abstract: The double copy denotes a technology to relate the scattering amplitudes of Yang-Mills theory to those of gravity. While enormously successful at the level of scattering amplitudes, until recently there was no first-principle understanding of how to derive such relations. Such an understanding would be needed in order to describe, for instance, a double copy of classical solutions. I present an approach based on homotopy algebras such as L-infinity algebras that allows one to provide such a first-principle derivation, at least to some finite order in perturbation theory. To this end I review how to formulate Yang-Mills theory as an L-infinity algebra, how to "strip off" color to obtain a different kind of homotopy algebra and, finally, how to combine two copies of these exotic algebras to obtain the L-infinity algebra of gravity in the form of double field theory.

Chris Hull (Imperial College London)
Tilte: Self-Dual p-Form Gauge Fields and the Topology of the Graviton
Abstract: TBD

Neil Lambert (King's College London)
Tilte: Non-Relativistic M2-Branes and AdS/CFT
Abstract: We discuss a peculiar limit of M2-branes that leads to a non-relativistic Chern-Simons-matter theory with an infinite dimensional spacetime symmetry group and whose dynamics leads to quantum mechanics on a Hitchin moduli space. We also discuss the corresponding limit in the gravitational dual which is described by an eleven-dimensional Membrane-Newton-Cartan theory about a background with an AdS2 factor.

Mario Garcia-Fernandez (Institute for Mathematical Sciences, Madrid)
Tilte: Gauge Theory for String Algebroids
Abstract: In this talk I will explain a moment map construction for string algebroids, a special type of Courant algebroids which arise as Atiyah algebroids of higher principal bundles. The zero locus of our moment map is given by the solutions of the Calabi system, a coupled system of equations which provides a unifying framework for the classical Calabi problem and the Hull-Strominger system in heterotic string theory. Our main results are concerned with the geometry of the moduli space of solutions, and assume a technical condition which is fulfilled in examples. We prove that the moduli space carries a pseudo-Kähler metric with Kähler potential given by the dilaton functional, a topological formula for the metric, and an infinitesimal Donaldson-Uhlenbeck-Yau type theorem. Based on joint work with Rubio and Tipler in arXiv:2004.11399 (to appear in JDG) and ongoing joint work with Álvarez-Cónsul and Tellez.

Emmanuel Malek (Humboldt University of Berlin)
Tilte: Kaluza-Klein Spectrometry for String Theory Compactifications
Abstract: I will present a powerful new method that for the first time allows us to compute the Kaluza-Klein spectrum of a large class of string theory compactifications, including those arising in maximal gauged supergravities and beyond. This includes geometries with little to no remaining (super-)symmetries, completely inaccessible by previous methods. I will show how these insights can be used to holographically compute the anomalous dimensions of protected and unprotected operators in strongly-coupled CFTs, as well as to study global properties of their conformal manifolds. I will also show how the method can be used to determine the perturbative stability of non-supersymmetric AdS vacua. We will see the importance of higher Kaluza-Klein modes to the physics of string compactifications, e.g. in realising the compactness of moduli spaces, restoring supersymmetry that is lost in a consistent truncation, and in destabilising vacua that appear to stable in lower-dimensional supergravities.

Ruben Minasian (Institute of Theoretical Physics, France)
Tilte: Constraining and Un-constraining Supergravities
Abstract: I will review various aspects and somewhat surprising consequences of cancellation of (different types of) anomalies in supergravity theories in eight and six dimensions. I will also discuss appearance and importance of exotic (singular, non-spin, non-orientable) backgrounds.

Titles and Abstracts

Christian Saemann (Heriot-Watt University)
Tilte: Atiyah Algebroids for Higher and Groupoid Gauge Theories
Abstract: We present an Atiyah algebroid picture for higher and groupoid gauge theories. Common to both is the fact that straightforward definitions of curvatures are only suitable for partially flat cases. Instead, one has to adjust the underlying cocycle relations, leading to new curvatures and gauge transformations. The Atiyah algebroid picture I sketch provides a good idea about the origin of adjustments and why they are required even in the relative conventional case of groupoid gauge theories.

Carlos Shahbazi (UNED, Madrid)
Tilte: The Differential Geometry and Topology of Four-Dimensional Universal Supergravity
Abstract: Using the cohomology of the appropriate locally constant sheaf I will explain how to implement the Dirac-Schwinger-Zwanziger integrality condition on four-dimensional classical ungauged supergravity and how to interpret it geometrically in order to obtain its duality-covariant, gauge-theoretic, differential-geometric global model. Using this construction, I will prove that four-dimensional bosonic ungauged supergravity is completely determined by a choice of polarized Siegel bundle defined over the total space of a vertically Riemannian submersion equipped with a complete Ehresmann connection, showing that its gauge sector reduces to a polarized self-duality condition for connections on the underlying polarized Siegel bundle. Furthermore, I will explore the continuous and arithmetic U-duality groups of the theory, characterizing them through short exact sequences and realizing the latter through the automorphism group of the underlying Siegel bundle acting on its adjoint bundle. This elucidates the geometric origin of U-duality and justifies the miraculous existence of U-dualities by describing them as a gauge transformation of the appropriately defined principal bundle.

Hisham Sati (NYU Abu Dhabi)
Tilte: M-Theory and Hypothesis H
Abstract: I will survey the (co)homotopical perspective on the fields and branes in M-theory, showcasing several recent developments. This talk highlights the classical/prequantum aspects, while the talk by Urs Schreiber will highlight the quantum aspects.

Urs Schreiber (NYU Abu Dhabi)
Tilte: Introduction to Quantum Hypothesis H
Abstract: A famous hypothesis in string theory says that the RR-fields in 10d supergravity are subject to "flux quantization" in topological K-cohomology theory. From a modernized point of view of rational homotopy theory, analogous reasoning applies to the C-field in 11d supergravity and suggests that its flux should be quantized in the "unstable CoHomotopy" cohomology theory of Borsuk, Pontrjagin and Spanier. I'll survey this "Hypothesis H" with focus on its implications for quantum observables on intersecting branes. This is joint work with Hisham Sati. Notes are available at: https://ncatlab.org/schreiber/show/Introduction+to+Hypothesis+H

Eric Sharpe (Virginia Tech, USA)
Tilte: Decomposition of 2D Pure Yang-Mills and the Gross-Taylor String Theory
Abstract: In this talk, we will attempt to reconcile two different results on two-dimensional pure Yang-Mills theory. Specifically, we will discuss how the fact that 2d pure Yang-Mills is equivalent to a disjoint union of theories, is related to the Gross-Taylor description of 2d pure Yang-Mills as the target-space field theory of a string theory. The Gross-Taylor picture can be understood by first rewriting the Yang-Mills partition function (in a large N limit) as a sum of correlation functions in Dijkgraaf-Witten theories for the symmetric group S_n, and then interpreting those Dijkgraaf-Witten correlation functions in terms of branched covers, which leads to the string theory description. We first observe that the decomposition of the pure Yang-Mills aligns perfectly with the decomposition of S_n Dijkgraaf-Witten theory, and then discuss decomposition and the branched covers interpretation. We encounter two puzzles, and to solve them, propose that the Gross-Taylor string theory has a higher-form symmetry.

Titles and Abstracts

Meng-Chwan Tan (National University of Singapore)
Tilte: Topological-Holomorphic N=4 Gauge Theory: From Langlands Duality of Holomorphic Invariants to Mirror Symmetry of Quasi-Topological Strings
Abstract: We perform a topological-holomorphic twist of N=4 supersymmetric gauge theory on a four-manifold of the form M4 = C1 x C2, and unravel the mathematical implications of its physics. In particular, we consider the cohomology of different linear combinations of the resulting scalar supercharges under S-duality, whence we would be able to derive novel topological and holomorphic invariants of M4 and their Langlands duals. As the twisted theory can be topological along C1 such that we can dimensionally reduce it to 2d, via the effective sigma-model on C2, we can also relate these 4d invariants and their Langlands duals to the mirror symmetry of Higgs bundles and that of quasi-topological strings described by the sheaf of chiral differential operators.