



Corfu2021: Humboldt Kolleg on Quantum Gravity and Fundamental Interactions

SEPTEMBER 17 - SEPTEMBER 21, 2021

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Scientific Programme

Zoom: tinyurl.com/pstrxpnm (Webinar ID 829 9931 6053)



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1 Program Summary

All times are in the [Eastern European Standard Time \(EEST\)](#) timezone ([click here to see current EEST time](#)).

Saturday, September 18, 2021

9:00	9:20		Greetings from G. Zoupanos and local representatives
9:20	9:40	G. Zoupanos	A von Humboldt presentation
9:40	10:20	D. Luest	The Gravitino and the Swampland
10:20	11:00	J. Kim	Blackhole Information (remote)
11:00	11:40	A. Sagnotti	String (In)Stability Issues with Broken Supersymmetry (remote)
11:40	12:00	Coffee Break	
12:00	12:30	C. Markou	Extracting Bigravity from string amplitudes (remote)
12:30	13:00	I. Lavdas	Entanglement Islands, AdS Massive Gravity and Holography (remote)
13:00	13:40	R. Minasian	Anomalies as obstructions: from dimensional lifts to swampland
13:40	16:00	Lunch	
16:00	16:40	S. Majid	Quantum gravity on finite spacetimes (remote)
16:40	17:10	I. Garcia Garcia	Bounce of Nothing (remote)
17:10	17:30	Coffee Break	
17:30	18:10	G. Dvali	S-matrix constraints on landscape, and naturalness
18:10	18:50	A. Linde	Inflation after Planck and BICEP (remote)
18:50	19:30	R. Kallosh	Sequestered inflation in M-theory and IIB string theory (remote)

Sunday, September 19, 2021

9:00	9:40	H. Kawai	Random geometry and naturalness (remote)
9:40	10:20	E. Pomoni	Type-B Anomalies on the Higgs Branch (remote)
10:20	11:00	H. Nicolai	A perturbative expansion schem for supermembrane and matrix theory (remote)
11:00	11:20	Coffee Break	
11:20	12:00	R. Szabo	Braided Symmetries in Noncommutative Field Theory (remote)
12:00	12:40	K. Krasnov	Spin(10), octonions and the symmetry breaking (remote)
12:40	13:20	G. Savvidy	Alternative Inflation Cosmology without Scalar Field
13:20	16:00	Lunch	
16:00	16:40	A. Ashtekar	Alleviating tensions in the CMB using Planck scale physics A Comic Tango between the very large and very small (remote)
16:40	17:20	G. Ross	R ² /Higgs inflation, gravitational contact terms and the hierarchy problem (remote)
17:20	17:40	Coffee Break	
17:40	18:20	M. Haack	Closed string disk amplitudes in the pure spinor formalism (remote)
18:20	19:00	C. Hull	Gravity above the Planck Scale
19:00	19:40	Y. Oz	Entanglement, Chaos and Quantum Computation (remote)

Monday, September 20, 2021

9:00	9:40	C. Bachas	A far-from-equilibrium horizon
9:40	10:20	V. Rivasseau	Introduction to Tensorial Data Analysis
10:20	11:00	G. Barnich	Photons & Gravitons in a Casimir box
11:00	11:20	Coffee Break	
11:20	12:00	C. Wetterich	Pregeometry and emergent general relativity (remote)
12:00	12:40	K. Stelle	Taxonomy of Brane Gravity Localisations (remote)
12:40	13:20	P. Nilles	High scale inflation a window to quantum gravity (remote)
13:20	16:00	Lunch	
16:00	16:40	H. Steinacker	Gravity as a quantum effect on quantum space-time
16:40	17:10	M. Martone	Characteristic dimension and isotrivial geometries (remote)
17:10	17:50	T. Weigand	Quantum Gravity Conjectures and their Geometric Manifestations (remote)
17:50	18:10	Coffee Break	
18:10	18:50	H. Ooguri	Completeness of Gauge Charges in Quantum Gravity (remote)
18:50	19:30	S. Giddings	Black holes and clues for quantum gravity (remote)
19:30	20:00	G. Zoupanos (chair)	Final Discussion

2 Detailed Program with Abstracts

2.1 Saturday, September 18, 2021

Time: 9:00 – 9:20

Title: Greetings from G. Zoupanos and local representatives

Time: 9:20 – 9:40

Speaker: G. Zoupanos (NTUA)

Title: A von Humboldt presentation

Time: 9:40 – 10:20

Speaker: D. Luest (LMU-Munich/Max-Planck-Institute Munich)

Title: The Gravitino and the Swampland

Abstract: In this talk we discuss a new swampland conjecture stating that the limit of vanishing gravitino mass corresponds to the massless limit of an infinite tower of states and to the consequent breakdown of the effective field theory. The proposal can be tested in large classes of models coming from compactification of string theory to four dimensions, where we identify the Kaluza-Klein nature of the tower of states becoming light. We point out a general relation between the gravitino mass and an abelian gauge coupling, which allows us to connect our conjecture to the weak gravity conjecture or the absence of global symmetries in quantum gravity. We discuss phenomenological implications of our conjecture in (quasi-)de Sitter backgrounds and extract a lower bound for the gravitino mass in terms of the Hubble parameter.

Time: 10:20 – 11:00

Speaker: J. Kim (Seoul Natl. U.)

Title: Blackhole Information

Time: 11:00 – 11:40

Speaker: A. Sagnotti (Scuola Normale Superiore)

Title: String (In)Stability Issues with Broken Supersymmetry

Time: 12:00 – 12:30

Speaker: C. Markou (MPI Munich)

Title: Extracting Bigravity from string amplitudes

Abstract: The origin of the graviton from string theory is well understood: it corresponds to a massless state in closed string spectra, whose low-energy effective action, as extracted from string scattering amplitudes, is that of Einstein-Hilbert. In this talk, based on arXiv:2106.04614, we will discuss the possibility of a such a string-theoretic emergence of ghost-free bimetric theory, a recently proposed extension of general relativity that involves two dynamical metrics and which around particular backgrounds propagates the graviton and a massive spin-2 field, with the latter having been put forward as a viable dark matter candidate.

Time: 12:30 – 13:00

Speaker: I. Lavdas (LMU Munich)

Title: Entanglement Islands, AdS Massive Gravity and Holography

Abstract: Studies on entanglement islands and Page curves in braneworld models realising systems of black holes in 4d gravity coupled to an external bath and their string theory uplifts, are recent developments with profound physical significance. In this talk, we focus on a special family of the above uplifts, where the IIB solution allows for a graviton with a small mass. In this context, we study the emergence of the islands and their behaviour on special limits of the geometry, we comment on the significance of the graviton mass and on the dual 3d super-conformal field theory. [Work in progress with S. Demulder, A. Gneccchi and D. Lüst]

Time: 13:00 – 13:40

Speaker: R. Minasian (IPhT CEA-Saclay)

Title: Anomalies as obstructions: from dimensional lifts to swampland

Abstract: I will discuss the consistency of six-dimensional supergravities with minimal supersymmetry

Time: 16:00 – 16:40

Speaker: S. Majid (Queen Mary University of London)

Title: Quantum gravity on finite spacetimes

Abstract: We outline how the new formalism of ‘quantum Riemannian geometry’ can be applied both to finite discrete spaces and to fuzzy ones such as algebras of matrices. This formalism starts with a bimodule of differential 1-forms over the coordinate algebra, which could be noncommutative, a metric as a noncommutative rank (0,2) tensor, and a quantum Levi-Civita connection. We recall how this has been used to construct quantum gravity on a square graph, among other models. We also discuss how tensoring Minkowski spacetime with such a finite quantum Riemannian geometry could appear as particle multiplets, and contrast with Connes’ existing approach to the Standard Model via spectral triples.

Time: 16:40 – 17:10

Speaker: I. Garcia Garcia (Santa Barbara, KITP)

Title: Bounce of Nothing

Abstract: Theories with compact extra dimensions are sometimes unstable to decay into a bubble of nothing – an instability resulting in the destruction of spacetime. In this talk, I will discuss the existence of these bubbles in theories where the moduli fields that set the size of the extra dimensions are stabilized at a positive vacuum energy – a necessary ingredient of any theory that aspires to describe the real world. Using bottom-up methods, and focusing on a five-dimensional toy model, I will argue that four-dimensional de Sitter vacua admit bubbles of nothing for a wide class of stabilizing potentials. I will show that, unlike ordinary Coleman-De Luccia tunneling, the corresponding decay rate remains non-zero in the limit of vanishing vacuum energy. Potential implications include a lower bound on the size of compactified dimensions.

Time: 17:30 – 18:10

Speaker: G. Dvali (ASC Ludwig-Maximilians-Universität and MPI München)

Title: S-matrix constraints on landscape, and naturalness

Time: 18:10 – 18:50

Speaker: A. Linde (Stanford University)

Title: Inflation after Planck and BICEP

Abstract: I will describe inflationary models which are favored by the Planck and BICEP/Keck data releases.

Time: 18:50 – 19:30

Speaker: R. Kallosh (Stanford University)

Title: Sequestered inflation in M-theory and IIB string theory

Abstract: I describe sequestered inflation in M-theory and IIB string theory: we sequester phenomenology of inflation from the Planckian energy scale physics. I explain the role of Goldstone supermultiplets and symmetries of the flux superpotentials as well as the role of the nilpotent multiplet for uplifting the flat directions to inflationary plateau potentials. Sequestered models include seven hyperbolic disks. Their predictions are among the main B-mode targets for future CMB experiments.

2.2 Sunday, September 19, 2021

Time: 9:00 – 9:40

Speaker: H. Kawai (National Taiwan University)

Title: Random geometry and naturalness

Abstract: We try to understand the dynamics of the baby universes in Lorentzian signature using the present tools of field theory or string theory. We further try to derive phenomenological consequences such as Higgs inflation and dark matter mass. As a result, we have the following picture: The rough structure of our universe is determined by the string dynamics, and the detailed parameters are fixed by the Big Fix. In the latter, the parameters are fixed irrespectively to the detail of the model

Time: 9:40 – 10:20

Speaker: E. Pomoni (DESY)

Title: Type-B Anomalies on the Higgs Branch

Abstract: We will study type-B conformal anomalies associated with 1/2-BPS Coulomb-branch operators in 4D $N=2$ SCFTs. We will derive the Ward identities these anomalies obey and the conditions under which these anomalies can match across the conformal phase and the Higgs phase. We will present examples of both matching and non-matching. On the one hand matching leads to a new class of data on the Higgs branch of 4D $N=2$ SCFTs that are exactly computable. On the other, non-matching imposes novel restrictions on the holonomy of the conformal manifold.

Time: 10:20 – 11:00

Speaker: H. Nicolai (AEI)

Title: A perturbative expansion scheme for supermembrane and matrix theory

Time: 11:20 – 12:00

Speaker: R. Szabo (Herriot-Watt U)

Title: Braided Symmetries in Noncommutative Field Theory

Time: 12:00 – 12:40

Speaker: K. Krasnov (University of Nottingham)

Title: Spin(10), octonions and the symmetry breaking

Abstract: Large orthogonal groups such as Spin(10) can be very efficiently described by an octonionic model. I will start by explaining the octonionic model for Spin(10), in which the Lie algebra matrices are 2×2 matrices with octonionic entries. The space on which these matrices act on is that of 2-component columns with entries in complexified octonions. I will then describe how the symmetry breaking from Spin(10) to the gauge group of the Standard Model is to a very large degree controlled just by a choice of a unit imaginary octonion. This choice parametrises all the structures that are needed to select a copy of the Standard Model gauge group inside Spin(10). Complex structures on octonions parametrised by a unit imaginary octonion play a prominent role in this story.

Time: 12:40 – 13:20

Speaker: G. Savvidy (Demokritos National Research Centre)

Title: Alternative Inflation Cosmology without Scalar Field

Abstract: We investigate the influence of the gauge field theory vacuum on the evolution of Friedmann cosmology, inflation and primordial gravitational waves. The Type II solution provides the initial exponential expansion of the universe of a finite time duration and the Type IV solution demonstrates a late-time acceleration. The solutions fulfil the necessary conditions for the amplification of the primordial gravitational waves.

Time: 16:00 – 16:40

Speaker: A. Ashtekar (Institute for Gravitation and the Cosmos, Penn State)

Title: Alleviating tensions in the CMB using Planck scale physics A Cosmic Tango between the very large and very small

Abstract: I will discuss a bridge between a fundamental description of the very early universe and the most recent observations from the PLANCK satellite. Certain anomalies in the CMB bring out a tension between the standard six-parameter Lambda-CDM cosmological model and observations. The PLANCK team has commented “...if any anomalies have primordial origin, then their large scale nature would suggest an explanation rooted in fundamental physics. Thus it is worth exploring any models that might explain an anomaly (even better, multiple anomalies) naturally, or with very few parameters.” I will show that this possibility is realized within Loop Quantum Cosmology where the primordial power spectrum is modified due to Planck scale physics.

Time: 16:40 – 17:20

Speaker: G. Ross (Oxford University)

Title: R^2 /Higgs inflation, gravitational contact terms and the hierarchy problem

Abstract: We analyse Starobinsky inflation in the presence of the Brout Englert Higgs (BEH) boson with a non-minimal coupling to the Ricci scalar, R . We discuss how the latter necessarily leads to gravitational contact terms in the effective Lagrangian and induces a coupling of the massive scalaron associated with the R^2 term to the BEH boson. This coupling leads to a radiative correction to the BEH mass that must be fine tuned to keep it light. For the case of R^2 driven inflation this requires a high level of fine tuning of order 1 part in 10^8 , for the case of Higgs inflation it is very much greater. We consider a scale invariant extension of the R^2 /Higgs model and find that for R^2 driven inflation but not for Higgs inflation the required fine tuning is significantly reduced to one part in 10^{34} . We consider the vacuum stability of the fine tuned model and its reheating and dilaton abundance after inflation. We also discuss the constraint on the mass of additional scalar or fermion dark matter candidates if they are produced by the gravitational couplings

of the scalaron.

Time: 17:40 – 18:20

Speaker: M. Haack (LMU Munich)

Title: Closed string disk amplitudes in the pure spinor formalism

Abstract: We describe how to calculate closed string scattering on the disk in the pure spinor approach to string perturbation theory. We exemplify the methods with certain low point functions and compare to the known results of the RNS formalism. Moreover, we discuss some potential applications to the study of higher derivative corrections to D-brane actions.

Time: 18:20 – 19:00

Speaker: C. Hull (Imperial College, London)

Title: Gravity above the Planck Scale

Time: 19:00 – 19:40

Speaker: Y. Oz (Tel Aviv University)

Title: Entanglement, Chaos and Quantum Computation

Abstract: Noisy Intermediate-Scale Quantum (NISQ) technology is being developed rapidly and poses a great challenge to come up with efficient quantum algorithms that will run on NISQ computers and perform better than classical ones. Many real-world use cases are associated with machine learning and optimization for which random circuits offer an appropriate framework. We will discuss the spread of information, entanglement and chaotic properties of random quantum circuits and their implications to computation performance.

2.3 Monday, September 20, 2021

Time: 9:00 – 9:40

Speaker: C. Bachas (ENS, Paris)

Title: A far-from-equilibrium horizon

Time: 9:40 – 10:20

Speaker: V. Rivasseau (Université Paris-Saclay)

Title: Introduction to Tensorial Data Analysis

Time: 10:20 – 11:00

Speaker: G. Barnich (Université libre de Bruxelles)

Title: Photons & Gravitons in a Casimir box

Abstract: We study finite size effects in gauge and gravitational theories. Photons and gravitons with Casimir boundary conditions are shown to be equivalent to a massless scalar field with periodic boundary conditions in a box double the size. The modular covariant partition function is expressed in terms of a real analytic Eisenstein series. The leading contribution to the entropy at low temperature or for a small box is shown to scale like the area.

Time: 11:20 – 12:00

Speaker: C. Wetterich (Heidelberg University)

Title: Pregeometry and emergent general relativity

Abstract: Geometry is not fundamental. The metric and general relativity can emerge from more basic pregeometry. We formulate a euclidean functional integral for quantum gravity as a Yang-Mills theory with local gauge symmetry $SO(4)$ and diffeomorphism invariance. It shows no instabilities and can be analytically continued to Minkowski signature. The quantum effective action leads to general relativity as an effective low energy theory. This ensures compatibility with the numerous precision tests for gravity. Adding a scalar field the cosmological solutions of the field equations describe an early inflationary epoch and late cosmology with dynamical dark energy and a candidate for dark matter. The beginning is a vacuum state which can be associated to the ultraviolet fixed point of the renormalisation flow. There is no big bang singularity.

Time: 12:00 – 12:40

Speaker: K. Stelle (Imperial College London)

Title: Taxonomy of Brane Gravity Localisations

Abstract: Effectively generating a lower-dimensional theory of gravity or supergravity on a subsurface brane worldvolume within a noncompact transverse space requires certain special conditions for the transverse space structure. Three different scenarios emerge, depending crucially on the nature of boundary conditions that are imposed on solutions as one transversely approaches the brane worldvolume. Genuinely lower-dimensional behaviour at long worldvolume distances can be compatible with short-distance higher-dimensional structure, but this requires a specific type of boundary condition compatible with the existence of normalisable transverse-space zero modes is chosen.

Time: 12:40 – 13:20

Speaker: P. Nilles (Univ. Bonn)

Title: High scale inflation a window to quantum gravity

Abstract: High scale inflation leads to sizeable tensor modes in the cosmic microwave background that could be observed in the near future. Arguments derived from the weak gravity conjecture seem to require an upper bound on these tensor modes. We investigate specific models of high scale inflation (based on axionic inflation) and explore the size of tensor modes as a potential test of the weak gravity conjecture.

Time: 16:00 – 16:40

Speaker: H. Steinacker (University of Vienna)

Title: Gravity as a quantum effect on quantum space-time

Abstract: We discuss covariant quantum spaces as solutions of the IKKT or IIB matrix model with mass term. This leads to a ghost-free higher-spin gauge theory, which contains all degrees of freedom for gravity. The gravitational sector can be understood in terms of an effective frame and an associated connection. The resulting covariant equations of motion of the classical model are discussed, which can be interpreted as pre-gravity, having 2 derivatives less than the Einstein-Hilbert action. The latter is recovered upon including the 1-loop effective action. This provides a new formulation of gravity which is intrinsically quantum.

Time: 16:40 – 17:10

Speaker: M. Martone (Simons Center for Geometry and Physics)

Title: Characteristic dimension and isotrivial geometries

Abstract: In this talk I will provide an update on the classification program of 4d $N=2$ SCFTs based on analyzing their moduli space geometries. After reminding the status of the two simplest cases, so-called rank-1 and rank-2, I will introduce novel techniques which will enable me to extend the classification to any rank. In particular I will introduce the characteristic dimension of an arbitrary 4d $N=2$ SCFT, a simple quantity which can take only one out of eight rational values, and give the complete answer when the characteristic dimension is not 1 or 2.

Time: 17:10 – 17:50

Speaker: T. Weigand (II. ITP Hamburg University)

Title: Quantum Gravity Conjectures and their Geometric Manifestations

Abstract: Consistency of effective field theories with Quantum Gravity poses a number of non-trivial constraints which are oftentimes hard to understand from a purely field theoretic perspective. Once confronted with concrete realisations of Quantum Gravity such as String Theory, these conjectured criteria for consistency with Quantum Gravity - the Swampland Conjectures - can be explicitly tested. In this talk we discuss various close connections between some of the Quantum Gravity Conjectures and the geometry underlying String Theory compactifications in various dimensions. This leads both to possible proofs of some of the Quantum Gravity conjectures within well-defined classes of string vacua or to new geometric conjectures, which in turn call for a proof or falsification within mathematics.

Time: 18:10 – 18:50

Speaker: H. Ooguri (Caltech & Kavli IPMU)

Title: Completeness of Gauge Charges in Quantum Gravity

Time: 18:50 – 19:30

Speaker: S. Giddings (UC Santa Barbara)

Title: Black holes and clues for quantum gravity

Time: 19:30 – 20:00

Speaker: G. Zoupanos (chair) (NTUA)

Title: Final Discussion
