

## Talks

### ***Propagation in a quantum spacetime and data on GRB photons and GRB neutrinos***

**Giovanni Amelino**

**Sapienza University, Rome**

In some quantum spacetimes it is found that particle propagation is affected by in-vacuo dispersion, as first noticed in studies of kappa-Minkowski spacetime. I offer an update on the relevant phenomenology, focusing on photons and neutrinos emitted by gamma-ray bursters.

### ***Is the noncommutative standard model a GUT?***

**Nadir Bizi**

**Université Pierre et Marie Curie**

Expanding on our work on indefinite spectral triples (arXiv:1611.07062) applied to the standard model on Lorentzian space-times, we show that many axioms of spectral triples can be recovered from a GUT based on the gauge group  $SO(4,6)$ . The connection between this GUT and NCG resides in the use of Clifford algebras.

### ***What is the standard model of particle physics trying to tell us about spacetime?***

**Latham Boyle**

**Perimeter Institute**

I will argue that the standard model contains a rather good hint that -- instead of being simply an ordinary continuous 4D manifold -- spacetime is actually the product of a 4D manifold and a certain discrete/finite 6D space (i.e. there are 6D discrete/finite "extra dimensions"). I will introduce this idea and the evidence for it in simple way, and then discuss various outstanding puzzles and future directions.

### ***Exact results in the STU model***

**Gabriel Lopes Cardoso**

**Instituto Superior Tecnico**

We consider a specific type II string theory model with N=2 local supersymmetry, the so-called STU model. This is a model with exact duality symmetries. Using holomorphy and duality, we obtain exact results for this model in a certain scaling limit recently introduced by Alim, Yau and Zhou. These results go beyond the perturbative formulation of topological string theory

***Line defects and their algebraic structures***

**Michele Cirafici**

**Instituto Superior Tecnico**

I will discuss a certain class of line operators in supersymmetric theories. I will show that many properties of these operators can be rephrased in terms of quiver representation theory. In particular one can study BPS invariants of a new kind, associated with moduli spaces of quiver representations. Remarkably such operators provide constraints on the ordinary spectra of BPS state in quantum field theory.

***The hard and soft pomeron in holographic QCD***

**Miguel Costa**

**Faculdade de Ciências, Universidade do Porto**

We consider the holographic description of the QCD pomerons. In particular, we show that both hard and soft pomerons can arise as the leading Regge poles of the dual graviton Regge trajectory. Our finds successfully reproduce deep inelastic scattering data at low Bjorken  $x$  from HERA experiment, and are consistent with current expectations for the low mass glueball spectrum from lattice QCD simulations.

## **The importance of Physics literacy with a gender perspective**

**Capitolina Diaz**

**University of Valencia**

General population literacy in physics is very limited and gender biased. There are mainly two lines of action to improve physics literacy and free from gender bias: a) Education and b) Intervention on the media and science dissemination techniques. In this presentation, I will refer to the first line of action.

As far as 1979 J. Taylor in “Sexist bias in physics textbooks”<sup>1</sup> shows no one case of textbooks free from gender bias and, apparently this have changed very little. That leads us to believe that the first contact of girls and boys with physics is sexist. The majority of people do not go studying physics after school; therefore, the general opinion of physics, the popular physics literacy, is gender biased.

If we move to university teaching, it appears that there is a gender gap in conceptual understanding in physics not so evident in primary school, besides the sexist books. The use of interactive engagement methods have been used to reduce part of the problem. One Harvard experiment<sup>2</sup> in 2006, by Mercedes Lorenzo and Catherine Crouch, shows that teaching with certain interactive strategies significantly increased understanding for both males and females, but also reduces the gender gap. RR Hake<sup>3</sup> had a similar experience in 1998, also with good results. But, other research, such as S. J. Pollock et al. (2007)<sup>4</sup>, showed that despite the use of interactive engagement techniques, the gap in performance on conceptual learning

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<sup>1</sup> J. Taylor (1979) “Sexist bias in physics textbooks” in *Physics Education*, <https://doi.org/PHEDA70031-9120> **14**(5), 277-280.

<sup>2</sup> Lorenzo, Mercedes & Catherine H. Crouch (2006) “Reducing the gender gap in the physics classroom” *American Journal of Physics*, Volume 74, Issue

<sup>3</sup> R. R. Hake (1998), “Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses,” *American Journal of Physics*, 66(1), 64–74; <https://doi.org/10.1119/1.18809>

<sup>4</sup> Physics Rev. ST Phys. Educ. Res. 3, 1.

### ***Noncommutative gravity and the relevance of the theta-constant deformation***

***Marija Dimitrijevic***

**University of Belgrade**

In this talk we discuss the noncommutative (NC) gravity model on the theta-constant NC space-time. The model is based on the NC  $SO(2,3)$  gauge group, the enveloping algebra approach and the Seiberg-Witten map. The effective action and the equations of motion are expanded up to second order in the deformation parameter. The equations of motion show that the noncommutativity plays a role of a source for the curvature and/or torsion. The NC correction to Minkowski space-time shows that in the presence of theta-constant noncommutativity Minkowski space-time becomes curved, but remains torsion-free. The breaking of diffeomorphism invariance is understood in terms of a preferred coordinate system. We show that the coordinates we are using are the Fermi normal coordinates. This suggests that the natural coordinate system in which one should study NC gravity is given by the Fermi normal coordinates.

### ***Gravity as a four dimensional algebraic quantum field theory***

**Gabor Etesi**

**Budapest University of Technology and Economics**

Based on a family of indefinite unitary representations of the diffeomorphism group of an oriented smooth 4-manifold, a manifestly covariant 4-dimensional and non-perturbative algebraic quantum field theory formulation of gravity is exhibited. More precisely among the bounded linear operators acting on these representation spaces we identify algebraic curvature tensors hence a net of local quantum observables can be constructed from  $C^*$ -algebras generated by local curvature tensors and vector fields. This algebraic quantum field theory is extracted from structures provided by an oriented smooth 4-manifold only hence possesses a diffeomorphism symmetry. In this way classical general relativity exactly in 4-dimensions naturally embeds into a quantum framework.

Several Hilbert space representations of the theory are found. First a "tautological representation" of the limiting global  $C^*$ -algebra is constructed allowing to associate to any oriented smooth 4-manifold a von Neumann algebra in a canonical fashion. Secondly, influenced by the Dougan--Mason approach to gravitational quasilocal energy-momentum, we construct certain representations what we call "positive mass representations" with unbroken diffeomorphism symmetry. Thirdly, we also obtain "classical representations" with spontaneously broken diffeomorphism symmetry corresponding to the classical limit of the theory which turns out to be general relativity.

Finally we observe that the whole family of "positive mass representations" comprise a  $2+2$  dimensional conformal field theory in the sense of G. Segal.

### ***Random fuzzy spaces***

**Lisa Glaser**

**Radboud University Nijmegen**

A fuzzy space is defined through its algebra, Hilbert space and Dirac operator. Keeping the algebra and Hilbert space fixed a path integral over all possible Dirac operators is an integral over geometries. We use Monte Carlo methods to explore this integral.

Warning, talk may contain: Computer simulations, spectral dimensions, pseudocritical points and excessive use of figures, viewer discretion is advised.

### ***Towards a background-independent construction of the bulk field in AdS3***

**Monica Guica**

**Uppsala University**

The HKLL prescription provides a concrete way to construct a bulk field in an asymptotically AdS background in terms of smeared operators in the boundary CFT. However, this prescription has the drawback that it is background-dependent, in the sense that it needs bulk input in order to determine the dual CFT operator around a given state. In this talk, I will discuss two background-independent approaches for obtaining the bulk field in AdS<sub>3</sub> black hole backgrounds - one based on conformal blocks and one on summation of diagrams - as well as the relation between the two.

### ***Invitation to random tensors***

**Razvan Gurau**

**CNRS**

In this talk I will give an introduction to random tensors and their applications, from higher dimensional random geometry to the Sachdev-Ye-Kitaev models.

### ***Chern-Simons theory and Koszul duality***

**Owen Gwilliam**

**Max Planck Institute for Mathematics**

The observables of perturbative Chern-Simons theory naturally form an algebra over the little 3-disks operad, as I will explain. In consequence, line operators form a braided monoidal category. We then use higher abstract nonsense, notably Koszul duality, to recover a quantum group with formal parameter. This work in progress is joint with K. Costello and J. Francis

### ***Noncommutative Minimal Surfaces***

**Jens Hoppe**

**Royal Institute of Technology, Stockholm**

Various aspects of noncommutative minimal surfaces will be discussed.

### ***Explaining Space***

**Nick Huggett**

**University of Illinois at Chicago**

This talk is a philosophical discussion of explanation; specifically the explanation of the appearance of commutative space in terms of theories, such as those of non-commutative geometry, that do not include commutative space among their basic objects. Along the way I argue, through some historical examples, that deciding what amounts to a good explanation is theory-dependent and philosophical (though still part of physics!). Moreover, the criteria for good explanation that come with familiar theories typically presuppose that there is a classical spacetime: for instance, that microscopic processes be co-located with the macroscopic processes they explain. Therefore, explaining space in terms of a non-spatial theory requires new principles of sound explanation -- and therefore, according to my argument, philosophical analysis. I illustrate with a simple example, and end with a question for the audience.

### ***Quantum field theory on curved graphene spacetimes***

**Alfredo Iorio**

**Charles University, Prague**

In the last decades the forefront research on the fundamental properties of space, time and matter has produced an enormous amount of fascinating hypotheses, theories, and conjectures that raise unanswered questions. In this talk I will show how a recently discovered two-dimensional allotrope of carbon (graphene) could become an experimental playground for some of those ideas, and help answering some of those questions.

### ***Quantum geometry from precanonical quantization and the classical limit***

**Igor Kanatchikov**

**University St Andrews**

I will outline the approach of precanonical quantization of gravity which is based on the De Donder-Weyl generalization of the Hamiltonian formalism, where no space-time splitting is required. This approach naturally leads to the description of the quantum geometry of space-time in terms of probability amplitudes of the values of spin-connection coefficients at different points of space-time. We show how the classical GR emerges as an averaged description similarly to the Ehrenfest theorem in quantum mechanics.

### ***Sigma-models on noncommutative spaces***

**Giovanni Landi**

**Università di Trieste**

We introduce noncommutative analogues of non-linear sigma-models or, said otherwise, noncommutative harmonic maps. Already the simplest example of a target space made of two points — for which the commutative theory is trivial — shows remarkable properties when taken together with a noncommutative source space. A natural action functional leads to self-duality equations for projections in the source algebra, with solutions having non-trivial topological content (topological charges). Results from time-frequency analysis and Gabor analysis are used to construct classes of sigma-model solitons over the Moyal plane and over noncommutative tori, taken as source spaces,

### ***Higher Riemann-Hilbert correspondence and its analogues***

**Andrey Lazarev**

**University of Lancaster**

The Riemann-Hilbert correspondence in its simplest form states that the category flat vector bundles on a smooth manifold  $X$  is equivalent to the category of local systems on  $X$ . Recently J. Block and A. Smith gave a far-reaching generalization of this result as an equivalence between derived categories of infinity local systems on  $X$  and certain differential modules over the de Rham algebra on  $X$ . There are at least two more results of this type, with the de Rham algebra replaced with the algebra of singular cochains on a topological space or the Dolbeault algebra on a smooth complex variety.

In this talk, which is a joint work with C. Braun, J. Chuang and J. Holstein, I will outline a general approach to the results of this kind. The main ingredient is novel point of view on Maurer-Cartan elements in  $A$ -infinity algebras and their minimal models.

***Canonical Loop Quantum Gravity: available framework***

**Jerzy Lewandowski**

**University of Warsaw**

The framework of Loop Quantum Gravity is background independent and manifestly invariant with respect to the diffeomorphisms of the underlying 3-dimensional manifold of initial data for the canonical GR. The main elements and structures of canonical LQG will be outlined with emphasis on the full degrees of freedom case without symmetry reductions.

***Open-closed modular operads, Cardy condition and string field theory***

**Martin Markl**

**Czech Academy of Sciences**

We prove that the modular operad of diffeomorphism classes of Riemann surfaces with both 'open' and 'closed' boundary components, in the sense of string field theory, is the modular completion of its genus 0 part quotiented by the Cardy condition. We also provide a finitary presentation of a version of this modular two-colored operad and characterize its algebras via morphisms of Frobenius algebras.

***Gravitational waves with Advanced LIGO***

**Alex Nielsen**

**Max Planck Institute**

The first observing run of the Advanced LIGO gravitational wave detectors successfully observed several coalescing black holes. These were the first binary black hole systems ever detected by any means and a milestone gravitational physics. I will present an overview of the detections, the science of gravitational wave astronomy, what we can learn from the detection in terms of astrophysics and fundamental physics and what the future may hold for this new field in astronomy.

***Testing Gauge/Gravity Duality with Membrane Matrix Models***

**Denjoe O'Connor**

**Dublin Institute for Advanced Studies**

I will review how relativistic membranes lead to membrane matrix models and compare non-perturbative studies of some of these matrix models with results from gravitational predictions. The principal models of interest will be the BMN model and the Berkooz-Douglas models.

### ***The Ward Identity for random tensor models in dimension 4***

***Carlos Perez Sanchez***

**University of Münster**

Having a common backbone with matrix models, coloured tensor models is a random geometry approach to quantum gravity in arbitrary dimensions. In particular, regularly edge-coloured bipartite graphs—precisely the Feynman graphs of these theories—generalise ribbon graphs and represent orientable PL-manifolds of dimension one less than the number of colours. Also, an integer called Gurau's degree, which generalises the genus, controls the  $1/N$  expansion. We introduce a graph theoretical representation of the connected sum that is additive with respect to Gurau's degree and compatible with the QFT-structure. Moreover, we find the general exact Ward Takahashi Identities and then discuss particular (with so-called melonic, or dominant, interaction vertices) quartic 3D and 4D coloured tensor theories. Recursions for the correlation functions of these theories are obtained. We shortly discuss attempts to add gauge fields to this initially purely gravitational models, via finite spectral triples in NCG.

### ***Group Field Theory Condensate Cosmology***

***Mairi Sakellariadou***

**King's College London**

I will first introduce Group Field Theory, a nonperturbative approach to quantum gravity, and then discuss some issues of Group Field Theory Condensate Cosmology. In particular, I will show the emergence of a cyclic universe and the onset of an early era of accelerated expansion without having to introduce an inflaton field with a fine tuned potential.

## ***Would Marie Curie get the Nobel Prize today? Gendered academic careers***

**Minna Salminen-Karlsson**

**Uppsala University**

The dearth of female researchers, in particular in science, has for a long time been regarded as a problem in European research policy. In some countries the problem has its roots already in secondary schools, with boys more frequently taking science subjects, in most countries it appears at undergraduate level, with more men enrolling in science programs, and in all countries it is apparent at researcher levels, and the higher the academic level, the higher the percentage of men.

When discussing the recruitment of women to science, Marie Curie has an iconic status in showing that women can succeed in science and she is sometimes even perceived as a role model for the girls and women who are encouraged study science subjects. However, in addition to her being an unreachable model for most women, her iconic status conceals the importance of different aspects in her environment that made her achievements possible.

This talk looks at different aspects of the lives of Marie Curie, Irène Curie and Maria Goeppert-Mayer, female Nobel Prize winners in history, to illuminate the conditions of women in scientific research today. It is based on current research on gender in the academy and in particular on the experiences from the FP7 project FESTA (Female Emergence in Science and Technology Academia). The focus of the project and of the talk is the importance of the academic environment, at its different levels, for taking advantage of the talent of both male and female researchers.

*The conflict between women's roles as researchers and their role as caregivers is often held forward as the only or main reason why success in scientific research is more difficult for women than for their male colleagues to attain. However, the conclusion from current research is that there are a number of other aspects in women's lives, and in particular in academic life itself, that create hurdles more often to women than to men. The geniality of Marie Curie would not have been enough for her to reach the topmost level in the research landscape of her time. Similarly, skill, passion and geniality may not be enough for female researchers of today to advance their careers in a research landscape that has been built up and is populated by men, in societies where science is still seen as primarily a male area of activity.*

### ***Yangian and SUSY symmetry of High Spin Parton Splitting Amplitudes***

**George Savvidy**

**Demokritos National Research Centre, Athens**

We have calculated the high spin parton splitting amplitudes postulating the Yangian symmetry of the scattering amplitudes for tensor gluons. The resulting splitting amplitudes coincide with the earlier calculations, which were based on the BCFW recursion relations. The resulting formula unifies all known splitting probabilities found earlier in gauge field theories. It describes splitting probabilities for integer and half-integer spin particles. We also checked that the splitting probabilities fulfil generalized Kounnas-Ross  $N = 1$  supersymmetry relations hinting to the fact that the underlying theory can be formulated in an explicit supersymmetric manner.

### ***Higher groupoid bundles and self-dual tensor field equations***

**Martin Wolf**

**University of Surrey**

Recent developments in formulating higher gauge theory with higher groupoids as gauge structure will be reviewed. The approach develops higher gauge theory from first principles and as such captures a wide class of theories including ordinary gauge theories and gauged sigma models as well as their categorifications. As an application, it will be explained how these ideas can be combined with those of twistor theory to obtain superconformal non-Abelian self-dual tensor field theories in six dimensions.