Wednesday 9

Irene Valenzuela

Title: *The Higgs Mass, the SUSY Breaking Scale and String Theory*

Abstract: We consider a scheme in which SUSY is broken at a large scale M_{SS} well above the electroweak scale M_{EW}, such that it could stabilize not the Higgs mass but the SM vacuum. Under standard unification assumptions, we compute the Higgs mass as a function of the SUSY breaking scale, obtaining for $M_{SS} \gtrsim 10^{10}$GeV a very constrained result: $m_H = 126 \pm 3$ GeV, consistent with CMS and ATLAS results. On the other hand even if there is no low energy SUSY, String Theory suggests its presence at some M_{SS} below the string scale to guarantee the absence of tachyons. We explore the possible value of M_{SS} consistent with gauge coupling unification and closed string fluxes as the main source of SUSY breaking, in the context of SU(5) F-theory GUT's. These two requirements fix $M_{SS} \simeq 10^{10}$GeV at an intermediate scale and a unification scale $M_c \simeq 10^{14}$GeV. The hierarchy problem for the Higgs mass is solved due to anthropic selection in a string landscape.

Sergio Hörtner

Title: *Gravitational duality*

Abstract: We will review some aspects of gravitational electric-magnetic duality in $D = 4$, as well as some recent progress in the understanding of the interplay between the graviton and its dual in the linearized theory at the action level for $D > 4$. The equations of motion can be rewritten as a twisted self-duality condition involving the electric and magnetic parts of the corresponding curvatures, and this holds for any dimension. We will also emphasize the importance of understanding the relationship between the graviton and its dual in the study of the so-called hidden symmetries of supergravity/M-theory.

Javier Martínez Magán

Title: *Fast Scramblers And Black Hole Horizons*

Abstract: In this talk i will review several aspects of the "Fast Scrambling Conjecture". According to this conjecture, Black Holes are the most efficient Information randomizers in nature, with a "scrambling" time scaling logarithmically with the entropy of the system. We show that Hyperbolic spaces and their discrete counterparts, the so-called expander graphs, are natural examples of Fast Scramblers. We review how these spaces appear universally in the near horizon region of any thermal horizon, providing "bulk" mechanisms of information diffusion in Black Holes. In view of these results, we show that Fast Scrambling on the Streched Horizon can be modeled by a diffusion process in an effective ultrametric geometry. Saturation of the causality bound on the stretched horizon corresponds to the fastest

possible ultrametric diffusion which is compatible with stability, realizing a limiting case of the so-called Kohlrausch law.

Giacomo Caruso

Title: *Duality and Dimensional Reduction of 5D BF theory and fermionization*

Abstract: A planar boundary introduced à la Symanzik in the 5D topological BF theory, with the only requirement of locality and power counting, allows to uniquely determine a gauge invariant, non topological 4D Lagrangian. The boundary condition on the bulk fields is interpreted as a duality relation for the boundary fields, in analogy with the fermionization duality which holds in the 3D case. This suggests that the 4D degrees of freedom might be fermionic, although starting from a bosonic bulk theory. In this model, adopting the Sommerfield tomographic representation of quantized bosonic fields, we explicitly build a fermionic operator and its associated Klein factor such that it satisfies the correct anticommutation relations. Interestingly, we demonstrate that this operator satisfies the massless Dirac equation and that it can be identified with a 3+1D Weyl spinor.

Mario Herrero-Valea

Title: *Weyl extension of Einstein Gravity and the lack of symmetry*

Abstract: It is belief that some sort of scale invariance should be relevant when studying physics at very short distances. When gravity is dynamical, the corresponding symmetry is Weyl invariance, local rescalings of the spacetime metric. Several approaches to Weyl invariant theories of gravity have been studied but there is always some sort of tension between finiteness (in the supersymmetric case) and unitarity.

A simple Tautological Weyl Gravity, which is free of this problems, is presented and studied both at the classical and 1-loop level. While it is invariant under diffeomorphisms and Weyl rescalings at tree level, it is impossible to extend both symmetries in the quantum theory due to a conformal-like anomaly. The subtleness of this anomaly is analyzed and several conclusions about how to (and which ones) preserve symmetries are obtained.

Marco Scalisi

Title: *Kaehler potentials for Planck inflation*

Abstract: We assess which Kaehler potentials in supergravity lead to viable single-field inflationary models that are consistent with Planck. We highlight the role of symmetries, such as shift, Heisenberg and supersymmetry, in these constructions. Also the connections to string theory are pointed out. Finally, we discuss a supergravity model for arbitrary inflationary potentials that is suitable for open string inflation and generalize it to the case of

closed string inflation. Our model includes the recently discussed supergravity reformulation of the Starobinsky model of inflation as well as an interesting alternative with comparable predictions.

Stephan Stetina

Title: *Superfluidity in dense quark matter*

Abstract: Hydrodynamics of superfluids can be described by formally dividing the fluid into a normal fluid and a superfluid part. In color-flavor locked quark matter, at least one superfluid component is present due to spontaneous breaking of baryon number conservation, and an additional one due to the breaking of strangeness arises once one takes into account kaon condensation. We show how such a two-component description emerges from an underlying scalar field theory which can be viewed as an effective theory for kaons. Furthermore, we relate the occurring hydrodynamic quantities to the microscopic parameters provided by the Lagrangian.

Felix Haehl

Title: *Effective actions for hydrodynamics: transport and anomalies*

Abstract: Relativistic hydrodynamics provides a description of long-wavelength, near-equilibrium quantum field theory in a very general sense. For decades, this theory has been studied in its own right and over the last years it has been of great renewed interest due to its holographic applications (fluid/gravity map) and its ability to describe strongly coupled systems. Although hydrodynamics is a typical example of an effective field theory, its traditional formulation is somewhat indirect and not derived from an action in terms of effective field theory degrees of freedom. Such a first principles derivation would be desirable because, among other things, it could explain the constraints on the hydrodynamic expansion from a fundamental point of view. I will present an effective action formalism for (non-dissipative) fluid dynamics and demonstrate how it can be used to gain insights into transport phenomena, quantum anomalies, and the very nature of hydrodynamics in general.

Pierre Clavier

Title: *The Schwinger-Dyson equation: a key to higher order of perturbation theory*

Abstract: We study the Schwinger-Dyson equation of the massless Wess-Zumino model with the help of the combinatorial Hopf algebra of graph. The asymptotic behavior of the solution leads to an ansatz which allows to separate its alternating and non-alternating parts. Then, we are able to reach higher orders of perturbation theory. An excellent agreement is found with previous numerical computations. The weight of zetas arising in the solution will

also be discussed.

Alexander Monin

Title: *Dilaton: Saving Conformal Symmetry*

Abstract: The characteristic feature of the spontaneous symmetry breaking is the presence of the Goldstone mode(s). For the conformal symmetry broken spontaneously the corresponding Goldstone boson is the dilaton. Coupling an arbitrary system to the dilaton in a consistent (with quantum corrections) way has certain difficulties due to the trace anomaly. In this paper we present the approach allowing for an arbitrary system without the gravitational anomaly to keep the dilaton massless at all orders in perturbation theory, i.e. to build a theory with conformal symmetry broken spontaneously.

Thursday 10

Pablo Ortiz

Title: *Localized features in the CMB spectra due to a transient reduction in the speed of sound*

Abstract: Heavy fields coupled to the inflaton may give rise to transient reductions in the speed of sound of the adiabatic mode in the effective single-field theory. This effect translates into localized, correlated features in the primordial power spectrum and bispectrum. More importantly, there is a regime in which the correlation can be calculated analytically. Thus, we can perform a statistical search for a feature in the power spectrum and predict the associated primordial bispectrum. We report on an ongoing first search for such features in the Planck data. Part I theory ; Part II CMB data analysis.

Jesús Torrado Cacho

Title: *Localized features in the CMB spectra due to a transient reduction in the speed of sound – Part II - CMB data analysis*

Abstract: Heavy fields coupled to the inflaton may give rise to transient reductions in the speed of sound of the adiabatic mode in the effective single-field theory. This effect translates into localized, correlated features in the primordial power spectrum and bispectrum. More importantly, there is a regime in which the correlation can be calculated analytically. Thus, we can perform a statistical search for a feature in the power spectrum and predict the associated primordial bispectrum. We report on an ongoing first search for such features in the Planck data.

Michal Wyrebowski

Title: *Inhomogeneity effect in Wainwright-Marshman space-times*

Abstract: Green and Wald have presented a mathematically rigorous framework to study the effect of small scale inhomogeneities on the global structure of space-time. The framework relies on the existence of a one-parameter family of metrics that approach an effective background metric in a certain way. In my talk, I will present the first example of such a family of exact non-vacuum solutions to the Einstein's equations. It belongs to the Wainwright-Marshman class and satisfies all assumptions of the Green-Wald framework.

Jakub Mielczarek

Title: *From cosmology to deformed Poincare algebra and back again*

Abstract: Recent calculations performed within loop quantum cosmology suggest that there is transition - via ultralocal phase - from Lorentzian to Euclidean space-time in the very early universe. This behavior is generated by quantum deformation of general covariance. At short scales, this effect manifests itself by deformation of the Poincare algebra. Analysis of the resulting modified dispersion relation sheds new light on the problem of trans-Planckian modes in the inflationary cosmology.

Cláudio Gomes Vieira

Title: *The Layzer-Irvine equation and cosmic structure formation*

Abstract: In this presentation we shall discuss a generalized Layzer-Irvine equation which can describe the gravitational collapse of cold dark matter in a dark energy background. We will show that the usual form of the Layzer-Irvine equation is valid if the dark matter is minimally coupled to an homogeneous dark energy distribution, regardless of its equation of state. We will further show that the corrections to the standard Layzer-Irvine equation are expected to be small, even in the the presence of dark energy inhomogeneities, if the dark energy has a constant equation of state parameter consistent with the latest observational constraints. Finally, we shall demonstrate that, in more general models, the impact of dark energy perturbations on the dynamics of clusters of galaxies might be significant.

Alessandro Sfondrini

Title: *Integrability for AdS3/CFT2*

Abstract: An interesting instance of the AdS/CFT correspondence is the case of AdS3/CFT2. The most supersymmetric backgrounds are $AdS3 \times S3 \times S3 \times S1$ or $AdS3 \times S3 \times T4$; strings living there can be completely understood when the background is purely NSNS thanks to 2-dimensional conformal symmetry. At the classical level, however, the theory is integrable for pure NSNSN, pure RR, as well as mixed-flux backgrounds. This stimulated an investigation of RR backgrounds through the S-matrix integrability techniques that already proved useful in illuminating the AdS5/CFT4 correspondence. This research may shed new light on the relation between conformal symmetry in D=2 and integrability in the "S-matrix approach". In my talk I will review such techniques and recent advances.

Matteo Baggioli

Title: *Holographic Emergence of Lorentz Invariance*

Abstract: We studied holographic RG flows between Non-Relativistic fixed points and Relativistic fixed points driven by spin 1 relevant operators. We generalize known flows by including nonminimal couplings to curvature of the bulk gauge boson. We analyse the relation

between the dimension of the spin 1 operator and the bulk parameters, as well as unitarity restrictions. The nonminimal couplings enlarge the range of dynamical exponents of the NR fixed points that can lead to a relativistic fixed point in the IR. The possibility of alternative quantization gets enhanced too. We also discuss similar flows driven by spin 2 operators.

Natalia Pinzani Fokeeva

Title: *Towards a general fluid-gravity correspondence*

Abstract: AdS/CFT is the best understood example of a broader paradigm going under the name of holography. By studying the Dirichlet problem on a finite time-like cutoff surface we aim into find a general fluid-gravity correspondence for non-asymptotically AdS spacetimes.

Alexander Patrushev

Title: *Entaglement entropy and squashed cone technology*

Abstract: We propose a regularization procedure for the integral curvature invariants on manifolds with conical singularities for the case of squashed cones. This allows to calculate conformal invariants in different dimensions and find entanglement entropy from purely CFT side . The method allows to establish a holographic formula for entanglement entropy in theories with different gravity duals.

Matteo Serra

Title: *Infrared behavior of scalar condensates in effective holographic theories*

Abstract: We investigate the spectrum of scalar-dressed, asymptotically Anti de Sitter (AdS) black brane (BB) solutions of effective holographic models, with a particular attention to the infrared (small r) behavior. These solutions describe scalar condensates in the dual field theories. We show that for zero charge density the ground state of these BB solutions must be degenerate with the AdS vacuum and it is isolated from the continuous part of the spectrum, while when a finite charge density is switched on, the ground state is not anymore isolated and the degeneracy is removed. As a check and illustration of our results we derive and discuss several numerical BB solutions of Einstein-scalar-Maxwell AdS gravity with different coupling functions and different potentials. We also discuss how our results can be used for understanding holographic quantum critical points and the associated quantum phase transitions.

Friday 11

Satiago Oviedo Casado

Title: *Quantum effects in pigment protein complexes*

Abstract: The influence of a non trivial environment in the strikingly long lived coherent states observed within photosynthetic complexes at room temperatures is studied using a semiclassical methods to efficiently treat some discrete vibrational states appearing in the spectral function, to whom part of the non-trivial dynamics of this open quantum system might be atributed.

Iñigo Urizar Lanz

Title: *Differential Magnetometry using Singlets*

Abstract: When dealing with a large number of spin-j particles, several quantum states have vanishing angular momentum, i.e., there exist several different singlet states. These singlet states can be used for measuring the gradient of a magnetic field. This quantity can be estimated from a measurement of the square of the angular momentum operator J_x . The measurement uncertainty can then be estimated by the error propagation formula if J_x^2 and J_x^4 are known as a function of the gradient. We show how these quantities can be computed for several singlet states.

Maien Binjonaid

Title: *Naturalness of non-minimal supersymmetric extensions of the standard model*

Abstract: Supersymmetry was originally adopted in particle physics in order to solve the Naturalness problem in the Standard Model associated with the scalar Higgs boson. The LHC had found a Higgs-like boson in 2012, but until recently there is no evidence of supersymmetry. This causes supersymmetric models to possess some amount of fine tuning (unnaturalness) that increases as the limits on the masses of supersymmetric particles increases. The amount of fine tuning differs according to the model. Here, we study and report on the naturalness and fine tuning in a class of non-minimal models, such as the Constrained Exceptional Supersymmetric Standard Model and new variants of the Next-to-Minimal Supersymmetric Standard Model.

Cristian Bosch Serrano

Title: *Discarding a 125 GeV heavy Higgs in an MSSM model with explicit CP-violation*

Abstract: We prove that the present experimental constraints are already enough to rule out the possibility of the ~ 125 GeV Higgs found at LHC being the second lightest Higgs in a general MSSM context, even with explicit CP violation in the Higgs potential. Contrary to previous studies, we are able to eliminate this possibility analytically, using simple expressions for a relatively small number of observables. We show that the present LHC constraints on the diphoton signal strength, tau-tau production through Higgs and BR(B $\to \chi s\ \gamma$) are enough to preclude the possibility of H2 being the observed Higgs with $m_H \sim 125$ GeV within an MSSM context, without leaving room for finely tuned cancellations.

María Luisa López

Title: *The 125 GeV Higgs boson as the lightest Higgs in a general MSSM model with explicit CP-violation.*

Abstract: We analyze the LHC experimental results in a general MSSM setup including CP violation where the resonance found at ~ 125 GeV corresponds to the lightest Higgs. In this framework, we rule out the possibility of having a Higgs mass spectrum aside from that corresponding to the decoupling limit. LHC constraints in Higgs decay to tau-tau, together with that of gamma gamma, are enough to reach this conclusion. Moreover, the excess in the diphoton channel found at CMS, corresponding to a second resonance at $m_H = 136$ GeV, proves to be complicated to accomodate in any minimal SUSY extension.

Mateo García

Title: *Supersymmetric Custodial Triplets*

Abstract: We analyze the extension of the Minimal Supersymmetric Standard Model which includes extra $Y = (0, \pm 1)$ supersymmetric triplets with a global $SU(2)_L \otimes SU(2)_R$ symmetry spontaneousy broken to the custodial $SU(2)_V$ by the vacuum expectation value of the neutral scalar components of doublets and triplets. The model is the supersymmetrization of the non-supersymmetric model introduced long ago by Georgi and Machacek where the ρ parameter is kept to unity at the tree-level by the custodial symmetry. Accordingly the scalar sector is classified into degenerate $SU(2)_V$ multiplets: singlets, triplets (including the one containing the Godstone bosons) and fiveplets. The singly and doubly charged chiral superfields play a key role in the unitarization of the theory. The couplings of the Standard Model-like Higgs to vector bosons (including $\gamma\gamma$) and fermions, and the corresponding Higgs signal strengths, are in agreement with LHC experimental data for a large region of the parameter space. Breaking of custodial invariance by radiative corrections suggests a low-scale mechanism of supersymmetry breaking.

Sergi González-Solís de la Fuente

Title: *The rare τ decays $\tau \to (\pi, K)(\eta, \eta')\nu_\tau$*

Abstract: The decay $\tau^- \to \pi^-(\eta, \eta')\nu_\tau$, which violates isospin and G-parity, is a clean example of the not yet experimentally evidenced second class current. It is strongly suppressed due to the small difference between the up and down quark masses, but not prohibited in the SM. On the other hand $\tau^- \to K^-\eta\nu_\tau$ is measured whilst $\tau^- \to K^-\eta'\nu_\tau$ is not and both neither theoretically estimated. We evaluate the form factors relevant for such a decays making use of RχT with the goal to have well under control the hadronisation process, requirement for making our predictions. The novelty of our work is the incorporation of the physical η and η' mesons.

Lucien Heurtier

Title: *Extra U(1), effective operators, anomalies and dark matter*

Abstract: In this talk I will present our recent paper, which is about a general analysis on the dimension-six operators mixing an almost hidden Z' to the Standard Model (SM), when the Z' communicates with the SM via heavy mediators. These are fermions charged under both Z' and the SM, while all SM fermions are neutral under Z'. We classify the operators as a function of the gauge anomalies behaviour of mediators and explicitly compute the dimension-six operators coupling Z' to gluons, generated at one-loop by chiral but anomaly-free, sets of fermion mediators. We prove that only one operator contribute to the couplings between Z' charged matter and on-shell gluons. We then make a complete phenomenological analysis of the scenario where the lightest fermion charged under Z' is the dark matter candidate. Combining results from WMAP/PLANCK data, mono-jet searches at LHC, and direct/indirect dark matter detections restrict considerably the allowed parameter space.

Carlos Naya Rodríguez

Title: *BPS Skyrme Model: Building nuclei*

Abstract: In this talk, we will present the Skyrme model focusing on a submodel known as the BPS Skyrme model. After a brief description of it and the implementation of the semi-classical quantization, and introducing the contributions of the Coulomb energy and the isospin-breaking, it will be used to describe nuclei. In this way, besides agreement with some properties as the behaviour of the nuclear radii, we find a good description for the binding energies per nucleon for nuclei with not too small baryon numbers.

Javier Virto

Title: *Flavor Wars: A New Hope*

Abstract: A long, long time ago, the quest for New Physics in flavor began, promising huge effects in loop suppressed flavor transitions and CP asymmetries. But for many years the fate of failure shadowed those who tried to break the curse of the CKM. History became legend. Legend became myth. But the elusive natural BSM theory above the EW scale has a will of its own, and it might be hidden behind the latest measurements of the $B \to K^* ll$ angular distribution. A New Hope has flourished in the hearts of those of us who still believe in a world without MFV...