ESQG 2010 – Abstracts

Alexander, Stephon

Quantum Gravity Phenomenology, Neutrino Oscillations and Dark Energy

Abstract: This talk is about the phenomenological consequences of many-body quantum gravity. In particular, when neutrinos couple to the gravitational field covariantly, the presence of the Immirizi parameter, yields an attractive four fermion interaction (similar to BCS superconductivity). When these neutrinos are at a finite number density in the early universe, they necesarily condense and generate potential energy that robustly lead to late time acceleration. We discuss the experimental consequences for cosmic neutrino oscillations and CMB neutrino detectors in the sprit of Fuller, Shimon and Keating et al [arxiv:1001.5088]. interpretations.

Amelino-Camelia, Giovanni

Quantum Gravity Phenomenology farther, slower

Abstract: Two recent developments on the experimental side invite an extension of the scopes of the programme of quantum-gravity phenomenology. The now estabslished ability of the Fermi telescope to observe high-energy emission from sources at redshift greater than 1 imposes that some of the quantum-gravity-phenomenology model building be adapted to situations in which spacetime curvature cannot be neglected. And the recent improvements of several techniques for the determination of the fine structure constant using ultracold particles opens the way for a quantum-gravity phenomenology aimed at long-wavelength particles, and inspired by the mechanism of ultraviolet/infrared mixing.

Bambi, Cosimo

Search for quantum gravity effects in astrophysical compact objects

Abstract: According to the Cosmic Censorship Conjecture, all the singularities produced by the collapsing matter must be hidden behind an event horizon, which implies that in 4D general relativity the final product of the collapse must be a Kerr-Newman black hole. Nevertheless, there are arguments suggesting that the conjecture might be violated because of quantum gravity effects. If this is the case, at least some current astrophysical black hole candidates might not be Kerr black holes and the study of these objects would teach us something about the theory of quantum gravity.

Bojowald, Martin

LQGD(S)R: On the low-energy implications of loop quantum gravity

Abstract: Before phenomenological consequences of loop quantum gravity (or any other canonical framework) can be addressed, a solution to the anomaly problem of space-time symmetries must be found. While no complete solution yet exists, some of the corrections expected from the quantum geometry underlying loop quantum gravity can be implemented consistently. As a result, (special) relativity is deformed, but not broken. Concrete examples provide a link with generic studies of deformations of spacetime symmetries, and cosmological perturbations provide cases of promising early-universe effects.

Calmet, Xavier

Unitarity in Quantum Gravity and Models of Particle Physics

Abstract: In this talk I shall discuss some of our recent works addressing the question of the unitarity of the S-matrix for linearized General Relativity. The scale at which quantum gravity becomes strong can be determined dynamically using the renormalization group equation of Newton's constant. This result together with a perturbative study of gravitational scattering of the matter content of the particle physics model leads to a bound on the number of particle allowed in that model. Our result has far reaching implications for different models ranging from inflation models to models of grand unification.

Cavaglia, Marco

Hunting for black holes at the LHC

Abstract: With the Large Hadron Colliders finally taking data, it is now time to hunt for man-made black holes in particle colliders. In this talk we will show how to find black holes in LHC data -if TeV black holes are produced at the LHC, and how to rule out their production -if they are not.

Christian, Joy

Probing the Planck Scale with Cosmic Neutrinos

Abstract: Most approaches to quantum gravity predict violations of some of the most basic principles of physics, such as the equivalence principle and/or Lorentz invariance. In fact, according to some even the superposition principle may have to be tampered with in order to arrive at the correct theory of quantum gravity. I will explore implications of such violations for neutrino flavor oscillations. It turns out that a violation of any of the three basic principles

would leave distinctive energy-dependent signature on the transition probability of flavor oscillations. What is more, even those signatures of violations that may be suppressed by many orders of Planck energy would become observable for ultra-high-energy neutrinos, provided such neutrinos have originated at cosmological distances. Accordingly, I will investigate realistic possibilities of experimentally testing the predicted violations. These would involve observing deviations in the flavor ratios of neutrino fluxes expected at the state-of-the-art neutrino telescopes such as IceCube.

Collins, Hael

The subtleties of a quantum field in an inflationary universe

Abstract: This talk explains some of the problems and subtleties associated with defining the short-distance properties of a quantum field in a rapidly expanding background, such as an inflationary universe. The time-dependence in these space-times means that energy scales do not remain fixed; rather, a distance which might once have been an extremely small, seemingly inaccessible scale can eventually be stretched to a macroscopic size with enough time. I shall discuss different approaches to these problems and what they imply for cosmological observations. However, a complete, decisive resolution to these questions is perhaps still lacking.

Dowker, Fay

Polarization Diffusion from Spacetime Uncertainty

Abstract: A phenomenological model of Lorentz invariant random fluctuations in photon polarization is presented. The effects are frequency dependent and affect the polarization of photons as they propagate through space. The model is confronted with the latest measurements of polarization of Cosmic Microwave Background (CMB) photons.

Hofmann, Stefan

Massive Cosmological Gravitons

Abstract: Modifying the IR sector of gravity in a consistent way inevitably leads to multi-diffeomorphic scenarios embedded in large extra dimensions or many world theories. These scenarios are characterised by a tremendous reduction of symmetries that gives rise to new degrees of freedom. Within the effective field theory framework, we will analyse multi-diffeomorphic scenarios and comment in great detail on unitarity and stability restrictions for massive cosmological gravitons.

Keating, Brian

Experimental Quantum Gravity with the BICEP CMB Polarimeter

Abstract: The Background Imager of Cosmic Extragalactic Polarization (BICEP) experiment is the first polarimeter designed to measure the B-mode polarization of the CMB, hypothesized to arise during the quantum Inflationary epoch. During three seasons of observing at the South Pole, Antarctica, BICEP mapped 2

Kelley, John

Searching for Quantum Gravity with High-energy Neutrinos

Abstract: Optical Cherenkov neutrino telescopes such as IceCube and ANTARES currently detect atmospheric neutrinos with energies up to 10 TeV, allowing searches for quantum gravitational (QG) effects such as violation of Lorentz invariance and quantum decoherence. In the neutrino sector, such effects can take the form of unexpected flavor-changing phenomena, such as neutrino oscillations with novel energy or directional dependencies. We present upper limits on these effects obtained by IceCube's predecessor, AMANDA-II, along with the expected ANTARES and IceCube sensitivity. Other detection methods, such as searches for radio pulses from neutrino- induced showers in the air or in ice, offer a way to extend these searches to EeV-scale energies and to use the cosmogenic neutrino flux to search for QG effects.

Kent, Adrian

Testing the (Non)locality of the Gravitational Field

Abstract: I give a natural definition of local causality applicable to probabilistic and deterministic metric theories. I explain the motivation for testing as directly as possible whether our spacetime metric is or (as most would confidently predict) is not locally causal. I describe and discuss the experiments carried out so far.

Landsberg, Greg

Vanishing Dimensions and Planar Events at the LHC

Abstract: We propose that the effective dimensionality of the space we live in depends on the length scale we are probing. As the length scale increases, new dimensions open up. At short scales the space is lower dimensional; at the intermediate scales the space is three-dimensional; and at large scales, the space is effectively higher dimensional. This setup allows for some fundamental problems in cosmology, gravity, and particle physics to be attacked from a new

perspective. The proposed framework, among the other things, offers a new approach to the cosmological constant problem and results in striking collider phenomenology.

Liberati, Stefano

Emergent gravity phenomenology

Abstract: There is a growing evidence that gravity may be an emergent phenomenon and that it is within the mindset that we should look for explanations of the puzzling features of our universe. In this talk I will discuss several facets of this framework with a particular attention to its phenomenological consequences. In particular the most recents constraints about Planck scale Lorentz violations will be presented and their implications or the emergent gravity framework discussed.

Magueijo, João

A quantum gravity foundation for inflation? Sleeping with the enemy.

Abstract: In this talk I propose an alternative way to look at quantum cosmology, based on the Kodama state. Remarkably it has not been noticed that this state can be seen as an approximation to the wave-function of inflation. This insight resolves several foundational problems plaguing inflation, but also allows the phenomenology of inflation to shed light into unresolved foundational matters, such as the inner product in the Hilbert space of quantum gravity. I propose that gravitational chirality might be a decisive test for this approach, with a remarkable and unique signature left in the polarization of the cosmic microwave background.

Mavromatos, Nikolaos

Naturalness, Planck scale, quantum-gravity induced refractive indices and the GRB 090510 results

Abstract: Recently the FERMI satellite telescope, through its observations on the GRB 090510, has put stringent limits on the scale of quantum gravity effects that could cause a sub-luminal refractive index due to quantum gravity media that grows linear with the photon energy.
This scale is of the order of the Planck scale 10^{19} GeV or slightly exceeds it (by a factor of order 1.22), depending on the details of the analysis. These result was interprteted by the FERMI collaboration as implying the end of such models, on account of naturalness. I will argue that this is a misintrerpetation of what a natural quantum gravity scale is. In a class of models of stringy

space-time foam, I will discuss as a concrete example, the effective scale of quantum gravity that induces the above effects is of the form Ms/n , where Ms is the string scale, and n is the density of space-time foamy defects that the photon interacts with.
The density n can be smaller than one and is essentially a model depenendent parameter that may depend even on the cosmological era. In this way, one may encounter a void of defects (D-void), for instance in the scales of red-shift $z = \mathcal{O}(1)$ where Fermi operates, while at the current era one may have $n = \mathcal{O}(1)$. This would reconcile the model with the findings of both FERMI and MAGIC collaborations on delayed arrivals of highly energetic photons, as compared to lower-energy ones. Moreover, as a curious result, I would like to point out that the red-shift of GRB 090510 (and hence such a D-void) is at the range of redshifts where a deceleration/acceleration transition of the Universe takes place, a feature which can be explained theoretically in this model. This example demonstrates that the scale of quantum gravity may thus be highly dependent on the details of the underlying microscopic model of quantum gravity, and hence attempts to draw generic conclusions on theory from such observations may be entirely misleading.
References: [1] N. E. Mavromatos, "Probing Lorentz Violating (Stringy) Quantum Space-Time Foam," AIP Conf. Proc. 1196, XXV Max Born Symposium, Wroclaw (Poland), 29 June-3 July 2009, pp 169 (2009); arXiv:0909.2319 [hep-th]. [2] J. Ellis, N. E. Mavromatos and D. V. Nanopoulos, "D-Foam Phenomenology: Dark Energy, the Velocity of Light and a Possible D-Void," arXiv:0912.3428 [astro-ph.CO].

Rizzo, Thomas
Testing Gravity at Colliders

Abstract: If higher-dimensional theories introduced to address the hierarchy problem are correct, the effective Planck scale may not be far above ~ 1 TeV allowing us to probe gravitational interactions at high energy colliders such as the LHC. I will provide an overview of the predictions for two such scenarios at the LHC: Large Extra Dimensions (due to Arkani-Hamed et.al.) and Warped Extra Dimensions (due to Randall and Sundrum). I will also talk about the collider signatures for two possible UV-completions of General Relativity which are potentially accessible at the LHC: string resonances and Asymptotic Safety, wherein the higher dimensional theory is non-perturbatively renormalizable and unitary at Planck-scale energies and above.

Roura, Albert
Quantum light-cone fluctuations: probing quantum metric fluctua-

tions with massless fields

Abstract: The low-energy effects of perturbative quantum gravity, regarded as an effective field theory, are often calculated as corrections to scattering amplitudes on a flat background. I will discuss how to study in this context the effects of quantum metric fluctuations on the propagation of massless fields for finite times. Our approach relies on the use of diffeomorphism-invariant observables that provide an operational definition of light-cone fluctuations. One of the goals is to establish a reliable framework where the phenomenological consequences for different kinds of models can be quantitatively analyzed. This will be illustrated with some examples with compact extra dimensions, and the absence of decoupling in previous studies will be clarified. Furthermore, it is also hoped that the insight gained at the conceptual level can help to improve our understanding of black-hole horizon fluctuations.

Sakellariodou, Mairi

Noncommutative Geometry as framework for Unification: Introduction and cosmological consequences

Abstract: I will review the Spectral Triple approach to NonCommutative Geometry which allows one to develop the entire Standard Model (and Supersymmetric extensions) of Particle Physics from a purely geometrical point of view. The Bosonic sector of the theory contains a modification to Einstein-Hilbert gravity, involving a nonconformal coupling of the Ricci curvature to the Higgs field and conformal Weyl term (in addition to a non-dynamical topological term). I will then show that neglecting the nonminimal coupling of the Higgs field to the curvature, noncommutative corrections to Einstein's equations are present only for inhomogeneous and anisotropic space-times. Considering the nominimal coupling however, one obtains corrections even for background cosmologies. I will derive the weak field limit of this gravitational theory and show that the production and dynamics of gravitational waves are significantly altered. I will finally investigate whether two-loop corrections to the Higgs potential could lead, within the NCG framework, to a slow-roll inflationary period in agreement with the CMB data.

Smolin, Lee

On the issue of non-locality in deformed special relativity

Abstract: The issue of whether there are non-local physical effects in deformed or doubly special relativity has been raised by several authors. Several possible responses to this issue will be discussed.

Sudarsky, Daniel

Phenomenology of a Lorentz -respecting space-time granularity.

Abstract: The remarkable constrains on the notion of a Lorentz violating space-time granular structure associated with quantum gravity, prompted us to consider a scheme where Lorentz invariance is respected but in which a space-time granularity might nonetheless become manifest. The initial proposals in these direction turned out to contain problematic ambiguities that have been removed in our latest proposal. I will show haw this is achieved , will and present the first set of bounds obtained on the parameters of the model, and discuss how we expect to strengthen those with new and much more accurate experiments.

Troja, Eleonora

Precursor activity in short duration GRBs

Abstract: The main gamma-ray event in GRBs is occasionally anticipated by a less intense episode of emission, called a precursor. Such precursors have been so far associated to the class of long duration GRBs. We carried out a systematic search of precursors on the sample of short GRBs observed by Swift. We found that $\sim$ 10% of short GRBs display such early episode of emission. One burst (GRB 090510) shows two precursors events, the former $\sim$ 13 s and the latter $\sim$ 0.5 s before the GRB. We show that emission started well before the main GRB, implying a maximum delay of 13.3 s between the lowest (¡50 keV) and highest (31 GeV) energy photons. We discuss the implications of precursor emission for the use of short GRBs as probes of Lorentz invariance violation effects, with particular emphasis on the precursors observed in GRB 090510.

Wagner, Robert

Exploring quantum gravity with VHE γ-ray telescopes - status, prospects and limitations

Abstract: Some models for quantum gravity (QG) violate Lorentz invariance (LIV) and predict an energy dependence of the speed of light, leading to a dispersion of high-energy gamma-ray signals that travel over cosmological distances. Recent limits on the dispersion from short-duration substructures observed in gamma-rays emitted by gamma-ray bursts (GRBs) at cosmological distances have provided rather strict bounds on LIV. Also observations of unprecedentedly fast flares in the very-high energy gamma-ray emission particularly of the active galactic nuclei (AGNs) Mkn 501 in 2005 and PKS 2155-304 in 2006 have provided tight limits on LIV from light-travel observations,

approaching the Planck mass scale, at which QG effects are assumed to become important. In the presentation, the current status of LIV searches using GRBs and AGN flare events as measured by the satellite-based Fermi Gamma-Ray Telescope and ground-based Imaging Cherenkov Telescopes (MAGIC, H.E.S.S., VERITAS) will be reviewed. I will also show some internal source effects that lead to dispersive signatures and how these might jeopardize LIV measurements; finally, I will discuss the limitations of light-travel time analyses and prospects for future ground-based gamma-ray telescopes (CTA, AGIS).
