Ana Avilez	University of Nottingham
Title: About the theoretical prior for the Brans-Dicke class at cosmological scales	
Abstract: So far, cosmological observations of the formation of galaxies and the accelerated expansion of the Universe suggest the existence of dark components of mass-energy of the Universe within the General Relativity theory (GR). However, dark energy as a standard building block of energy components of the Universe is not yet supported either phenomenologically or theoretically. It is then natural to wonder which part of our physical picture should be modified: matter or gravity. The latest and future observations of the LSS will shed some light on the answer. Any deviation to the standard cosmology might be detected by changes in the way that geometry and the matter content of the universe are related. In order to quantify these changes, functional parametrizations of the mass screening and the anisotropic stress have been proposed. These theoretical priors provide an effective framework to study deviations and tests of GR. Here I am going talk about the prior corresponding to the Brans-Dicke-like class and briefly discuss the constraints on it.	
Joseph Hongchul Bae	Yale University
Title: Modified semi-classical solutions to the Bianchi IX Wheeler-DeWitt equation	
Abstract: A modified semi-classical method has been used to find solutions in quantum Bianchi IX (Mixmaster) cosmology. Employing a modified form of the semi-classical ansatz, we solve the ADM-Dirac Hamiltonian constraint equation for the Mixmaster space by integrating a set of transport equations along the flow of a solution to the Euclidean-signature Hamilton-Jacobi equation. For the Moncrief-Ryan (wormhole) state solution, we compute the ground state quantum correction terms associated with factor-ordering ambiguities. Unlike previous work that give local approximations, our solutions are globally defined in the minisuperspace. In addition, we are able to calculate for the first time the excited states in the quantum Bianchi IX minisuperspace. The modified semi-classical method as applied to Mixmaster cosmology developed here is proposed to be applicable to more general models, and it is hoped that this approach will open the door to making progress in the Wheeler-DeWitt approach to quantum gravity.	
Alan Barnes	Aston University
Title: Vacuum spacetimes with a constant Weyl eigenscalar	
Abstract: Vacuum spacetimes (with or without a cosmological constant) which possess a constant Weyl eigenvalue are investigated. The Petrov type I case where the eigenvalue is zero was excluded long ago by Brans and the type III & N cases are not restricted by the assumption of a zero eigenvalue, so this paper concentrates on the non-zero case. The general Petrov type II and D cases can be obtained explicitly in closed form whereas for Petrov type I if the assumption is made that all three Weyl eigenvalues are constant, it turns out that the only solution is a pure vacuum homogeneous spacetime. The Type I case with only one constant eigenvalue appears much richer and some preliminary results will be presented. Some applications to the isometric embedding of vacuum spacetimes in 6-D flat Lorentz manifolds will be presented.	
Priscilla Canizares	Institute of Astronomy, Cambridge
Title: Fast Markov chain Monte Carlo for gravitational-wave parameter estimation	
Abstract: Gravitational waves (GWs) usually consist of high-dimensional parametric functions. Hence, the computational cost of modeling, searching and performing parameter estimation studies is very high, and in many cases prohibitively in practice. In this talk we will see how employing Reduced Order Quadratures (ROQs), an application and data-specific quadrature rule based on Reduced Order Modeling (ROM) and the Empirical Interpolation method (EIM), we can perform fast and accurate Markov chain Monte Carlo (MCMC) evaluations of the correlations between a signal and a catalogue of gravitational wave templates to estimate the parameters of the source of a GW. We illustrate our approach through one of the standard models of gravitational-wave burst waveforms, and we will show results for four-dimensional MCMC searches of synthetic data, which asses that already for such a simple GW model ROQs can be around X 20 faster than the standard approach, without loss of accuracy.	

Adam Christopherson	University of Nottingham
Title: Isocurvature perturbations and reheating in multi-field inflation	
Abstract: Isocurvature, or entropy, perturbations naturally arise in models of inflation consisting of more than one scalar field. Their presence is constrained by current observations to be around 10% of the spectrum of adiabatic perturbations, and they could have other observable consequences, such as through the sourcing of vorticity at higher order in perturbation theory. In this talk I present some recent work on the topic. Focussing on three canonical two-field models of inflation, we first investigate the evolution of isocurvature during inflation. Next, we study reheating for these three inflationary potentials, modelling the reheating phase by allowing decay of the fields into both matter and radiation fluids. We show that, under our approximations, the isocurvature is subdominant in all cases, and is negligible in all but the product exponential model. We close with some prospects for the future.	
Stephanie Erickson	University of Southampton
Title: Simulating the shattering of the neutron star crust	
Abstract: Although the neutron star crust contributes only a small fraction to the total mass of the star, it is expected to affect the dynamics of systems where interface or crustal modes are excited, such as during binary neutron star mergers, where excitation of these modes could lead to tidal shattering of the crust. To model such systems, we have developed a general relativistic conservation-law formalism for nonlinear elasticity; this allows us to use high-resolution shock-capturing methods to resolve strong shocks. We plan to use this formalism, along with appropriate methods for treating the solid-fluid and solid-vacuum interfaces at the edges of the crust, to simulate a toy-model evolution of discontinuities caused by shattering and refreezing of the crust.	
Johnny Espin	University of Nottingham
Title: Second order fermions and unification with gravity	
Abstract: It has been proposed several times in the past that one can obtain an equivalent, but in many aspects simpler description of fermions by first reformulating their first-order (Dirac) Lagrangian in terms of 2-component spinors, and then integrating out the spinors of one chirality (e.g. primed or dotted). This is possible whenever the Lagrangian is quadratic in the fermions, which is the case for physically realistic theories. The resulting new Lagrangian is second-order in derivatives, and contains 2-component spinors of only one chirality. The new second-order formulation simplifies the fermion Feynman rules of the theory considerably, e.g. the propagator becomes a multiple of an identity matrix in the field space. When recast as a second-order theory, fermions start looking much more similar to other theories relevant for the description of Nature, and it may be that the second-order formulation may help in the task of giving a unified description of all of them.	
Hugo Ferreira	University of Nottingham
Title: Warped AdS_3 black holes: are they classically stable?	
Abstract: 3D gravity allows us to study aspects of general relativity and quantum gravity in a simpler technical setting which retains much of the conceptual complexity of the 4D version. However, pure Einstein gravity has no local degrees of freedom in 3D. Topologically Massive Gravity is a deformation of pure Einstein gravity which adds a gravitational Chern-Simons term and includes propagating gravitons. For many years several attempts at finding a stable vacuum solution for this theory were made and it has been recently established that the Anti-de Sitter (AdS3) solution is unstable for almost all values of the coupling constant of the Chern-Simons term. Warped AdS3 solutions are recent candidates for a stable vacuum solution. In this talk I first describe these solutions and the black hole space-times obtained from them. In addition, I consider scalar field perturbations on these black hole backgrounds and discuss the issue of classical stability to these perturbations and progress towards determining the renormalized stress energy tensor for the Hartle-Hawking vacuum state.	

Michael Fil'chenkov/Yuri Laptev | People's Friendship University of Russia, Moscow

Title: Quantum accretion of baryons onto miniholes

Abstract:
A quantum accretion of baryons onto miniholes has been considered in the framework of E. Madelung's quantum hydrodynamics. The total luminosity of the accretion disc and the energy of quanta being emitted have been calculated. The results obtained may be of importance in an interpretation of the electromagnetic radiation of graviatoms.

Markus Fröb | Universitat de Barcelona, Spain

Title: The good, the bad and the ugly: including matter loops in the graviton two-point function in de Sitter

Abstract:
I present the one-loop correction to the graviton propagator in the Poincaré patch of de Sitter space due to conformally coupled scalars. De Sitter space is relevant as a model for the inflationary phase of the early universe, and quantum fluctuations are believed to lead to structure formation. However, existing calculations are either classical, at tree level or incorporate loop effects only approximately. I exhibit the full one-loop correction and discuss its observational relevance as well as generalizations to other type of matter fields.

Carsten Gundlach | University of Southampton

Title: Critical phenomena at the threshold of immediate merger in binary black hole systems: the extreme mass ratio case

Abstract:
Pretorius and Khurana have shown in numerical simulations in high-speed black hole collisions that one can achieve many orbits, and radiate a lot of energy, by fine-tuning the impact parameter to the threshold between scattering and merger. They have explained this in analogy with zoom-whirl behaviour of a test particle in a black hole space-time. We turn this toy model into a quantitative model of high-speed collisions where one black hole is much larger than the other by adding the gravitational self-force.
Carsten Gundlach, Sarp Akcay, Leor Barack, Alessandro Nagar

Ian Hawke | University of Southampton

Title: The nonlinear development of the relativistic two-stream instability

Abstract:
The two-stream instability has been mooted as an explanation for a range of astrophysical applications from GRBs and pulsar glitches to cosmology. Using the first nonlinear numerical simulations of relativistic multi-species hydrodynamics we show that the onset and initial growth of the instability is very well described by linear perturbation theory. In the later stages the linear and nonlinear description match only qualitatively, and the instability does not saturate even in the nonlinear case by purely ideal hydrodynamic effects.

Anna Heffernan | University College Dublin

Title: Regularisation of the self-force in Kerr space-time

Abstract:
By computing high-order expansions of the Detweiler-Whiting singular field in the cases of point scalar, electromagnetic and gravitational charges in Kerr space-time, we examine and extend on current regularisation procedures available. We calculate the previously unknown mode-sum regularisation parameters and also propose an enhanced regularisation procedure for use in the *m*-mode effective source approach, for which we provide *m*-mode regularization parameters.

Carlos Hidalgo	University of Portsmouth

Title: Relativistic effects on the simulation of cosmological structure formation

Abstract:
The growth of matter inhomogeneities in the Universe, from the tiny fluctuations observed in the CMB to the present large scale structure, can only be studied numerically, through large computer simulations. Current Newtonian N-body codes seek high accuracy by studying inhomogeneities of size comparable to, or even larger than, the cosmological horizon and by going beyond the linear order of initial perturbations. Relativistic effects are expected in these two regimes, so it is important to quantify them if one wants to test the accuracy of Newtonian simulations. In this talk I will present the set of equations solved in numerical simulations in the context of cosmological perturbation theory. These relativistic non-linear equations are equivalent to their Newtonian counterpart in a specific gauge, and when the adequate identifications are made. This implies that the relativistic corrections are encoded in the set of initial conditions, as dictated by the constraint equations of General Relativity. I will show how to parametrise the relativistic effects in terms of a gauge-invariant definition of the curvature perturbation.

Benito Juarez Aubry	University of Nottingham

Title: Detector for a massless (1+1) field: Hawking effect without infrared sickness

Abstract:
We modify the Unruh-DeWitt particle detector by coupling the detector's monopole moment to the derivative of a (1+1)-dimensional scalar field, rather than the field itself. We show that issues of time-dependency in the trajectory, the quantum state and the switching can be handled within first-order perturbation theory essentially as for a non-derivative coupling in 3+1 dimensions. Crucially, we present evidence that the detector remains well-behaved in the limit of a massless field, despite the divergence in the two-point function, and we use the detector to analyse the onset of the Hawking and Unruh effects in strongly time-dependent situations.

Christian Krueger	University of Southampton

Title: Oscillations of maturing neutron stars

Abstract:
We investigate the oscillation spectrum of maturing neutron stars where our calculations aim to be as realistic as possible. To date, we account for density discontinuities, a composition gradient and the elastic crust; we are using a modern, realistic equation of state and our calculations include thermal pressure. We calculate the region in which the crust is crystallised by assuming a one component plasma. All calculations are carried out in the framework of general relativistic perturbation theory and we investigate the effect of temperature on the different oscillation modes as the neutron star cools over time.

Yuri Laptev	People's Friendship University of Russia, Moscow

Title: Quantum accretion of baryons onto miniholes

Abstract:
A quantum accretion of baryons onto miniholes has been considered in the framework of E. Madelung's quantum hydrodynamics. The total luminosity of the accretion disc and the energy of quanta being emitted have been calculated. The results obtained may be of importance in an interpretation of the electromagnetic radiation of graviatoms.

Tim Lemon	University of Southampton

Title: Numerical simulations on relativistic jets

Abstract:
Astrophysical jets are some of the most powerful transient phenomena thus far detected in the known Universe. Jets can be formed as part of the accretion process from a main sequence star onto a compact object, such as a neutron star or stellar mass black hole, within an X-ray Binary (XRB). The formation processes of such jets are still not very well understood, and can be affected by such things as spin and magnetic fields. By studying their formation, it should be possible to find out more about the compact object powering the jet. We describe the numerical methods used to create a general relativistic magneto-hydrodynamical (GR-MHD) model of an accreting system.

Godfrey Leung	University of Nottingham
Title: Reheating in multifield inflation makes life harder for predicting observables	
Abstract: In this talk, I will summarize the main results in my recent papers arXiv:1206.5196 and arXiv:XXXX.XXXX (to appear soon) about the fate of primordial inflationary observables such as non-Gaussianity in multifield inflation models during the reheating stage. In various 2-field models studied, we found that the reheating period is important for correctly evaluating the statistics of primordial curvature perturbations, even in the simplest perturbative reheating scenario. This suggests that one need to be cautious when comparing model predictions in multifield models with observations if the details of reheating are unknown in the models.	
Jorma Louko	University of Nottingham
Title: Quantum fields in accelerated cavities: from relativistic velocities to a desktop experiment	
Abstract: We address quantum fields in an accelerated cavity in (3+1)-dimensional Minkowski spacetime in a perturbative formalism that assumes acceleration to remain small but allows the velocities, travel times and travel distances to be arbitrary, and remains in particular valid when the velocities become relativistic. The formalism is well suited for analysing the effects of acceleration on quantum information protocols, and it generalises to analogue systems that simulate mechanical cavity motion. As an application, we identify a desktop experimental scenario where mode mixing within the cavity appears to be at the threshold of current technology. (Based largely on D. E. Bruschi, J. Louko, D. Faccio and I. Fuentes, arXiv:1210.6772 [quant-ph].)	
Christian Luebbe	University College London
Title: The cosmic-no-hair conjecture for 'almost-Bianchi' spacetimes	
Abstract: This talk discusses the long term behaviour of spacetimes which are initially expanding, close to Bianchi spacetimes and satisfy the Einstein field equations for radiation fluids or Einstein-Maxwell with a positive cosmological constant.	
Cesar Merlin	University of Southampton
Title: Self force in a modified radiation gauge for circular and eccentric orbits.	
Abstract: We develop a new formulation of the gravitational self force (or "radiation reaction"), acting on a point particle in a curved space-time, in a new gauge. We derive the appropriate gauge transformation generator that goes from the Radiation gauge to this new "modified" Radiation gauge. This gauge behaves like the Lorenz gauge near the particle and deforms to resemble the Radiation gauge away from it. This idea has been previously suggested but never fully implemented. In this gauge the self-force is well-defined. We analytically obtain an expression for the deviation of the self force calculated in the Radiation gauge and obtain a multipole decomposition that yields the regularization parameters in the new mode-sum formula. We compute the self force in a Schwarzschild background in a computationally efficient fashion and validate our analytical results.	
Peter Millington	University of Sheffield
Title: Perturbative non-equilibrium thermal field theory	
Abstract: In arXiv:1211.3152 and arXiv:1302.6361, we present a new perturbative formulation of non-equilibrium thermal field theory, based upon non-homogeneous free propagators and time-dependent vertices. The resulting time-dependent diagrammatic perturbation series are free of pinch singularities without the need for quasi-particle approximation or effective resummation of finite widths. Introducing a physically meaningful definition of particle number densities, we derive master time evolution equations for statistical distribution functions, which are valid to all orders in perturbation theory and to all orders in a gradient expansion. For a scalar model, we truncate these evolution equations in a loopwise sense, whilst still capturing the dynamics on all time-scales. We show that the early-time transient behaviour of this system is dominated by non-Markovian energy-violating processes.	

Jack Morrice	University of Sheffield

Title: Constraints on disformal couplings from the CMB temperature evolution

Abstract:
Certain modified gravity theories predict the existence of an additional, non-conformally coupled scalar field. A disformal coupling of the field to the Cosmic Microwave Background (CMB) is shown to affect the evolution of the energy density in the radiation fluid. Therefore, measurements of the CMB temperature at various redshifts can be used to constrain these disformal couplings. Such measurements strongly support the predictions of general relativity, that the CMB temperature evolution with redshift is linear. For both exponential and power law potentials for the scalar field we find an excluded range for the strength of this coupling, characterised by an energy scale M, to be few times 10^{-6} eV < M < few times 10^{-3} eV. For certain values of M, we find that the effective disformal coupling to radiation becomes singular.

John Muddle	University of Southampton

Title: Multi-component numerical methods with magnetic fields

Abstract:
Neutron star mergers are considered strong candidates for the emission of detectable gravitational waves. The numerical simulation of these systems is possible by using appropriate approximations. A multi-component model allows us to combine different physical models which approximate different regions of the star. So far we have extended the work of Millmore & Hawke to include a magnetic field. We show our results for MHD interfaces where we see vorticity propagation along the field lines. This could lead to new interesting dynamical effects in neutron star mergers.

Ellie Nalson	Queen Mary, University of London

Title: Generating intergalactic magnetic fields in the early universe

Abstract:
We present a generation mechanism for intergalactic magnetic fields. We use cosmological perturbation theory to show that these large scale magnetic fields can be sourced by vorticity in the early universe and give an estimate for the expected magnitude of such magnetic fields.

Brien Nolan	Dublin City University

Title: On the existence of dyons and dyonic black holes in Einstein-Yang-Mills theory

Abstract:
We study dyonic soliton and black hole solutions of the $su(2)$ Einstein-Yang-Mills equations in asymptotically anti-de Sitter space. We prove the existence of non-trivial dyonic soliton and black hole solutions in a neighbourhood of the trivial solution. For these solutions the magnetic gauge field function has no zeros and we conjecture that at least some of these non-trivial solutions will be stable. The global existence proof uses local existence results and a non-linear perturbation argument based on the (Banach space) implicit function theorem. (Joint work with Elizabeth Winstanley)

Patrick Nolan	University College Dublin

Title: Electromagnetic and gravitational self force calculations in Schwarzschild space-time

Abstract:
We discuss the mode sum method for calculating the self force of an electromagnetic and a massive particle in a circular orbit around a Schwarzschild black hole. The self force is regularised by subtracting known l-mode coefficients to present the fully regular self force for the particle.

Rebecca Palmer	Birmingham University
Title: Noise modelling for atom interferometry	

Abstract:

Atom interferometry [1] has measured gravity to ~10^-8g/Hz^1/2 [2], and has the potential for even higher precision. This could be used to detect buried objects by their gravity, or to test fundamental physics such as the equivalence principle.

However, reaching this precision requires careful minimisation of many noise sources [3-5], including shot noise, laser frequency noise, wavefront distortions, and rotation. We develop a computer model of atom interferometry for this purpose.

In particular, we consider wavefront distortions and rotation noise, which both enter through imperfect control of the atom clouds' velocity and size. They can hence be suppressed using a detection aperture to select the near-axis atoms, or subtracted off using an image-forming detector. Our model predicts noise reductions of around a factor of 10 using an aperture and 15 using imaging detection.

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[2] J. Kitching, S. Knappe, and E. Donley, IEEE Sensors Journal 11, 1749 (2011).
[3] A. Peters, K.Y. Chung, and S. Chu, Metrologia 38, 25 (2001).
[4] J. Le Gouët, T.E. Mehlstäubler, J. Kim, S. Merlet, A. Clairon, A. Landragin, and F. Pereira Dos Santos, Applied Physics B 92, 133 (2008).
[5] F. Sorrentino, Y.-H. Lien, G. Rosi, L. Cacciapuoti, M. Prevedelli, and G.M. Tino, New Journal of Physics 12, 095009 (2010).

Mark Roberts	
Title: String theory explanation of galactic rotation	

Abstract:

The unique spherically symmetric metric which has vanishing Weyl tensor, is asymptotically de Sitter, and can model constant galactic rotation curves is presented. Two types of field equations are shown to have this metric as an exact solution. The first is Palatini-varied scalar-tensor theory. The second is the low energy limit of string theory modified by inclusion of a contrived potential.

Ippocratis Saltas	University of Nottingham
Title: Asymptotically safe cosmology: an effective description	

Abstract:

I will discuss the cosmology of a renormalisation group improved Einstein-Hilbert action in the context of the asymptotic Safety scenario for quantum gravity. In particular, I will explain how the quantum corrections in the action, which appear in the cut-off scale dependence of the gravitational couplings, can be alternatively viewed as non-linear corrections in the scalar curvature, i.e as an effective f(R) model. I will then proceed to discuss the emerging early- and late-time cosmology in this context, explaining how a large hierarchy between primordial and late time acceleration naturally occurs for this model, as well as how GR is recovered at solar and astrophysical scales. Finally, I will point out some key problems of this scenario and suggestions of how these could be resolved in future work.

Wahiba Toubal	University of Sheffield
Title: Defining mass for black holes with scalar field hair in anti-de Sitter space-time	

Abstract:

We investigate gravity minimally coupled to a scalar field in anti-de Sitter (AdS) space-time. We first define and calculate the mass in matter-free AdS using Henneaux's approach. We obtain a set of boundary conditions which give a finite mass. We show that by introducing a scalar field with a potential, these asymptotic conditions are no longer satisfied. The scalar field has a slow fall off at infinity which modifies the geometry. An extra contribution to the mass from the scalar field subleading terms is needed to cancel divergences and obtain finite masses.

Neils Warburton	University College Dublin

Title: Isofrequency pairing of geodesic orbits in Kerr geometry

Abstract:

Bound geodesic orbits around a Kerr black hole can be parametrized by three constants of the motion: the (specific) orbital energy, angular momentum and Carter constant. Generically, each orbit also has associated with it three frequencies, related to the radial, longitudinal and (mean) azimuthal motions. Here we note the curious fact that these two ways of characterizing bound geodesics are not in a one-to-one correspondence. While the former uniquely specifies an orbit up to initial conditions, the latter does not: there is a (strong-field) region of the parameter space in which pairs of physically distinct orbits can have the same three frequencies. In each such isofrequency pair the two orbits exhibit the same rate of periastron precession and the same rate of Lense-Thirring precession of the orbital plane, and (in a certain sense) they remain "synchronized" in phase.

Barry Wardell	University College Dublin

Title: Green function approach to self-force calculations

Abstract:

The computation of the self-force is of fundamental importance to the accurate calculation of the orbital evolution of EMRI (extreme mass ratio inspiral) binary systems and the prediction of their gravitational radiation waveform. Formal solutions of the self-force problem have been found whereby the solution is expressed in terms of an integral of the retarded Green function over the entire past world-line of the particle. Although in principle this formal solution gives the desired result, in practice the calculation of the Green function poses a formidable challenge. Various techniques have been employed to solve this issue to varying degrees of success, but as yet no approach has been successfully applied to compute the self-force in a black hole space-time. I present a novel approach to the problem which combines new numerical and analytical techniques for calculating the retarded scalar Green function and hence the scalar self-force.

Helvi Witek	University of Cambridge

Title: Lighthouses in the sky

Abstract:

Black holes are key players in a wide range of fundamental physics including astrophysics as well as high energy physics. Crucial questions concern their stability properties with potentially important implications for the phase-space of solutions or the understanding of condensates in the vicinity of black holes. Of particular interest is the superradiant or ''BH-bomb''-like instability of Kerr BHs, which arises naturally in aymptotically anti-de Sitter spacetimes or in the presence of massive fields surrounding the BH.

Here, we focus on the latter scenario and present our investigations of massive scalar fields in BH environments. In particular, we wish to present the first results concerning the time evolution of these systems in the non-linear regime and discuss the resulting scalar and gravitational wave emission.