Britgrav 6

University of Nottingham, 4–5 April 2006

Talk titles and abstracts (alphabetical by speaker)

(Last updated April 4, 2006.)

Anderson, Edward (DAMTP, University of Cambridge)
Problem of Time in Quantum Gravity

Time is conceptually distinct in conventional quantum theory and general relativity. This makes it hard to bring these two theoretical schemes together. I will talk about several suggested strategies to bring about such a resolution — timeless records approaches, emergent semiclassical time approaches and hidden time approaches. In doing so, I will use various illustrative toy models.

Andersson, Nils (University of Southampton)
Modelling dissipation in superfluid neutron stars

In this talk I will provide a brief summary of our understanding of dissipation in superfluid neutron stars. I will present a recent multifluid viscosity model and describe the so-called mutual friction, which is thought to be the main damping agent that prevents gravitational-wave driven mode instabilities in superfluid neutron stars. I may also discuss future fully relativistic extensions of the present framework.

Barrett, John (University of Nottingham)
3d quantum gravity

Calabrese, Gioel (University of Southampton)
Consistent boundary conditions in numerical relativity

The last year has seen remarkable progress in the numerical simulation of binary black hole systems. As the accuracy and duration of these simulations increases and we move closer to detecting gravitational wave signals, the ability to extract the gravitational wave signals from the simulations has become a matter of urgency. The Cauchy-characteristic matching approach provides a promising technique to achieve this goal. In this talk I will discuss numerical and analytical issues related to the axisymmetric evolution of a scalar field around a black hole.

Dolan, Sam (Cavendish Laboratory, University of Cambridge)
Wave Scattering and Absorption by a Schwarzschild Black Hole

In this talk I will review a simple 'model problem', in which a monochromatic plane wave impinges upon a Schwarzschild black hole and is partially absorbed, scattered and polarised. Though wavelength-dependent diffraction effects may never be observable, this has not discouraged the detailed theoretical study of this problem by numerous authors. The scattering of massless waves of integer spin is now well understood. The scattering of massive spin-half waves has received less attention. In this talk, I outline some analytic techniques that can be applied to the fermion case, and present recent numerical results. I conclude with a discussion of the gravitational analogue of Mott polarisation.

Gundlach, Carsten (University of Southampton)
Recent progress in binary black hole formulations

After a decade of failure, the numerical simulation of binary black hole mergers has at last become feasible through two different approaches: Pretorius, March 2005, and the Goddard and Brownsville groups, November 2005. I will review for a non-specialist audience what has made this progress possible.

Haskell, Brynmor (University of Southampton)
Detecting mountains on neutron stars

I will examine some of the different mechanisms that can give rise to a "mountain" on a Neutron Star and present the estimates that we have on the "size" of the mountain. I will then discuss the impact that these scenarios can have on gravitational waves and what the prospects of detecting the signals with ground based interferometers are, compared to current upper limits.

Hawke, Ian (University of Southampton)
Gravitational waves from the collapse of a neutron star to a black hole

Gravitational wave signals will provide unprecedented insights about the structure of matter at extreme temperatures and pressures, but will be extremely difficult to extract from the background noise in detectors such as LIGO and GEO600. Hence template wavesignals are required. Here we discuss one set of template wavesignals produced by direct numerical simulation of the collapse of an isolated neutron star in full general relativity. As well as discussing the structure and behaviour of the horizons that appear in the formation of a black hole, we will discuss the impact of the wavesignals on gravitational wave astroseismology.

Heineke, Reece (Cavendish Laboratory, University of Cambridge)
Torsion-driven inflation in Einstein-Cartan theory

General relativity may not be the last theory before a full quantum gravity theory is developed. Einstein-Cartan (EC) theory may provide a transitional semiclassical formulation. EC theory has several indirect theoretical arguments in its support and among those is that torsion drives inflation in a wide range of cosmological models. I cover models considered in the past such as spinning fluids, and discuss some of our own results using Riemann-squared Lagrangian or universes filled with fermionic matter or DKP scalar fields. While all of these models must be considered toys for various reasons, inflation driven by torsion in physically accurate way remains possible.

Hilditch, David (University of Southampton)
First steps towards using 'asymptotically null' slices in the Einstein initial value problem

Numerical relativity has made vast progress in simulating binary space-times in the last year or so, but one missing element is a cheap way to resolve far-field, outgoing waves. We discuss a possible solution to this problem: asymptotically null slices combined with a stretch or compactification in the radial coordinate. Numerical simulations of the spherical wave equation on Schwarzschild show that waves can be evolved to infinity at good accuracy and that power-law tails are also well resolved.

Johnson, Richard (University of Nottingham)
Twistor Transform for the Lorentz Group

The Twistor Transform is an integral transform between functions on Twistor Space and functions on space-time. The talk will outline this transform for a Twistor Space arising naturally from the Lorentz Group using functions of interest from Conformal Field Theory.

Jones, Ian (University of Southampton)
Astrophysical input for gravitational wave searches for spinning neutron stars

In this talk I will describe ways in which astrophysicists can help guide gravitational wave detection strategies, either by giving information on likely source strengths and frequencies, or by helping observers focus their attentions on particular locations in the Galaxy.

Kottanattu, George (University of Nottingham)
Static axisymmetric SU(2) geon black holes

Geon-type black holes exist as a loosely defined class of single-exterior black-and-white hole spacetimes modelled on the example of the "$\mathbb{R}P^3$ geon" of Friedman *et al* (gr-qc/9305017). The interest in these particular spacetimes originates in the findings on the peculiar thermodynamical properties of the $\mathbb{R}P^3$ geon by Louko and Marolf (gr-qc/9802068) and the desire to probe these effects in more general settings. Up to date, only one non-abelian geon has been presented to the community, the static spherically symmetric SU(2) geon of Louko, Mann and Marolf (gr-qc/0412012); the aim of this talk will be to present and discuss preliminary results concerning the construction of a set of new, static axisymmetric SU(2) geon black holes based on the numerical exterior black hole solutions of Kleihaus and Kunz (gr-qc/9712086).

Krasnov, Kirill (University of Nottingham)
Quantum gravity from Feynman diagrams

Kunstatter, Gabor (University of Winnipeg)
Highly damped quasinormal modes of black holes: Universality and relevance

I will describe recent work that investigates the universality of the famous ln(3) result for the highly damped quasinormal modes of generic one and two horizon black holes. We will show that the universality holds in a limited sense and discuss the possible relevence that these modes have to the quantum spectrum of black holes.

Larkin, Peter (University of York)
A Simple Example of Algebraic Holography

In 1999, K.-H. Rehren introduced the concept of "algebraic holography" [1] according to which, for a given quantum field theory on the bulk of Anti-deSitter space, there is a well-defined geometrical procedure for obtaining a quantum conformal field theory on the conformal boundary which, in a certain natural sense, is isomorphic to the given bulk theory. This is different from the usual conjectured AdS/CFT correspondence (it involves local quantum field theories in the bulk, not string theory) but it seems to bear some relation to the latter. In his paper, Rehren mentions some simple examples including, for the 1+1 dimensional case, the isomorphism between a free massless scalar field in the bulk and a free massless scalar chiral theory on the conformal boundary. In joint work with Bernard Kay, we have attempted to improve our understanding of this example by adopting a "quantum field theory in curved spacetime" approach in which the existence and properties of the isomorphism are reduced to appropriate questions about the space of solutions of the underlying classical wave equation. We report on our progress in this endeavour and discuss the prospects for generalization to other field theories and dimensions.

[1] K.-H. Rehren, Algebraic Holography, Annales Henri Poincare 1, 607–623, 2000 (hep-th/9905179)

Losert-Valiente Kroon, Christiane Maria (University of Vienna)
Static elastic shells in Einsteinian and Newtonian gravity

We study the behaviour of a specific system of relativistic elasticity in its own gravitational field: a static, spherically symmetric shell whose wall is of arbitrary thickness consisting of hyperelastic material. We give the system of field equations and boundary conditions within the framework of the Einsteinian theory of gravity. Furthermore, we analyze the situation in the Newtonian theory of gravity and obtain an existence result valid for small gravitational constants and pointwise stability by using the implicit function theorem.

Louko, Jorma (University of Nottingham)
Classical singularities versus quantum superselection sectors

When a gauge noninvariant quantum state is averaged over gauge transformations, the outcome ought to be a gauge invariant quantum state provided the 'averaging' can be given a sufficiently well-defined meaning. After briefly recalling the current status of this programme, this talk addresses group averaging in a 'minisuperspace' gauge system (gr-qc/0505097) whose classical solution space contains singularities. After the concomitant divergences in the averaging are renormalised, the quantum theory breaks into disjoint sectors, each corresponding to singularities of a specific strength, but only one of which has the expected semiclassical limit.

Naish-Guzman, Ileana (University of Nottingham)
Observables in the Ponzano-Regge model of quantum gravity

The Ponzano-Regge model for (3+0)–dimensional quantum gravity, in its naïve definition, yields infinite results and thus needs regularizing. In this talk we apply the standard regularization to a selection of observables and show that in certain cases it is ill-defined. The search for a viable regularization remains an open issue.

Nolan, Brien (Dublin City University)
Bounds for scalar waves in self-similar collapse

We show that a massless scalar field propagating on a spherically symmetric self-similar background space-time admitting a naked singularity maintains finite L^2 norm as it impinges on the Cauchy horizon. We also demonstrate that the field obeys a pointwise bound, as does its locally observed energy density and discuss the results in the context of the cosmic censorship hypothesis.

Nolan, Louise (Dublin City University)
Dynamical Systems Analysis of Non-Hyperbolic Equilibrium points in General Relativity

The Einstein Field equations for a cylindrically-symmetric self-similar spacetime containing pressureless matter reduce to a third order ODE. This can be rewritten as a three dimensional autonomous dynamical system. The dynamical systems analysis gives rise to some non-hyperbolic equilibrium points. The talk focuses on methods of examining these points.

Osterbrink, Lutz (University of York)
Energy inequalities for the nonminimally coupled scalar field

The nonminimally coupled scalar field is one of the only matter models which permits negative energy densities at the classical level. That is, it violates the weak energy condition of classical relativity. In this talk we derive lower bounds on weighted averages of the classical stress-energy tensor, with the bound depending on the square of the classical field (but not its derivatives). These are analogous to bounds previously derived for the kinetic energy density in quantum mechanics. This classical observation forms the basis of analogous results for the quantized nonminimally coupled scalar field.

Samuelsson, Lars (University of Southampton)
Torsional oscillations in the neutron star's crust

Some of the most energetic events recorded in our galaxy are the giant flares. These are thought to be connected to magnetic outbursts in magnetars, highly magnetised neutron stars. In the aftermath of these events a quasi periodic oscillation is observed in the electromagnetic signal. The frequency of the signal suggest that it may be connected to torsional oscillations of the magnetar's crust. If this is so, vital information about the global properties of neutron stars and the equation of state at super-nuclear densities may be inferred.

Sarnobat, Prakash (Loughborough University)
The Wahlquist exterior? Second order physical interpretation

The metric of an arbitrary stationary axisymmetric matter distribution have been obtained to first and second order in the rotation speed using the Ernst potential method. It is shown that by perturbing the boundary of the Wahlquist solution, it is possible to perform both first and second order matching of the interior and exterior fields. Finally, it is shown that while the first order solution is asymptotically flat, the second order counterpart is not so, and a means of interpreting this is suggested.

Satz, Alejandro (University of Nottingham)
How often does a moving detector click?

We analyse the instantaneous excitation rate of an accelerated Unruh-DeWitt particle detector whose coupling to a quantum field on Minkowski space is regularised by a finite spatial profile. We show, under mild technical assumptions, that the zero size limit of the detector response is well defined, independent of the choice of the profile function, and given by a manifestly finite integral formula that no longer involves epsilon-regulators or limits. Applications to specific trajectories are discussed, recovering in particular the thermal result for uniform acceleration.

Sidery, Trevor (University of Southampton)
Evolution Models of Rotating Superfluids

Using a two fluid formulation of the equations of motion, simple evolution models of rotating superfluid neutron stars are found. Superfluids rotate by the creation of vortices which causes a mutual friction between the two constituents. The effect of mutual friction and a coupling 'entrainment' term is investigated. If we consider pinned vortices this may be used as a simple model of neutron star glitches.

Valiente Kroon, Juan Antonio (QMUL)
On smoothness-asymmetric null infinities

We discuss the existence of asymptotically Euclidean initial data sets to the vacuum Einstein field equations which would give rise (modulo an existence result for the evolution equations near spatial infinity) to developments with a past and a future null infinity of different smoothness. For simplicity, the analysis is restricted to the class of conformally flat, axially symmetric initial data sets. It is shown how the free parameters in the second fundamental form of the data can be used to satisfy certain obstructions to the smoothness of null infinity. The resulting initial data sets could be interpreted as those of some sort of (non-linearly) distorted Schwarzschild black hole. Its developments would be so that they admit a peeling future null infinity, but at the same time have a polyhomogeneous (non-peeling) past null infinity.

Walsh, Darragh (University College Cork)
Non-Uniqueness in the Extended Conformal Thin Sandwich System

We present an analytical explanation for the non-uniqueness results found by Pfeiffer and York for the Einstein constraints in this formulation. The five equation system is shown to follow from variation of a non-convex action so that solutions are unstable. The linearised system reveals a consistency problem. The Fredholm properties of the system and a standard theorem from nonlinear analysis suggest that the branching of solutions noted by Pfeiffer and York occurs when the system develops a non-trivial Kernel. We propose that less radical conformal treatments are better suited to modelling strong gravitational fields.

Winstanley, Elizabeth (University of Sheffield)
Abundant stable EYM hair for black holes in AdS

29 talks

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List of participants

(As of April 4, 2006.)

Abel, Paul (University of Leicester)
Adams, Judith (IOP Publishing)
Akcay, Ali Riza ()
Anderson, Edward (DAMTP, University of Cambridge)
Andersson, Nils (University of Southampton)
Barnes, Alan (University of Aston)
Barrett, John (University of Nottingham)
Blacker, John (University of Leicester)
Calabrese, Gioel (University of Southampton)
Carr, Bernard (QMUL)
Clavering, Will (QMUL)
Dolan, Sam (Cavendish Laboratory, University of Cambridge)
Fewster, Chris (University of York)
Fil'chenkov, Michael (Peoples' Friendship University of Russia)
Gundlach, Carsten (University of Southampton)
Haskell, Brynmor (University of Southampton)
Hawke, Ian (University of Southampton)
Heineke, Reece (Cavendish Laboratory, University of Cambridge)
Hilditch, David (University of Southampton)
Johnson, Richard (University of Nottingham)
Jones, Ian (University of Southampton)
Kay, Bernard (University of York)
Kottanattu, George (University of Nottingham)
Krasnov, Kirill (University of Nottingham)
Kunstatter, Gabor (University of Winnipeg)
Larkin, Peter (University of York)
Losert-Valiente Kroon, Christiane Maria (University of Vienna)
Louko, Jorma (University of Nottingham)
MacCallum, Malcolm (QMUL)
Martin, Giles (University of York)
Martin, Nigel ()
Naish-Guzman, Ileana (University of Nottingham)
Nolan, Brien (Dublin City University)
Nolan, Louise (Dublin City University)
Osterbrink, Lutz (University of York)
Phillips, Adam (IOP Publishing)

Samuelsson, Lars (University of Southampton)
Sarnobat, Prakash (Loughborough University)
Satz, Alejandro (University of Nottingham)
Senovilla, José (Basque Country University)
Sidery, Trevor (University of Southampton)
Valiente Kroon, Juan Antonio (QMUL)
Walsh, Darragh (University College Cork)
Winstanley, Elizabeth (University of Sheffield)

44 participants