UK-QFT V

Progress in Quantum Field Theory and Gravity: from Colliders to Cosmology

Friday, 15th January, 2016
Particle Theory Group, University of Nottingham
A113, Cripps Centre for Astronomy and Particle Theory (building no. 25)

Programme

10:00 – 10:20	Refreshments
10:20 – 10:30	Welcome
10:30 – 12:30	**Session 1**
10:30 – 11:10	*Dimitri Skliros (King's College London)* Tadpoles, cephalopods and complete normal ordering
11:10 – 11:50	*Daniele Teresi (Université Libre de Bruxelles)* Symmetry-improved 2PI approach to the Goldstone-boson IR problem of the SM effective potential
11:50 – 12:30	*Peter Millington (University of Nottingham)* Constraining the effective action with external sources
12:30 – 14:00	Lunch*
14:00 – 16:00	**Session 2**
14:00 – 14:40	*Carlos Tamarit (IPPP Durham)* Gauge independence of tunneling rates
14:40 – 15:20	*Stephen Stopyra (Imperial College London)* Gravity and electroweak vacuum stability beyond the fixed background approximation
15:20 – 16:00	*Jean Alexandre (King's College London)* Dynamical mechanism for ultra-light scalar dark matter
16:00 – 16:30	Refreshments
16:30 – 18:30	**Session 3**
16:30 – 17:10	*David Stefanyszyn (University of Nottingham)* Vacuum energy sequestering
17:10 – 17:50	*Vladimir Prochazka (University of Edinburgh)* Flow of gravitational central charges from dilaton effective action
17:50 – 18:30	*Anthony Preston (University of Southampton)* Towards a manifestly diffeomorphism invariant exact renormalization group
18:30	Close

* Please note that lunch will not be provided. We will however lead the way to the University food court, where there is a wide selection on offer.

Abstracts

Session 1 (Chair: Paul Saffin)

Tadpoles, cephalopods and complete normal ordering
Dimitri Skliros (King's College London)

I will explain how to (when this is desirable) cancel all tadpole (and all cephalopod more generally) Feynman diagrams in a generic interacting scalar field theory to any finite order in perturbation theory in generic curved spacetime backgrounds. This is achieved by introducing a generalised notion of standard normal ordering that we call 'complete normal ordering', a novel tool that significantly simplifies perturbative amplitude computations.

Symmetry-improved 2PI approach to the Goldstone-boson IR problem of the SM effective potential
Daniele Teresi (Université Libre de Bruxelles)

The effective potential of the Standard Model (SM), from three loop order and higher, suffers from infra-red (IR) divergences arising from quantum effects due to massless Goldstone bosons. Such IR pathologies also hinder accurate evaluation of the two-loop threshold corrections to electroweak quantities, such as the vacuum expectation value of the Higgs field. The so-called Two-Particle-Irreducible (2PI) effective action provides a rigorous framework to consistently resum these divergent contributions, thus obtaining an IR safe effective potential. By considering the recently proposed symmetry-improved 2PI formalism, I will discuss how to address the problem of the Goldstone-boson IR divergences of the SM effective potential in the gaugeless limit of the theory, after taking into account quantum loops of scalars and chiral fermions. I will also present some details concerning the renormalization of spurious custodially breaking effects triggered by fermionic Yukawa interactions. Finally, I will compare our results with those obtained with other methods presented in the literature.

Constraining the effective action with external sources
Peter Millington (University of Nottingham)

We propose a novel method of evaluating the effective action, wherein the physical one- and two-point functions are obtained in the limit of non-vanishing external sources (in vacuum). We illustrate the self-consistency of this method by recovering the well-known Cornwall, Jackiw and Tomboulis two-particle irreducible (2PI) effective action, differing only by the fact that the saddle-point evaluation of the path integral is performed along the extremal *quantum*, rather than *classical*, path directly. This approach is therefore of particular relevance to situations in which the dominant quantum and classical paths are non-perturbatively far away from one-another, such as occurs in the decay of meta-stable vacua to radiatively-generated global potential minima. In addition, we describe how the external sources may instead be chosen so as to yield the two-particle-point-irreducible (2PPI) effective action of Coppens and Verschelde and, in the spirit of the symmetry-improved effective action of Pilaftsis and Teresi and to its complement, we explain how the external sources can be constrained so as to preserve global symmetries in truncations of the 2PI effective action.

Session 2 (Chair: Peter Millington)

Gauge independence of tunneling rates
Carlos Tamarit (IPPP Durham)

Despite the gauge dependence of the effective action at zero and finite temperature, it is shown that it leads to tunneling and nucleation rates that remain independent of the choice of gauge-fixing. Taking as a starting point the path integral that defines the transition amplitude from a false vacuum to itself, a careful treatment of the boundary conditions and the gauge-fixing allows to show that decay rates are exactly determined by the effective action evaluated at a generalized bounce configuration. The latter is a solution to the quantum equations of motion, with boundary conditions fixed by the false vacuum. The resulting tunneling rate is gauge-independent, as the Nielsen identities imply that the explicit gauge dependence in the effective action is exactly cancelled by the gauge dependence of the solution. This holds for any election of gauge-fixing that leads to an invertible Faddeev-Popov matrix. The result is nonperturbative and model-independent, and also clarifies how to incorporate radiative corrections in tunneling calculations.

Gravity and electroweak vacuum stability beyond the fixed background approximation
Stephen Stopyra (Imperial College London)

Calculations of the vacuum decay rate for the Standard Model electroweak vacuum usually assume a fixed background metric, either flat Minkowski spacetime or, for example, de Sitter space (in the case of inflation). However, within current uncertainty the parameters of the Standard Model Higgs potential allow for a very deep true minimum where this cannot be assumed to hold. The bounce solutions dominating vacuum decay for low Inflationary Hubble rates (and ultimately, today with a small positive cosmological constant) probe this depth and thus the effect of gravitational back-reaction is not small. I will present calculations of the vacuum decay rate including back-reaction for a scalar field in Standard-Model-like potentials, and discuss the effect of this both back-reaction and of non-minimal coupling of the scalar field to gravity.

Dynamical mechanism for ultra-light scalar dark matter
Jean Alexandre (King's College London)

Assuming a double-well bare potential for a self-interacting scalar field, with the Higgs vacuum expectation value, it is shown that non-perturbative quantum corrections naturally lead to ultra-light particles of mass 10^{-23} eV, if these non-perturbative effects occur at a time consistent with the Electroweak phase transition. This mechanism could be relevant in the context of Bose Einstein Condensate studies for the description of cold Dark Matter. Given the numerical consistency with the Electroweak transition, an interaction potential for Higgs and Dark Matter fields is proposed, where spontaneous symmetry breaking for the Higgs field leads to the generation of ultra-light particles, in addition to the usual Higgs mechanism. This model also naturally leads to extremely weak interactions between the Higgs and Dark Matter particles.

Session 3 (Chair: Ed Copeland)

Vacuum energy sequestering
David Stefanyszyn (University of Nottingham)

In this talk I will discuss the main aspects of the cosmological constant problem and present a mechanism that sequesters the vacuum energy generated by matter fields from gravity. I will emphasise the global nature of the problem and present a theory that only affects the trace of the gravitational field equations in the extreme infra-red. I will argue that the sequestering is effective regardless of the order of the loop expansion to which the vacuum energy is calculated, thereby eliminating the need to repeatedly fine tune a classical counter term.

Flow of gravitational central charges from dilaton effective action
Vladimir Prochazka (University of Edinburgh)

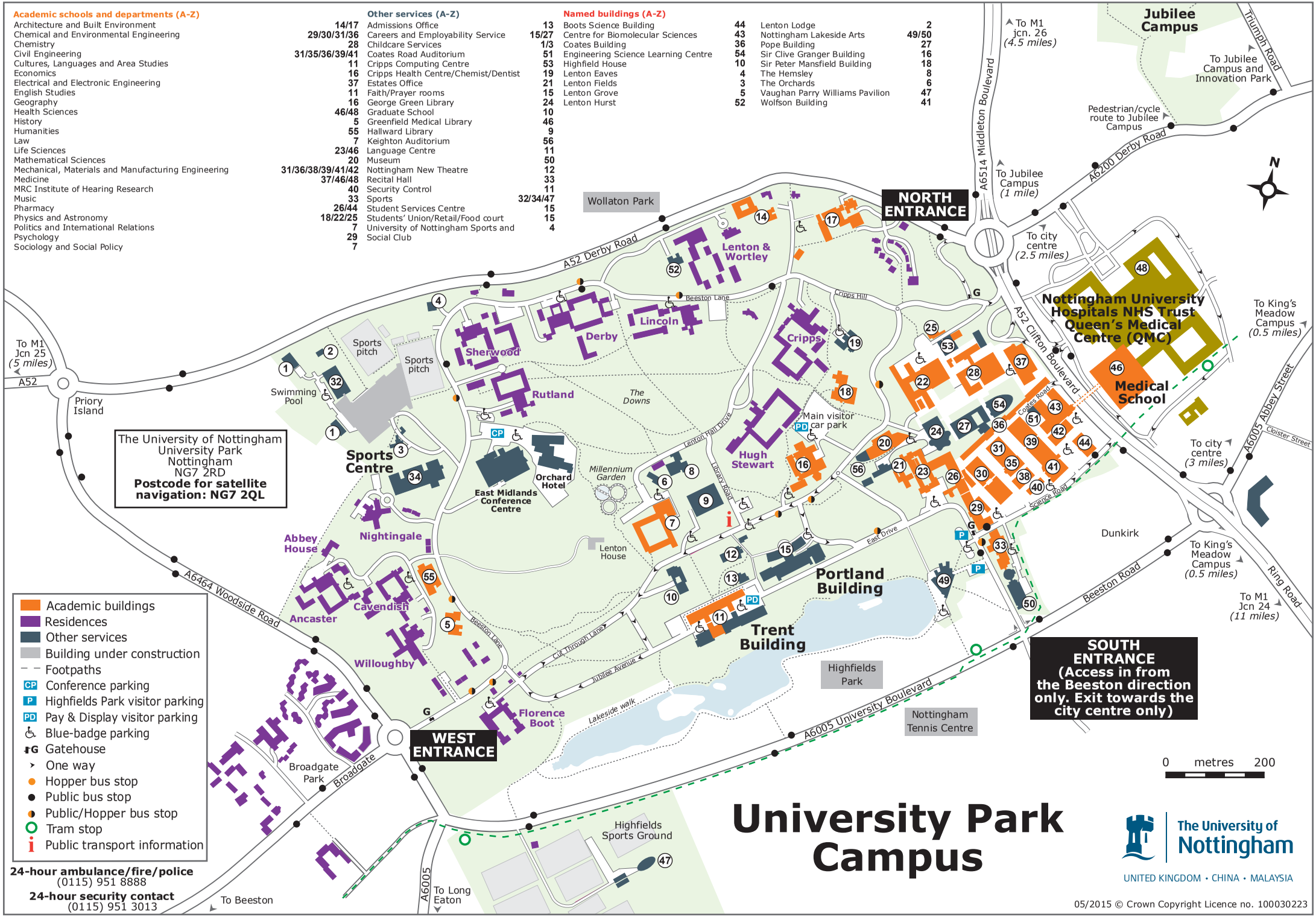
I will present some recent calculations of the RG flow of gravitational central charges in gauge theories (with and without SUSY). In our approach the running of the gauge coupling is absorbed into the metric by applying combination of field rescaling and Weyl-transformation. The computation then becomes equivalent to the one on curved background carrying the information of the renormalisation group flow. We use the techniques of conformal anomaly matching and dilaton effective action, by Komargodski and Schwimmer, to find the flow of the Euler anomaly coefficient 'a' between two fixed points of the flow.

Towards a manifestly diffeomorphism invariant exact renormalization group
Anthony Preston (University of Southampton)

I will present progress towards a manifestly diffeomorphism invariant Exact Renormalization Group. Based on a generalization of the Polchinski flow equation, this is an approach towards quantum gravity without fixing a gauge. It has both fixed-background and background-independent versions that are complementary to each other. I will discuss the structure of the flow equation, expansion of the effective action in background-independent form, and the derivation of the effective propagator and Ward identities in the fixed-background formalism. I will compare this to the manifestly gauge invariant ERG.

Attendees

Dr Jean Alexandre	Senior Lecturer	King's College London
Dr Tasos Avgoustidis	Research Fellow	University of Nottingham
Mr Anshuman Bhardwaj	MRes Student	University of Nottingham
Mr Wan Mohamad Husni Bin Wan Mokhtar	PhD Student	University of Nottingham
Mr Andrew Bond	PhD Student	University of Sussex
Dr Daniel Burns	Visitor	University of Manchester
Dr Clare Burrage	Royal Society University Research Fellow	University of Nottingham
Prof Ed Copeland	Professor	University of Nottingham
Mr Robert Dickinson	Visitor	University of Manchester
Mr Edward Gillman	PhD Student	Imperial College London
Mr Oliver Gould	PhD Student	Imperial College London
Mr Benito A Juarez-Aubry	PhD Student	University of Nottingham
Mr Christian Kading	PhD Student	University of Nottingham
Dr Peter Millington	Research Fellow	University of Nottingham
Mr Anthony Preston	PhD Student	University of Southampton
Mr Vladimir Prochazka	PhD Student	University of Edinburgh
Prof Arttu Rajantie	Professor	Imperial College London
Mr David Rodriguez	PhD Student	King's College London
Dr Paul Saffin	Lecturer	University of Nottingham
Dr Dimitri Skliros	Research Associate	King's College London
Dr Thomas Sotiriou	Associate Professor and Reader	University of Nottingham
Dr Michael Spannowsky	Reader	IPPP Durham
Mr David Stefanyszyn	PhD Student	University of Nottingham
Mr Stephen Stopyra	PhD Student	Imperial College London
Dr Carlos Tamarit	Research Associate	IPPP Durham
Dr Daniele Teresi	Post-doctoral Research Fellow	Université Libre de Bruxelles


Academic schools and departments (A-Z)
Architecture and Built Environment 14/17
Chemical and Environmental Engineering 29/30/31/36
Chemistry 28
Civil Engineering 31/35/36/39/41
Cultures, Languages and Area Studies 11
Economics 16
Electrical and Electronic Engineering 37
English Studies 11
Geography 16
Health Sciences 46/48
History 5
Humanities 55
Law 7
Life Sciences 23/46
Mathematical Sciences 20
Mechanical, Materials and Manufacturing Engineering 31/36/38/39/41/42
Medicine 37/46/48
MRC Institute of Hearing Research 40
Music 33
Pharmacy 26/44
Physics and Astronomy 18/22/25
Politics and International Relations 7
Psychology 29
Sociology and Social Policy 7
Other services (A-Z)
Admissions Office 13
Careers and Employability Service 15/27
Childcare Services 1/3
Coates Road Auditorium 51
Cripps Computing Centre 53
Cripps Health Centre/Chemist/Dentist 19
Estates Office 21
Faith/Prayer rooms 15
George Green Library 24
Graduate School 10
Greenfield Medical Library 46
Hallward Library 9
Keighton Auditorium 56
Language Centre 11
Museum 50
Nottingham New Theatre 12
Recital Hall 33
Security Control 11
Sports 32/34/47
Student Services Centre 15
Students' Union/Retail/Food court 15
University of Nottingham Sports and Social Club 4
Named buildings (A-Z)
Boots Science Building 44
Centre for Biomolecular Sciences 43
Coates Building 36
Engineering Science Learning Centre 54
Highfield House 10
Lenton Eaves 4
Lenton Fields 3
Lenton Grove 5
Lenton Hurst 52
Lenton Lodge 2
Nottingham Lakeside Arts 49/50
Pope Building 27
Sir Clive Granger Building 16
Sir Peter Mansfield Building 18
The Hemsley 8
The Orchards 6
Vaughan Parry Williams Pavilion 47
Wolfson Building 41
Jubilee Campus
To M1 jcn. 26 (4.5 miles)
Triumph Road
To Jubilee Campus and Innovation Park
Pedestrian/cycle route to Jubilee Campus
A6514 Middleton Boulevard
A6200 Derby Road
To Jubilee Campus (1 mile)
NORTH ENTRANCE
To city centre (2.5 miles)
Wollaton Park
A52 Derby Road
Lenton & Wortley
Beeston Lane
Cripps Hill
Nottingham University Hospitals NHS Trust Queen's Medical Centre (QMC)
Medical School
A52 Clifton Boulevard
To King's Meadow Campus (0.5 miles)
A6005 Abbey Street
Cloister Street
To M1 Jcn 25 (5 miles)
A52
Priory Island
Swimming Pool
Sports pitch
Sports pitch
Sherwood
Derby
Lincoln
Cripps
Rutland
The Downs
Main visitor car park
Coates Road
Science Road
The University of Nottingham
University Park
Nottingham
NG7 2RD
Postcode for satellite navigation: NG7 2QL
Sports Centre
Orchard Hotel
East Midlands Conference Centre
Millenium Garden
Lenton Hall Drive
Library Road
Hugh Stewart
To city centre (3 miles)
Abbey House
Nightingale
Lenton House
East Drive
Dunkirk
Portland Building
A6464 Woodside Road
Ancaster
Cavendish
Willoughby
Beeston Lane
Cut Through Lane
Jubilee Avenue
Trent Building
To King's Meadow Campus (0.5 miles)
Beeston Road
Ring Road
To M1 Jcn 24 (11 miles)
Highfields Park
Lakeside walk
SOUTH ENTRANCE (Access in from the Beeston direction only. Exit towards the city centre only)
Nottingham Tennis Centre
A6005 University Boulevard
WEST ENTRANCE
Florence Boot
Broadgate Park
Broadgate
Highfields Sports Ground
A6005
To Long Eaton
To Beeston
Academic buildings
Residences
Other services
Building under construction
Footpaths
CP Conference parking
P Highfields Park visitor parking
PD Pay & Display visitor parking
Blue-badge parking
G Gatehouse
One way
Hopper bus stop
Public bus stop
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