

**UK-QFT XIV**

# **Report of Contributions**

Contribution ID: 2

Type: **Talk**

## An Open System Approach to Gravity

*Wednesday 26 November 2025 14:00 (25 minutes)*

Several major open problems in cosmology involve spacetime-filling media with unknown micro-physics, and can only be probed through their gravitational effects. This observation motivates a systematic open-system approach, in which gravity evolves in the presence of a generic, unobservable environment.

After a brief review of the Schwinger–Keldysh path integral formalism for open systems, I will present a general framework for open gravitational dynamics, with particular attention to the constraints imposed by diffeomorphism invariance. As an application, I will focus on inflation, where the framework reproduces the known Open Effective Field Theory of Inflation in the decoupling limit and naturally extends it to include gravitational interactions. These yield both conservative and dissipative corrections to graviton propagation. Remarkably, leading-order gravitational birefringence is dissipative, while conservative birefringence only appears at higher derivative order—contrary to the electromagnetic case.

**Authors:** Dr PAJER, Enrico (University of Cambridge); DUFNER, Lennard (University of Cambridge); AGUI SALCEDO, Santiago (University of Cambridge); COLAS, Thomas (DAMTP - University of Cambridge)

**Presenter:** DUFNER, Lennard (University of Cambridge)

**Session Classification:** III

Contribution ID: 3

Type: **Talk**

## Quantum Corrections to Fifth Forces

*Wednesday 26 November 2025 10:25 (25 minutes)*

Non-linear scalar-tensor theories of modified gravity may explain observations attributed to dark matter and dark energy. Much is understood of their classical properties, but their quantum nature is relatively unexplored. We discuss a Green's function method for obtaining the leading order quantum corrections to the classical symmetron field in the vicinity of a spherically symmetric extended source. Our calculations indicate that leading-order quantum corrections can dramatically weaken the fifth force mediated by the symmetron field.

**Author:** UDEMBA, Michael (University of Manchester)

**Co-author:** MILLINGTON, Peter (University of Manchester)

**Presenter:** UDEMBA, Michael (University of Manchester)

**Session Classification:** I

Contribution ID: 5

Type: **Talk**

## Lattice defect networks in 2d Yang-Mills

*Wednesday 26 November 2025 12:35 (25 minutes)*

In the context of quantum field theory (QFT), there are no known examples of non-topological fully local theories. In the topological case, constructing a fully local theory is equivalent to finding all defects. We extend this framework to non-topological theories, proposing that defects might arise from quantising classical degrees of freedom. This idea seems particularly plausible within the context of Lagrangian field theory. In this project, we test these assumptions in the setting of two-dimensional Yang-Mills theory.

Using a refined lattice approach, we are able to construct defect networks in pure Yang-Mills theory in two dimensions. This refinement preserves the locality of individual defects while maintaining compatibility with the solvability of the theory via subdivision invariance. We also explicitly demonstrate that the building blocks of these defect networks close under fusion. This is based on our recent paper [1].

**Authors:** MARIENI, Elisa Iris (University of Southampton); Dr YAAKOV, Itamar (University of Southampton); Prof. GRIGUOLO, Luca (University of Parma)

**Presenter:** MARIENI, Elisa Iris (University of Southampton)

**Session Classification:** II

Contribution ID: 8

Type: **Talk**

## Vacuum decay in theories with no instanton solutions

*Wednesday 26 November 2025 16:10 (25 minutes)*

In QFT, a metastable vacuum state can decay through quantum tunnelling. The calculation of the decay rate relies on instantons —non-trivial classical solutions in the Euclideanized theory, saddle points of the Euclidean action. However, sometimes theories with metastable vacua do not have any instanton solutions, thus rendering the usual method of calculating decay rates unusable. An important example of such a theory is the Electroweak theory, where vacuum decay is directly related to baryon number violation, but where there are no instanton solutions to mediate the decay.

In this talk, I will discuss a method for computing the decay rate in theories with no exact instanton solutions using constrained instantons. It is based on a perturbative approach by Affleck from the 1980s, which we have generalised and made fully non-perturbative. I will begin by outlining the method in general, and I will then apply it to a simple toy model - a single, real, massive scalar field in 4 dimensions.

**Author:** GAWRYCH, Kinga (Imperial College London)

**Presenter:** GAWRYCH, Kinga (Imperial College London)

**Session Classification:** IV

Contribution ID: 9

Type: **Talk**

## Matter Sourced Bubble Nucleation in the Asymmetron Scalar-Tensor Theory

*Wednesday 26 November 2025 10:00 (25 minutes)*

We investigate how matter density distributions affect thin-wall bubble formation in the asymmetron mechanism, a scalar–tensor theory with a universal coupling to matter and explicit symmetry-breaking, and analyse the stability of its metastable state. We show that the screening mechanism of the asymmetron inside dense objects induces a surface tension associated with the boundary of the screening object, leading to a richer class of bubble solutions than the standard Coleman–Callan bulk nucleation. These boundary surface tensions are used to modify the Nambu-Goto action for instantons, allowing for the computation of the corresponding Euclidean action for bubbles nucleating on flat planes, as well as on concave and convex cylindrical surfaces. We find that the smallest Euclidean action occurs for bubbles nucleating along the edge of a concave spherical surface. Comparing this edge nucleation channel with the bulk one, we determine the maximum curvature radius for which concave edge nucleation is preferred. Since the maximum radius of curvature is exponentially suppressed by the action of a bulk bubble, we find that within the regime of the instanton approximation, edge nucleation is always preferred. This is largely due to the weak couplings of the asymmetron. We apply these findings to determine the maximum curvature radius of a cosmic void and discuss how our results affect the seeding of  $N$ -body simulations of asymmetron domains, showing that domain wall nucleation preferentially occurs at the edges of cosmological voids. We also demonstrate that the presence of a homogeneous gas around the dense substrates reduces the maximum curvature radius, enabling bulk bubbles to form preferentially as the asymmetron undergoes a density-driven phase transition.

**Author:** AQEEL, Usama Syed (University of Nottingham)

**Co-authors:** Prof. BURRAGE, Clare (University of Nottingham); Dr GOULD, Oliver (University of Nottingham); Prof. SAFFIN, Paul (University of Nottingham)

**Presenter:** AQEEL, Usama Syed (University of Nottingham)

**Session Classification:** I

Contribution ID: 10

Type: **Talk**

## Massive spinning fields during inflation

*Wednesday 26 November 2025 15:15 (25 minutes)*

There are two major descriptions of massive spinning fields during inflation, coined as cosmological collider (CC) physics and cosmological condensed matter (CCM) physics. We will go through each description, how it couples to the inflaton, and compare the cosmological signatures each description can produce. If time allows, we will also go into corrections to Feynman rules of the CC description present in the literature.

**Authors:** STEFANYSZYN, David (University of Nottingham); CHEUNG, Trevor (University of Nottingham)

**Presenter:** CHEUNG, Trevor (University of Nottingham)

**Session Classification:** III

Contribution ID: 11

Type: **Talk**

## Hamiltonian Truncation Framework for Gauge Theories on the Interval

*Wednesday 26 November 2025 12:10 (25 minutes)*

Gauge theories in two dimensions provide a powerful testing ground for understanding strongly coupled quantum field theories. In this talk, I'll present an alternative numerical approach based on Hamiltonian truncation for investigating these theories nonperturbatively. We work on a spatial interval and fix to axial gauge, eliminating gauge field degrees of freedom entirely, thus allowing us to express the interacting theory directly in the basis of free Dirac eigenstates, truncated at finite energy. As a first step, I'll show how this framework accurately reproduces the spectrum of the Schwinger model, matching the exact results from bosonisation across a wide range of couplings. I'll then explain how the same construction can be extended to nonabelian gauge groups, and I'll present results for  $SU(3)$  gauge theory with a single massless Dirac fermion. This provides a complementary and versatile alternative to lattice field theory, opening new avenues for real-time dynamics and quantum simulation of gauge theories.

**Authors:** INGOLDBY, James (Durham (IPPP)); Prof. HOUTZ, Rachel (Florida U)

**Presenter:** INGOLDBY, James (Durham (IPPP))

**Session Classification:** II

Contribution ID: 12

Type: **Talk**

## Spinning Boundary Correlators from AdS<sub>4</sub> Twistors

*Wednesday 26 November 2025 14:50 (25 minutes)*

We develop a twistor-space framework to compute boundary correlators via a boundary limit of nested Penrose transforms in (A)dS<sub>4</sub>. Starting from correlators of (anti-)self-dual bulk fields, the boundary limit reproduces the correlators of the dual conserved currents; we demonstrate this explicitly for two- and three-point functions. The two-point correlator is rendered finite by working in Euclidean signature. At three points, we obtain compact rational twistor-space representatives obeying a double-copy relation, thereby clarifying the twistor-space origin of the results in Baumann et al. (2024). We further extend the analysis to non-conserved currents with integer conformal dimension, dual to massive bulk fields, as well as to the free scalar.

**Authors:** Dr CARRILLO GONZÁLEZ, Mariana (Imperial College London); KESEMAN, Theo (Imperial College London)

**Presenter:** KESEMAN, Theo (Imperial College London)

**Session Classification:** III

Contribution ID: 15

Type: **Talk**

## Spectral Functions of Lorentzian Quantum Gravity

*Wednesday 26 November 2025 11:45 (25 minutes)*

The asymptotic safety scenario, according to which a quantum field theory of gravity is made non-perturbatively renormalizable via an interacting renormalisation group fixed point, is a viable contender for the theory of quantum gravity.

Using modern functional RG methods adapted to Lorentzian signatures, we compute the asymptotically safe non-perturbative Kallen-Lehmann spectral functions for all graviton modes. To that end, we determine the interacting UV fixed point in Lorentzian signature, find UV-IR trajectories that connect to a general-relativity regime, and solve a coupled system of running Kallen-Lehmann spectral representations. The resulting spectral functions are compatible with causality and unitarity. They provide direct access to the full quantum propagators and the quantum effective action up to quadratic order in the curvature. Renormalisation schemes that simplify the RG flows are identified, which paves the way for the computations of non-perturbative scattering amplitudes directly in Lorentzian signatures.

**Author:** ASSANT, Gabriel

**Co-authors:** Prof. LITIM, Daniel (Sussex University); Dr REICHERT, Manuel (Sussex University)

**Presenter:** ASSANT, Gabriel

**Session Classification:** II

Contribution ID: 16

Type: **Talk**

## EFT for strong phase transitions

*Wednesday 26 November 2025 17:00 (25 minutes)*

I present an EFT framework for strong, indeed the strongest, cosmological phase transitions this is precisely where standard high-temperature dimensional reduction fails. After reviewing high-temperature dimensional reduction for weak and intermediate transitions and pinpointing where its standard assumptions fail we construct EFTs that remain valid for very strong transitions. The approach applies to Higgs-like and multi-field models, including those with tree-level barriers.

**Authors:** RASSOULI, Farbod (University of Nottingham); GOULD, Oliver (University of Nottingham); SAFFIN, Paul (University of Nottingham)

**Presenter:** RASSOULI, Farbod (University of Nottingham)

**Session Classification:** IV

Contribution ID: 17

Type: **Talk**

## Hawking radiation from double-copy

*Wednesday 26 November 2025 10:50 (25 minutes)*

Gravity and gauge theory are connected in a precise way through the double copy correspondence. While this relationship has been extensively explored in the context of perturbative scattering in vacuum, much less is understood about its non-perturbative features or its extensions to nontrivial backgrounds. In this work, we demonstrate how Hawking radiation in a collapsing spacetime—along with its characteristic thermal spectrum and horizon dependence—arises from the double copy of particle production in a background gauge field, where no global horizon or thermal spectrum exists. Our framework combines worldline and amplitude-based techniques, providing a unified perspective on several classical and quantum double copy constructions relevant to black hole spacetimes.

**Authors:** ILBERTON, Anton (University of Edinburgh); RAJEEV, Karthik (University of Edinburgh); LINDVED, William (University of Edinburgh)

**Presenter:** RAJEEV, Karthik (University of Edinburgh)

**Session Classification:** I

Contribution ID: 18

Type: Talk

## Gravitational Waves from Confinement in $SU(N)$ Yang-Mills Theory

*Wednesday 26 November 2025 16:35 (25 minutes)*

The advent of gravitational wave astronomy has brought with it the potential for novel approaches to study physics beyond the Standard Model. In particular, the null searches for signatures of dark matter at direct and indirect detection experiments has left the so-called “nightmare scenario”, where the dark matter interacts with the Standard Model only through gravity, a distinct possibility. However, gravitational wave detection offers an escape clause. In this talk, I will consider the case of a dark sector described by  $SU(N)$  Yang-Mills theory which is decoupled from all Standard Model fields. Lattice studies have shown that for  $N \geq 3$ , the corresponding confinement phase transition is of first order, such that a stochastic gravitational wave background would have been generated. I will give an overview of the lattice-informed effective theory we have used to study the nucleation of true vacuum bubbles and then describe the computation of parameters which enter formulae for the gravitational wave power spectrum. Finally, I will present our results of the power spectra, which demonstrate generically weak signals but strong  $N$ -dependence. As the spectra vary greatly with  $N$ , our results show that sensitive future interferometers will be able to constrain the particle content of such a hidden sector.

**Author:** PHIPPS, Rory (University of Sussex)

**Presenter:** PHIPPS, Rory (University of Sussex)

**Session Classification:** IV

Contribution ID: 19

Type: **Talk**

## Counting degrees of freedom in open systems

*Wednesday 26 November 2025 14:25 (25 minutes)*

Cosmological systems involve unknown microphysics with which gravity interacts. To circumvent the lack of a precise description of all cosmic constituents, it is necessary to adopt an open-system approach, in which interactions between the fields of interest and an unspecified environment are modelled through dissipation and stochastic noise. Within this framework, the concept of physical degrees of freedom may appear to lose its meaning, since their conventional definition relies on the presence of a Hamiltonian. In my work, I adapted an algorithm that discriminates between physical and unphysical degrees of freedom to the path integral formulation of open theories, focusing on deriving the most general dissipative dynamics of the Proca field. This approach contributes to the systematic formulation of open theories of gravity, offering a model-independent framework for characterizing the dissipation and noise present in any realistic experiment.

**Author:** LAUSDEI, Enrica (University of Cambridge)

**Presenter:** LAUSDEI, Enrica (University of Cambridge)

**Session Classification:** III