QUIRK London University Physics Conference Itinerary

Time	LT1	LT2	LT3	539
9:00	Welcome			
9:30	PLENARY TALK Nuclear Fusion: Achieving Ignition *Dr Aidan Crilly (post-doc, NIF)*			
10:30	An Introduction to Gauge/String Duality *Carlos Barredo (PhD, ICL)*	Heavy Neutral Leptons in Accelerators, Beta Decay & Cosmology *Zhong Zhang (PhD, UCL)*	Naturalness in Particle Physics *Maximilian Detering (PhD, KCL)*	
11:30	Physics informed machine learning for solving forward and inverse 3D multi-layered consolidation problems *Umar Siddique (UG, UCL)*	Stochastic Physics and Thermodynamics *Gabriel Tong (UG, ICL)*	Ward Identity and Virasoro Algebra CFT2 *Sihun Hwang (UG, ICL)*	How is the History of Neptune imbibed on Trans Neptunian Objects? *Shaza Fathima Azeez (MSc, QMUL)*
12:30	Lunch in foyer level 3 Careers stalls in foyer level 2	Lunch in foyer level 3 Careers stalls in foyer level 2	Lunch in foyer level 3 Careers stalls in foyer level 2	Lunch in foyer level 3 Careers stalls in foyer level 2

13:30	Solar System Grand Tour Design: How to get to Neptune in 129 years *Tomas Bezkorowajnyj (UG, ICL)*	Fractional Calculus and its Applications to the Physical Sciences *Conrad Ho (UG, RHUL)*	The Theoretical Treatment of Light-Activated Nanoclusters *Dr Robert Jones (post-doc, KCL)*	Imprints and Consequences of Extra Dimensions in Fundamental Physics *Panagiotis Giannadakis (PhD, KCL)*
14:30	Use of an Autoencoder for SETI related Anomaly Detection *Kai Mulcock (UG, ICL)*	Negative Mass – A Beautiful Speculation *Larion Aklan (UG, ICL)*	Black Hole Internals: Is There a Singularity? *Aidan Randall (UG, ICL)*	Complexity Physics, Brain Network and Spirituality *Aryan Khedkar (UG, ICL)*
15:30	Symmetry Protected Topological Phases *Alexandre Chatudeau (PG, ICL)*	Modulated Deuteron Spectra Observed by the Magnetic Recoil Neutron Spectrometer at NIF (remote) *Bao Nguyen (UG, ICL)*	London's Urban Heat Island – What Measures Can We Take to Mitigate It? *Anoushka Nairac (UG, ICL)*	Microscopic Telescopes: A Historical Overview of Neutrino Detection and the KM3NeT Project *Filippos Kaloudis (UG, ICL)*
16:30	Final remarks			
17:00	End – opportunity for networking			

List of talks

Title	Speaker	Abstract
PLENARY TALK Nuclear Fusion: Achieving Ignition	Dr Aidan Crilly	Recent inertial confinement fusion (ICF) experiments have greatly increased their fusion energy output, exceeding the laser energy used to drive the system. These ICF experiments compress and heat hydrogen isotopes (deuterium and tritium) to pressures and temperatures comparable to the cores of stars. This leads to a rapid rate of nuclear fusion, releasing large amounts of energy. If the initial pressures obtained are high enough and the fuel is well confined, then the fusion heating can lead to positive feedback, 'igniting' the fuel. This ignition process has been demonstrated for the first time in the lab (and repeated) in the last few of years. Along with developments in magnetic confinement fusion, this marks a great step in nuclear fusion research. In this talk I will describe the complex physics of inertial fusion, and the work performed at Imperial's Centre for Inertial Fusion Studies to numerically model ICF experiments.
An Introduction to Gauge/String Duality	Carlos Barredo	The gauge/string duality (AdS/CFT correspondence) proposes a map between parameters of a bulk theory of gravity (string theory) on a (d+1) dimensional space and a gauge theory living on its d-dimensional boundary. In this talk, I will introduce some of the necessary ingredients to understand the correspondence at a general level. I will also briefly mention my research interests, which are primarily focused on understanding this correspondence in non-maximally supersymmetric cases.
Heavy Neutral Leptons in Accelerators, Beta Decay & Cosmology	Zhong Zhang	Heavy Neutral Leptons (HNLs) are a popular extension of the Standard Model to ex-plain the lightness of neutrino masses and the matter-antimatter asymmetry through leptogenesis. This work studies the phenomenology of low scale Seesaw HNLs with their mass between 1 MeV and 1 GeV in direct searches, neutrinoless double beta decay and

		cosmology. Future direct searches, such as fixed target setups like DUNE, and neutrinoless double beta decay, such as LEGEND-1000, are both expected to probe the regime of the standard Seesaw scenario of neutrino mass generation for HNL masses around $m_N \lesssim 1$ GeV. We analyse the complementarity between the two experiments to probe the nature of HNLs, i.e., the Majorana nature and CP-violating phases in the HNL sector. Following an analytic discussion of the complementarity, a statistical analysis is performed in the combined search for HNLs. HNLs in the MeV-scale mass range are very constrained by Big Bang Nucleosynthesis (BBN) as their decay significantly impacts the formation of the primordial elements. We propose here a model where the primary decay channel for the HNLs is to an axion-like particle (ALP) and a neutrino. Consequently, HNLs decay much earlier and can evade the BBN bound for much lower masses, provided the ALPs themselves decay considerably later. Further cosmological and astrophysical constraints limit severely the range of validity of the ALP properties. We find that a new parameter region opens for HNLs with masses between 1 MeV and 1 GeV, and active-sterile mixing between 10−9 −10−6 that is consistent with observations. In such a scenario, current HNL bounds, as well as sensitivities of future direct HNL searches such as at DUNE or PIONEER, will be affected.
Naturalness in Particle Physics	Maximilian Detering	Naturalness is a fundamental principle in physics and has played a guiding role in shaping our most successful theory, the Standard Model of Particle Physics. This lecture explores the concept of naturalness through key examples in physics and examines its implications within the Standard Model. This discussion leads to open questions, most notably the Higgs Hierarchy Problem. We also outline alternative approaches that attempt to resolve this puzzling issue. The lecture emphasizes conceptual insights rather than technical details.

Physics informed machine learning for solving forward and inverse 3D multi-layered consolidation problems	Umar Siddique	An approach for performing inverse analysis using surrogate modelling of a multi-layered three-dimensional consolidation problem using physics-informed neural networks (PINNs) is proposed. Solutions for a range of 3D Terzaghi's consolidation problems were considered as part of this study. A PINNs surrogate of the multi-layered three-dimensional model was constructed using different combinations of the analytical reference solution for each of the layers over a typical range of coefficient of consolidation values in soils. To validate the approach, inverse analysis was performed on synthetic data with unknown parameters. Following training, inverse analysis using the surrogate model was found to accurately predict the solutions for any combination of parameters new to the network, provided they are within the training domain. Finally, a detailed assessment of the computational resources required for training and validation is provided to highlight challenge of widespread implementation and adoption.
Stochastic Physics and Thermodynamics	Gabriel Tong	Stochastics, greatly recognised in financial mathematics and the Black-Scholes model, has become one of the most promising theories of modern physics. Contrary to equilibrium states in classical thermodynamics, stochastic calculus allows us to study thermodynamics far from equilibrium. One example is Brownian Motion, where particles are moving randomly under the influence of collisions. Here, I will introduce the basic theory of stochastics, and how we can analyse non-equilibrium thermodynamics by Fokker-Planck equations and Langevin mechanics. Then, we will talk about fluctuation theorem and the fundamental physics behind.
Ward Identity and Virasoro Algebra CFT2	Sihun Hwang	We will introduce radial quantization and compactification, then discuss Noether’s theorem and its connection to conserved currents and the stress-energy tensor. The conformal Ward identities will be derived using operator product expansions, leading to an

		examination of the Virasoro algebra and its mode expansions. We will cover the highest weight representations, differential realization of descendant fields, and the completeness of the Hilbert space as a Verma module. The role of null descendants, the Kac determinant, and the construction of irreducible representations will also be discussed, highlighting the algebraic and geometric elegance of 2D CFT.
How is the History of Neptune imbibed on Trans Neptunian Objects?	Shaza Fathima Azeez	Neptune's migration and dynamical evolution have left an enduring imprint on the structure and distribution of Trans-Neptunian Objects (TNOs). The complex interplay between Neptune and these distant icy bodies is primarily governed by mean motion resonances (MMRs), which have acted as a crucial mechanism for trapping and sculpting TNO orbits over billions of years. This presentation explores how Neptune's past is recorded in the orbital architecture of resonant TNOs, offering insights into the planet's migration, early formation environment, and long-term dynamical stability.
Solar System Grand Tour Design: How to get to Neptune in 129 years	Tomas Bezkorowajnyj	The gravity assist (or the slingshot manoeuvre) is a common manoeuvre in interplanetary spaceflight as it allows for vessels to change their velocity using the potential energy gained from the flyby of a large planet. But how exactly are long chains of gravity assists like those used for the Cassini or Voyager missions discovered? This talk outlines the process of finding both simple and complicated trajectory designs given a set of initial conditions. The talk will also cover more sophisticated methods such as applying v-infinity relations and Tisserand plots to confirm feasibility of these trajectories, and applications of such techniques to simulations of my own.
Fractional Calculus and its Applications to the Physical Sciences	Conrad Ho	Although the first mention of Fractional Calculus dates to 1695, the field of Fractional Calculus and its applications has seen a significant development over the last four decades, consequently, this led to many interesting applications to Physical Science, such as: Anomalous Diffusion, Fractal Optics,

		Fractional Schrodinger's Equation etc. This talk will mainly focus on the definitions, computation of Fractional Calculus and some strange behaviour associated with it.
The Theoretical Treatment of Light-Activated Nanoclusters	Dr Robert Jones	Metallic nanoparticles have long been studied for their vast array of promising, novel applications; from biosensors to photovoltaics. We are particularly interested in the optical properties of noble metal metallic nanoparticles, primarily gold and platinum, as a means of probing their viability as photocatalysts for the splitting of water into its molecular components to facilitate the extraction of molecular hydrogen to potentially be used in fuel cells. Attention is paid to noble metals as they exhibit surface plasmon resonance in the Ultra-violet-visible (UV-Vis), making them ideal candidates for use in solar technologies. In this slide-aided chalk and talk, we will motivate the need for a theoretical treatment of the scale-spanning components of this project with an emphasis on classical molecular dynamics for evaluating structural properties and ab initio density functional theory methods to predict optoelectronic responses. Furthermore, we aim to characterise and classify the geometrical properties of these metallic nanoparticles to identify the impact that local properties may have on optical responses.
Imprints and Consequences of Extra Dimensions in Fundamental Physics	Panagiotis Giannadakis	TBC
Use of an Autoencoder for SETI related Anomaly Detection in Green Bank Telescope Data	Kai Mulcock	Anomaly detection methods are applied to Green Bank Telescope data to aid in the search for astronomical phenomena and potential techno signatures. A deep autoencoder is trained on background and injected signals, and the latent space is explored for anomalous classes. Broadband complex signals injected as anomalous classes are successfully retrieved in a proof-of-concept test.

Negative Mass – A Beautiful Speculation	Larion Aklan	In physical theories it is usually not specified on which set of number does it hold. The same thing is true for the mass, the inertia of a body and the gravitational charge, so it is reasonable to think of the possible existence of negative mass. In this presentation I will be investigating the effect a negative mass would have on physics in a range of topics from classical mechanics, orbital motion and quantum mechanics. At the end I will show some real-life applications of this concept in problem solving.
Black hole internals: Is there a singularity?	Aidan Randall	Review of reasoning that led to belief there was a singularity examine the Hawking and Penrose papers as well as Chandrasekhar's statement upon which they are based. This will be followed by an explanation of the recent Kerr solution violating this statement.
Complexity Physics, Brain Network and Spirituality	Aryan Khedkar	My talk explores the confluence of complexity physics, neurophysics, and consciousness studies to attempt at understanding the emergent nature of human experience. By leveraging principles from statistical mechanics, brain network theory, and models of consciousness, I propose a conceptual framework to understand how large-scale order arises from interactions at smaller scales—whether it's spin alignment in magnetic systems, neuronal synchronization in cognitive processes, or the coalescence of social systems around shared beliefs. The central aim is to bridge quantitative rigor with qualitative insight, addressing foundational questions: How do spatiotemporal patterns of neuronal activity give rise to the subjective experience of selfhood? Can phase transitions in physical systems offer analogs for sudden cognitive or spiritual transformations? Is there an underlying symmetry between the laws governing material particles and the emergent properties of human consciousness? This synthesis is not merely theoretical. By extending the concept of entropy beyond its thermodynamic roots, I will explore how it functions as a metaphor for cognitive

		dissonance, psychological transformation, and moments of insight. Theoretical tools from statistical mechanics and network science provide a means to understand how systems maintain coherence at the edge of chaos—an insight that may reveal new perspectives on spirituality as an emergent phenomenon. This presentation builds on the research and findings from my 3rd Year Physics thesis at Imperial College London, conducted under the supervision of Dr. Tim Evans. The thesis investigated the interplay between complexity physics, brain networks, and consciousness, and this talk seeks to present key insights and conclusions drawn from that research. The presentation will offer a clear, methodical exposition of these ideas, grounded in academic rigour yet accessible to a broad interdisciplinary audience. By weaving together concepts from physics, neuroscience, and philosophy, I aim to demonstrate that the pursuit of meaning, order, and self-transcendence is not merely a human aspiration, but a principle embedded within the very fabric of complex systems.
Symmetry Protected Topological Phases	Alexandre Chatudeau	This is a Theory talk. I will talk about one-dimensional Symmetry-Protected Topological Phases of Matter. I will specifically treat the Kitaev-Majorana chain and its topological classification, and if time permits, my current research on modelling its edges as an SYK model, which displays quantum chaos.
Modulated Deuteron Spectra Observed by the Magnetic Recoil Neutron Spectrometer at NIF (remote talk)	Bao Nguyen	Since its commission at the OMEGA and National Ignition Facility (NIF), the Magnetic Recoil neutron Spectrometer (MRS) has played a crucial role in advancing inertial confinement fusion (ICF) and high-energy-density physics (HEDP). The MRS has supported years of deuterium-tritium (DT) implosion studies at these leading facilities, successfully guiding the American ICF program to ignition. With the MRS, DT yield, ion temperature, and compression are inferred by converting neutrons to deuterons in a CD foil and momentum-separating the recoil

		deuterons with a permanent magnet. However, modulated deuteron spectra have been observed in high-yield shots at NIF, which can distort the inferred implosion parameters. Addressing this effect is critical for optimizing future MRS designs and ensuring continued support for ICF/HEDP initiatives. In this work, we present simulation studies detailing the initial conditions and origin of energy modulation. The effect of modulations on the inferred implosion metrics is also studied through synthetically generated spectra. This work is particularly relevant to fusion facilities such as SPARC and Pacific Fusion, where accurate neutron spectrum measurements are critical for assessing fusion performance.
London's Urban Heat Island – What Measures Can We Take to Mitigate It?	Anoushka Nairac	In recent years, the UK has seen a marked increase in extreme heat events and heat related deaths. London, in particular, is vulnerable to heatwaves due to its Urban Heat Island (UHI), which compounds with the wider scale issue of climate change to create significantly raised temperatures in the urban centre when compared to surrounding suburban and rural areas. London's UHI requires urgent appraisal and mitigation–but how can this be achieved? This talk will aim to familiarise listeners with UHIs and their causative factors, the importance of reducing them, and potential methods of doing so; these methods will be assessed in terms of their potential costs, efficacy and the negative impacts of their implementation. Can any of these methods, or any combination of them, shield London's population from increasingly severe heat episodes?
Microscopic Telescopes: A Historical Overview of Neutrino Detection and the KM3NeT Project	Filippos Kaloudis	For many centuries, electromagnetic radiation has been considered the primary carrier of information for astrophysical phenomena. Observation and knowledge of the different parts of the electromagnetic spectrum has enabled scientists to unravel many secrets of our cosmos. However, the discovery of the neutrino, which interacts very weakly with any

		form of matter or field, introduced a new candidate for an even more effective carrier of information. This resulted in numerous developments in the field of neutrino detection with the evolution of both optical and acoustic detection methods relying on several principles ranging from scintillation to Cherenkov radiation to pressure pulse production during interaction with matter. The purpose of this presentation is to qualitatively explain different methods and provide a historical overview of neutrino detection while highlighting some of the most notable neutrino detectors and their impact. There will be special focus on KM3NeT, one of the most prominent, contemporary, CERN-approved neutrino detection experiments from the perspective of an intern at the Institute of Nuclear and Particle Physics of Greece's National Centre for Scientific Research, "Demokritos", which manages one of the experiment's three sites (offshore Pylos, Peloponnese, Greece).