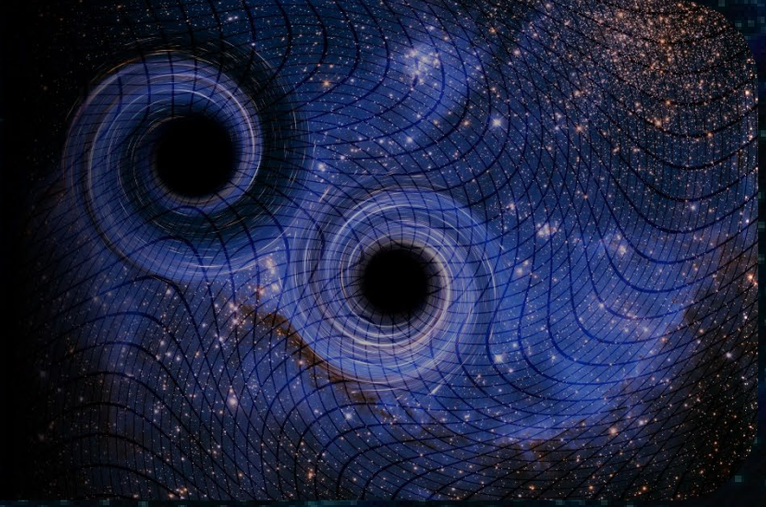


# IOP Joint APP and HEPP Annual Conference 2026

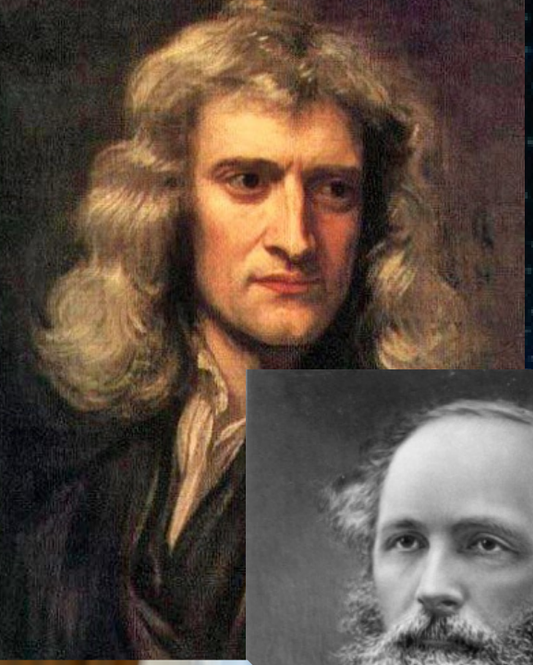
## Update on the 2025 PPTheory opportunity

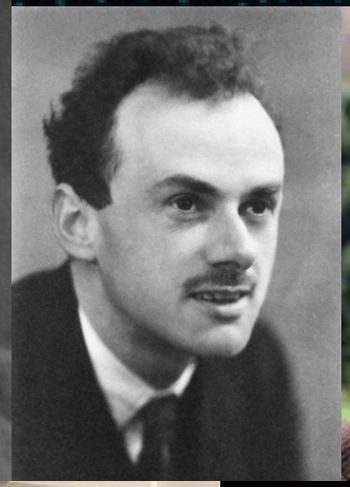
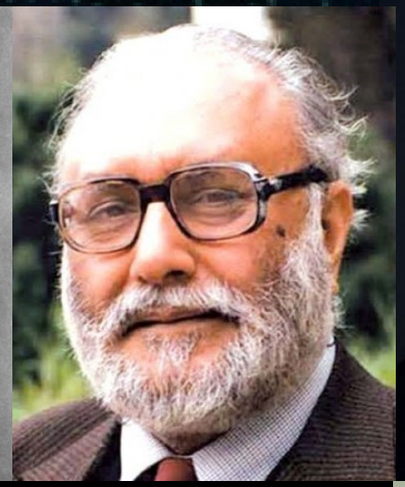
Claudia de Rham

9th April 2026

# Formal Theory

sets the ground rules for particle physics and fundamental physics as a whole in the UK and internationally

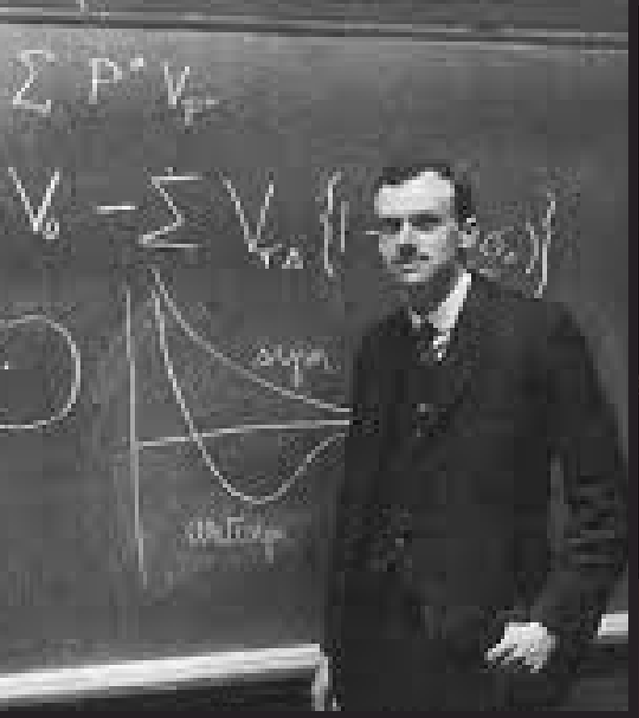


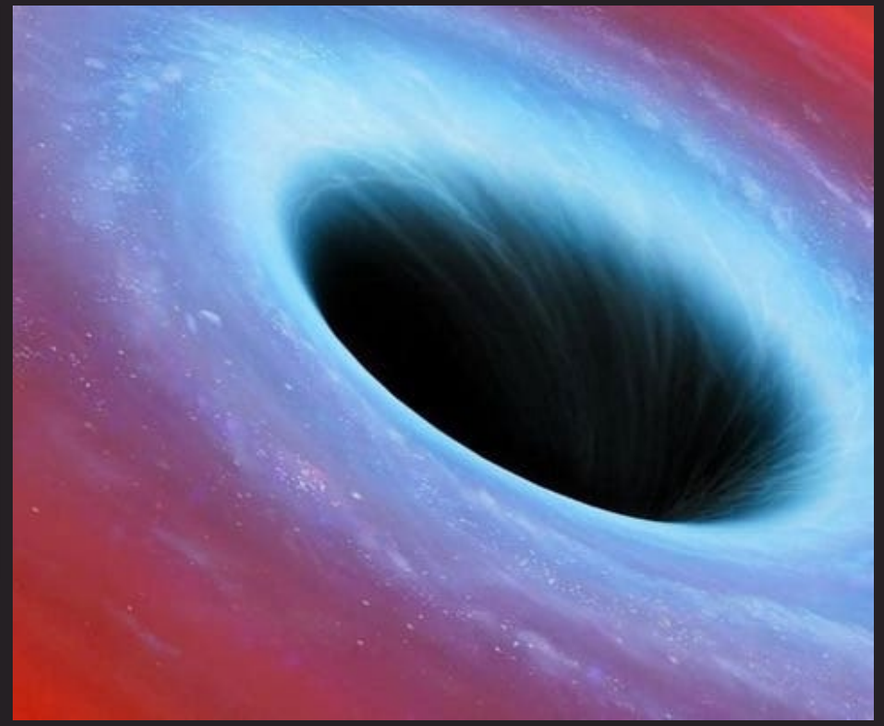



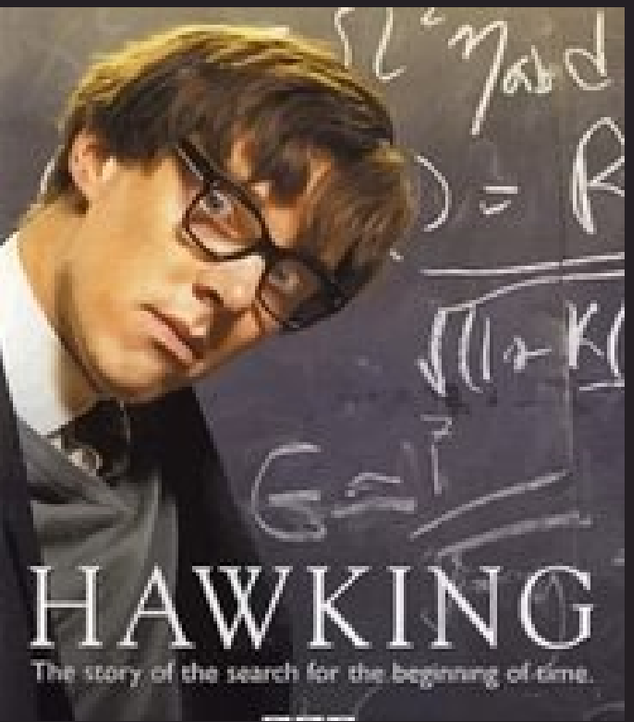


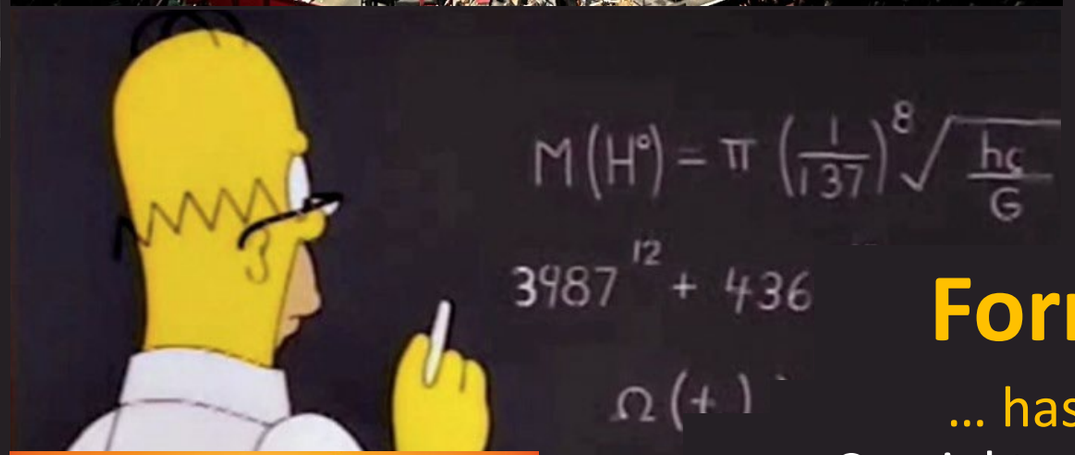








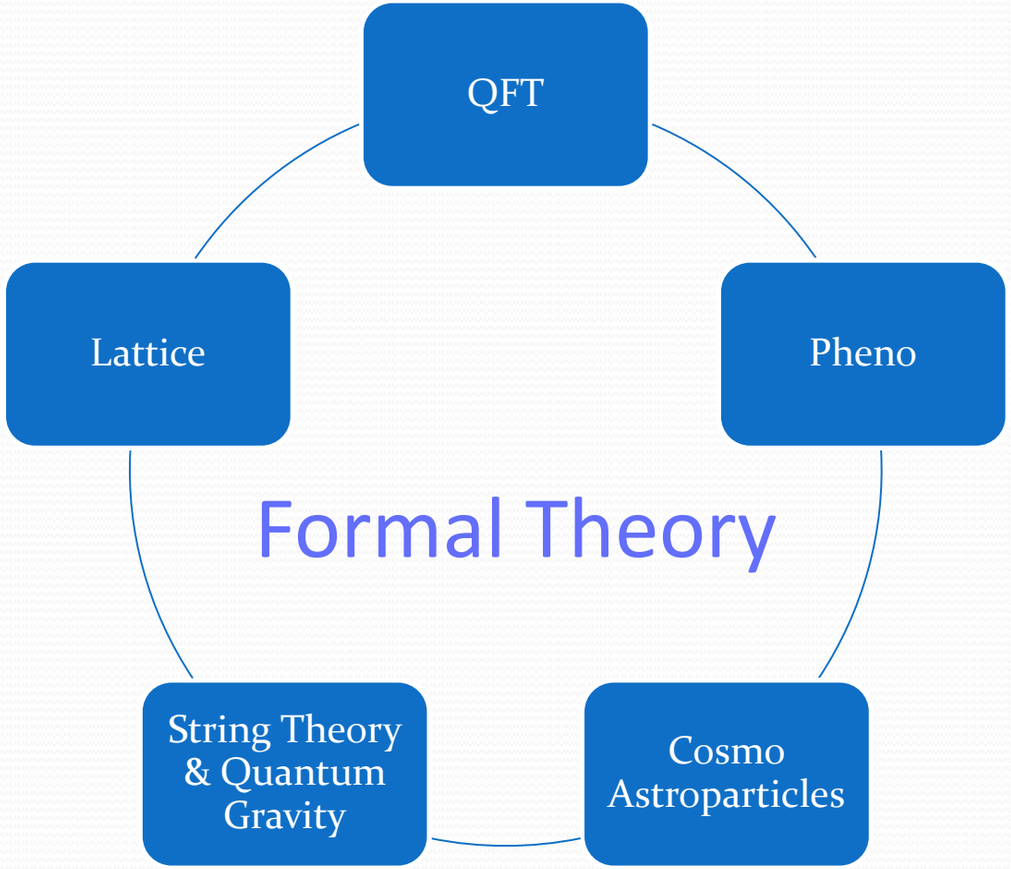


# Formal Theory

… has a brand… that is

- Crucial to science recruitment (well beyond physics),
- Critical to school & UG training & education
- Innovation in other fields,
- Translational impact and applications,
- Public and societal engagement.

# 5 “traditional” science themes




*The formal and phenomenological development and study of quantum field theories and their applications in mathematics, experiments & observations in fundamental physics, astrophysics, gravitational, cosmological settings and beyond.*

# Formal Theory

QFT

Lattice

Pheno

String Theory & Quantum Gravity

Cosmo Astroparticles

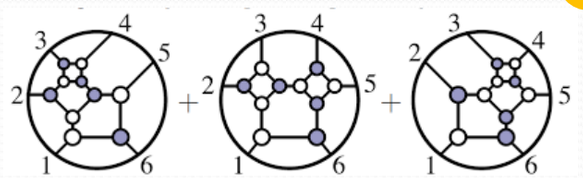
CFT & QCD amplitude

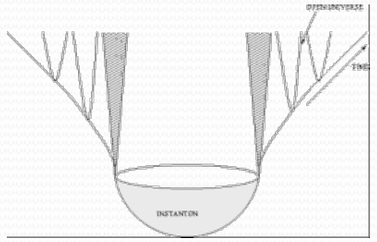
SM anomalies

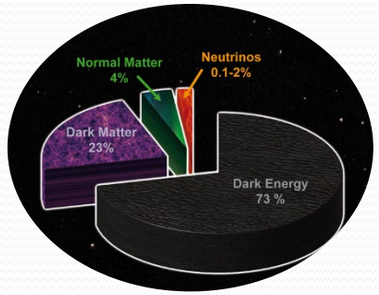
Bootstrapping & Amplitude for Gravity

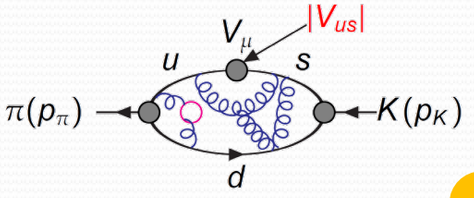
Dark Matter/Dark Energy

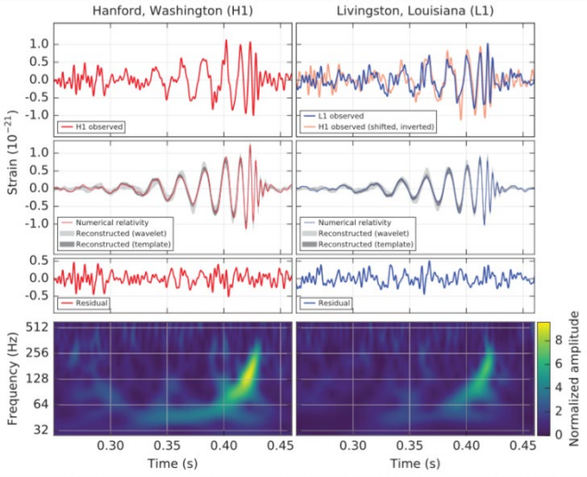
Gauge/gravity duality

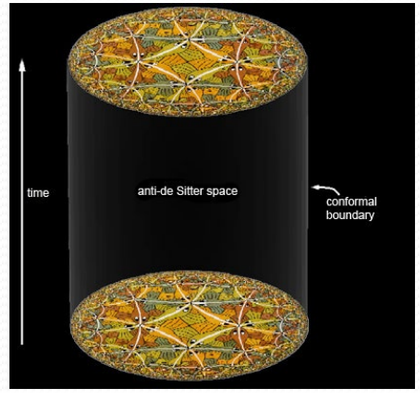


# Theory CG call 2025

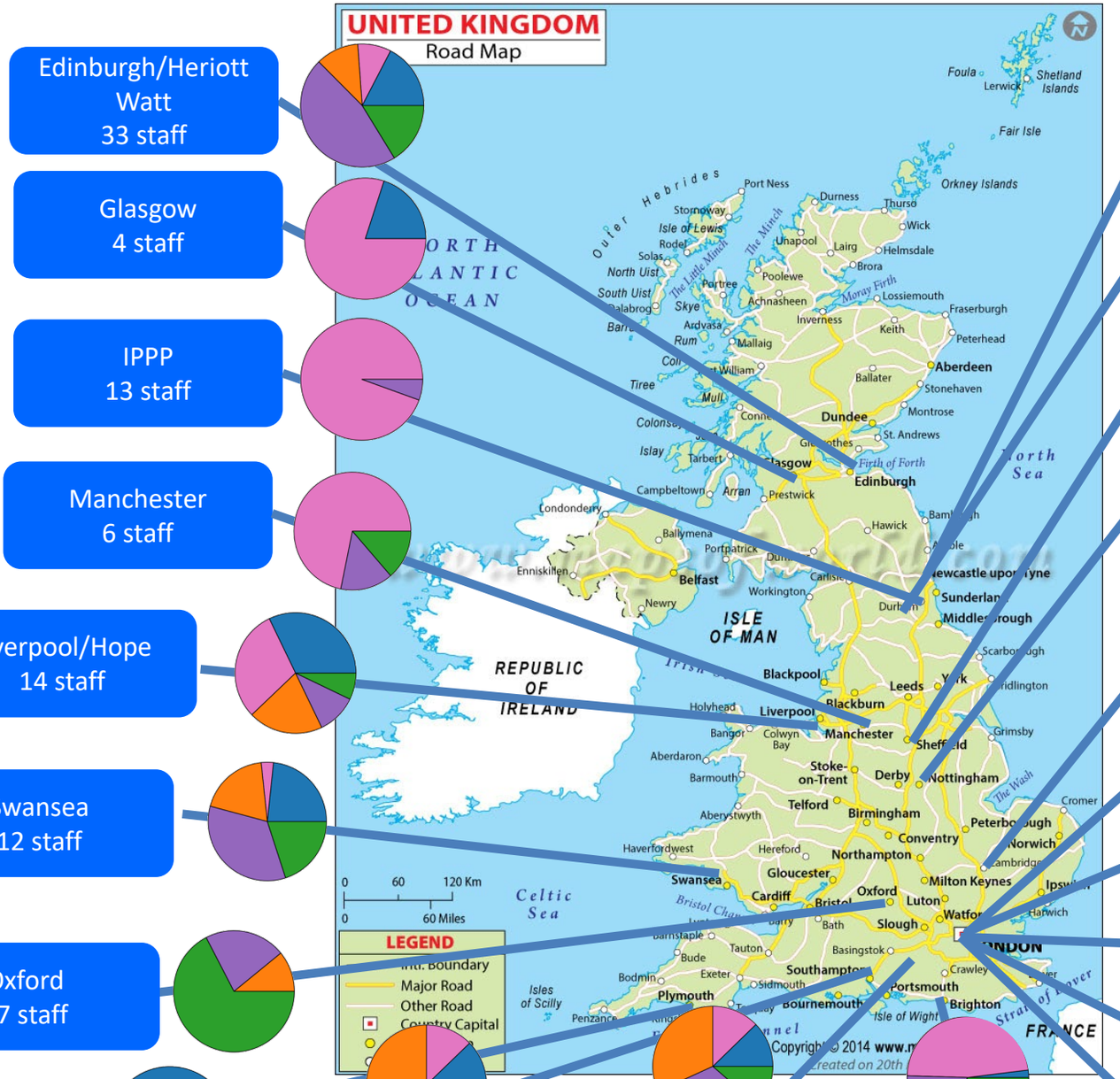
2026-2030

21 Proposals

25 Universities

58 science areas

269 staff


Edinburgh/Heriott Watt
33 staff

Glasgow
4 staff

IPPP
13 staff

Manchester
6 staff

Liverpool/Hope
14 staff

Swansea
12 staff

Oxford
17 staff

Plymouth
5 staff

Southampton
22 staff

Surrey
4 staff

SEPTA Sussex-RHUL
13 staff

Newcastle
3 staff

Durham
17 staff

Sheffield/ Lancaster
8 staff

Nottingham
16 staff

Cambridge
20 staff

UCL-Sussex
4 staff

City
5 staff

QMUL
15 staff

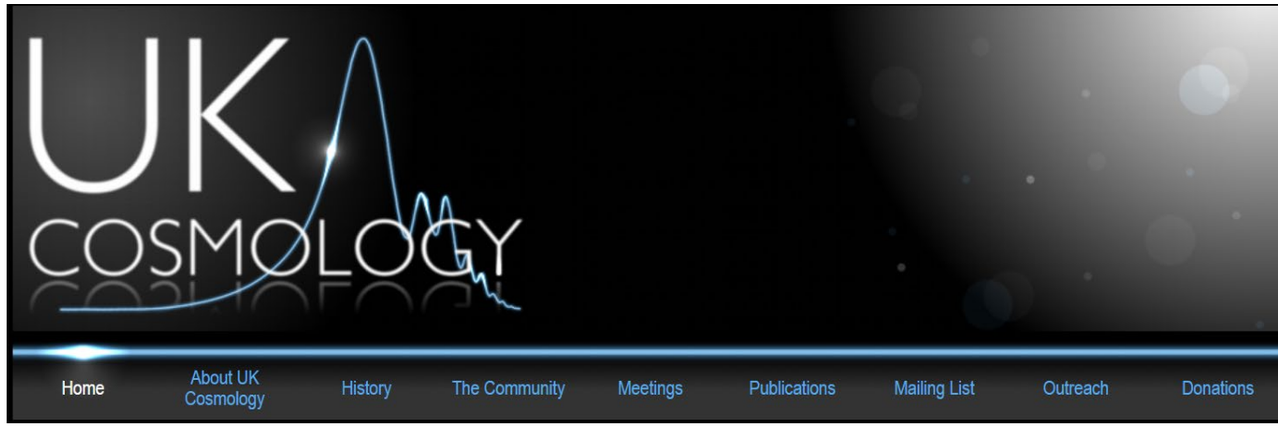
KCL
25 staff

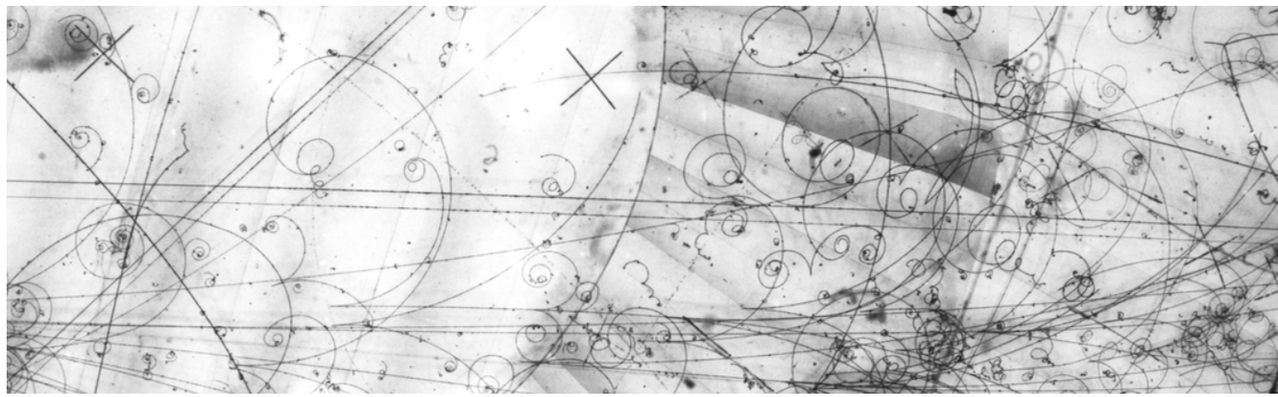
Imperial
12 staff

+ bid for renewal of 3 virtual centres:

Lattice Field Theory UK Virtual Centre (UKLFT)
UK Cosmology Virtual Centre (UK COSMO)
Fundamental Physics UK Virtual Centre (FPUK)

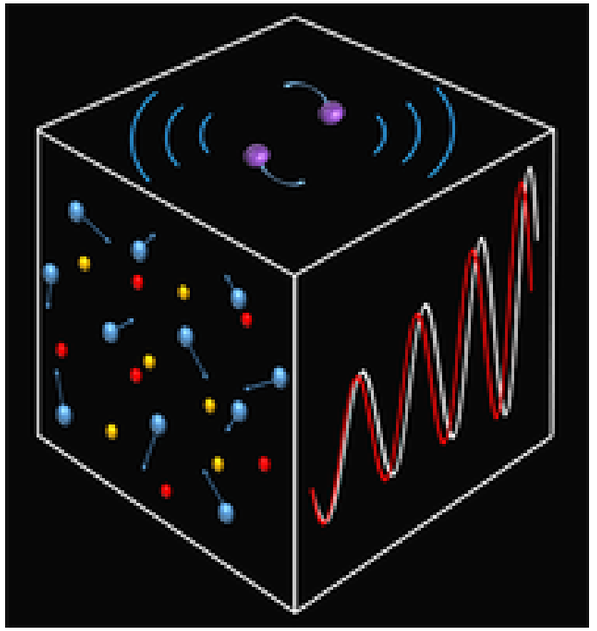
- Foster interactions and sharing of knowledge between UK research groups
- Train PhD students and Postdocs
- Organise regular meetings of the formal UK theoretical physics community
- Represent the theory community within STFC



# Key Observations

- Increase not only in number of requests but significant increase in quality of applications
- Many new upcoming science themes that spread across multiple “traditional” disciplines and beyond
- Theory community services fields beyond traditional particle physics
- **Slight shift in paradigm in the traditional particle physics landscape.**
  Fluidity between science themes expected to evolve within the next coming rounds following outcomes from new precisions measurements at particle colliders, gravitational physics and cosmology.

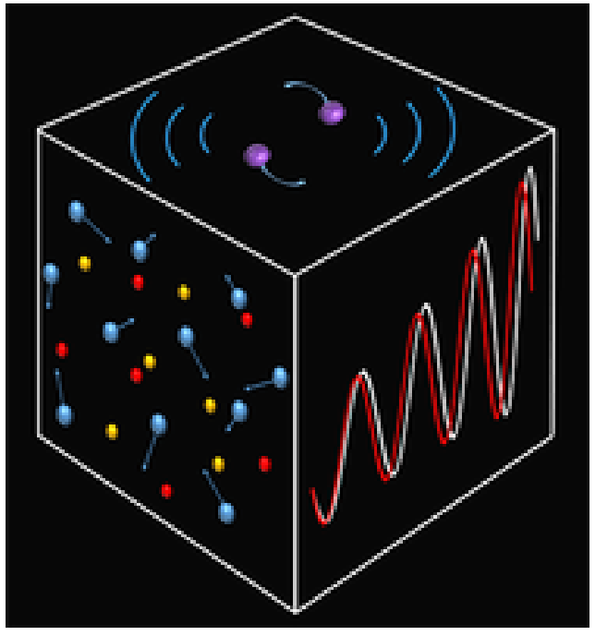


# Key Observations

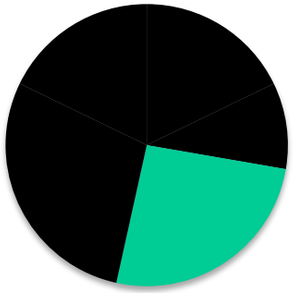
- Increase not only in number of requests but significant increase in quality of applications
- Many new upcoming science themes that spread across multiple “traditional” disciplines and beyond
- Theory community services fields beyond traditional particle physics:

Formal theory serving

  - Experimental BSM (including axions, dark photons…)
  - Gravitational Waves
  - Black Holes, entropy & microstates,
  - Cosmology
  - Strongly coupled, complex systems, emergent systems
  - Quantum information, quantum computing



# Phenomenology



1. UK leadership: UK leads two of the three major LHC event-generator projects and two of the three global Parton Distribution Functions and tools used universally by all four main LHC experiments.

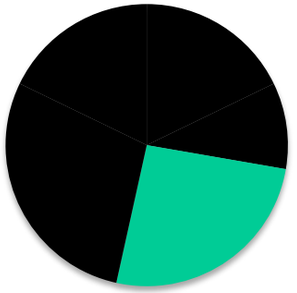
2. Strong integration with experiments which has seen an amplified scientific impact
   close work with LHC, flavour, and neutrino experimental communities, shaping analyses, interpreting data, and constraining theoretical models with exceptional precision.

3. Breadth and depth across BSM and precision physics
   BSM model building, EFT development, Higgs physics, electroweak symmetry breaking, neutrino physics, and flavour dynamics….

4. Recognised as providing an essential service role with impact that exceeds expectations
   Experimental panel members stressed that UK pheno provides vital support to experimental programmes, with impact “exceeds expectations”

5. Decline in resources allocated to this theme
   - Traditional theme boundaries are blurred and shift of some BSM pheno toward experimental HEP, dark matter searches, atom interferometry, or astrophysics.
   - The panel highlighted the need to ensure no research areas fall between remits & leveraging new programmes (e.g., GW and astrophysics CGs).

# Phenomenology
# Quotes from international referees



*Powerhouse covering the entire spectrum of particle physics research*

*The quality of proposed research is of world-leading standard (…) significant impact on the field and beyond*

*reaches previously unseen levels of precision for a hadron collider*

*leading experts in high energy particle physics delivering critical and urgent work to fully exploit collider experiments*

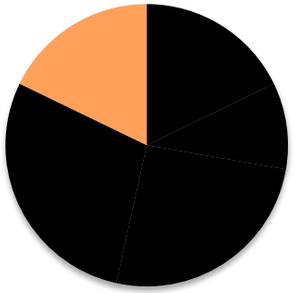
*developing tools that will be standard in next decade*

*a unique concentration of expertise in studies of (ultra-)light bosonic fields, such as axions, ALPs and dark photons*

*Each academic post is a field's leading expert with common aim to find an emerging picture of TeV-scale physics*

*shape international research*

# String Theory



1. World-leading breath across String Theory and Supergravity
   UK theory covers the full spectrum from M-theory, generalised geometry, double field theory, integrability, supersymmetric gauge theories, black-hole solutions, and string/M-theory in diverse geometries while driving new developments.

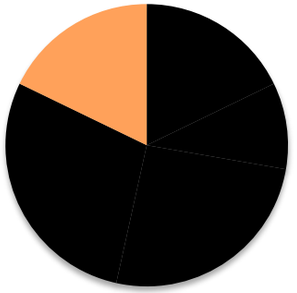
2. Leading advances in areas at the frontier of theoretical physics
   e.g. Strong leadership in non-invertible symmetries, effective field theories of chaos, and emergent systems,…

3. Cutting-edge developments in holography and strongly-coupled systems
   UK groups drive key advances in gauge-gravity duality (AdS/CFT), impacting QCD, many-body physics, defect theories, entanglement entropy, tensor networks, and new directions such as celestial holography and non-asymptotically flat extensions.

4. Leadership in quantum gravity, black holes, and microstate physics
   Significant contributions to black hole microstate counting, entropy / information-loss resolution, and the quantum behaviour of strings at high temperature—informing the modern understanding of the spectrum of black-hole states and beyond

5. Strong interconnected links to QFT, amplitudes, and gravitational-wave physics
   Deep interplay with quantum field theory: advanced scattering-amplitude techniques (SUSY + QCD), and growing impact on precision gravitational-wave predictions from compact-object collisions.

# String Theory
# quotes from international referees



*Excellent scientists who are of the highest international standing*

*All the PIs are well-known experts in their fields with established track records (…) at the forefront of current research*

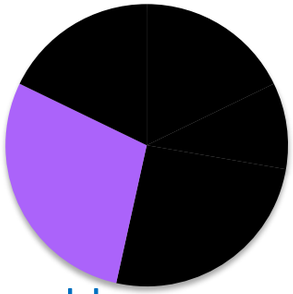
*Great potential for fundamental progress (…) and also with interesting implications and applications.*

*Encompassing foundational mathematical questions on the quantum field and string frameworks*

*Leading role in understanding the role of quantum chaos in holography*

*Exceptionally high-quality*

# QFT



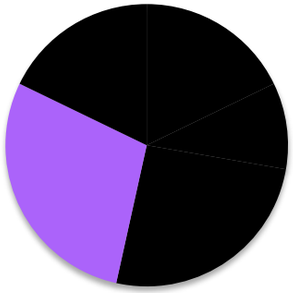
1. Rapid expansion of modern QFT techniques
   New methods—especially in scattering amplitudes for gravity, gravitational waves, and cosmological observables—are reshaping the field far beyond traditional collider-physics approaches.

2. Broad theoretical advances across multiple frameworks
   Growth in supersymmetric gauge theories, conformal and integrable models (e.g., N=4 SYM), EFT bootstrap, IR/UV fixed-point studies, and fundamental constraints such as causality and unitarity.

3. Breakthroughs in amplitude methods and their applications
   UK has led development of powerful tools beyond perturbative Feynman diagrams (twistors, double-copy, bootstrapping, etc.) enabling efficient calculations in QCD, gravity, and precision gravitational-wave physics (e.g., neutron-star EoS constraints).

4. QFT at the interface of major disciplines
   Emerging new directions lead by the UK include e.g. generalised symmetries, cosmic strings, topological defects, BSM physics
   This highlights QFT's pivotal role linking string theory, gravity, cosmology, and particle physics.

# QFT – international referees



*at the forefront of research*

*very strong and broadly recognized internationally*

*development of theoretical tools*

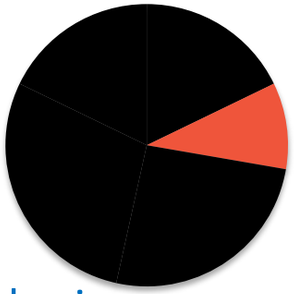
*world class leaders in the field who have made seminal contributions to the field*

*In a surprising development, methods developed for the calculation of scattering amplitudes in particle physics turned out to be highly efficient for the calculation of general relativistic observables*

*consistently at the forefront of modern amplitudes research, uncovering and exploitation of mathematical structures of amplitudes in various theories, including those relevant to gravitational waves and collider physics*

*potential to take our understanding of matter and their interactions to a completely new level*

# Lattice QCD



1. Precision physics powered by UK-led computing support

   Lattice QCD in the UK is strongly enabled by DiRAC HPC, supporting high-statistics calculations in flavour physics (light & heavy quarks), CKM constraints, excited-state spectroscopy, and precision hadronic contributions to the muon g−2.

2. Advances in QCD dynamics, BSM models, and beyond

   Major progress includes QED precisions corrections, transport coefficients in hot QCD, Sp(4) gauge dynamics for BSM electroweak symmetry breaking, and new methods to incorporate isospin breaking and tackle the Sign Problem in dense nuclear matter.

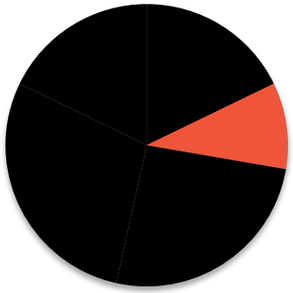
3. Growing links to cosmology, dark sector, and gravitational waves

   Lattice studies are increasingly connected to primordial phase transitions, dark-sector interactions, and early-Universe signals with potential gravitational-wave implications and new signs of fundamental physics.

4. Emergence of quantum-computing methods for lattice field theory

   The field has been seen to recently open towards the applications of quantum computing to lattice field theory, perceived as a new and exciting field, which has the potential to open problems that are not accessible with traditional computation methods.

# Lattice QCD – international referees



*very strong and broadly recognized internationally*

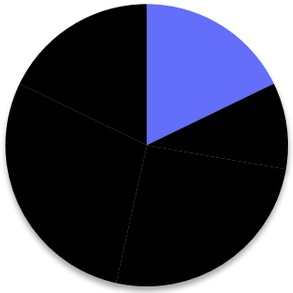
*a high potential to contribute to discovering physics beyond the Standard Model*

*very timely given current needs of experiments*

*leading research in strongly coupled dynamics, BSM physics including composite Higgs strongly coupled dark sector and phase transitions and production of primordial gravitational wave*

*broad research program, and all PIs have considerable track record aiming to answer important questions beyond the particular field of lattice field theory.*

# Particle Astrophysics and Cosmology



1. World-leading contributions across dark matter, dark energy, and early-Universe physics
   The UK community drives major advances in direct and indirect dark-matter searches, dark-energy and modified-gravity models, baryogenesis mechanisms, and solutions to the Hierarchy and Cosmological Constant Problems.

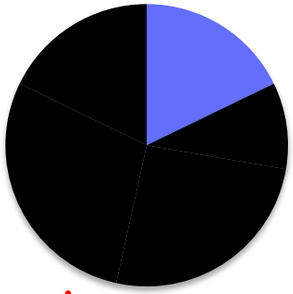
2. Strong engagement with next-generation cosmological and gravitational-wave surveys
   The UK theory community plays a leading roles in exploiting new large-scale structure surveys, GW observations, atomic interferometers and tests of gravity in the strong field regime (black-holes), extracting precision constraints on fundamental physics.

3. Deep theoretical innovation at the interface of cosmology, QFT, and string theory
   Progress includes cosmological correlators, new stable screening mechanisms, brane inflation, extra-dimensional models, cosmic strings, and new bootstrap tools, linking low-energy observables to consistent high-energy completions.

4. Early-Universe phase transitions and GW signatures as a growing frontier
   Significant advances in modelling primordial phase transitions including in many models of inflation and their alternatives and predicting their signatures, driving connections with future GW detectors and multi-messenger cosmology.

5. Strong connections with other fields and computational capabilities underpin precision science
   Access to DiRAC HPC enables first-principles modelling of cosmological processes and accelerates theory–data confrontation in dark-sector, inflationary, and GW-related research.

# Cosmology – international referees



*an impressive track record with successful line of research on EFT techniques applied to gravity and cosmology*

*leading names in numerical relativity*

*central role within the MoEDAL experiment*

*strong depth and alignment with current frontiers in cosmology, gravity, high-energy physics and astrophysics*

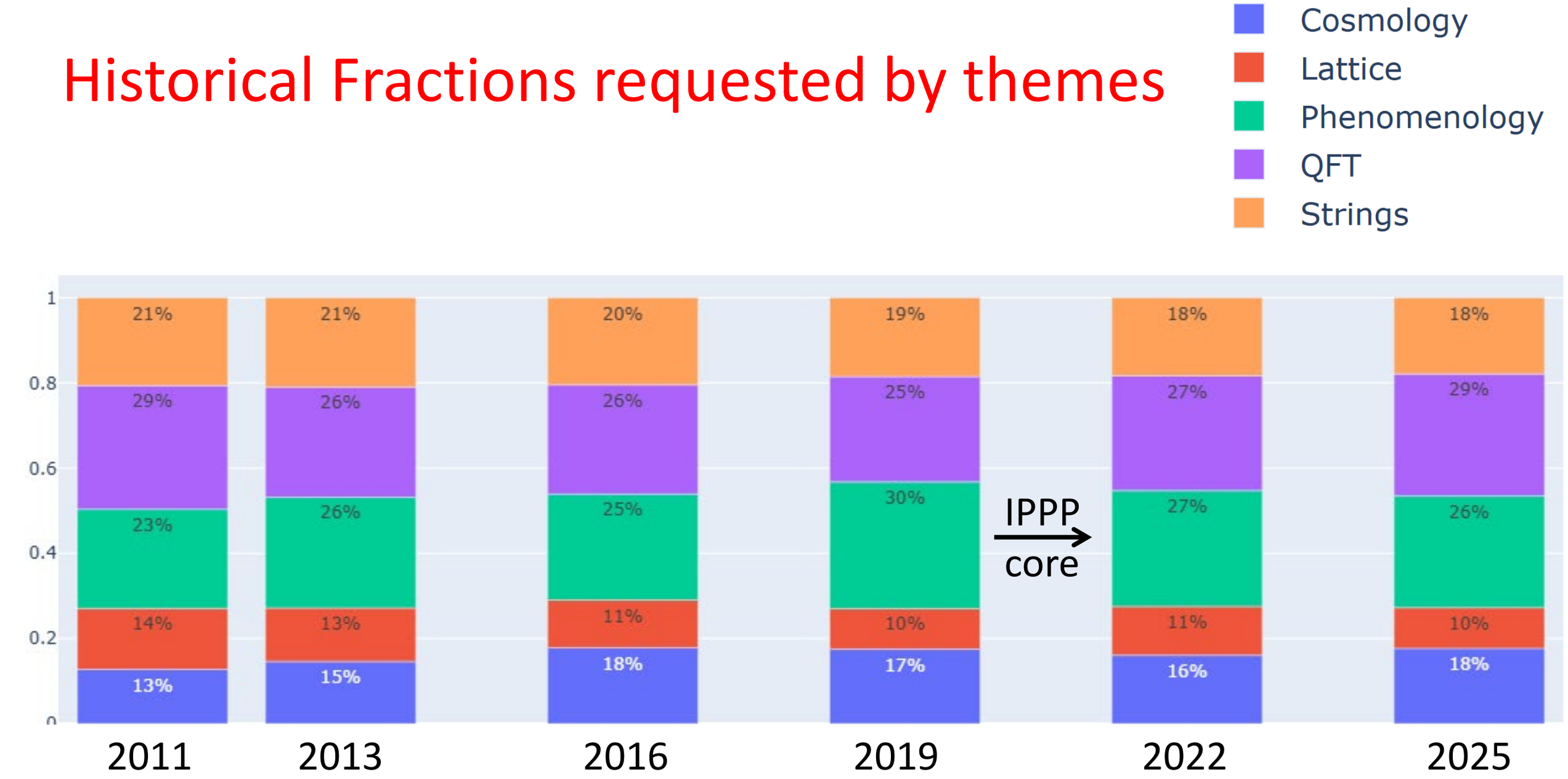
*well-recognized experts, each contributing to core topics in early Universe physics, dark matter, inflation, and gravitational wave cosmology.*

*closely tied to observations and data analysis (...) with a strong impact*

*a strength is the symbiosis between theory and experiments*

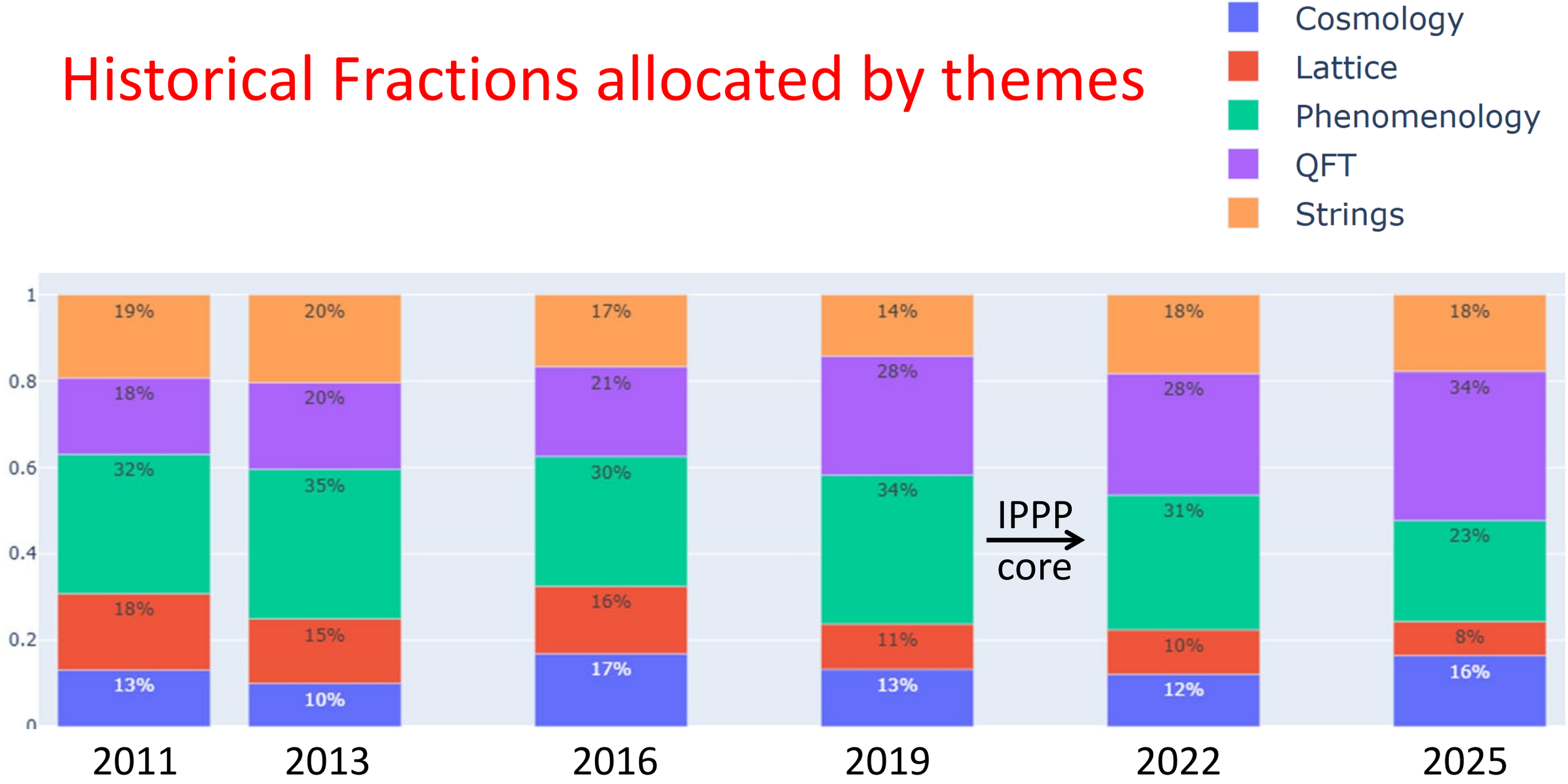
*clear potential to significantly advance our understanding of gravity in regimes inaccessible to particle colliders, with implications spanning from high-energy physics to cosmology.*

# Historical Fractions requested by themes



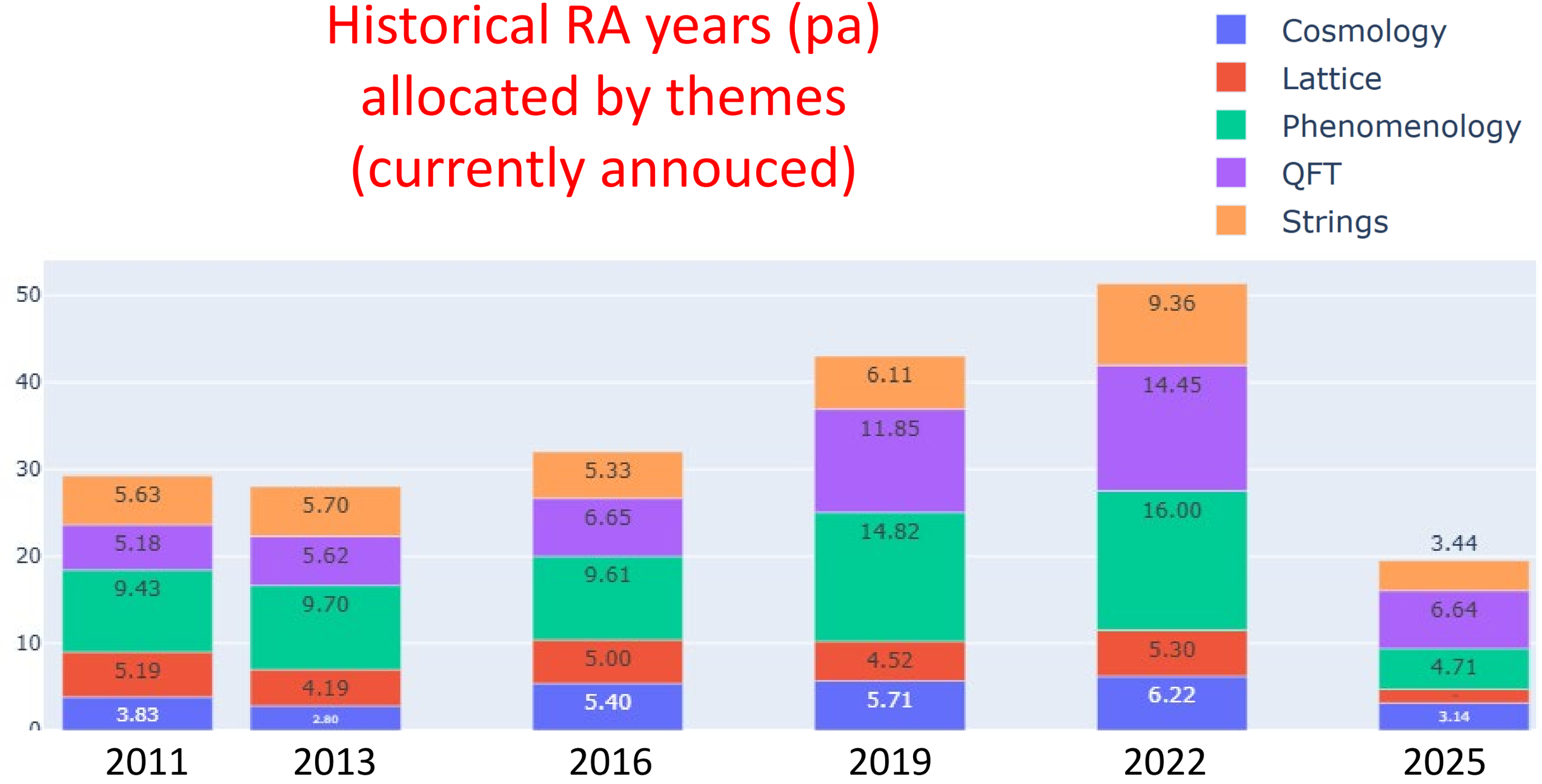

Thanks to Daniel Maitre

# Historical Fractions allocated by themes



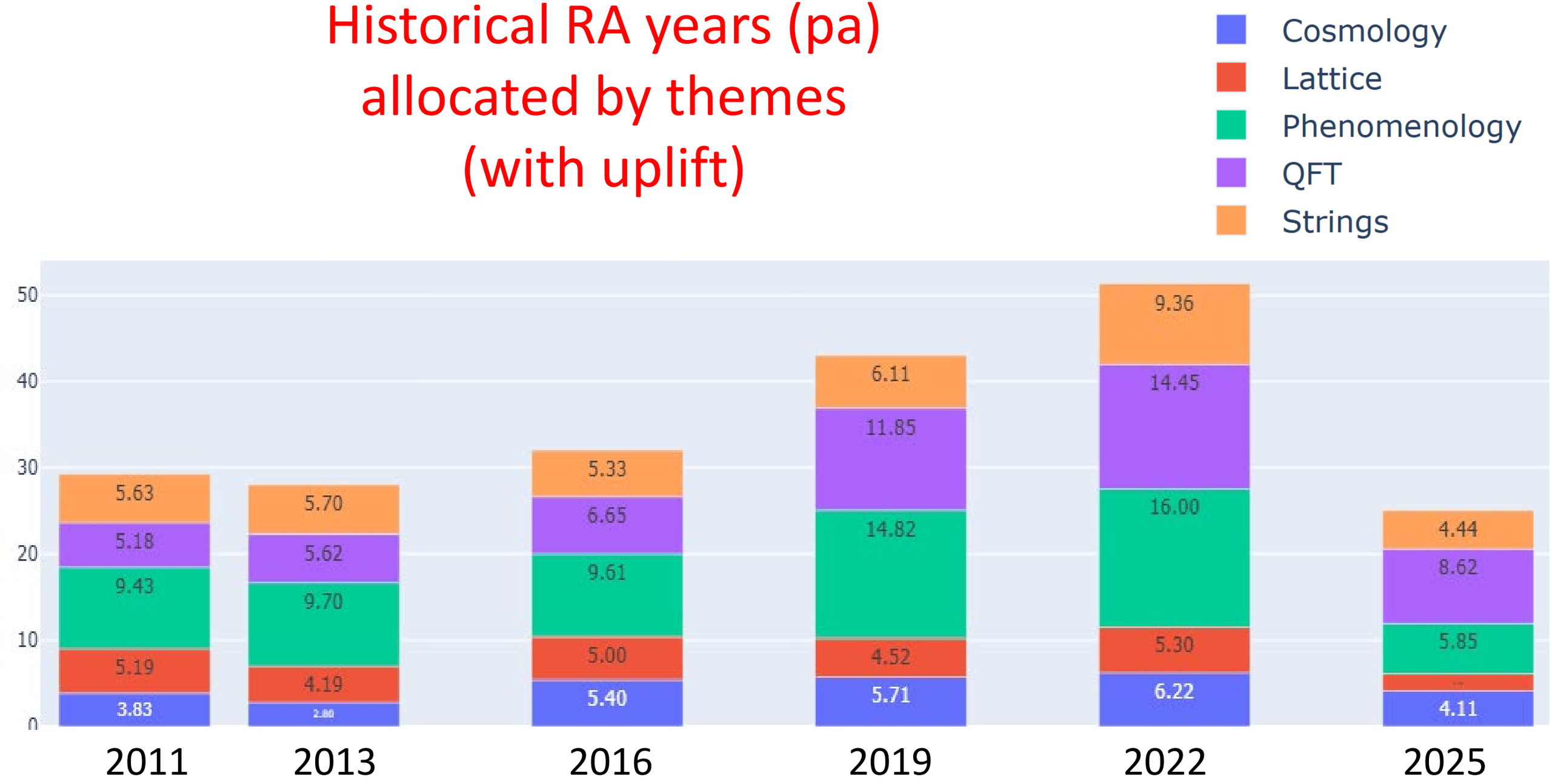

Thanks to Daniel Maitre

# Historical RA years (pa) allocated by themes (currently annouced)




Thanks to Daniel Maitre

# Historical RA years (pa) allocated by themes (with uplift)




Thanks to Daniel Maitre

# Early Careers

- As a UK theory community, we have missed the opportunity to hire PDRAs for the coming AY2026-27.
  → O(30-50) PDRAs who will not be hired and are likely to either leave the field or to establish their leadership elsewhere.

- Further absorbing cuts through reductions in theory PDRA positions implies:

  - Unable to hire best emerging talents in the UK
  - Gap across an entire generation of researchers
  - Loss of researchers in whom we have already invested – both financially and through their training as a community
  - Consequences that extend far beyond the 4 year grant period, with irreversible impact over 40 year+ careers and on future training capacities.

# A few last points…

(going where we've never been before given the boundary conditions)

## Priorities:

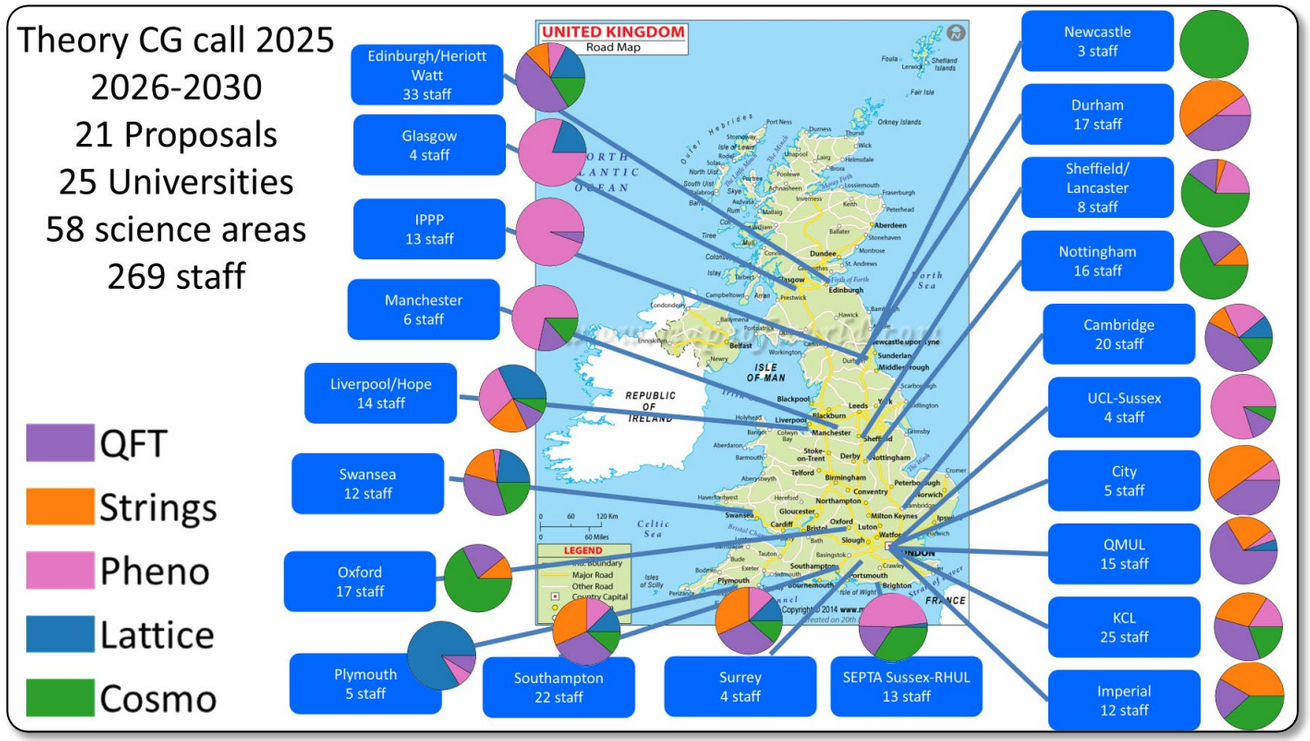
1. Best Science impact (focus on quality)
2. Early Careers
3. Balance of programmes
4. Virtual Centres (consistently praised for service they provide to UK theory community)
5. Sharing ideas is essential to theory – need to maintain some level of travel resources (and consumables)

## What we had to consider:

- Academic time award now fixed at 4%
- Situation is unprecedented – cannot continue adiabatically dialing down
- Further cuts will amplify imbalance of programmes
- Theory serving ever broader ecosystem – panel conscious that no field should fall between cracks but not sustainable
- Cutting some institutions entirely would have dramatic results and amplify any imbalance
- Not all academics could be named on grants despite most being highly competitive
- Considered one year of PDRA support (to be leveraged with other opportunities)

# Thanks to UK theory Community

- The 2025 theory CG call confirms that UK theory is ever more innovative and world-leading.
- Its role and impact are not only increasingly central but in fact critical to many areas of physics and science and to the broader societal ecosystem.
- The current funding trajectory makes that position fragile, particularly for early careers.



# & Special Thanks to panel and STFC office

Daniel Maitre (IPPP) deputy-chair

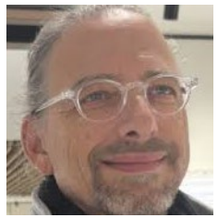
Gert Aarts (Swansea)

Bobby Acharya (KCL / ICTP)

Andi Brandhuber (QMUL)

Ben Gripaios (Cambridge)

Daniel Litim (Sussex)



Susha Parameswaran (Liverpool)

Sakura Schäfer-Nameki (Oxford)

Roman Zwicky (Edinburgh)

Mitesh Patel Exp-chair

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