Particle Theory Overview

Nick Evans (Southampton)

The CG round for 2023-26 was recently announced…. 22% rise in funding has made for a good period.

The PPGP(T) Panel

Nick Evans, Southampton (Chair)	(QFT/strings)
Richard Ball - Edinburgh	(phenomenology)
Daniel Maitre – Durham IPPP	(phenomenology)
Christoph Englert – Glasgow	(phenomenology)
Gert Aarts – Swansea	(lattice)
Claudia de Rham – Imperial	(astroparticle - formal)
Malcolm Fairbairn – KCL	(astroparticle - pheno)
Gabriele Travaglini - Queen Mary	(QFT)
Sakura Schafer-Nameki - Oxford	(Strings)
Susha Parameswaran – Liverpool	(Strings)
+ 2 from experimental panel	
Ryan Nichol – UCL	(experimental)
Helen O'Keeffe – Lancaster	(experimental)

Sarah Verth – STFC Ass. Director
Karen Clifford – Head of PP
Jane Long – STFC Grants Manage
Lindsay Clark – Prog manager
Nicole Ashman – Prog manager

Special thanks to everyone here who have had to do extra work relative to a normal round this year.

24 UK Theory Groups (243 staff)

Cambridge	phenomenology; strings; QFT; lattice
City	QFT; strings
Durham + Newcastle – Maths	QFT; strings
- IPPP	phenomenology; cosmology
Edinburgh + HW	phenomenology; lattice; QFT; strings; cosmology
Glasgow	phenomenology; lattice
Imperial	QFT; strings
KCL – Maths	QFT; strings
- Physics	cosmology; phenomenology
Lancaster & Sheffield	cosmology; phenomenology
Liverpool	phenomenology; QFT; strings; lattice
Manchester	cosmology; phenomenology
Newcastle	cosmology
Nottingham	cosmology; QFT
Oxford	phenomenology; QFT; strings; cosmology
Plymouth	lattice
QMUL	QFT; strings
Southampton	phenomenology; cosmology; lattice; QFT; strings
SEPTA (Sussex, UCL; RHUL)	cosmology; phenomenology; QFT
Surrey	QFT; strings
Swansea	QFT; strings; lattice ; cosmology
UCL	phenomenology

50% growth since 2011

10% growth since 2019

In total 56 science areas requested funding

The panel noticed not just a rise in academic numbers but also a rise in academic quality and leadership since 2019.

(The panel directly considered covid impact in its decisions.)

Group submissions still tend to too technical too fast – do remember the panel has non-theorists and colleagues that don't know your sub-field…

Phenomenology

Guides search strategies & communicates theory and experimental constraints

IPPP lead for UK.

Parton distribution functions
Monte Carlo development - HERWIG, SHERPA
AI/Machine Learning for data and models
Precision SM – SMEFT
- QCD - N^3LO
- higgs – NLO & N^3LO computations
- neutrino (with many expts)
- flavour (with LHCb and NA62 and g-2)

Model building – naturalness; discrete flavour symmetries

NOTE: no precision experiment can be done without a robust theoretical prediction!

Lattice

Including QED and isospin-breaking effects
Precision calculations of Standard Model phenomenology, such as:

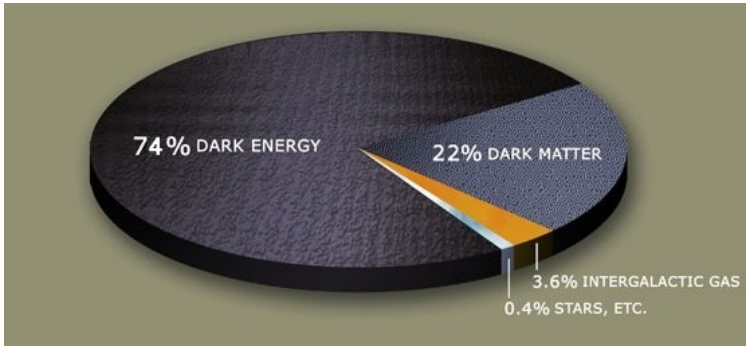
Nucleon structure
Kaon/D physics and rare decays
b-physics
μ g-2

] Crucial for precision tests of SM and search for BSM signals

Hadron resonances and multihadron scattering
BSM studies using non-QCD theories – composite higgs, DM, holographic cosmology
ML & quantum simulation for gauge theories

Cosmology/Astro-particle/Dark Theory

DM – WIMPS, Axions, primordial BHs & their signals



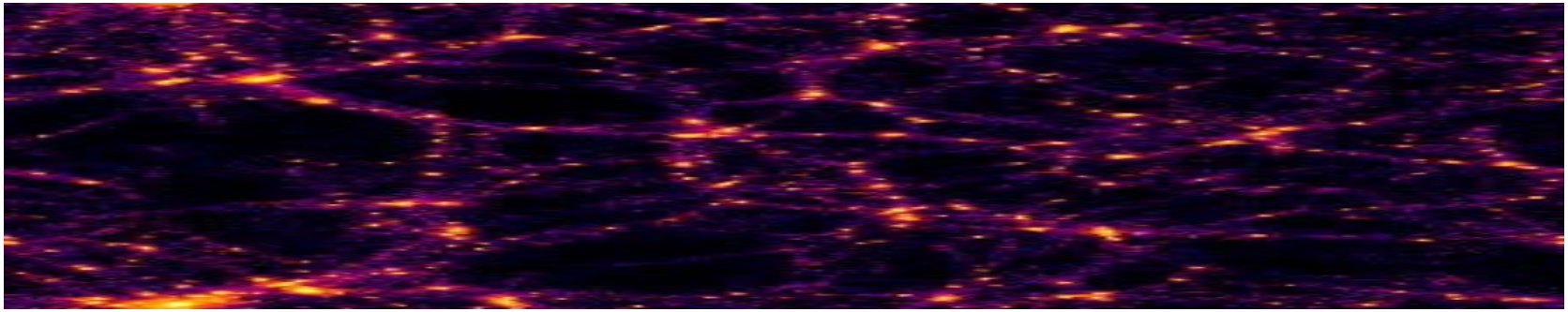
Dark energy & fine tuning

Cosmological scalars (including higgs), inflation mechanisms and models

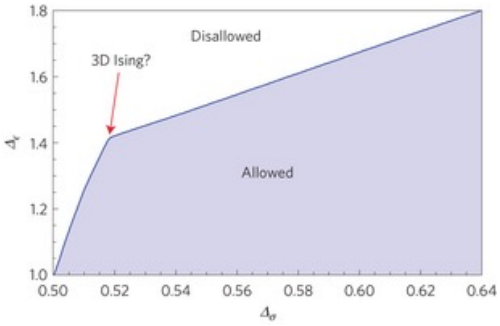
Gravity wave signals of phase transitions (SM or dark)

Modified gravity in the IR eg massive gravity

String phenomenology



Quantum Field Theory



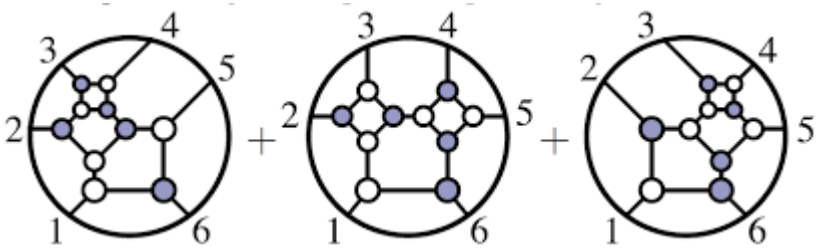
* Supersymmetric gauge theories

* Conformal theories (IR fixed points and UV asymptotic safety)

* Integrable models eg N=4 SYM – large sectors have been exactly solved even at strong coupling

* Bootstrap methods in conformal models

* Amplitude methods – escaping Feynman Diagrams and efficient computation



* Using amplitudes for gravity wave signals – double copy method

Gauge/Gravity Duality/Strings

* Black Hole information loss progress; holographic interpretations of interior; fuzzball picture

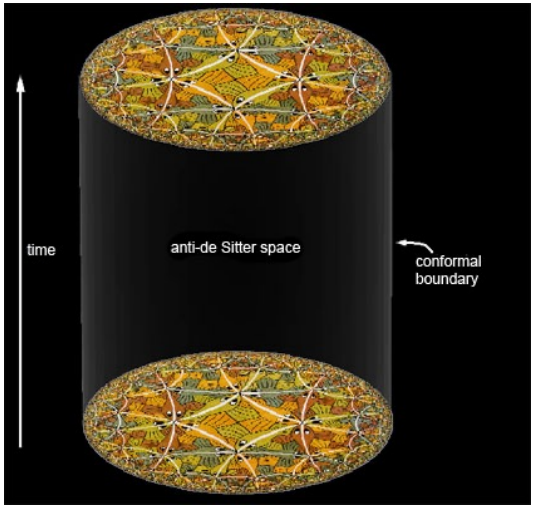
* Chaos and scrambling

  * Holography for boundary CFTs, black holes, neutron star equation of state, (magneto) hydrodynamics

  * ML in string cosmology

  * deeper understandings of M-theory/branes

  * dS space in string theory



Initial Process

We originally had to plan around flat (+ inflation) cash…

We have inherited funding only 2/3rds of academics – this is very uncomfortable – *"death of the balanced pathway" "beware leadership roles" "beware trying to strike out in a new direction"*

Given increasing academic numbers – best we could hope was to preserve this. Increasing academic numbers remains a boon for the community.

We understand that some academics who are not funded are very strong… have chosen other highly important and productive paths within their Universities…

We need line managers to help us keep people on board and fight their case in their Universities…

We expect PIs to use their funding to support full groups not just named academics

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Overheads (only) up 3% vs 2019.

Our strategic guidance from STFC Theory Review is to protect and grow RA numbers

- we hoped to protect RA numbers

The only way to free money is to continue to pressure academic time – we declared this to be a computed variable after the preservation of the programme – it came out at 4% (down from 8%) - clearly fEC is dead… groups are still growing which suggests there is understanding in Universities…. not ideal…

Travel + Support + Consumables

These have been frozen for over a decade and we again froze them…

We expect most groups to have underspend on their 2019 CG they can no cost extend….

Has to be hitting communication of UK results and international impact.

	Flat cash	Uplift
Travel and subsistence	£4500 per FTE	£4500 per FTE
Computing / consumables	£1800 per FTE	£1800 per FTE
Secretarial support	1.25% per FTE to the nearest 10%	1.25% per FTE to the nearest 10%
Computing support	1.5% per FTE to the nearest 10%	1.5% per FTE to the nearest 10%

Green agenda: leadership vs damage – need national guidance

PPGP(T) does not fund experiment contributions – please compete in PPGP(Ex)!

IPPP & Virtual Centres

Science Board moved IPPP core funding to a separate panel and PPGP(T) did not assess the core work.

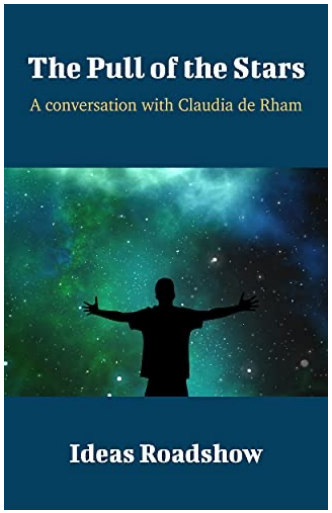
Pre-covid PPGP(T) had encouraged the set up of

Lattice Strings Cosmology Virtual Centres

To encourage cohesion in the community a la IPPP… they valiantly tried online….
Considered a positive addition to the community.

The panel renewed their funding to allow them a shot in the post covid period!

Outreach



STFC has direct grants for outreach – on the CG we only fund outreach directly linked to the research agenda – in practice this is none.

Print: New Scientist Guardian Times

Radio: eg In Our Time; Infinite Monkey Cage…

Dana Centre Café Scientifque Science Societies

Teacher visits to CERN University Open Days Masterclasses

Talks to schools British Science Week Science Exhibitions

Science at Music Festivals Teacher CPD

Flat cash programme

164 funded academics

124 RA years awarded according to quality; panel scored; panel discussed for 2 days.

The panel considered this a meagre programme

Scientific/Technical Excellence
International Competitiveness
Strategic Value within STFC Programme
Scientific Leadership, planning project management
Social and Economic Impact

+22% to core programme

£18M -> £22M

Thanks to STFC & UKRI for making the core case

The panel was expecting a rise and had discussed how to use it:

- raising fEC would give 100% to Universities; yet we couldn't raise it sufficiently to change academics' lives.

- We could fund more academics – again essentially gifting the money to Universities – nevertheless we did revisit the border line and funded 10 or so more academics including ECRs

- Funding 55 further RA years would directly increase science output and give Universities additional overheads – 1 3 year RA for every 4 academics

- More travel funds were considered (covid under spend)… left as mop up of left over…

We went to Science Board to approve this decision.

Then we rescored and reconvened to assign the additional money.

The proposed RA increase (+45%) did mean some of the largest top scored (well resourced) groups had not put in sufficient RA cases… a few have not got 1-2 years of proportionate funding…

However, the CG allows a balanced distribution of resource.

An additional round of funding would have brought delays; overly favoured the top scoring groups; and been an administrative pain all round….

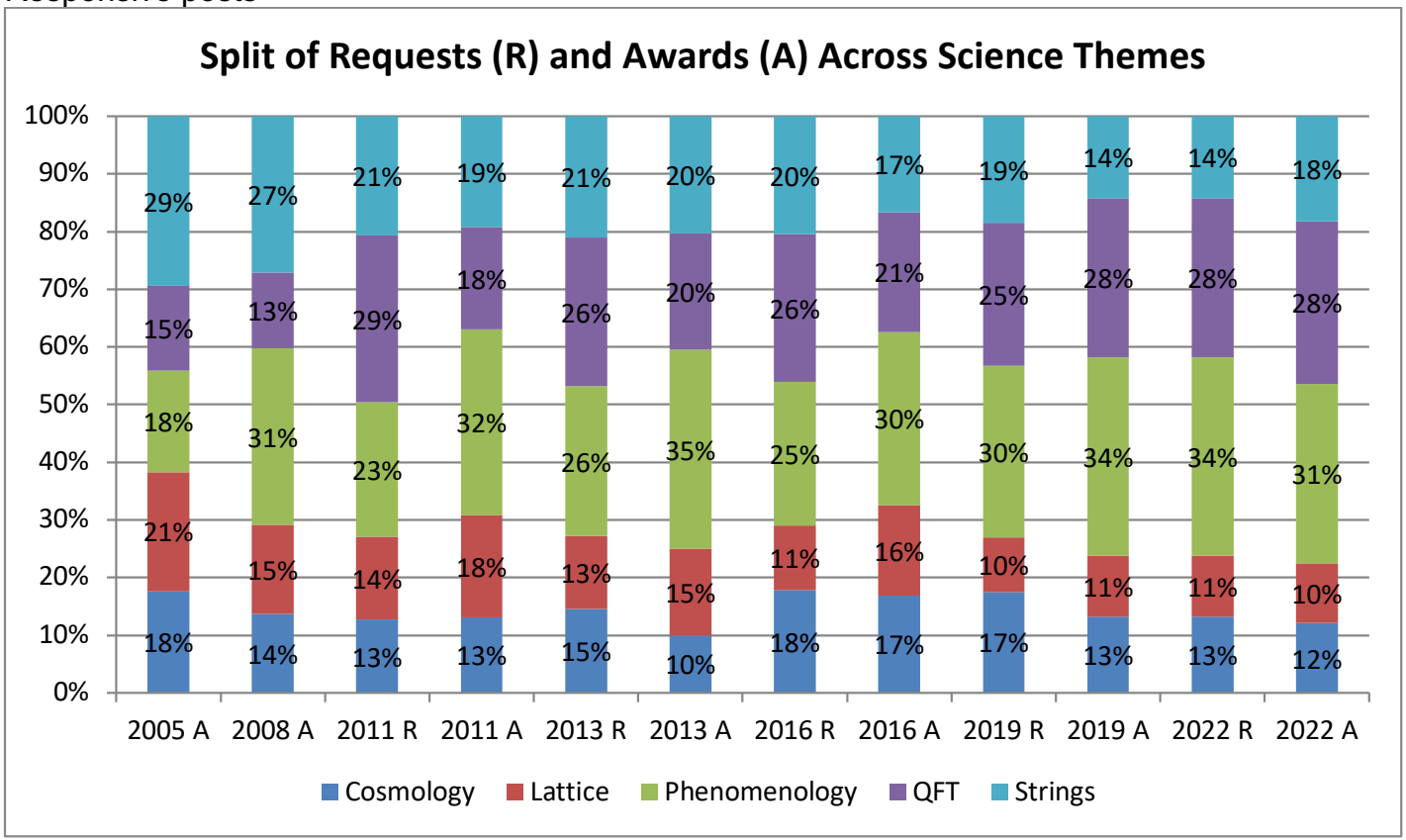
The panel believes its proposed assignment makes excellent use of the resource

* we raised many 2 year positions to 3 years
* larger groups were funded more proportionately
* some smaller groups awarded RAs that have potential to hugely increase productivity.

We hope overall that the community will be happy with the additional funding available.

Balance of Programme

Responsive posts



Overview & Outlook

- The panel thinks the uplift has placed STFC support for particle theory at a sensible level for the size of the field.
- We hope it will raise moral and research output.
- We think the UK theory community is growing in science leadership and will exploit the funding superbly.
- Full economic cost is a problem still – it's not funded sufficiently. There's only one more bite left in it to protect the programme from inflation (10%+!!)… (some panels fund far fewer academics at a higher level but that's the same problem rewritten!)
- The community is likely to keep growing and further pressure funding decisions.

NE is now stepping down as PPGP(T) Chair…

Good luck to Claudia de Rham (Imperial) in the role

Hopefully in my time

We've improved the panel precision with a process that puts the panel in control

We've played our role in the lobbying that has led to increased funding

Thank you to all the panelists I've served with and to the STFC staff!