

Formal Particle Theory

David Tong
University of Cambridge

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Formal Theory in the UK

- Extraordinary Tradition
- Enormous contributions to Standard Model, String Theory, Supersymmetry, Black Holes, Dualities...



Formal Theory in the UK Today

- Vibrant community working on diverse fundamental questions.

“The UK continues to have world-class research programmes in several of the more mathematical areas of theoretical physics, including general relativity, cosmology, string theory”

International review of mathematical sciences, 2010

- In the past two years, 7 ERC starting grants won by UK-based scientists in fundamental theory.
- Attracting very top young international talent.

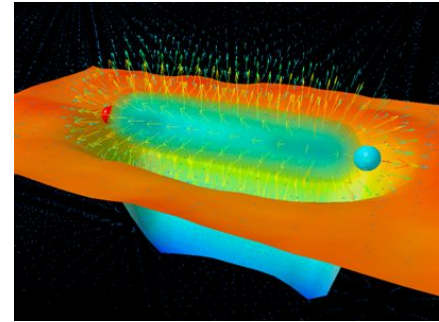
The Diverse Landscape of Theory

What we actually do

Understanding Quantum Field Theory

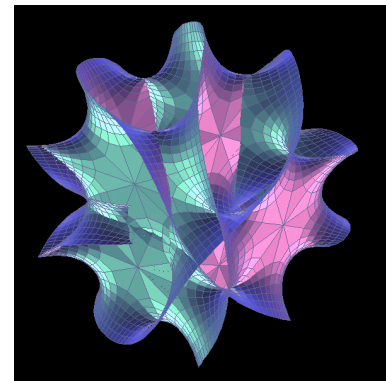
Important Questions

- What is the mechanism for confinement?
- Phases of gauge theories?
- Spectrum of gauge theories?



Important Results

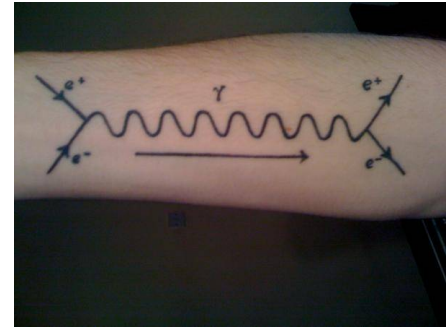
- Exact results in strongly interacting theories
 - Supersymmetry, Integrability, Solitons
- Major implications in mathematics
 - Mirror symmetry



Scattering Amplitudes

Important Questions

- What is the mathematical structure underlying amplitudes?
- How do we efficiently calculate them?



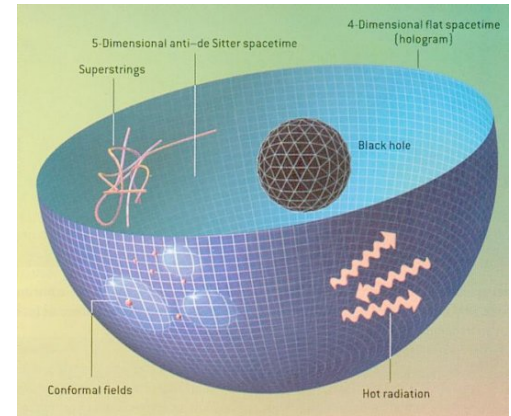
Important Results

- Twistors + Unitarity
- Higher order QCD calculations (BlackHat)

Gauge Theory is Gravity

AdS/CFT Correspondence

A new tool to understand strongly interacting field theories



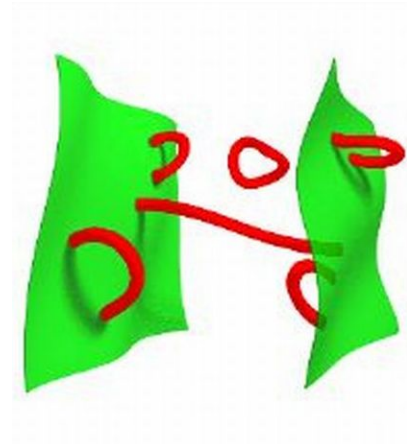
Important Results

- Toy model for quark-gluon plasma
- Einstein equations = Navier-Stokes equations.
 - “Fluid/Gravity Correspondence”
- Applications beyond particle physics to condensed matter

Quantum Gravity

Important Questions

- Black holes: microstates, information loss
- Initial singularity of big bang
- Entropy of de Sitter space
- Is the Universe a hologram?
- What is string theory?



Important Results

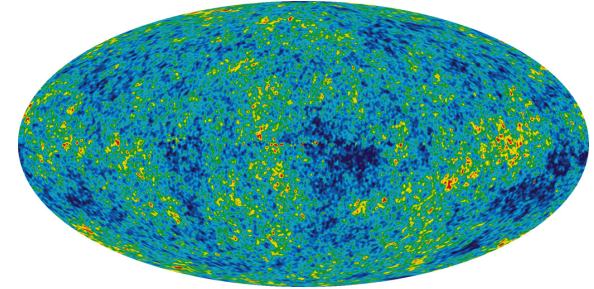
“Bagger, Lambert and Gustavsson – of course! BLG was not a sandwich – and their Lagrangian description of M2-branes”

Ian McEwan, Solar

Particle Cosmology

Important Questions

- Early Universe inflation
- What is dark matter?
- What the hell is dark energy?
- PLANCK 2013, DES (First light 1 hour ago)



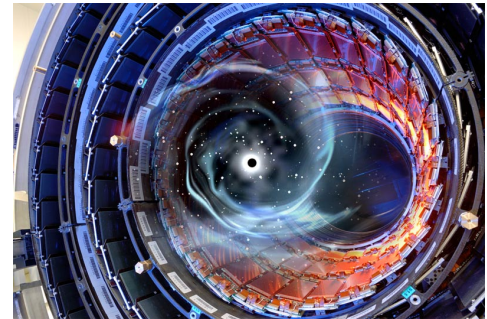
Important Results

- Modified theories of gravity
- Cosmic (super)strings
- Models of inflation from string theory
- Signatures of non-Gaussianity in CMB

String Phenomenology

Important Questions

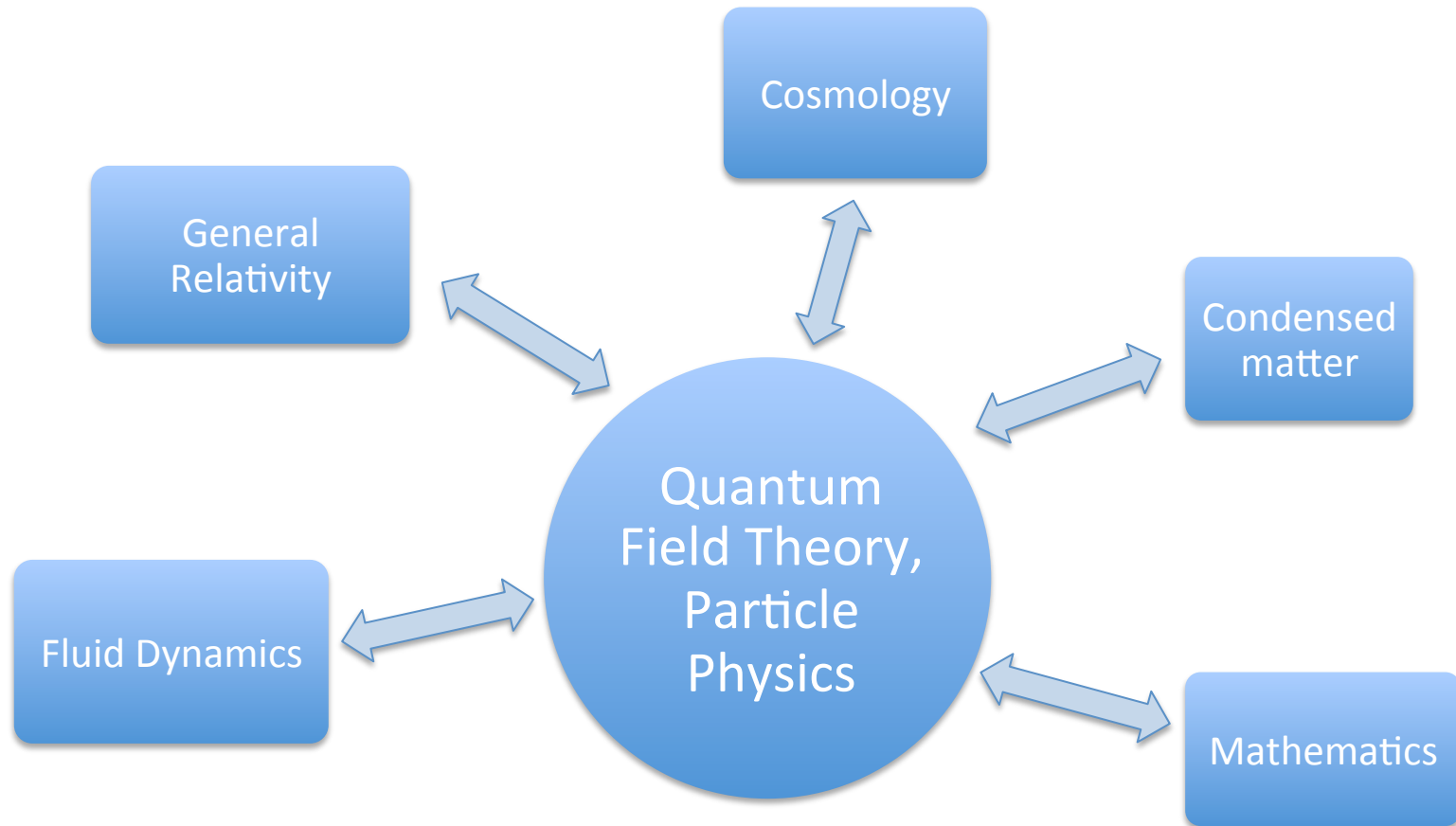
- Naturalness and the hierarchy problem
- Flavour, masses
- Novel low energy physics
- Susy mediation and breaking



Important Results

- Controlled string constructions
- String inspired spectacular BSM scenarios
 - Black holes at LHC?

Diverse Landscape of Theory



Community Concerns

EPSRC

Thank You