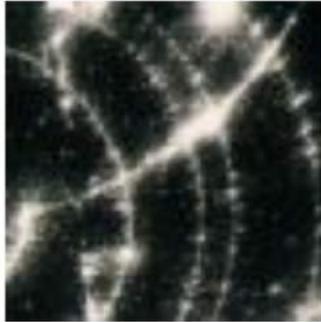




UNIVERSITY OF  
OXFORD

*Michaelmas 2018*



## Particle Theory

We study the fundamental nature of matter and forces in the universe ... seeking to explain why the world is the way it is?

**Academics** Subir Sarkar, Jorge Casalderrey-Solana, Joseph Conlon, Lucian Harland-Lang, Andre Lukas, John March-Russell, Gavin Salam, Andrei Starinets, John Wheeler

SHOW  
and TELL

<http://www2.physics.ox.ac.uk/research/particle-theory>

# OXFORD PARTICLE THEORY GROUP



On sabbatical 2018-19

John Wheeler 1986-

*Conformal field theory & quantum gravity*

Founded in 1963 by **Richard (Dick) Dalitz**  
Former members: **Jack Paton, Ian Aitchison, John Taylor, Chris Llewellyn-Smith, Frank Close, Graham Ross\*, Mike Teper\*, Giulia Zanderighi, Uli Haisch**



On sabbatical 2018-19

Andrei Starinets 2008-

*Gauge-string duality, holography, AdS-CFT*

+ presently 3 postdocs & ~18 DPhil students

+ Visitors: Christopher Herzog (KCL)  
Stephen West (RHUL)  
James Unwin (Illinois) - for MT18



Andre Lukas 2004-

*String theory and phenomenology*

+ Many associates in Astro, PP & Maths Inst

Supported by: UKRI, EU, Royal Society ...



At U. Barcelona 2017-

Jorge Casallerrey Solana RSURF 2014-



Subir Sarkar 1990/98-

*Particle astrophysics and cosmology*



Joe Conlon 2008/14-

*Physics beyond the Standard Model*



John March-Russell 2002-



Gavin Salam 2018-

*Phenomenology of EW & strong interactions*



Fabrizio Caola 2019-



Lucian Harland-Lang ERF 2017-

# Oxford alumnus shares Nobel Prize in Physics 2016



7.B.1

Nuclear Physics B9 (1969) 273-285. North-Holland Publ. Comp., Amsterdam

## A DOUBLE REGGE MODEL OF PRODUCTION PROCESSES

J. M. KOSTERLITZ

Department of Theoretical Physics, Oxford University,  
12 Parks Road, Oxford, England

Received 15 July 1968

Abstract: The Feynman diagram method is used to calculate the amplitude for a bi-Regge pole exchange for multiparticle production processes at very high energies. The two cases of normal and abnormal coupling at the Reggeon-Reggeon-particle vertex are considered. Certain differential cross sections are evaluated and compared to previous results.

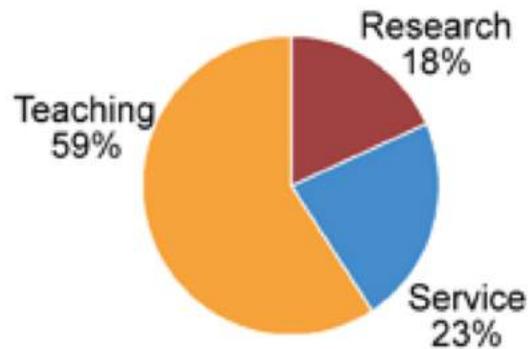
The author would like to thank Dr. J. C. Taylor and Mr. G. Thomas, the former for suggesting this problem, and both for many helpful conversations. He is indebted to the Science Research Council for a grant.

Theoretical Physics Theses					
PARRY, David Emsley.	Nucleon Resonance Production at High Energies: A Quark-Model Calculation.	DPhil	1971	Dalitz, R H	PT
MOTLEY, C. J.	Matrix Elements of the Nucleon-Nucleon Interaction.	DPhil	1970	Brink, D M	PT
KOSTERLITZ, J M	Problems in strong interaction physics	DPhil	1969	Taylor, J C	PT
HOLDSWORTH, D.	Numerical Calculations of Quark-Antiquark Bound State Masses, Using the Bethe-Salpeter Equation.	DPhil	1968	Dalitz, R H	PT
KEAM, R. F.	Some Properties of the Ladder Approximation Bethe-Salpeter Equation	DPhil	1968	Not stated	PT
PEREZ, S. M.	Inelastic Scattering and the Nuclear Shell Model.	DPhil	1968	Hodgson, P E	PT
BARNETT, A. R.	Research in Nuclear Structure.	DPhil	1965	Tanner, N W	PT
FRAMPTON, Paul Howard.	Strong Interactions of Elementary Particles: Regge Theory and Sum Rules.	DPhil		Taylor, J C	PT
LONDERGAN, J. Timothy.	Hypernuclear Decay Spectra.	DPhil		Dalitz, R H	PT

# Staff

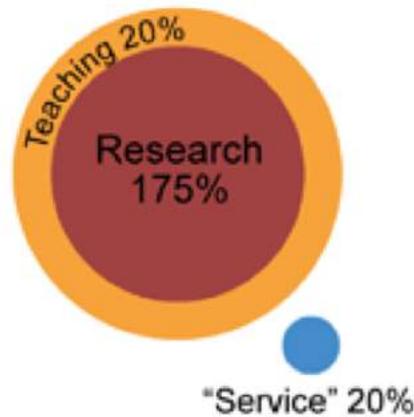
## HOW PROFESSORS SPEND THEIR TIME

How they actually spend their time:



Source: Higher Education Research Institute Survey (1999)

How departments expect them to spend their time:



How Professors would like to spend their time:



WWW.PHDCOMICS.COM

Fabrizio Caola

# Higher order QCD calculations and precision collider phenomenology



## Theoretical aspects:

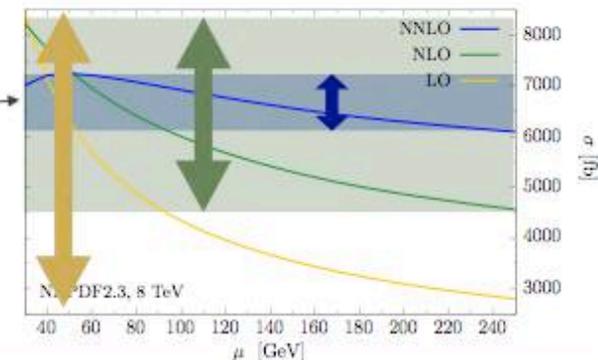
- soft / collinear structure of QCD, NNLO and higher order subtractions
- new ideas for amplitude computations

$\beta_{2N12}$   $\beta_{2N34}$

$$\partial_x \vec{f} = \epsilon \hat{A}_x(x, y, z, \dots) \vec{f}$$
$$G(a_n, a_{n-1}, \dots, a_1, t) = \int_0^t \frac{dt}{t_n - a_n} G(a_{n-1}, \dots, a_1, t_n)$$

## Phenomenological implications:

- Higgs studies (off-shell, VH, bbH, H+j...)
- Single-top@NNLO
- Vector bosons (gg  $\rightarrow$  VV& off-shell H...)



*I will move to Oxford in January. I should be visiting for a couple of days in November*

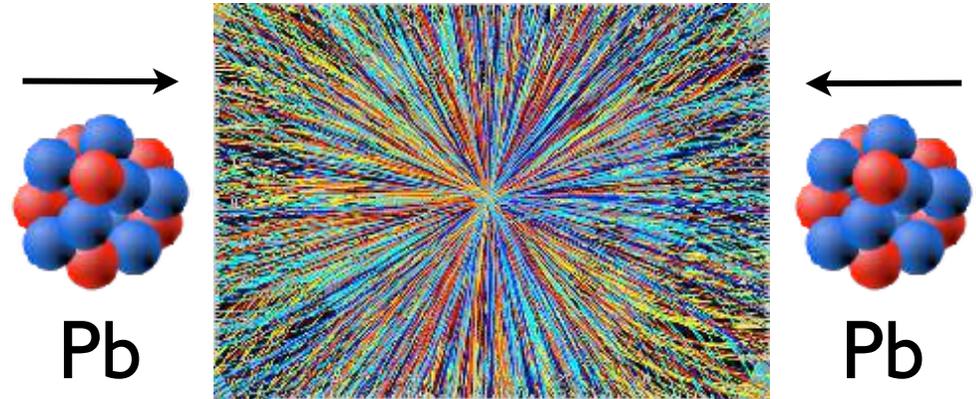
# Heavy Ion Collisions & Holography

- Extremely high temperatures

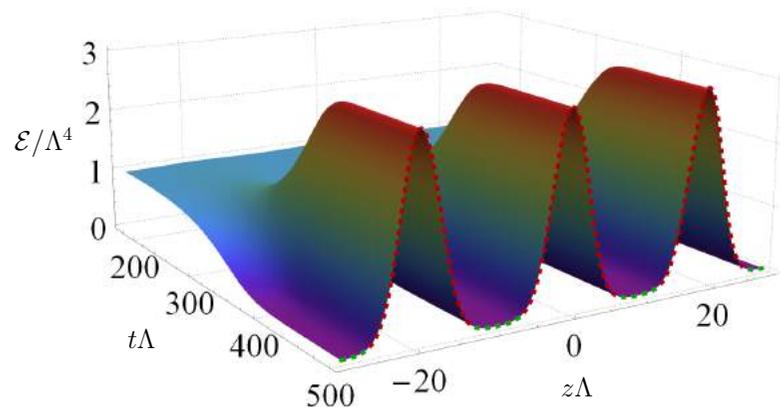
$$T > 2 \times 10^{12} \text{ K} = 170 \text{ MeV}$$

- A new state of matter  
Quark Gluon Plasma
- A strongly coupled fluid

- LHC: Pb-Pb @  $\sqrt{s} = 2.76 \text{ TeV}$



*phase separated system*



*inhomogeneous horizon*

- Main tool that I use: Holography
  - Strong coupling field theory solved by classical gravity
- Topics I will address this year
  - Phase transitions and holography
  - Onset of hydro behaviour
  - Inhomogeneous horizons in 5D
  - Gravitational waves at strong coupling

# JOSEPH CONLON

String theory and compactifications

String phenomenology

Also interest in astroparticle physics, cosmology and BSM

Students: Nick Jennings (just defended PhD viva)

# Lucian Harland-Lang

STFC Rutherford Fellow



I am a **QCD phenomenologist**. Two main topics of research:

- **P**arton **D**istribution **F**unctions:

- ★ Precise extraction of proton structure. Essential to all LHC physics- member of **MMHT** collaboration.

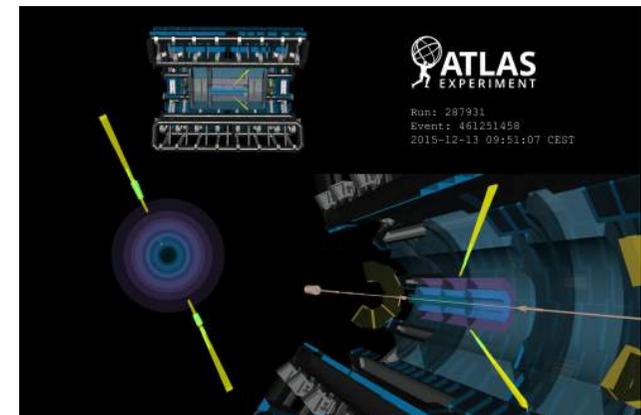
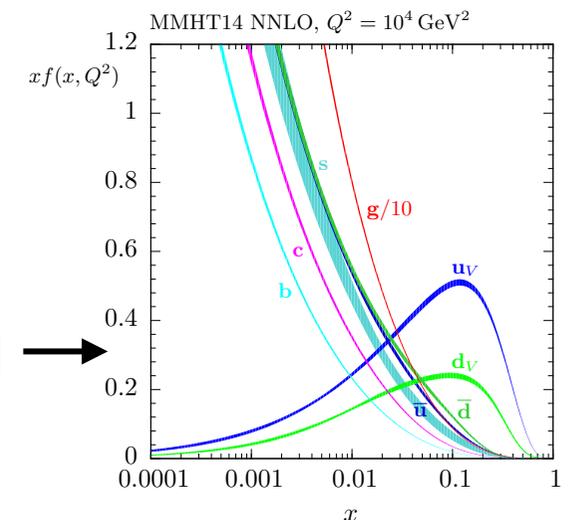
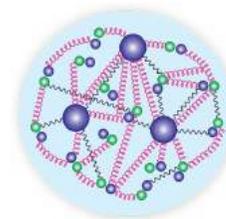
- ★ Ongoing/recent work: new 'MMHT18' release, including theoretical uncertainties, looking to the HL-LHC (w. Shaun Bailey).

- **C**entral **E**xclusive **P**roduction:

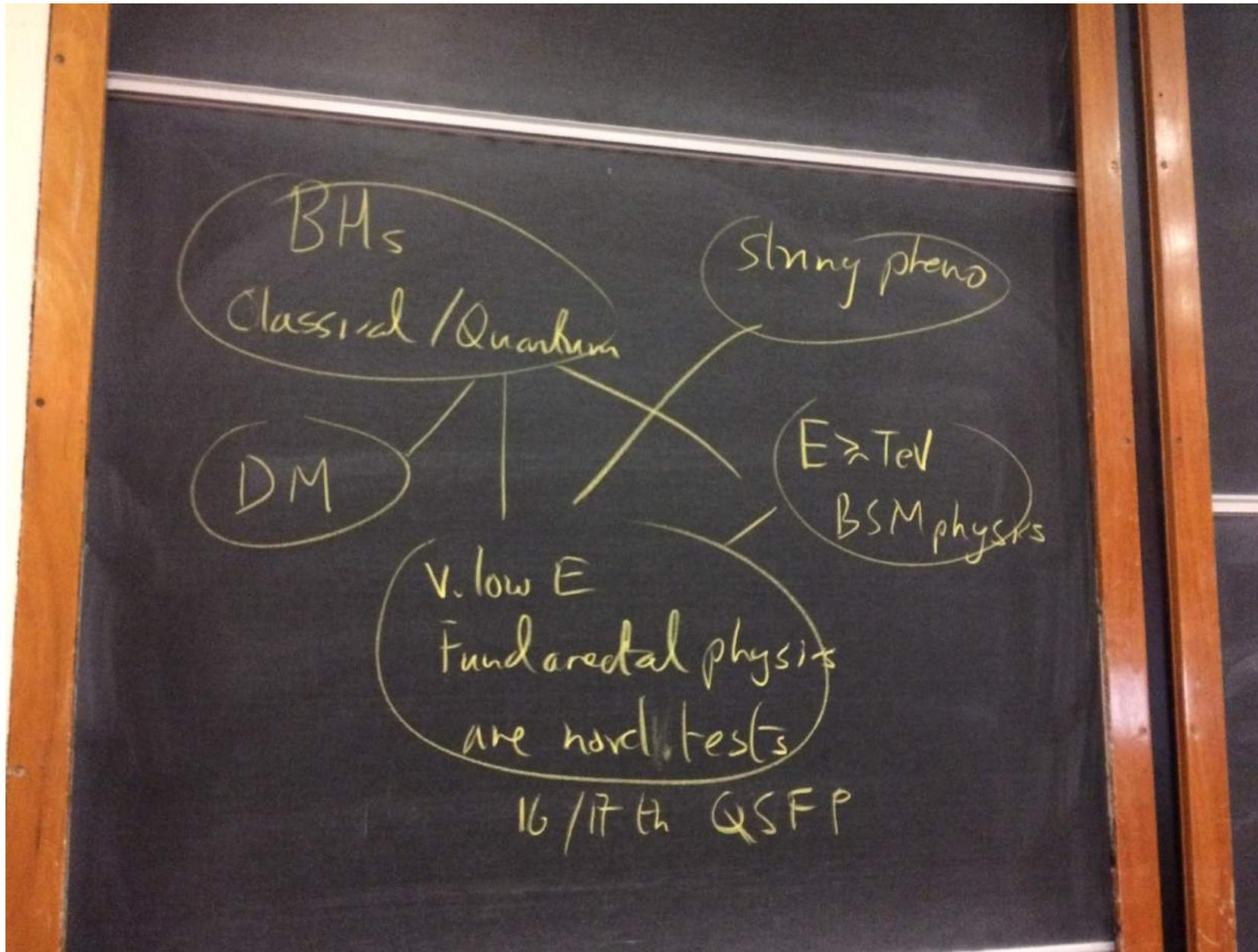
$$pp \rightarrow p + X + p$$

- ★ Unique 'elastic' class of event. Different avenue of exploration vs. standard 'inclusive' channels.

- ★ Ongoing/recent work: updating **SuperChic** MC to include heavy ions, glueballs at the LHC.



# JOHN MARCH-RUSSELL



# Andre Lukas

Main interest: string theory, with emphasis on compactifications, model building and phenomenology.

More specifically:

- Calabi-Yau manifolds, vector bundles and heterotic model building
- Flux compactifications and non-CY manifolds
- (Computational) algebraic geometry and string theory
- M-theory compactifications and F-theory
- String cosmology

Major theme: "Getting the standard model from string theory"

For example arXiv:1810.00444:

## Counting String Theory Standard Models

Andrei Constantin

*Department of Physics and Astronomy, Uppsala University, SE-751 20, Uppsala, Sweden\**

Yang-Hui He

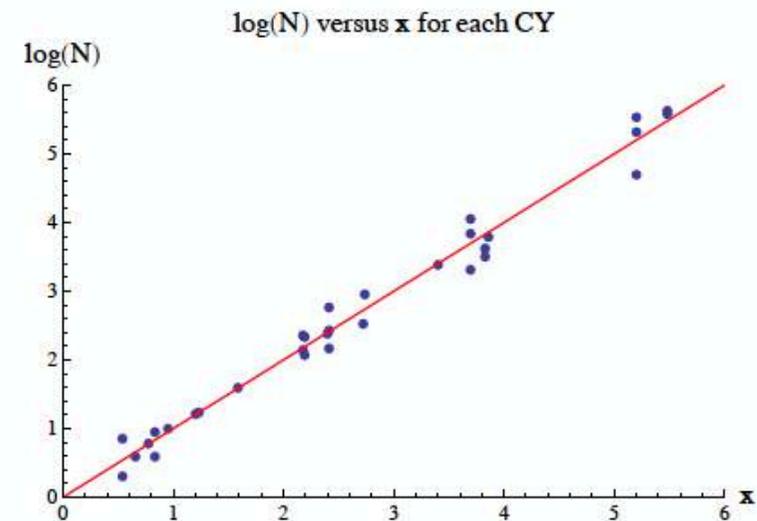
*Department of Mathematics, City, University of London, EC1V 0HB, UK,  
Merton College, University of Oxford, OX14 JD, UK, and  
School of Physics, NanKai University, Tianjin, 300071, China<sup>†</sup>*

Andre Lukas

*Rudolf Peierls Centre for Theoretical Physics, Oxford University, 1 Keble Road, Oxford, OX1 3NP, U.K.<sup>‡</sup>*

(Dated: October 2, 2018)

We derive an approximate analytic relation between the number of consistent heterotic Calabi-Yau compactifications of string theory with the exact charged matter content of the standard model of particle physics and the topological data of the internal manifold: the former scaling exponentially with the number of Kähler parameters. This is done by an estimate of the number of solutions to a set of Diophantine equations representing constraints satisfied by any consistent heterotic string vacuum with three chiral massless families, and has been computationally checked to hold for complete intersection Calabi-Yau threefolds (CICYs) with up to seven Kähler parameters. When extrapolated to the entire CICY list, the relation gives  $\sim 10^{23}$  string theory standard models; for the class of Calabi-Yau hypersurfaces in toric varieties, it gives  $\sim 10^{723}$  standard models.



$$\log(\bar{N}(h)) \simeq -5.0 + 1.5 h$$

Current students: Stefan Blasneag, Callum Brodie

# Gavin P. Salam

Just joined Dept. + All Souls

funded by ERC & Royal Society Research  
Professorship

[on leave from CERN & CNRS]

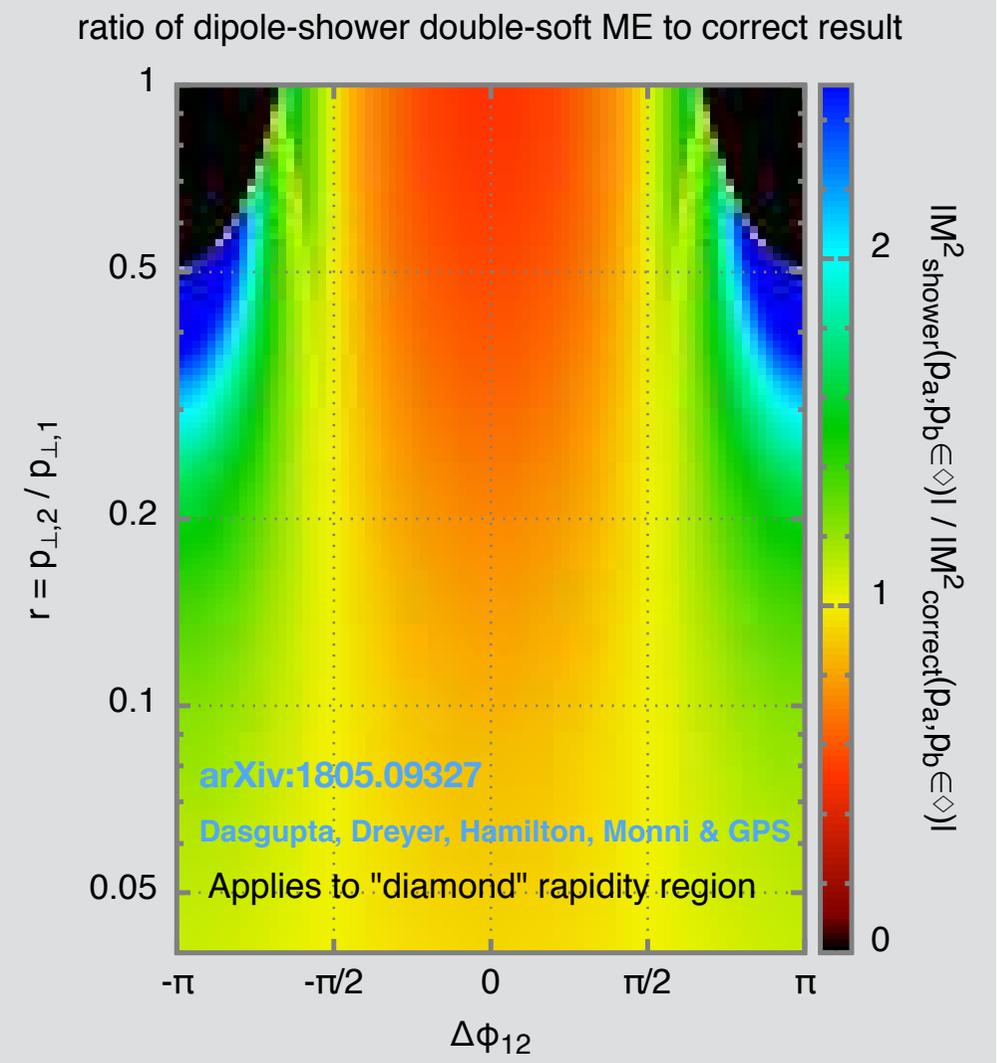
## Main interest: LHC physics

mostly from a QCD point of view

- Jet-physics  
(*anti-kt algorithm, FastJet*)
- Higgs studies  
(*e.g. VBF @ NNLO, jet vetoes*)
- Parton Distribution Functions  
(*e.g. hoppet, LUXqed photons*)
- BSM searches  
(*jet substructure, ColliderReach*)
- heavy-ion collisions
- future colliders

## Current main project:

Attempting to reformulate the foundations of “parton showers”, which are used in almost every measurement at the LHC



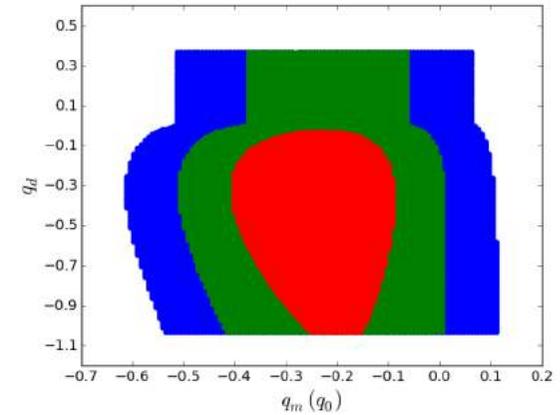
# SUBIR SARKAR *PARTICLE ASTROPHYSICS & COSMOLOGY*

**Late universe:** Our local ‘bulk flow’ extends out *much* further than is expected in a (statistically) homogeneous universe ... biases determination of cosmological parameters using Type Ia Supernovae - evidence for acceleration only  $2\sigma$  and it has a comparable dipole along the bulk flow direction!

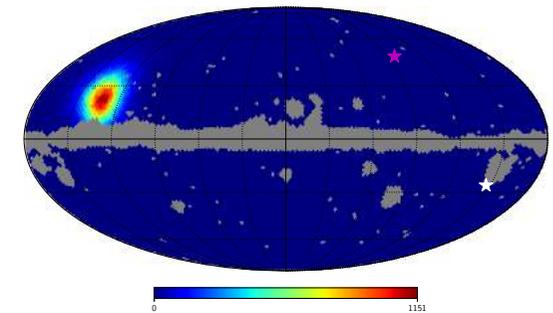
**Early universe:** Tikhonov reconstruction of a quadrupolar modulation in the spectrum of primordial scalar fluctuations from Planck data  $\rightarrow$  spectral features may be evidence for multiple episodes of inflation (with associated non-Gaussianity)

**High energy neutrinos:** I participate in the IceCube expt. which discovered cosmic high energy neutrinos ... predicted deep inelastic scattering cross-section using HERAPDF  $\rightarrow$  now confirmed upto  $\sim 1000$  TeV (measured absorption in the Earth)

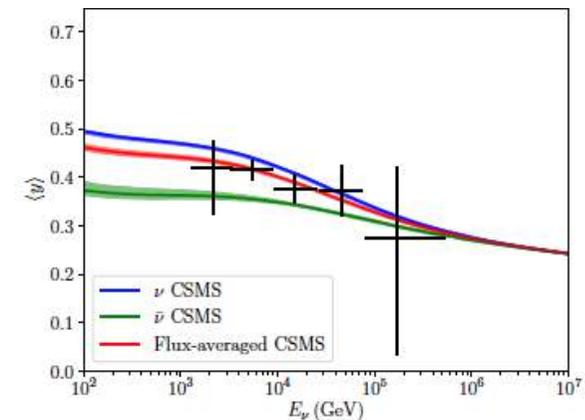
**Dark matter:** Particularly interested in asymmetric relic particles and their phenomenology – and attempts at detection by both terrestrial and cosmic experiments ...



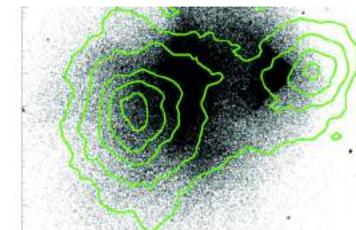
arXiv: 1808.04597



JCAP 02 (2018) 012



arXiv:1808.07629



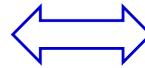
Nature Astron.  
(2018) In press

AdS-CFT correspondence

Gauge-gravity duality

Gauge-string duality

Holography



conjectured  
exact equivalence



**Open strings picture:** dynamics of strings & branes at low energy is described by a quantum field theory without gravity

**Closed strings picture:** dynamics of strings & branes at low energy is described by string theory in curved space in higher dim.

STRONG COUPLING

WEAK COUPLING

Allows study of correlation functions, Wilson loops, thermodynamics, transport, non-equilibrium behavior, turbulence, quantum quenches etc in STRONGLY interacting systems (of some class) by using their DUAL weak gravity description

Oxford Holography Group: **B.Meiring**, **C.Herzog** (long-term visitor), A.Starinets (on sabbatical)



John Wheeler

Discretized models of  
Quantum Gravity & Quantum Geometry

Manifolds



Graphs

Quantum Field  
Theory



Statistical  
Mechanics

Matrix Models

Rigorous  
Combinatorics

[Numerical  
Simulation]

JW, Aravindh Kulanthaivelu, Dennis Xavier,  
collaborators in Copenhagen & Reykjavik

# Emeriti & Visitors



# Graham Ross - Physics Beyond the Standard Model?

- B physics FCNC anomalies

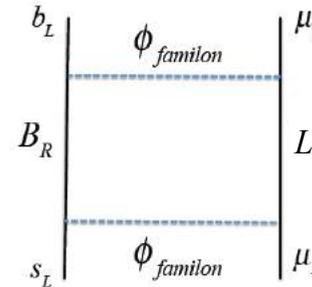
$$m_L \sim 70 \text{ GeV}$$

$$R_{K,K^*} \quad \checkmark$$

$$g_\mu - 2 \quad \checkmark$$

$$\text{DM} \quad \checkmark$$

$$R_D \quad \times$$



+Ben Grinstein,  
Stefan Pokorski

- Scale invariant theories (including gravity)

Classical + quantum

...inflation

...the hierarchy problem  $m_h \ll M_{\text{Planck}} ?$

+Pedro Ferreira,  
Chris Hill,  
Johannes Noller

- SUSY GUT:

Gauge coupling unification

Threshold effects:  $M_{\text{SUSY},i} = F(M_{\text{KK},i})$

+Kazuki Sakurai,,  
Stefan Pokorski

## Mike Teper – Lattice Field Theory

physics of strongly-coupled field theories e.g. gauge theories

recent and current:

- Spinorial flux tubes in  $SO(N)$  gauge theories in 2+1 dimensions

Michael Teper: arXiv:1712.01185

- $SO(4)$ ,  $SO(3)$  and  $SU(2)$  gauge theories in 2+1 dimensions: comparing glueball spectra and string tensions

Michael Teper: arXiv:1801.05693

- On the spectrum and string tension of  $U(1)$  lattice gauge theory in 2+1 dimensions

Andreas Athenodorou, Michael Teper: being written

- Pfaffian particles and strings in  $SO(2N)$  gauge theories

Michael Teper: being written



## Dark Matter and Hidden sectors

- \* Beyond WIMP DM - freeze-in, Nuclear Dark matter...
- \* Link to matter-antimatter asymmetry - asymmetric dark matter
- \* Dark matter consequences for stars
- \* Dark matter direct and indirect detection
- \* How do we probe more complicated hidden sectors?

## BSM physics at the Colliders

- \* Long lived states
- \* Anything BSM including SUSY

## Black Holes

- \* Colliding particles in the fields of...

## Electroweak Symmetry breaking

- \* Extended Higgs sectors

## Early Universe Cosmology

## Neutrino Physics

- \* Phase Transitions
- \* Topological Defects

# Postdocs



JORGE CHAM © 2013

# Rehan Deen

## Bio:

Henry Skynner Research Fellow in Astrophysics at Balliol

Ph.D. at University of Pennsylvania under direction of Burt Ovrut

Thesis: "Aspects of Phenomenology and Cosmology in Heterotic M-theory"

## Previous work:

- ▶ SUSY phenomenology:  $R$ -parity violating  $B - L$  MSSM - arXiv:1604.08588
- ▶ Cosmology: Sneutrino-higgs inflaton model, reheating – arXiv:1606.00431, arXiv:1804.07848
- ▶ Higher derivative SUSY/SUGRA: Analogues of galileons, dynamical auxiliary fields – arXiv:1705.06729, arXiv:1707.05305

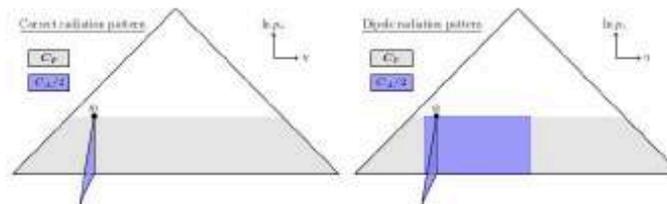
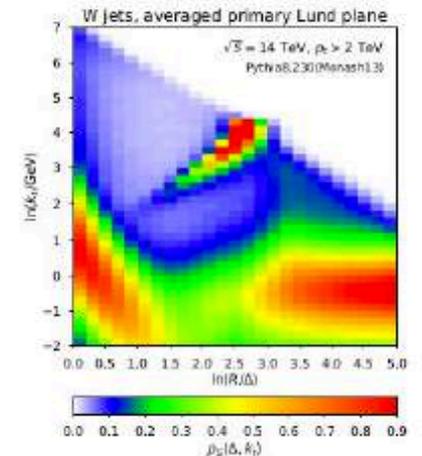
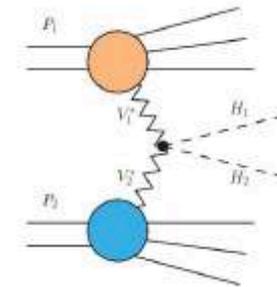
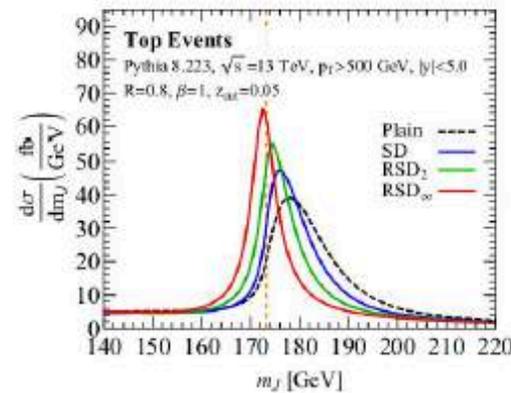
## Interests:

- ▶ String model building: Constructing standard models from smooth heterotic compactifications – Moduli stabilization
- ▶ Cosmology from string theory: Dynamics of moduli in quintessence and inflation – Bouncing cosmologies – Hidden sector dynamics + dark matter in het. M-theory

# Frédéric Dreyer

## LHC Phenomenology

- Jet substructure and boosted object tagging at the LHC.
- Applications of machine learning in jet physics.
- Accuracy of parton showers and connection with resummation.
- Higgs physics and fixed order QCD corrections.



# Michael Duerr: STFC PDRA

## Beyond the Standard Model / Dark Matter phenomenology

### > Gauge extensions of the SM

Violation of  $B$  and  $L$

Model building:  $G_{SM} \otimes U(1)_B \otimes U(1)_L$

Low-scale breaking of  $U(1)_B$ : testable

### > Consistent simple DM models

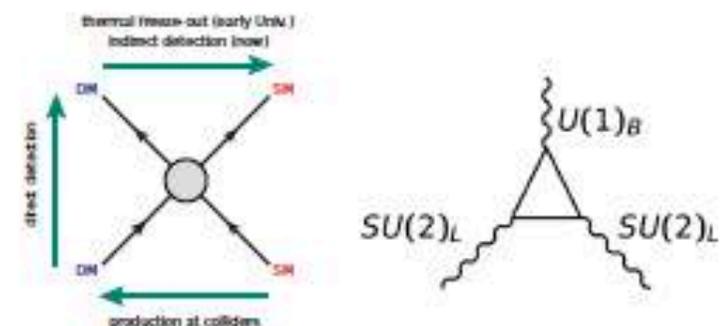
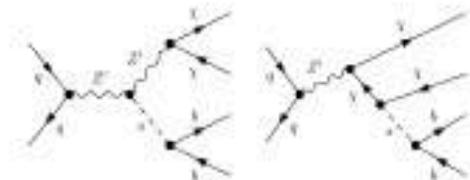
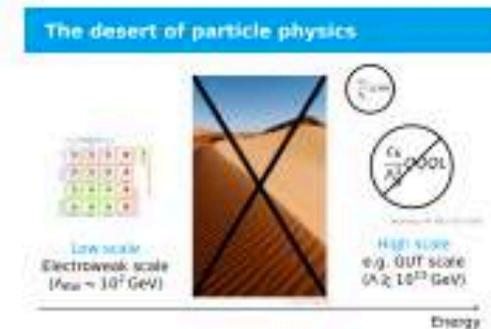
Add the minimal amount of structure to the SM that is necessary to explain DM

How simple can these setups be?

### > Current projects

Inelastic DM searches at Belle II

Signatures of/constraints on anomaly-free DM models



Interested in many other things: axions, neutrinos, self-interacting DM, ...

→ happy to discuss and start new projects!

# Associates

## Particle physics

### Research themes



#### High-energy frontier physics

Exploring fundamental physics with high-energy colliders

**ATLAS Oxford Group**

**LHCb** Neville Harnew, Guy Wilkinson, Malcolm John



#### Neutrinos

The group studies the properties of neutrinos, one of the most abundant particles in the Universe.

**Group Leaders** Giles Barr, Steve Biller, Alfons Weber

**Liquid Argon Neutrino Experiments**

**MINOS / MINOS+** Alfons Weber

**SNO+** Steve Biller

**SoLid** Antonin Vacheret

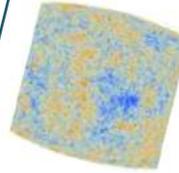
**T2K** Giles Barr, Alfons Weber



#### Dark matter and Precision measurements

Particle physics is not just huge detectors and collaborations. We study fundamental particles from a different perspective, with small high precision experiments.

**Group Leaders** Samuel Henry, Hans Kraus



## Cosmology

We lead observational and theoretical work to determine what the dark matter is, what is the dark energy, why they behave the way they do and how did the Universe start off this way.

**C-Band All Sky Survey**

**Cosmic Microwave Background**

**Cosmological Gravity**

**Dark Matter & Dark Energy**

**Euclid** Lance Miller, Matt Jarvis

**Large-Scale Structure**

**Supernova Cosmology**

**Weak Lensing**

## Mathematical Physics Group

Welcome to the web pages of the Mathematical Physics Group. We are part of the [Mathematical Institute](#) at the [University of Oxford](#), and are located on the first floor of the north wing of the [Andrew Wiles Building](#) on Woodstock Road: click [here](#) for a map.

The group's research is centred around gauge and gravity theories with an emphasis on their quantum field theories. There is also a subgroup working on [quantum computation and cryptography](#). Much of our research is connected in one way or another with string theory; see the [string theory](#) pages for a unified view of this group, which includes people in the [Theoretical Physics Group](#) in the [Department of Physics](#) in addition to the [Mathematical Institute](#). This includes [Calabi–Yau manifolds](#) and related heterotic geometry, [AdS/CFT](#) and [twistor theory & scattering amplitudes](#). Much of the work of the group impacts on mathematics as well as physics, and we enjoy close relations with the [Geometry Group](#) in the [Mathematical Institute](#). More detailed descriptions of our [Research Areas](#) may be found by exploring the panel on the left. The specific research interests of individual members are contained in their department profiles, which can be accessed from our [Members](#) page.

# Astrophysics

- Circa 29 faculty, HoSD: Prof Steve Balbus
- Areas:
  - Instrumentation (ELT, SKA, CBASS, WEAVE, ...)
  - Observations (CMB, Optical, Radio, IR, Xray)
  - Theory (compact objects, galaxies, large scale structure, early universe)
- Oxford Astro is involved most big surveys (Simons Observatory, CBASS, LOFAR, MeerKat, SKA, Weave, Euclid, LSST but also KIDS, RCSlens)

# Beecroft Institute (BIPAC)

- Max Abitbol (CMB)
- Emilio Bellini (GR, Early Universe)
- Tessa Baker (GR, LSS)
- Katy Clough (GR)
- Elisa Chisari (WL)
- Giulia Cusin (Early Universe, Gravity)
- Harry Desmond (LSS, Galaxies)
- Chris Duncan (WL)
- Harley Katz (Galaxies)
- Shahab Joudaki (LSS, WL)
- Clotilde Laigle (LSS, Galaxies)
- Eva-Maria Mueller (LSS)
- Julian Mertens (WL)

# Cosmology

- David Alonso (Cosmology) - Large scale structure, CMB, statistical methods
- Julien Devriendt (Galaxy evolution and formation)- computational and analytical techniques
- Pedro G Ferreira (Cosmology theory)- Early universe, general relativity, large scale structure, CMB
- Lance Miller (Weak Lensing)- CFHTLenS, Euclid, KIDS
- Joe Silk (Astroparticle and Galaxies)- dark matter, large scale structure, CMB
- Adrienne Slyz (Galaxy evolution and formation)-

# Weekly Events

- Cosmology seminar (Tuesdays, 11:30)
- Journal Club and group meeting (Fridays, 11:00 - 12:30, BIPAC)

# String Theory Group (Maths Branch)

James Sparks  
AdS/CFT

Chris Beem  
N=4 SYM, conformal field theories

Fernando Alday  
Integrability, strong coupling limit SYM

Lionel Mason  
Scattering amplitudes of N=4 SYM, gravity

Sakura Schafer-Nameki  
F-theory, heterotic string theory

Xenia de la Ossa and PC  
Heterotic string theory, CY manifolds

# Oxford Experimental Particle Physics



Oxford is one of the few universities on the planet that has an experimental programme addressing most of these questions in the same department as an active theory group

<p><b>Higgs boson and EWSB</b></p> <ul style="list-style-type: none"> <li>□ <math>m_t</math> natural or fine-tuned?</li> <li>→ if natural, what new physics/symmetry?</li> <li>□ does it regularize the divergent <math>V_V</math> cross-section at high <math>M(V,V)</math>? Or is there a new dynamics?</li> <li>□ elementary or composite Higgs?</li> <li>□ is it alone or are there other Higgs bosons?</li> <li>□ origin of couplings to fermions</li> <li>□ coupling to dark matter?</li> <li>□ does it violate CP?</li> <li>□ cosmological EW phase transition</li> </ul> <p><b>ATLAS</b></p>	<p><b>Quarks and leptons</b></p> <ul style="list-style-type: none"> <li>□ why 3 families?</li> <li>□ masses and mixing</li> <li>□ CP violation in the lepton sector</li> <li>□ matter and antimatter asymmetry</li> <li>□ baryon and charged lepton number violation</li> </ul> <p><b>LHC b</b></p>
<p><b>Dark matter</b></p> <ul style="list-style-type: none"> <li>□ composition: WIMPs, sterile neutrinos, axions, other hidden sector particles</li> <li>□ one type or more?</li> <li>□ only gravitational or other interactions?</li> </ul> <p><b>LZ</b></p>	<p><b>Physics at the highest scales</b></p> <ul style="list-style-type: none"> <li>□ how is gravity connected to the other forces?</li> <li>□ <math>d=4</math> theory at high energy?</li> </ul> <p><b>HL-LHC/HE-LHC/ILC/GLIC/FCG</b></p>
<p><b>Two epochs of Universe's accelerated expansion</b></p> <ul style="list-style-type: none"> <li>□ primordial: is inflation correct?</li> <li>□ which (scalar) fields? role of quantum gravity?</li> <li>□ today: dark energy (why is <math>\Lambda</math> so small?) or gravity modification?</li> </ul> <p><b>LSST</b></p>	<p><b>Neutrinos</b></p> <ul style="list-style-type: none"> <li>□ <math>m</math> masses and their origin</li> <li>□ what is the role of <math>M(125)</math>?</li> <li>□ Majorana or Dirac?</li> <li>□ CP violation</li> <li>□ additional species</li> </ul> <p><b>DUNE HyperK SuperK</b></p>
<p><b>Underpinned by strong theory group - YOUT</b></p>	<p><b>T2K SNO+0wBB</b></p>

Chris Hays for Experimental PP

Theory PP introductions, 11 October 2018

# Oxford ATLAS

- Standard Model
  - PDF-sensitive measurements (W & Z production)
  - EW measurements (W mass, VBF W production)
- Higgs
  - Many production/decay channels & searches
    - $H(\rightarrow WW^*), H(\rightarrow ZZ^*), VH(\rightarrow bb), H(\rightarrow \mu\mu), HH(\rightarrow bbbb), HH(\rightarrow WW^*bb)$
  - Combinations & interpretations using EFT
- Supersymmetry
  - Strong production: multijets and boosted objects
  - Electroweak production: soft leptons
- Exotics
  - Strong production (dijets, ISR+dijets, multijets)

Amanda Cooper-Sarkar  
Claire Gwenlan  
Chris Hays

+ postdocs  
+ students

Daniela Bortoletto  
Chris Hays  
Cigdem Issever  
Ian Shipsey

Alan Barr  
Claire Gwenlan

James Frost (Royal Society)  
Todd Huffman  
Cigdem Issever  
Tony Weidberg

# Oxford ATLAS & phenomenology

- Leading ATLAS PDF fits
  - Cooper-Sarkar & Gwenlan have been ATLAS PDF forum conveners
  - Cooper-Sarkar on PDF4LHC steering committee, Gwenlan has IPPP fellowship
  - Have had joint students with theory
- Many Higgs phenomenology grants & paper
  - Barr, Issever: IPPP fellowships on di-Higgs production
  - Issever: ERC on di-Higgs
    - Joint paper with Bortoletto & Rojo on HH to 4b prospects
  - CH: IPPP on Higgs & EFT (also ATLAS LHC Higgs WG2 convener)
- Supersymmetry studies
  - Multiple joint students with theory
  - Papers on SUSY phenomenology and search interpretations

# ATLAS SM group @ Oxford

- W boson measurements
  - Mass
  - Vector-boson fusion production
- Parton distribution functions
  - PDF fits adding V, ttbar, jets, V+jets, ...
  - Strangeness suppression?
  - Low x and BFKL resummation

**Academics:**  
Amanda Cooper-Sarkar  
Claire Gwenlan  
Chris Hays

**Students:**  
Francesco Giuli  
Gavin Pownall

# ATLAS Exotics group @ Oxford

- High-mass probes
  - Multi-jets
  - Di-jets
  - ISR+di-jets
- Boosted Higgs (Runs 2 & 3)
  - Added b-tagging and Higgs tagging
  - ISR+X/H( $\rightarrow$ bb) searches
  - Di-Higgs to bbbb (& WWbb) searches
  - H( $\rightarrow$ bb) + MET searches

**Academics & senior fellow:**  
 James Frost (Royal Society)  
 Todd Huffman  
 Cigdem Issever (with ERC)  
 Tony Weidberg

**Junior fellow:**  
 Lydia Beresford

**PDRA:**  
 Bill Balunas

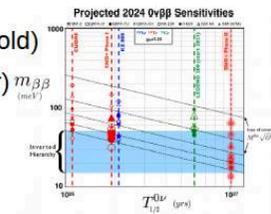
**Students:**  
 Nurfikri Bin Norjoharuddeen  
 Santiago Paredes Saenz  
 Beojan Stanislaus  
 Migle Stankaityte

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# Oxford neutrinos

- SNO+
  - New approach to Neutrinoless double beta decay
    - $^{130}\text{Te}$ -loaded scintillator proposed by Biller
  - Responsible for software (Tseng) & laser system (Reichold)
  - Path to mass measurement with normal hierarchy (Biller)
- T2K/HyperK/SuperK/DUNE
  - Organizing data acquisition (Barr) & near detector (Weber)
  - Past T2K international co-spokesperson (Wark)
  - DUNE UK PI (Weber)

Steve Biller  
 Armin Reichold  
 Jeff Tseng



Giles Barr  
 Dave Wark  
 Alfons Weber

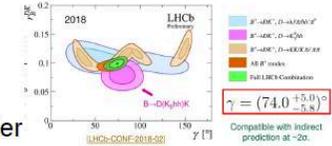
+ postdocs  
 + students

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# Oxford flavour

- LHCb
  - Precise determination of the angle  $\gamma$ 
    - Led by John & Malde
  - Rare heavy-flavour decays
  - Electroweak physics (W mass)
  - Diffractive physics
  - Flavour anomalies ( $B \rightarrow D^{(*)} \tau \nu$ )
  - Wilkinson recent spokesperson, Harnew RICH leader
- CLEO-c & BESIII
  - Strong phase difference between D &  $\bar{D}$
- TauFV
  - Proposal for best sensitivity in  $\tau \rightarrow 3l$  decays
  - Other experimental sensitivity studied by CH through IPPP

Neville Harnew  
 Sneha Malde (Royal Society)  
 John Malcom  
 Guy Wilkinson



Sneha Malde (Royal Society)  
 Guy Wilkinson

Guy Wilkinson

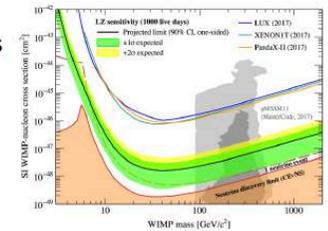
+ postdocs  
 + students

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# Oxford dark sector

- LZ
  - Kraus chief editor of technical design report
  - Designing and commissioning front-end electronics
- LSST
  - Shipsey on executive board
  - Work on camera control systems (Azfar) and database (Tseng)

Hans Kraus



Farrukh Azfar  
 Ian Shipsey  
 Jeff Tseng

+ postdocs  
 + students

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