IOP Institute of Physics
High Energy Particle Physics Group

Newsletter
Issue 13

Happy New Year From The IoP HEPP Committee

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Meet the Committee

IoP HEPP group Chairperson's Report

It is already a year since I wrote my first piece for this newsletter as incoming Chair of the HEPP Group Committee. I am happy to say that 2015 has been another eventful year in particle physics, with the restart of the LHC in the early part of the year being one of the highly-anticipated events for many in our community. The progress over the summer as the experiments started taking data again has been very exciting, and we look forward to further running in 2016.

Later in the year, in quick succession in October and November, we welcomed the news that the Nobel Prize for Physics, and the $3M Fundamental Physics Breakthrough Prize had both been awarded to physicists and experiments in recognition of the impact of neutrino experiments over the past two decades, namely Super-K, SNO, KamLAND, T2K/K2K and Daya Bay.

The Breakthrough Prize is unusual as a general physics prize in rewarding as laureates all of the authors of the seminal papers in which the discovery of the oscillations of three generations of neutrino was shown. This includes many UK colleagues through our participation in the SNO and T2K experiments, which is worth of celebration!

We work in a field where much progress is made through the collective work of large numbers of individuals, and I believe we should applaud the Breakthrough Prize for recognising this fact.

In addition to the LHC and neutrinos, our field of course spans many different approaches to studying the building blocks of the universe, and the HEPP Conference in Manchester, held jointly with the Astroparticle and Nuclear Physics groups earlier this year with about 400 participants, was a wonderful opportunity to review the progress in our field, in particular in the areas which are closely related to nuclear physics.

There it was announced that the 2016 conference will be hosted by the University of Sussex. I very much look forward to participating and seeing many of you there on the South Coast in the days running up to Easter.

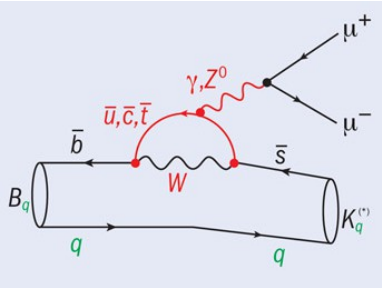
In addition to the annual conferences, our half-day meetings continue to be excellent occasions for like-minded colleagues to meet to discuss recent results as well as possible new directions of research. They are held at venues across the country, and can be organised by any group members, and I look forward to seeing more of these being held in 2016, on many different topics.

Finally, please do not hesitate to contact the committee if there are any issues in our field that you would like to raise, or any suggestions for the group; we are constantly in discussion to help us do the best we can for the group, and new ideas are always welcome.

Dr. Yoshi Uchida

Rare *B* meson decays

The term rare *B* meson decays refers to a set of processes where the *b*-quark in the meson changes flavour into a lighter *s*- or *d*-quark without changing charge. These processes are unlikely in the Standard Model (SM) of particle physics because there are no neutral flavour-changing interactions. The processes can only occur via loop-order Feynman diagrams involving the charge current interaction. In extensions of the SM, new particles can contribute through competing diagrams. This makes rare decays of *B* mesons an interesting place to search for effects of new particles at the TeV-scale.

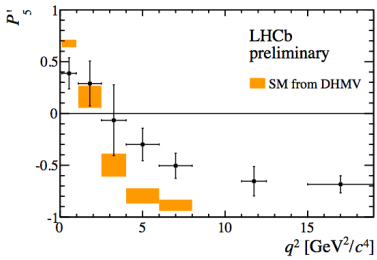


At the LHC, we compensate for the scarcity of rare B meson decays by producing huge numbers of *B* mesons (10^{12} in a nominal year of running). This large dataset enabled a joint analysis by the LHCb and CMS experiments to make a first observation of the very rare decay $B_s \rightarrow \mu\mu$, which happens once in every 300 million times a B_s

meson decays (Nature 522, 68–72).

The LHCb experiment has also collected unprecedented samples of decays involving $b \to s$ μμ transitions. In reality, we don't have free quarks and we therefore have to worry about QCD effects. Fortunately, we can build observables where the hadronic uncertainties can be partially cancelled out, for example in angular asymmetries. The LHCb experiment has recently produced a measurement of the full angular distribution of the $B \to K^*$ μμ decay using its full Run 1 dataset. One of the angular observables measured in this analysis (labelled P'_5) is shown in the figure below as a function of the squared mass of the dimuon system, q^2. In the range $4 < q^2 < 8$ GeV$^2/c^4$, the data appear to deviate from the SM predictions by about three standard deviations (σ). Global analyses of all of the experimental data on $b \to s$ μμ transitions show a consistent picture; the data are about 4σ from Standard Model predictions.

In the summer of 2014, the LHCb experiment made a related measurement comparing the rate of $B \to K$ μμ and $B \to K$ ee decays, R_K. The measured value, $R_K \sim 0.75$, is 2.6σ away from SM predictions (PRL 113 (2014) 151601). Despite the modest significance, this result generated a lot of interest in the community; lepton non-universality would be a major departure from the SM.



The angular observable P'5 measured by the LHCb collaboration in B →K μμ decays (LHCb-PAPER-2015-051).*

Tom Blake

Exhibiting Fundamental Physics

I'd like to thank the IOP HEPP Group for the award of the Science in Society Prize, particularly for my work on the "Collider" exhibition at the Science Museum. I was privileged to work on Collider with a talented team including curators, architects, theatre set designers, video artists, conservators, craftspeople, graphic designers, animators and playwrights. We were all extremely keen that the particle physics community enjoy the exhibition, as well as members of the public, and so I know that they will appreciate this award.

After an initial run in London that succeeded all our expectations in terms of visitor numbers and critical response, Collider is now on a world tour, currently at the ArtScience Museum in Singapore where it opened in November 2015. So far Collider has been seen by over 400,000 people across Europe, who parted with their hard-earned cash to learn about particle physics, which is really rather remarkable. Collider will continue its tour until 2017 taking in further venues in Asia, Australia and possibly South America. I've also recently curated a small exhibit, "Einstein's Legacy", which opened on the 25th November at the Science Museum to mark the centenary of the general theory of relativity. The exhibition looks back on Einstein's influence on science and society over the past century and will be on display until late 2016. I'm very much looking forward to sharing some of what I've been working on at the HEPP/APP IoP conference at Sussex in March.

Dr. Harry Cliff

IoP Half Day Meetings 2015

As you may be aware the IOP HEPP committee has funding available for half day meetings on any topic of interest to the HEP community in the UK. We have had many interesting and fruitful meetings on topics including Higgs Physics, LHC extensions, Neutrinoless Double Beta Decay: Status and Prospects, The future of Long Baseline Neutrino Oscillation Experiments, Dark Matter, Neutrino Interaction Physics and many more.

You can apply for £500 to fund speakers travel, coffee and lunch if funding allows (attendees travel could also be funded from this but the maximum award is £500 total).

To apply simply email the organiser Melissa Uchida at m.a.uchida@imperial.ac.uk and write in your email: title,venue, organisers, date (can be tentative) and give a short abstract explaining the topic, remit and benefit of the meeting.

This year we had a half day meeting on October 22, 2015 at Manchester University; Event Reconstruction in LAr TPC detectors_

Abstract: The workshop is to review the status of Liquid Argon (LAr) TPC event reconstruction software. Event reconstruction in these high-quality imaging detectors is a real challenge for the neutrino community, committed to building very large scale LAr detectors in the future. We will describe the current status of existing reconstruction software, focusing on the internationally used LArSoft platform, and will discuss how it can address the present needs of neutrino physics and how improvements can be made. While targeted at neutrino physicists, this workshop could be relevant to other HEP community members who use LAr technologies (such as Dark Matter experiments) or complex event reconstruction in particle physics. The half-day workshop will be followed by a more technical workshop focusing on LAr experiments at Fermilab.

We have two meetings planned so far for the new year.

Title: Exploring exotic physics with current neutrino detectors

Location: Lancaster University

Date: December 14th, 2015 -> Postponed to Jan/Feb due to flooding

Abstract: Most neutrino oscillation experiments use two detectors (near and far) to measure the mixing matrix elements. In such experiments, the main goal of the near detectors is to measure the composition of the un-oscillated neutrino flux. However, the near detectors can be

used to perform many other measurements.

The aim of the workshop will be to explore what measurements are possible with existing near detectors of neutrinos experiments. In addition to discussions on sterile neutrinos searches we will cover Lorentz violation, muon neutrino magnetic moment and milli-charges, strange quark contribution to proton spin measurements, coupling to the dark sector and searches for new physics.

Part of the discussion will focus on potential upgrades to current detectors and modifications to future detector that would expand their sensitivities to the discussed measurements.

For more information about this workshop send a email: j.nowak@lancaster.ac.uk

Title: Muon Beams In The Near Future

Date: ~Feb 2016

Abstract: A workshop to present and review the current muon beam experiments globally and the UK involvement in them, and to workshop ideas for future UK involvement in muon beams and muon beam experiments. To answer the questions: What are the physics goals of the next decade? What are the challenges we face? What can we do as a community to best forward muon beam physics and experimentation?

For more information about this workshop send a email: m.a.uchida@imperial.ac.uk

More information about the half day workshops can be found at **http://www.iop.org/activity/groups/subject/hepp/calendar/index.html**

IoP Particle Accelerator and Beams Newsletter

Our friends of the IoP PAB group also have a newsletter which may be of interest and you can be viewed through the following link.

http://www.iop.org/activity/groups/subject/pab/news/page_40592.html

IoP HEPP Prizes 2015

Group Prize:

Tom Blake - For his leadership in the study of rare B meson decays and lepton universality violation and other measurements at the LHCb Experiment

Science in Society Prize:

Harry Cliff -For his work as Curator and Head of Content for the successful "Collider" exhibition and other outreach work with the Science Museum, CERN, and the Cavendish Laboratory

Poster Prize:

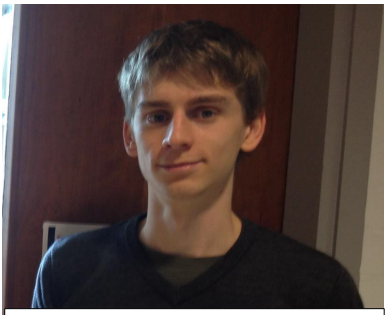
Steve Marsden - ATLAS

Meet the Committee

Yoshi Uchida (Imperial): chair

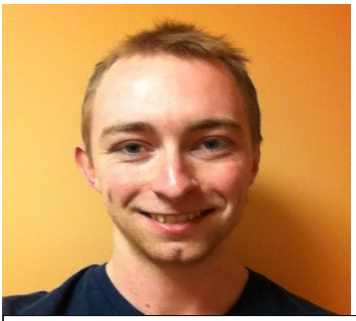
Melissa Uchida (Imperial): Half Days & PAB group liaison

Sinead Farrington (Warwick): treasurer/secretary



Kevin Maguire (Manchester): student experimental rep.

Franz Muheim (Edinburgh)



Darren Scott (Durham): theory student representative

Celine Boehm (Durham)

Jarek Nowak (Lancaster): Newsletter

Mrinal Dasgupta (Manchester)

Trevor Vickey (Sheffield)

Helen Heath (Bristol)

We have ex-officio/cross members to provide links with other IoP and STFC groups:

Neville Hollingworth, **Penny Woodman** (STFC Science and Society)
Claire Sheherd-Themistocleous (STFC PPAP)

Peter Williams (Particle Beams and Accelerators group)

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