

IOP | Institute of Physics
High Energy Particle
Physics Group

NEWSLETTER

HAPPY NEW YEAR FROM THE IOP HEPP COMMITTEE

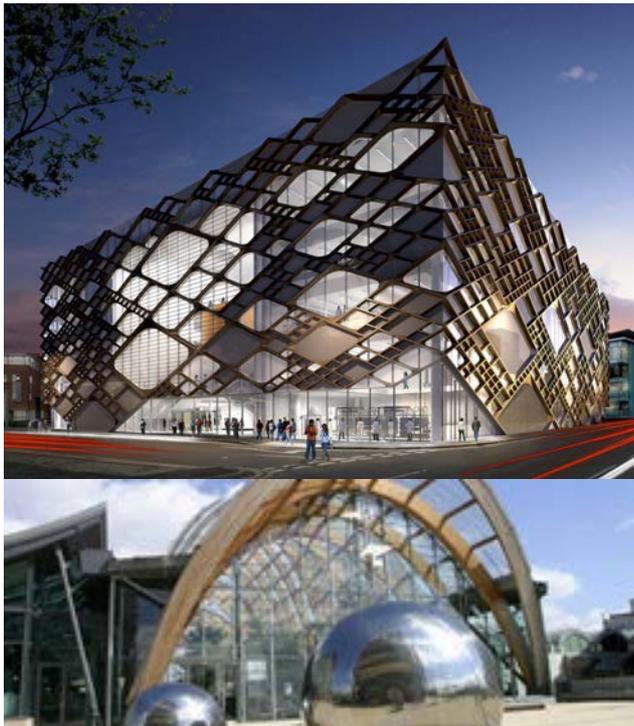
IOP Institute of Physics

Joint APP and HEPP Annual Conference

10–12 April 2017, University of Sheffield, Sheffield, UK



Website: <http://heppapp2017.iopconfs.org>



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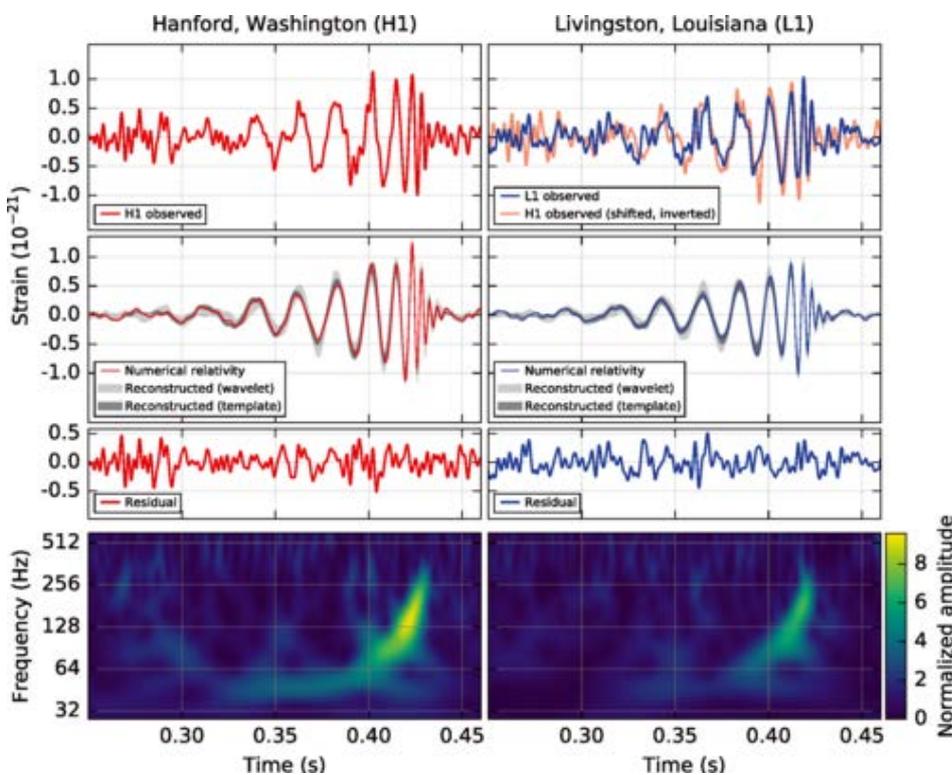
Key dates for the Joint APP and HEPP Annual Conference

Early registration deadline: 13 March 2017

Registration deadline: 03 April 2017

Report for HEPP group Chair

Welcome to the 2016 edition of the HEPP group newsletter. In the world of physics, this year will be remembered as the year when the first observation of gravitational waves, from a black hole binary no less, was announced. The field of gravitational physics is close to ours, in particular with the many researchers who have worked in both areas, and we congratulate those who contributed to this discovery through the several decades of work that it took to reach this monumental moment.



The gravitational-wave event GW150914 observed by the LIGO Hanford (H1, left column panels) and Livingston (L1, right column panels) detectors. Phys. Rev. Lett. **116**, 061102

In particle physics, the LHC continues to run strongly, with the experiments accumulating huge amounts of data that bring with them the promise of understanding the Standard Model better, and what may lie beyond it.

The HEPP group supports a number of conferences each year, and one of these was the biannual Neutrino conference at Imperial College this summer, for which I am happy to say I was involved as a local organiser. The UK continues to prove to be a popular destination for conference-goers, with close to 700 physicists in attendance this year, the largest number ever in the Neutrino series. Every edition of the conference brings

with its new discoveries and progress towards a better understanding of neutrinos. This time around one of the reasons for excitement was the possibility that we may be close to confirming CP violation in neutrinos, which would be a landmark discovery in particle physics.

The IOP awards many prizes annually, of which the Isaac Newton Medal is the most prestigious, and this year it was awarded to Tom Kibble for work including that which led to spontaneous symmetry breaking as a description for the weak vector bosons being massive, and eventually the discovery of the Higgs Boson. Since the Newton Medal covers all areas of physics, this is reason for celebration in the HEPP community—but to our great sadness, Prof Kibble was not able to receive it in person at the IOP Awards, held in November, as he passed away in June, shortly after the decision had been made by the awards panel. The award was presented instead to his children, and a commemorative lecture given by his colleague Prof Kellogg Stelle.

The IOP is undergoing significant changes as it adapts and evolves with the times, including having a more significant presence on social media, moving to new membership structures, and being ready for Brexit, and as Committee members we are kept aware of, and have a chance to influence, these changes. One of these is the recent introduction of the Early Career Researchers Fund—this is intended for early-career postdoctoral researchers and follows the highly successful Research Student Conference Fund, and provides travel money to help researchers



Prof Tom Kibble, Imperial College



The Kibble family accepting the Isaac Newton Medal and Prize by the President Roy Sambles

attend international conferences. We are always happy to see strong applications from HEPP group members, which have a good success rate. Please do consider applying for these funds if you are planning on making a presentation at an overseas conference.

We always welcome input from our members; in particular, I would like to invite our student members to raise any issues they may have with our student representatives, and those who are not working within university research groups, such as retired members, to reach out to us to let us know how we can help us engage better with you.

This year's annual HEPP Conference was held at the University of Sussex in March, where, in addition to an excellent series of talks and a lively poster session, we had a memorable banquet that was held in the magnificent new football stadium of second-division Brighton and Hove Albion, just across from the Sussex campus in the South Downs. The social aspect of our conference is at least as important as the physics programme, and I would like to thank the Sussex group and their sponsors for the wonderful occasion to mingle with our friends from across particle physics.

The annual conference for 2017 will be held at the University of Sheffield in April, once again jointly with the Astroparticle Physics group. It is always fantastic to see so many young members give oral presentations on their current research work, as well as the plenary talks from more senior members of our community. The poster presentations are one of the highlights of these conferences, with the local organisers working creatively to make sure the poster sessions are active and vibrant affairs.

Please do note that anyone can present a poster, including those who are also giving talks in the parallel sessions—you will be able to reach a wider audience if you also present a poster, and it will make it easier for those who do see your talk to come along and discuss your work with you in person.

I look forward to seeing many of you in Sheffield in April,

Dr Yoshi Uchida, Imperial College London

Particle Accelerators for Humanity

I was recently honored to receive the IOP HEPP group 'Science in Society' prize for my work in public engagement with particle accelerators and particle physics. Particle accelerators are frequently viewed as just tools of the trade in the High Energy Physics community, but in fact their application reach is vast, from cancer treatment and radioisotope production, to removing pathogens from food and medical products, to industrial processing and potential future energy sources. Accelerator science is an extremely rewarding field to work in and one that the public and schools have a huge appetite for.

I recently worked with the Royal Institution to showcase the wide-ranging applications of particle accelerators, the diverse people who work on them and highlighting their crucial role in our society. The project, including two live events, an animation and four short films, was supported by a grant from the Science and Technology Facilities Council (STFC) Public Engagement Large Awards Scheme.

It was an incredibly enriching experience working with the Ri team to share the story and science of particle accelerators. Their professional production crew enabled me to focus on the science I wanted to communicate, while their creative and technical direction ensured the finished product was truly excellent. Through this



Photo: Suzie presenting a Friday Evening Discourse at the Royal Institution, June 24th 2016. Photo Credit: Katherine Leedale

About the author:

Suzie is an accelerator physicist based in the John Adams Institute for Accelerator Science, University of Oxford, where she leads research in high intensity hadron accelerators in a joint appointment with the ISIS Intense Beams Group. Suzie also teaches graduate level accelerator physics in the JAI and leads a range of public engagement initiatives.

Her longest running initiative is the 'Accelerate!' science show, which after 9 years of running is about to be updated and re-launched with a new team, so keep an eye out at major UK science festivals in 2017.

project a number of colleagues had their first experience on camera and tens of thousands of people have learned about the wider applications and science of particle accelerators.

The formal evaluation is still in progress, but all of the videos have been very well received. The wonderful animation about accelerators by Andrew Khosravani featured on websites like BoingBoing and Nerdist. Surprisingly, the most in-depth and longest video is the most watched! In the month it launched, the film of the 'Accelerators Reimagined' Friday Evening Discourse in the Royal Institution Faraday Theatre was second only to Richard Dawkins in views of talks on the Ri YouTube Channel.

The videos have all been released under creative commons license, so we'd love for you to incorporate them in your teaching and public engagement. They are already being used for communication and teaching purposes as far away as China.

I've been communicating this topic through live shows, lectures and videos for a decade. My first project, the 'Accelerate!' science shows have now run for almost a decade. I've also had the privilege of co-presenting the biggest and most spectacular science shows in the UK, the headline shows at the Big Bang Fair, alongside food writer and BBC presenter Stefan Gates. These shows bring particle and accelerator physics together with food and other areas of science (featuring CERN@School detectors, giant beach ball particles and glowing quantum mechanical drinks), reaching 12,000 people in four days, three years in a row.



Photo: Big Bang Fair headline show with Stefan

Probably the hardest part of public engagement in High Energy Physics is truly learning where your audience is starting from and what they want out of the interaction. If you can form a connection to their interests, lives and emotions, you can begin to lead them on a spectacular journey through the story of your research in an experience that rewards both of you. Luckily, fundamental particles are quite literally everywhere, so we have no shortage of inspiration. What are you waiting for?

- Dr Suzie Sheehy

Links:

Accelerate! shows: <http://www.physics.ox.ac.uk/accelerate>

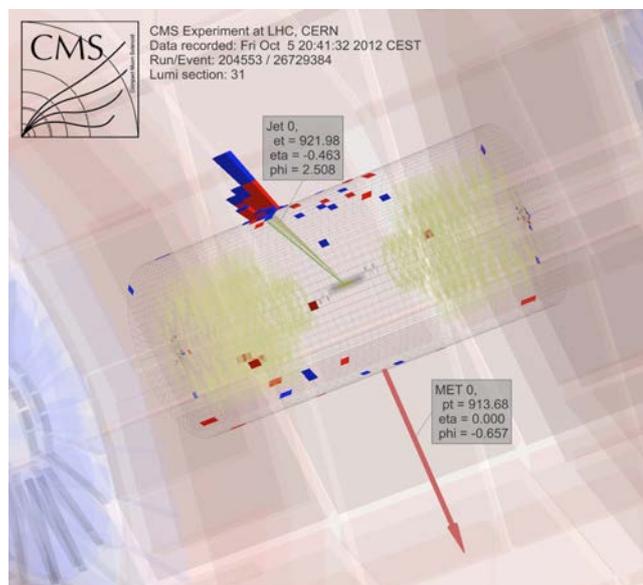
Stefan Gates & Gastronomer Shows <http://thegastronaut.com>

Particle Accelerators for Humanity: <http://richannel.org/collections/2016/particle-accelerators-for-humanity>

Suzie's website: <http://www.suziesheehy.co.uk>

Putting the LHC on the map for dark matter

There is mounting evidence from numerous astrophysical measurements that a dominant fraction of the matter density in the Universe is non-luminous. The latest results from the Planck experiment show that this 'dark matter' comprises 26% of the matter-energy content of the Universe. While the Standard Model (SM) of particle physics encapsulates our best theoretical understanding of fundamental particles and their interactions and describes the 'visible' matter in the Universe very well, it does not provide a suitable candidate(s) to



A 3-D display of a candidate monojet event in the CMS detector.

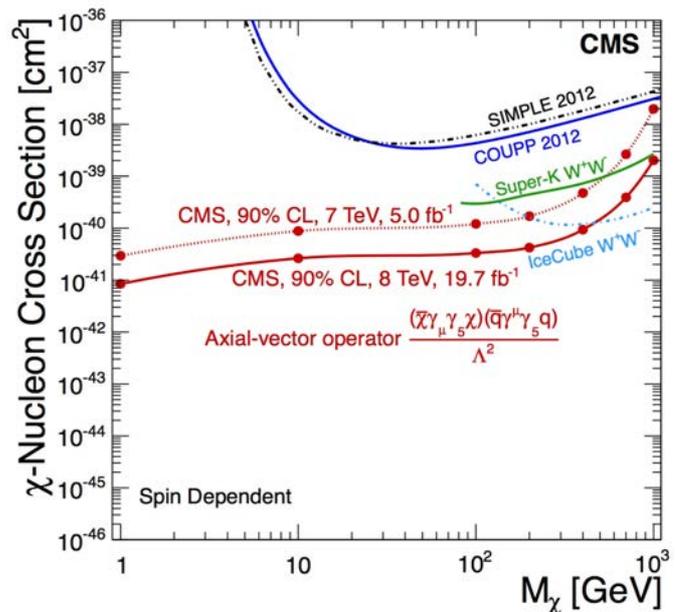
explain dark matter. The existence of dark matter is therefore our strongest indication yet that there must be physics beyond the Standard Model.

A compelling idea put forth to explain the nature of this non-luminous matter are subatomic particles known as Weakly Interacting Massive Particles (WIMPs). Independently postulated by particle physics and cosmology, the discovery or otherwise of WIMPs will be a revolutionary step forward for the field.

Our search for these particles currently follows a three pronged approach; the direct detection experiments are looking for the recoil of a WIMP off an atomic nucleus in one of their underground detectors, indirect detection experiments look for the products of the annihilation of WIMPs, and particle colliders like the Large Hadron Collider (LHC) try to create these particles and then detect them.

If WIMPs can be produced in pairs at the LHC, the simplest signature this would yield is a hadronic jet from the initial state partons and missing transverse momentum from the neutral and weakly interacting particles escaping the detector without interacting, referred to as a monojet signature. The dominant Standard Model process that can mimic this signature is a Z boson produced in association with a jet where the Z decays to neutrinos.

The Compact Muon Solenoid (CMS) detector at the LHC studied monojet events using the full data collected at proton-proton center of mass energies of 8 TeV and found that the number of such events observed in the data agreed well with what was expected from simulation. In other



Constraints on the WIMP-nucleon scattering cross section from CMS monojet results compared with other experiments. Region above the curves is excluded

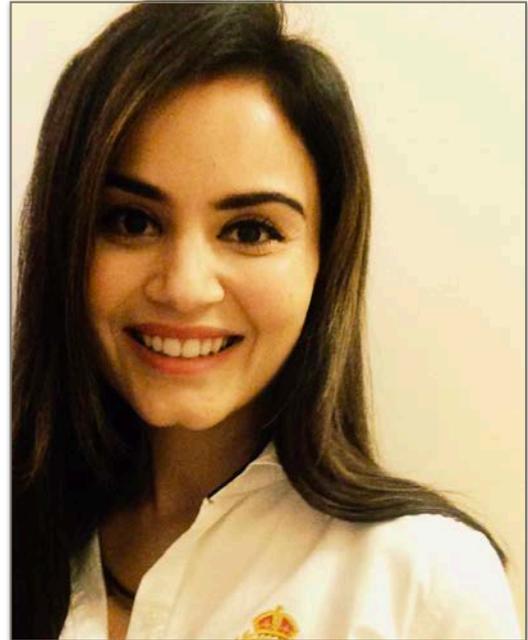
words, there was no evidence of an excess of events that would have indicated the presence of physics beyond the SM. The results of this search were used to constrain one of the most generic theoretical models of WIMP production. It put the collider on the map for dark matter by showing that the LHC has an instrumental and competitive role to play and can probe regions of phase space that are complementary to the direct detection experiments. The published results have accumulated hundreds of citations and are among the most cited papers in CMS.

The LHC restarted operations last year, colliding protons at unprecedented center of mass energies of 13 TeV and is expected to accumulate orders of magnitude more data than previously studied.

In parallel, the direct detection experiments are poised to start taking data with orders of magnitude larger and more powerful detectors.

As these experiments enter a new era of sensitivity, the next few years could prove to be game changing for either proving or severely disfavoured the popular WIMP paradigm.

Dr Sarah Malik, Imperial College London



About the author:

Sarah Malik is a Royal Society University Research Fellow at Imperial College London. She works on dark matter searches on the CMS experiment at the Large Hadron Collider.

IoP Prizes awarded in 2016

- HEPP Group Prize winner is Dr Sarah Malik (Imperial College) for her pioneering role in dark matter searches at colliders
- HEPP Group Science in Society Prize winner is Dr Suzie Sheehy (STFC ASTeC/Oxford University) For outstanding public engagement in accelerator science and particle physics
- HEPP Group Poster Prize
 - Franco La Zia (DEAP-3600), Royal Holloway University of London
 - Nicola Abraham (ATLAS), University of Sussex
 - Hugo Prager (Theory), University of Southampton

This Year's IoP Half Day Workshops

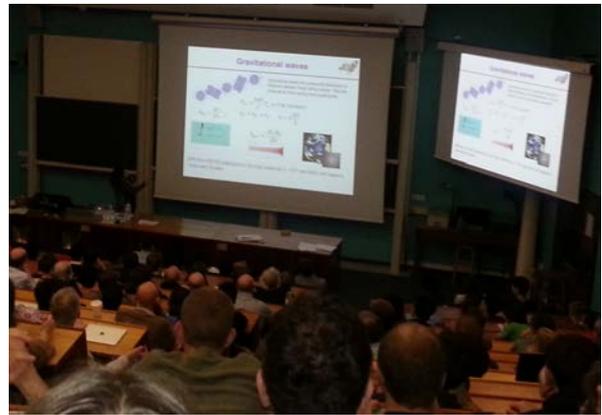
The IOP HEPP committee has funding available for half day meetings on any topic of interest to the HEP community in the UK. We have had many interesting and fruitful meetings on topics including Higgs Physics, LHC extensions, Neutrinoless Double Beta Decay, Status and Prospects, The future of Long Baseline Neutrino Oscillation Experiments, Dark Matter, Neutrino Interaction Physics, Gravitational Waves, Exotic hadrons spectroscopy, Exotic phenomena in neutrino physics and many more.

You can apply for up to £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.

Gravitational wave symposium (Imperial College London)

Bjoern Penning

The Gravitational wave symposium was very well attended with about 200 people. The audience were researchers from London's and other universities as far as Scotland, Students and the interested public . The main talk was given by the LIGO spokesperson Gabriella Gonzalez and followed by shorter presentations highlighting the underlying theory, cosmological and astronomical follow up measurements, future space based mission and the strong UK contributions to the LIGO experiment.



A keynote speaker Prof. Gabriela Gonzalez from LSU

Workshop website: <https://indico.cern.ch/event/563302/>

Dark Matter Interpretations from Direct Detection (Lincoln College, Oxford)

Steve Worm

The IOP Half Day funds were used to support a workshop to facilitate new interpretations for direct detection dark matter search results. Held in Lincoln College, Oxford on August 9, 2016, the residential workshop was attended by more than 50 people, attracting participants from as far away as the USA and Japan. Many major experimental collaborations were represented, including Cresst, LUX, LZ, XENON and XMASS. Theory talks included UK scientists as well as participants from North America, Asia and Europe. We addressed two general topics in the meeting, that of the effective field theory (EFT) interpretations and also how the astrophysical uncertainties play a role in the final results. The workshop itself was hugely successful, and has created interest in follow-up meetings and a community (and cross-experiment) mailing list to discuss common

issues in the interpretation of experimental data as dark matter. Workshop website: <http://conference.ippp.dur.ac.uk/e/DMInterpretations>.

Exotic hadron spectroscopy (University of Edinburgh)

Greig Cowan, Matthew Needham, Mikhail Bashkanov, Daniel Watts

The workshop was highly successful, bringing together many experts in the field of exotic hadron spectroscopy from both the particle and nuclear physics communities in the UK and beyond. The schedule of the workshop left plenty of time for discussion following each presentation, which proved fruitful



with new ideas generated for future experimental searches for exotic resonances that could be made at current facilities. Importantly, many PhD students were in attendance, allowing them to benefit from interaction with leading physicists. There was significant enthusiasm for a repeat event in 2017, which we will endeavour to organise in once the proposals and ideas discussed during (and after) the workshop have had time to develop.

Workshop website: <https://higgs.ph.ed.ac.uk/workshops/exotic-hadron-spectroscopy>

Exotic neutrinos workshop (Lancaster University)

Dominic Brailsford, Laura Kormos, Jarek Nowak

The workshop was very successful, bringing together experts to discuss research topics outside of the mainstream neutrino physics. We had talks on neutrino magnetic moment searches, neutrino as a gateway to the Dark Sector, tests of Lorentz and CPT symmetries, testing of flavour symmetries with oscillations experiments, sterile neutrinos, non-standard interactions, extra dimensions, reactor antineutrinos, searching for nuclearities in Super-Kamiokande, and a possible new type of neutrino detector. We had

plenty of time for engaging discussions during the talks and coffee breaks. The workshop was attended by academics, postdocs, PhD students and undergraduate students.

Workshop website: <https://indico.fnal.gov/conferenceDisplay.py?confId=13278>

Research Student Conference Fund

The Institute of Physics provides financial support to research students to attend international meetings and major national meetings.

Eligibility: Research Student Conference Fund (RSCF) bursaries are available to PhD students who are a member of the Institute and of an appropriate Institute group. For example, if an applicant is a member of the Women in Physics Group only then they could only seek support to attend a conference related to women in physics and not to low

Supporting research students

Research Student Conference Fund

Providing financial support to research student members, to attend international conferences and major national meetings.

Apply for up to £300 during the course of your PhD.

Applications are considered on a quarterly basis and should reach the Institute by: 1 March, 1 June, 1 September or 1 December

For further information see www.iop.org or contact supportandgrants@iop.org

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temperature physics. To be eligible for that meeting, the applicant would also need to be a member of the Low Temperature Group.

More details can be found at http://www.iop.org/about/grants/research_student/page_38808.html

Early Career Researchers Fund for Group Members

The Institute of Physics provides financial support to early career researchers to attend international meetings and visit international facilities.

Eligibility: For the purpose of this fund, an early career researcher is defined as an individual within three years of beginning their first paid contract of employment in industry or academia, either full-time or part-time, where research and/or the application of physics is the primary function of their role. This excludes any career breaks.

Early career researchers may apply for up to £300.

More details can be found at http://www.iop.org/about/grants/early-career/page_67022.html

Early Career Researchers Fund

Providing financial support to early career researchers to attend international meetings and visit international facilities.

Bursaries up to the value of £300 are available. Applications are considered on a quarterly basis and should reach IOP by 1 March, 1 June, 1 September and 1 December.

Am I eligible?

Early career researchers must meet the following eligibility criteria:

- Be within three years of beginning their first paid contract of employment in industry or academia, either full-time or part-time, where research and/or the application of physics is the primary function of their role (excluding career breaks)
- Be a member of IOP and at least one of its special interest groups
- Researchers in industry must secure funding from their employer or a third party to match the value of the bursary.

Note that grants will normally cover only part of the expenses incurred in attending a conference or visiting a facility, and are intended to supplement grants from other sources.

Meet the Committee



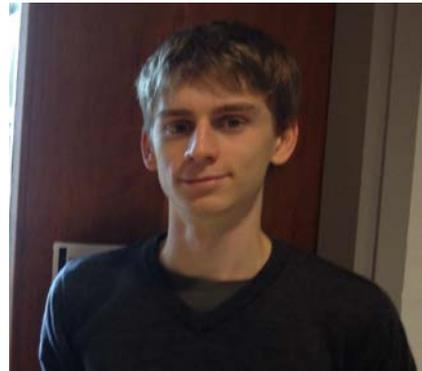
Yoshi Uchida (Imperial): Chair



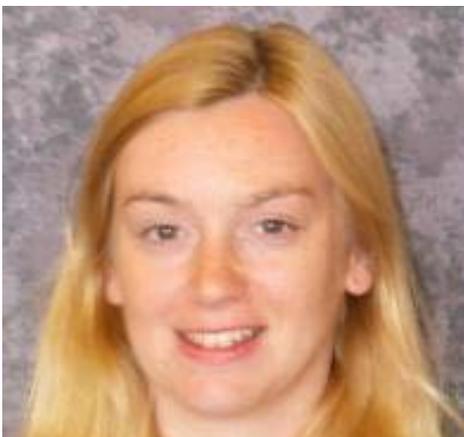
**Melissa Uchida (Imperial):
Half Days & PAB Group Cross-Member**



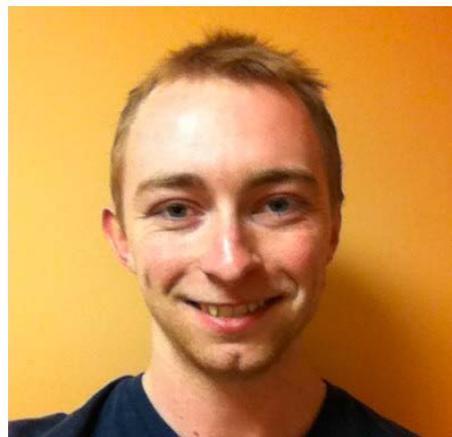
Franz Muheim (Edinburgh): Treasurer



**Kevin Maguire (Manchester):
Student Experimental Representative**



Sinead Farrington (Warwick)



**Darren Scott (Durham):
Theory Student Representative**



Celine Boehm(Durham):
Astroparticle Physics Cross-Member



Jarek Nowak (Lancaster):
Newsletter



Mrinal Dasgupta (Manchester)



Trevor Vickey (Sheffield):
Honorary Secretary



Helen Heath (Bristol)

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

Claire Shepherd (STFC, co-opted as chair of PPAP)

Elizabeth Cunningham (STFC, co-opted as head of particle physics outreach)

Disclaimer: views expressed herein are not necessarily those of the Institute of Physics, nor are they indicative of any current or future policy of the Institute.