

UK Plasma Physics News – Summer 2019.

Welcome to the UK IOP Plasma Physics Group (PPG) e-newsletter. If you have items for inclusion in future newsletters e.g. any meeting announcements or reports, research achievements, new appointments, facilities, projects, buildings etc. please contact: ken.mccléments@ukaea.uk.

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COMMITTEE NEWS

There have been two committee meetings since the last newsletter with several changes to the committee. We would like to take this opportunity to say thank you to those committee members whose terms have ended Ceri Brenner (treasurer), Paul Maguire, Bogdan Hnat and Ben Dudson, and would like to welcome David Carroll (treasurer), Anne-Marie Broomhall, Mohammad Hasan, David Dickinson and Kirsty McKay who are joining the committee. Further details of committee activity and actions are available on the [Group website](#).

RECENT MEETINGS

The University of York physics postgraduate conference 2018

On Thursday 20th and Friday 21st September 2018, the physics postgraduate conference was held, with a plethora of activities, talks and posters for PhD students to enjoy. It is the one time in the social calendar that students from all the different physics research groups (the condensed matter group, the nuclear group, the laser-plasma group, and the biological physics group) can get together and showcase their research, which is exactly what they did. They even had a few new starting postgraduates come down, many of whom hadn't been at the university for much more than a week, giving them inspiration for where they could be in a years' time.

A previous alumnus of the University of York, Dr Chris Kelley, opened the conference with an excellent presentation entitled "After a York PhD" in which he showcased some of the places he'd been and people he'd worked with since obtaining a PhD in physics, with a focus on the transferable skills and qualities that he obtained outside of specific subject and research knowledge. This was complemented nicely by a careers workshop provided on day two by Andrew Hirst which covered some useful tips about the subtle changes in CVs and the application process required in applications for jobs in industry compared with jobs in academia.

The main bulk of the conference was made up with contributions from York's Physics PhD students. The rest of day one was filled with ten-minute talks on whatever their research area was, with subjects

from the world's largest and most powerful lasers, to new modelling and imaging techniques of DNA in the human body. Day two kicked off with a more relaxed atmosphere during the poster session, where again students could showcase, explain, and discuss their research, with talks all throughout the afternoon to end the conference. They were fortunate this year to have the event sponsored by various IOP groups, and one private company too. The sponsors for the event were IOP Ion and Plasma Surface Interactions group, Nanoscale Physics and Technology group, Nuclear Physics group, Plasma Physics group, Shock Wave and Extreme Conditions group and Unitive Design & Analyse Ltd (London).



Sponsorship allowed the conference organisers to provide refreshments such as teas, coffees and biscuits throughout the conference, for which they are hugely grateful. They were also able to provide sponsored prizes for the best talks and posters of the conference. There were seven awards in total: three prizes for posters and four prizes for

talks. The winners of the prizes are Joshua Boothroyd for best poster on "Potential method to measure atomic chlorine reactivity in ambient air", Ashley Poole runner up for his poster on "Temperature measurement in opaque shocked solids using x-ray diffraction", Ryan Llewellyn honourable mention for his poster on "Isospin symmetry and nucleon collectivity in the neutron-deficient A=80 region", George Watson for best presentation on "Molecular dynamics of super coiled DNA mini circles". The runner up presentation winners were Daniel Clarke for "Magnetic hyperthermia in medical applications", Stuart Morris for "Bremsstrahlung characteristics in focussing plasma mirror experiments", and William Trickey for "A shock ignition scheme using an x-ray driver for inertial confinement fusion". Congratulations to all the prize winners.

A large thank you should be expressed to Nicola Farthing who worked tirelessly to organise the event. The physics postgraduate conference certainly wouldn't have come together without all her efforts, but also a large thank you to everyone who either delivered a talk, presented a poster, or even those who just came to participate by asking questions. All in all, a fantastic conference, that they look forward to the same again this year!

4th Microwaves and Beams in Plasmas Meeting 2018

The fourth Microwaves and Beams in Plasmas meeting was hosted by the York Plasma Institute (YPI) on the 11th - 12th December 2018. There were 13 delegates representing Culham Centre for Fusion Energy (CCFE), the University of Strathclyde, the University of York, University of Oxford, the Max-Planck-Institute for Plasma Physics, Universität Stuttgart and Tokamak Energy. Experimentally led papers included: an update on ST40 at Tokamak energy, focussing on microwave heating, current drive and diagnostics; results presented of a major step forward in high power fast wave microwave amplifier research with potential impact on heating and diagnostics for fusion plasma (and other applications); development of a new Linear experiment for microwave-plasma coupling experiments; development of new diagnostics for fusion plasmas (SAMI-2).

Numerical simulations and theory underpinned three papers investigating the propagation of microwave beams into complex plasma environments, including turbulence and edge plasma effects

and the implications for interpretation of diagnostic measurements. There were two papers on high power interactions of microwaves non-linearly perturbing plasma. Opportunities for collaboration between these teams, the theoretical groups (at York and Strathclyde), and the new facility being developed at Strathclyde were recognised. Numerical simulations also featured strongly in two reports from the experimental teams at Strathclyde and York. Strathclyde reported on progress towards future high power slow wave amplifiers, whilst York outlined capability in high frequency precision diagnostics.

The hosts at YPI arranged a visit for all delegates to their laboratories, which led to further discussions and opportunities for collaboration. The meeting closed with the agreement that the next (5th) meeting would be hosted by Strathclyde about a year later. The co-ordinators of the meeting (CCFE, York and Strathclyde) and participants gratefully acknowledge the sponsorship of the Institute of Physics Plasma Physics Group, which was used to help with the costs of hosting the meeting at York. Support for T&S for overseas participants from the Computational Consortium in Plasma Physics (CCPP) is also gratefully acknowledged. There is a substantial developing interest in microwave diagnostics in magnetised plasmas, driven by forthcoming experiments on MAST-U, the development of the Spherical Tokamak for Energy Production (STEP) project, research at Tokamak Energy, the new experiments at Strathclyde and the forthcoming EISCAT-3D capability. The organisers look forward to the developments to be reported in December 2019.

International Conference on High Energy Density 2019



The International Conference on High Energy Density (ICHED 2019) that Peter Norreys chaired on behalf of the Institute of Physics Plasma Physics Group brought together 110 scientists from all over the world. The concept of the meeting was to allow interactions and new collaborations to form among the participants. High-energy-density physics concerns the behaviour of systems roughly characterized as having a pressure above one million atmospheres. One finds high-energy-

density conditions in the big bang, in stars, in planets, and in dynamical systems such as supernovae and gamma-ray bursts. Beyond that, these systems are the only laboratory environments that access high-Mach-number shock waves in ionized matter, conditions also common to many observed astrophysical phenomena. Many of these topics were covered in the conference.

The first day was given over to tutorial talks by eminent scientists for new students and post-doctoral scientists. There was also a special dinner in honour of Professor Steven Rose to celebrate his distinguished career in plasma physics, including appointments as Associate Director of the Central Laser Facility, Head of Plasma Physics at AWE plc and at Imperial College London, as well as vice-Dean Natural Sciences at Imperial College London. The oral talks were given in the beautiful setting of University College Chapel. Tea, coffee and lunch



breaks were served in the Univ Hall. At the end of the meeting, participants commented on how useful they found the meeting (with everyone able to interact at the coffee breaks, over lunch and dinner), similar to a Gordon-conference.

I am deeply grateful to the sponsors of the meeting – AWE plc, STFC and First Light Fusion in the UK, the NNSA in the USA, as well as the CEA, CELIA and Ecole Polytechnique in France – to allow us to provide a supportive environment for next-generation scientists to be introduced to these cutting edge topics by the world's leading experts.

The best student presentation was awarded to Miss Kelli Humbird from LLNL for her talk entitled “Machine learning guided discovery and design for inertial confinement fusion” with runner up awards for Alexander Savin from the University of Oxford for his presentation “Energy absorption in the laser-QED regime” and Gabriel Rigon (LULI Laboratory, Ecole Polytechnique) for his paper “Effect of the Atwood number and initial perturbation on the Rayleigh-Taylor instabilities”. Many congratulations to these young scientists on receiving this recognition of distinction.

We look forward to assembling again in two years' time in the United States under the leadership of Professor Carolyn Kuranz (University of Michigan).

46th IOP Plasma Physics Conference

The 46th IOP plasma physics conference took place at Holywell Park Conference Centre, Loughborough from 23rd-26th April 2019. Around 70 delegates attended and a total of 33 talks were given including the Rutherford Prize talk given by William Trickey of the University of York on behalf of A Glass of



Seawater, the Culham thesis prize talk given by Dr Kevin Verhaegh of the University of York, and the Malcolm Haines prize talk given by Dr Nick Walkden of CCFE. The delegates enjoyed an excellent programme of talks and posters covering all aspects of plasma physics including magnetic and inertial confinement, lasers, space plasmas and technological plasmas. They also had the opportunity to enjoy optional excursions to Woolsthorpe Manor, King Richard III Visitor Centre and John Taylor Bell Foundry Museum, and a conference dinner held at Burleigh Court (a four-star hotel and conference centre). During the dinner the prize winners were awarded their certificates and the student poster prize

winner Patrick McCarthy of the University of Liverpool, for a poster entitled “Enhanced fuzzy tungsten growths due to tungsten deposition” was announced. A public lecture was given on the Wednesday evening by Professor Ian Chapman (CEO of UKAEA), with the title "The Path to Delivering Fusion Power". This was well attended and was an interesting and well received talk. For the first time the conference was also co-located with the UK Pulsed Power Symposium (a one-day international event), which gave even more networking



opportunities. We thank Felipe Iza (Loughborough), Claire Garland (IOP) and Joseph MacNamara (IOP) for all the hard work they put in to organising this meeting. We are also very grateful to the IOP, CCFE, STFC and AWE for their financial support, without which the meeting could not have taken place.

FORTHCOMING MEETINGS

[TPW 2019](#): 9-10 October 2019 at Ricoh Arena, Coventry, UK. Early registration and abstract submission deadline: 1 September 2019.

5th Microwaves and Beams in Plasmas Meeting: 2019 at Strathclyde University

Joint meeting with IOP Medical Physics Group 2019: October or November 2019 at IOP, 37 Caledonian Road, London, UK.

[47th IOP Plasma Physics Conference](#): 21-24 April 2020 at IOP, 37 Caledonian Road, London, UK. Abstract submission deadline: 24 January 2020.

COMMUNITY NEWS

AWE/University of Oxford

AWE-SOME Oxford Stargazing



The exhibit at Oxford Stargazing (Pictures courtesy of University of Oxford)

A large plasma ball definitely drew in the crowd with extra gasps of awe, and not just from the children, when the stall-holders, Charlotte Palmer and Jacob Topp-Mugglestone, University of Oxford, demonstrated how a fluorescent tube begins to glow as it approaches the ball. After that, everyone was excited to get stuck into the practicalities of laser experiments and after learning the fundamental laser rules ('Never look into a laser, or shine it in somebody's eye'),

Despite the dreary weather over 1,000 members of the general public visited the 'Oxford Stargazing' Event on Saturday 26th January in the Denys Wilkinson Building, Physics Department, University of Oxford, with one youngster overheard saying they wanted to stay forever!

The event covered an enormous range of space-based activities included 15-minute talks from academics within the University of Oxford Physics Department such as 'A history of the Universe for those short on time' and 'How to discover a planet', an inflatable planetarium, 'astro-crafts', and of course what stargazing was possible through the clouds! In addition to this a number of interactive stalls were set-up in the café including one show-casing our very own terrestrial Orion and the laboratory astrophysics experiments from recent years.



You're never too young to learn how to align a laser!

they got busy building laser beamlines with the ‘LaserMaze’ game.



The fascination of the plasma ball.

The material for the event was first put together for the Royal Society Summer Science Exhibition 2017, a joint collaboration between the University of Oxford, Imperial College London and AWE, with the pull-ups shown later used in a ‘Science Museum Lates’ exhibition in London.

With wonderful baseball cards, book-marks and fridge-magnets, designed by Oxford researcher Dr. Jena Meinecke and commissioned by AWE, people were able to take a little souvenir to remind themselves of their AWE-some, astrophysics day.

CCFE

JET operations contract

The future of JET was secured in March 2019 with a new contract signed between the UK and the European Commission. The new contract guarantees JET operations until the end of 2020, regardless of the Brexit situation. UK Science Minister Chris Skidmore said: “Having made my first speech at Culham, I know how hardworking and dedicated the staff there are, which is why I’m pleased to announce this agreement, which is great news for the future of scientific research in Oxfordshire, the UK and Europe.



“Extending this contract means cutting-edge and world-leading fusion research can continue in this country, which I know will be a welcome reassurance to the hundreds of workers at Culham.

“Science has no borders and as we leave the EU, this kind of international collaboration remains at the heart of our modern Industrial Strategy to maintain the UK’s position as a world leader in research and innovation.”

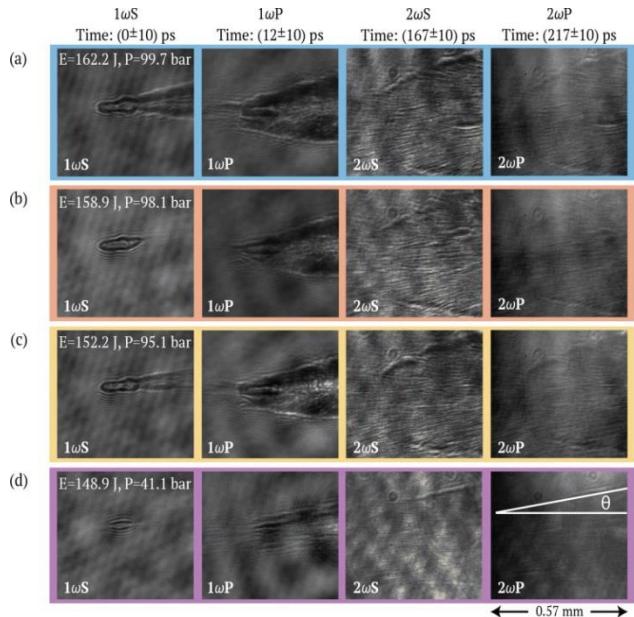
JET is operated by UKAEA for scientists from 28 European countries, who use it to conduct research through work co-ordinated by the EUROfusion consortium, which manages and funds European fusion research activities on behalf of the European Commission. As JET is covered by the Euratom Treaty, its future has been under discussion since 2017, when the UK Government decided to leave Euratom as part of the process of exiting the EU. This new contract means that JET can conduct a series of vital fusion tests planned for 2020. These tests will serve as a ‘dress rehearsal’ for the international experimental fusion reactor, ITER, currently being built in France.

Professor Ian Chapman, UKAEA's CEO, said: “The extension to the contract is excellent news for both EU and UK science. JET has been a shining example of scientific co-operation between EU members, and this news means that these mutually beneficial collaborations will continue, allowing us to do essential experiments on the path to delivering fusion power.”

Prof Tony Donné, Programme Manager of EUROfusion, added: “A heavy weight has been lifted off our shoulders. This is extraordinarily good news for EUROfusion and the European fusion community as a whole. We can now continue to work on the realisation of fusion energy together with the indispensable experience of our British partner.”

CLF

That was fast – making movies of picosecond laser plasma dynamics



Using a new approach to ultra-fast imaging, researchers at the University of Strathclyde and CLF have been able to capture snapshots of laser plasma interactions on the picosecond scale and measure the evolution of important plasma processes. Laser-plasma interactions are a point of interest as they offer a way to access exotic states of matter and can serve as a compact source of radiation. It is therefore essential that the underpinning plasma dynamics are understood.

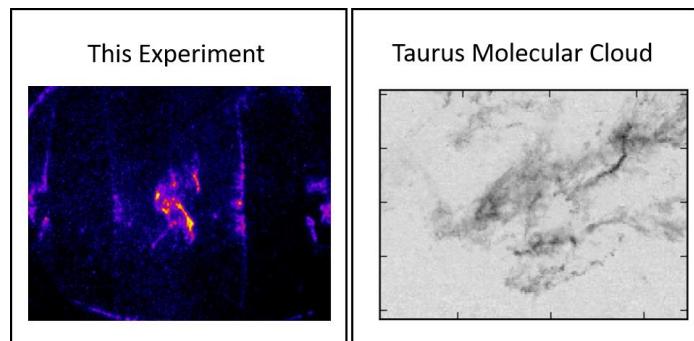
The newly developed system consists of a multi-channel optical probe which is capable of spatial and temporal imaging of laser

plasma interactions. The system was tested on Vulcan in an intense laser-plasma interaction experiment. The laser pulse rapidly self-focuses in the plasma because the intense laser pushes electrons away from the centre of the plasma channel causing the low intensity wings of the laser pulse to propagate faster than the peak. With the new optical probe it is possible to observe this happening in a single shot and the subsequent breakup of the plasma channel as it filaments. The primary takeaway from these first results is the difference in temporal evolution for shots with very small fluctuations in initial parameters.

For the full story and link to the Optics Express publication, see here: https://www.clf.stfc.ac.uk/Pages/That_was_fast_%E2%80%93_making_movies_of_picosecond_laser_plasma_dynamics.aspx

Scientists tackle the great unpredictability of turbulence using Vulcan Laser

Turbulence is a familiar term to most of us – from the seemingly random turbulence that aeroplanes encounter, to the way milk swirls as it mixes into your tea. However it remains that, despite decades of effort, astrophysical turbulence in particular has so far been impossible to predict. While many



observations have been made, and there has been progress in the past to simulate or calculate mathematically turbulence's seemingly random whirls and cascades, the phenomenon remains largely mystery.

For example, observations of the turbulence in the Orion B and Perseus molecular clouds show large deviations from those predicted for turbulence, yet attempting to improve predictions through observation may take millions of years, as these are the timescales that astronomical molecular turbulence patterns move in.

Part of the reason why astronomical molecular turbulence is so hard to predict, is the creation of small shock waves during the process. So, in order to simulate turbulence complete with shockwaves, a team from the University of Oxford led by Gianluca Gregori in collaboration with the Central Laser Facility (CLF) recreated it right in the CLF's Vulcan lab – effectively creating miniature astronomical turbulence on a tiny, observable scale. They were able to watch the turbulence transition from low-velocity turbulence to the sort of high-velocity turbulence seen in star-forming nebulae – the first time this has been studied in the laboratory.

For the full story and link to the Nature Communications publication, see here: <https://www.clf.stfc.ac.uk/Pages/turbulence-using-Vulcan-Laser.aspx>

PRIZES AND AWARDS

Rutherford Prize for the Communication of Plasma Physics 2019 (sponsored by STFC) 2019



The Rutherford Plasma Physics Communication Prize is an annual award sponsored by STFC Central Laser Facility and hosted by the IOP Plasma Physics Group.

The award recognises those who exemplify excellence in outreach to the general public through the communication of plasma physics to those that are non-experts and is open to ALL members of the plasma physics community, whose application is judged by a

distinguished panel of scientists and communicators (including one plasma physicist, one non-plasma physicist and one non-physicist).

This year's winner is the A Glass of Seawater team for their podcast series on fusion and fusion-related plasma physics. The judges were particularly impressed with this grass roots initiative to start a relaxed and entertaining series that adds plasma physics to the subjects available on this fast-growth communication platform: "I listened to the one with Jim Al Khalili and it was very good! Relatively high production, thoughtful questions, a good range of topics covered and well-pitched. Plus it sounded like a conversation, not just an interview which is a good thing."

The team is made up of Fusion CDT PhD students who volunteer their time to write, present, and produce each episode, with a new one coming out approximately once a month. The series is available on iTunes and can also be streamed from their website (<https://www.fusion->

cdt.ac.uk/outreach/podcast-2/ where they include additional notes and links to support the content featured in each episode. William Trickey, University of York, collected the prize on behalf of the team and gave an introduction to the podcast, which is now on its second series, at the IOP PP Conference 2019. Twitter account: @GlassOfSeawater

Culham Thesis Prize (sponsored by CCFE) 2019

The Culham Thesis Prize is an annual award sponsored by [Culham Centre for Fusion Energy](#) (CCFE) and jointly coordinated by CCFE and the [IOP Plasma Physics Group](#).

The [Culham Thesis Prize](#) is awarded to the candidate who has displayed the highest degree of excellence in the execution of the scientific method as witnessed by the award of Doctor of Philosophy in plasma science from a UK or Irish university in the last two calendar years.

The thesis content should exhibit significant new work and originality, clearly driven by the nominee, be well explained and demonstrate a good understanding of the subject.

This year's winner is Dr Kevin Verhaegh from the University of York for his thesis: Spectroscopic investigations of detachment on the Tokamak à Configuration Variable (TCV).

He received a prize of £500 plus an expenses paid trip (to a maximum of £500 for travel) to the annual [IOP plasma physics conference](#), where he gave an invited talk. Congratulations Kevin!



Malcolm Haines Prize 2019



The [Malcolm Haines Prize](#) is a new biennial award funded by Malcolm Haines' widow, Polly Haines and hosted by the IOP Plasma Physics Group.

The Malcolm Haines Prize was created in honour of the late [Malcolm Haines](#), an outstanding plasma physicist at Imperial College London. It recognises early researchers for outstanding research carried out in the UK or Ireland, leadership and/or innovation in any area of experimental or theoretical plasma physics. A panel of experts is appointed to act as judges for the prize.

The first ever winner of the Malcolm Haines Prize is Dr Nicholas Walkden who is currently a research scientist at CCFE.

The award is in recognition of his important research on the physics of low-temperature plasmas in the edge (scrape-off layer) and divertor regions of tokamak fusion devices. His rare combination of capabilities, encompassing theory, modelling and experimental measurement, has provided fundamental insights into plasma transport.



His contributions include: measurements and simulations which led to the identification of transport mechanisms driving the observed spatially-broadened density profiles in the scrape-off layer; and the first efforts to explain the nature of the turbulence in the divertor region, and what role it may be playing in transport. The resulting publications are internationally recognised for their quality and novelty, and his participation on different tokamaks is much sought after. He received a prize of £500. Congratulations Nick!