

IOP | Institute of Physics **Plasma Physics Group**

UK Plasma Physics News – Christmas 2015

Seasons greetings to all PPG members, and wishing you all every success for 2016!

Welcome to the UK IOP Plasma Physics Group (PPG) e-newsletter. If you have items for inclusion in future newsletters, please send these to p.browning@manchester.ac.uk – meeting announcements, research achievements, new appointments, facilities, projects, buildings etc.

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RECENT MEETINGS

13th Technological Plasma Workshop: 14th -15th October 2015

The Technological Plasma Workshop was held in Coventry alongside the Vacuum Symposium at the Vacuum Expo at the Ricoh Arena, on the 14th and 15th of October 2015. The Technological Plasma Workshop (TPW) is principally a UK-based international forum in science and technology of plasmas and gas discharges. Presentations were given on opportunities for UK universities to be involved with the Mega Amp Spherical Tokamak experiment at Culham Centre for Fusion Energy and the quest for compact fusion by Tokamak Energy Ltd. Other presentations covered diverse topics ranging from diamond based micro-plasma devices for chemical processing and the use of micro-discharges for the production of high current density electron beams for the generation of THz radiation, to surface modification of polymer films using atmospheric-pressure plasma jets and the study of charging of micro-sized water droplets laced with bacteria through an atmospheric plasma system. The use of atmospheric-pressure dielectric barrier discharges for bacterial inactivation was presented. For materials modification circular ion sources for plasma enhanced atomic layer deposition applications and plasma analysis of an inductively coupled impulse sputtering system for the deposition of magnetic materials were presented. An overview of the plasma modelling code VSim was also given at the meeting.

The conference programme consisted of 11 oral presentations and 15 poster presentations with thirty people attending the TPW session from a mixture of UK institutes. The best student poster prize supported by Hiden Analytical Ltd was awarded to Alex Shaw of the University of Loughborough for his work on using cold atmospheric-pressure plasma to promote cell adhesion onto polydimethylsiloxane to study the response of corneal epithelial cells to mechanical stress. The support of IoP Plasma Physics Group and Vacuum Expo which had over 120 delegates presenting at the symposium enabled no registration fee to be set for this two day conference. The workshop based within the wider Vacuum Symposium was used as a form for exploring collaborative opportunities between the academic and industrial communities. The Ricoh Arena is an excellent venue with high quality attendees and provided the ideal meeting place for the next generation of researchers in this field to engage with leading researchers in both academia and in the wider

plasma and vacuum based industries. We look forward to seeing you at TPW 2016 at this excellent venue in October 2016.

FORTHCOMING MEETINGS

43rd IOP Plasma Physics Conference: 23rd – 26th May 2016, Isle of Skye

<http://plasma16.iopconfs.org>

We are very pleased to remind you that our annual conference in 2016 will be held at Sabhal Mor Ostaig in the beautiful Isle of Skye, hosted by Declan Diver (University of Glasgow).

As ever, this conference covers all aspects of plasma physics, including Magnetic and Inertial confinement Fusion, Astrophysical and Space Plasmas, Low Density and Technological/Industrial Plasmas, High Energy Density and Laser Plasmas, Dusty and Complex plasmas, Plasma Surface interactions, and Plasma Applications including Medical applications and Plasma Diagnostics. This is a very attractive venue which should foster discussions and interactions between delegates (as well as presenting wonderful opportunities for holidays post- or pre- conference!). The costs of the conference are likely to be very reasonable, which should offset (possibly) higher than usual travel costs. Coach travel will be available from Inverness airport.

Call for abstracts coming soon - deadline February 8th, so start planning!



The PPG Committee is always keen to receive offers from members to organise one day meetings, especially on topics which bring together different areas of research. We have a small amount of funding available to support such meetings, and can assist with publicity, finding speakers etc.

PRIZES AND AWARDS

Award of IOP Payne-Gaposchkin Medal

We congratulate Valery Nakariakov, University of Warwick, on the award of the prestigious Institute of Physics Payne-Gaposchkin medal, for excellent achievements in plasma physics. This was awarded to Valery in recognition of his leadership and major contributions to the discovery of MHD wave activity in the corona, and his role in the creation of the field of coronal seismology. The medal was presented at the IOP Awards Dinner in November.

http://www.iop.org/about/awards/subject/payne_gaposchkin-/medallists/page_65834.html

IOP Bates Prize

We would like to congratulate Dr Janet Anders from the University of Exeter on being the winner of the IOP Bates Prize 2015 for her pioneering contributions to quantum information theory and its application to quantum thermodynamics. The Bates Prize is awarded in odd years to commemorate Sir David Bates FRS and his pioneering studies of atomic and molecular processes and their role in atmospheric science, plasma physics and astronomy. It is awarded to an early-career researcher for outstanding research on a topic relevant to the QQQ, AMIG, MPG, QEP and Plasma Groups.

Other prizes and awards

We are pleased to announce that the winner of the IOP Women in Physics Group Very Early Career Award this year was a plasma physicist – Jena Meinecke from the University of Oxford.

Congratulations to Jena!

http://www.iop.org/news/15/nov/page_66531.html

We also congratulate Manuel Macias Montrose from the University of Ulster, on the award of the Spanish Ebro Foods award

www.ciccartuja.es/en/highlights/ciccartuja-ebro-foods-award/2014-award/

Rutherford Plasma Physics Communication Prize

The Rutherford Plasma Physics Communication prize, generously sponsored by STFC, is awarded for an excellent achievement in outreach – this could be a podcast, video, lecture, public talk, website, essay, blog, article etc. All plasma physicists within our group should be eligible to apply (rather than just PhD students, as previously). So start thinking now about good cases, from yourself or people you know!

A full announcement will be circulated in the New Year, with deadline Friday 8th April.

IUPAP Commission on Plasma Physics Young Scientist Prize

The IUPAP Commission on Plasma Physics has announced that it is seeking nominations for its 2016 Young Scientist Prize, with nominations due 31 January 2016. We have some exceptional young plasma physicists in the UK, and it is important that this is reflected in the strength of our nominations.

The website which gives more details and the nomination procedure is at

<http://iupap.org/commissions/c16-plasma-physics/c16-news/>

COMMUNITY NEWS

News from CCFE - New JET campaign underway



A new JET campaign (C35) recently started with a focus on preparation for the D-T campaign towards 2020 which aims to demonstrate D-T fusion power of 10-15 MW in stationary conditions (for ~5 s).

The campaign will run from November 2015 – Spring 2016 during which high performance sustained plasma scenarios of ~5s duration will be investigated with particular emphasis on how they interact with JET's ITER-Like 'metal' wall. In practice, this means optimising high confinement and so-called hybrid plasmas with high levels of heating power from the Neutral Beams and Radio Frequency heating systems whilst carefully controlling the power into the divertor region using gas seeding mechanisms.

If successful, the results of the 2015-2016 campaign, taken together with studies in other devices, are expected to improve our predictive capabilities and confidence in future experiments in JT-60SA, ITER and DEMO.



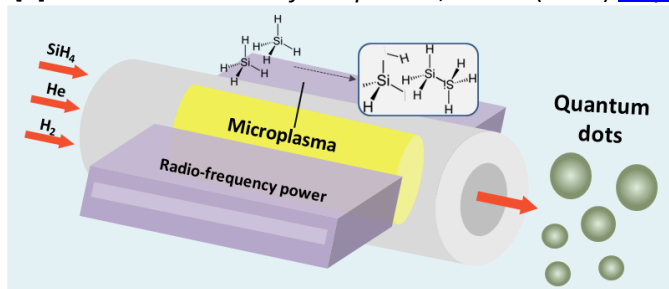
Photos: JET Control Room - November 2015.

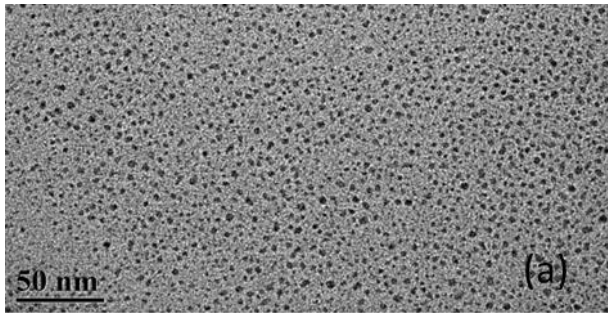
News from University of Ulster - new nanomaterials with atmospheric pressure plasmas and liquids

University of Ulster plasma and materials groups, led by Profs Mariotti and Maguire, have just reported a number of interesting breakthroughs in quantum confined nanomaterials using atmospheric pressure gas-phase plasma synthesis and in highly dispersed polymer nanocomposite fabrication via plasma – liquid – solid interactions. Their paper in *Advanced Materials* [1] demonstrated quantum confinement in free-standing amorphous silicon nanoparticles, as a complement to their existing work on crystalline silicon nanoparticles, with important consequences for application in biomedicine or drug delivery. Adding nanomaterials to polymers to form composite materials is a very active research area but suffers significant challenges in getting the nanomaterials to integrate with the polymer. In their *Scientific Reports* paper [2], they demonstrate a stable dispersion and binding of TiO₂ nanoparticles to a conductive polymer, PEDOT:PSS, for up to 75% solids loading, using an atmospheric pressure plasma in contact with the liquid monomer. This has important implications for the design and fabrication of third generation solar cell devices. These examples highlight the increasing worldwide recognition of atmospheric pressure plasmas as a key enabler of high quality nanomaterials synthesis with prospects for scaling in the near future to an operational Green Chemistry Technology for a wide range of applications.

[1] Askari, S. et al., The Interplay of Quantum Confinement and Hydrogenation in Amorphous Silicon Quantum Dots. *Adv. Mater.* (2015) <http://dx.doi.org/10.1002/adma.201503013>

[2] Yazli Liu et al. *Scientific Reports* **5**, 15765 (2015) <http://dx.doi.org/10.1038/srep15765>





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Further information on the groups' activities are at www.plasmamate.org and www.plasmamate.net

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News from Central Laser Facility: research highlights

The CLF's Vulcan laser has been used to shed light on our understanding of some of the most mysterious celestial objects just beyond the solar system - brown dwarfs. The work, led by York's Nigel Woolsey and CLF's Nicola Booth, involved creating "lumps" of plasma to recreate the conditions similar to those found deep inside brown dwarfs and was published in Nature Communications. The full article is available on the CLF website:

<http://www.clf.stfc.ac.uk/CLF/45360.aspx>

The laser-driven method of taking highly detailed x-ray images of bone has been demonstrated using the CLF's Gemini laser and published in Nature Scientific Reports. The Imperial College team, led by Jason Cole and Stuart Mangles, acquired a high resolution 3D reconstruction image using the X-rays emitted from a laser-plasma Wakefield accelerator. The full article is available on the CLF website: <http://www.clf.stfc.ac.uk/CLF/News+and+Events/45253.aspx>

News from Central Laser Facility: Alex Robinson is the new CLF Group Leader for Plasma Physics

As you may know, Peter Norreys has for the last 2 years been a 50:50 joint appointment between CLF and Oxford University where he has a Chair in Inertial Fusion Science in the Clarendon Laboratory, and where he also runs the Oxford-Imperial-Warwick "Centre for Postgraduate Training in Plasma Physics and High Energy Density Science". Recently, he has also been appointed a tutor at University College, the oldest of all of the Oxford Colleges. Consequently, given these multiple demands on his time, he has reviewed his work load and has decided that he needs to relinquish his group leader responsibilities in the CLF. Peter though will remain an STFC Individual Merit Scientist and you will still see him about the CLF on a regular basis.

"I'm delighted that Alex Robinson has agreed to take over the leadership of the CLF's Plasma Physics group – Alex is a scientist of the highest calibre that is well known to everyone in the department and our community, and I'm certain will be an excellent leader taking the group forward. I trust that you will join with me in wishing both Peter and Alex all the best in their respective new roles." John Collier, CLF Director.

Alex was until recently Treasurer of the PPG Group, and the Committee offers him warm congratulations on this new role.

SOME THOUGHTS ON MAGNETISED PLASMAS

The following letter from an eminent member of the PPG Group should be of interest to members, and may perhaps spark some interesting debate.

The views expressed do not necessarily reflect the views of the PPG Committee.

Letter to Physics Today from John Allen, Emeritus Professor of Physics, University of Oxford

I am rather worried about whether or not the Fusion Community understands the behaviour of a plasma. On looking up ITER on the web I found the following sentence “In a plasma, electrons and ions move independently”, but nothing could be further from the truth. In a collision-free plasma the electrons and ions move under the influence of both electric and magnetic fields; these fields are produced by the spatial distribution of charged particles, and by their velocities. It seems to be assumed by the Fusion Community that the motion of the charged particles depends solely upon the magnetic field, such that they perform helical orbits. But it is very difficult indeed to find a plasma which is free from an electric field. Electric fields are produced by tiny differences between the electron and ion number densities. Such fields in a quasi-neutral plasma were studied by Tonks and Langmuir¹ in 1929; it was Langmuir² who introduced the name “plasma” in this field of physics in 1928.

A well-known relation pertaining to the self-magnetic “pinch effect” was obtained by Bennett³ in 1934. At an EPS Conference⁴ in 2010 I presented a poster entitled “The Bennett pinch revisited”. The theory used by Bennett was entirely different from that found in the textbooks on Plasma Physics, which use a theory being based on Magnetohydrodynamics (MHD), the theory of electrically conducting liquids. Bennett considered instead two assemblies of particles, one of electrons and one of positive ions. A relativistic treatment was employed, although the “non-relativistic” results could be readily deduced and were given by Bennett. The conclusion reached on reading this paper is that, in the well-known “pinch effect”, the positive ions are contained by a radial electrostatic field (ignoring instabilities for the present discussion). The ($\mathbf{j} \times \mathbf{B}$) force is transmitted to the ions *via* the electrostatic field. It follows that the generally accepted picture of ions and electrons gyrating around magnetic field lines is simply incorrect. The ion Larmor radius is not a relevant quantity when the ($\mathbf{j} \times \mathbf{B}$) force exists, e.g. in systems employing magnetic confinement.

1. L. Tonks and I. Langmuir, *Phys. Rev.* **34**, 448 (1929).
2. I. Langmuir, *Proc. Natl. Acad. Sci.* **14**, 627 (1928).
3. W.H. Bennett, *Phys.Rev.*45, 890, (1934).
4. J.E.Allen, *37th EPS Conference on Plasma Physics, E.C.A.*, **34A**, P4, 181 (2010).

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