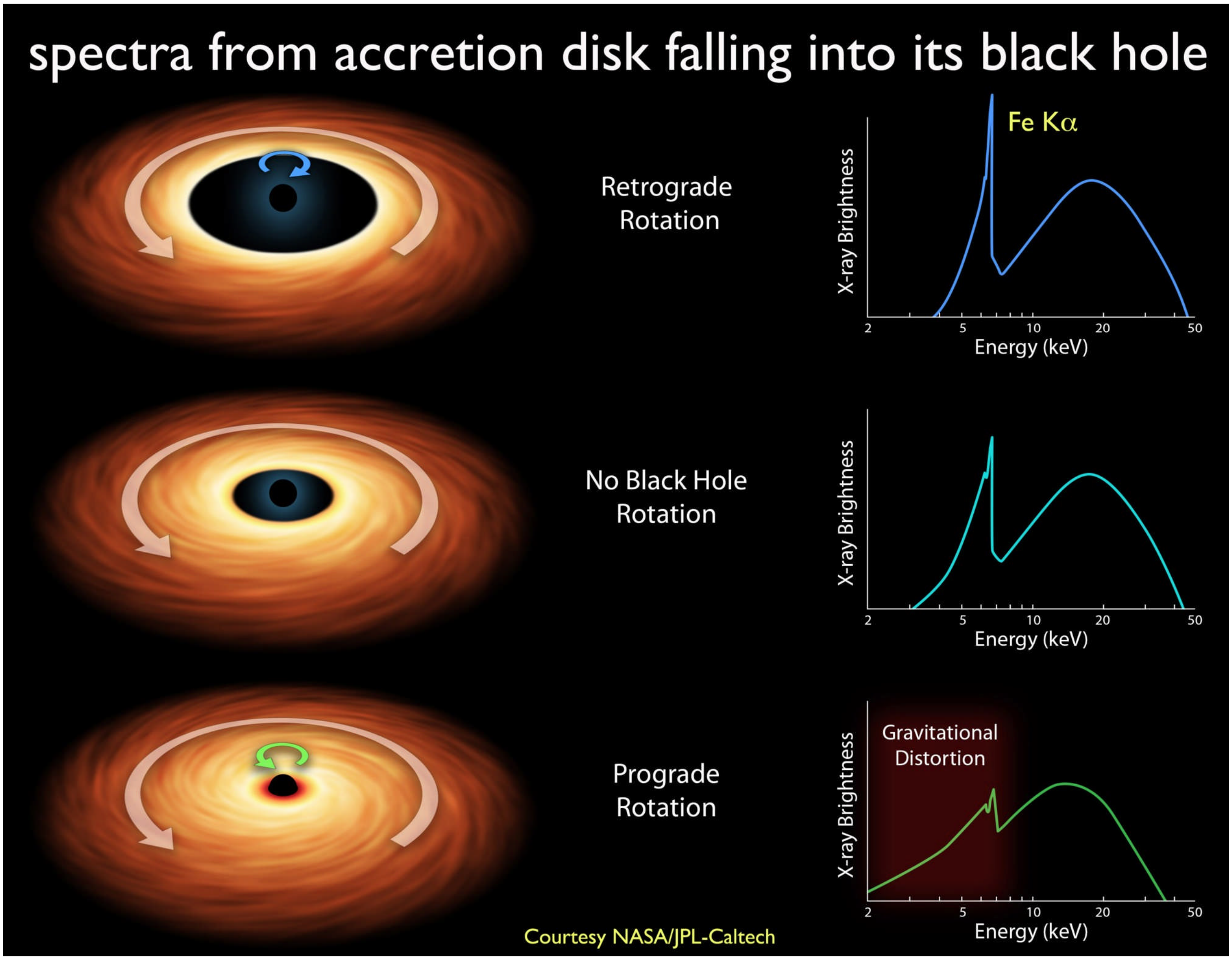
IRPS BULLETIN

Newsletter of the International Radiation Physics Society

Vol 27 No 1 March, 2013



One is constantly amazed at the exotic applications and breadth of physical insight that continues to spring from "old fashioned" x-ray spectroscopy. The choice of the cover art for this issue was inspired by a recent report in Nature* on the first determination of the spin rate of a supermassive black hole; and it is 84% as fast as Einstein's theory of gravity will allow. This required combining measurements from two x-ray spectroscopic space observatories, NASA's Nuclear Spectroscopic Telescope Array (NuSTAR) and the European Space Agency's XMM-Newton, in this instance both focused upon a galaxy-centered black hole (NGC1365) that has a mass 2 million times that of our sun and is 56 million light years distant. This required assessing both the higher energy continuum portion of spectra (10 keV to 30 keV from NuSTAR) as well as the broadened x-ray emission lines from neutral and partially ionized iron (XMM-Newton), interpreted as fluorescence produced by the reflection of hard X-rays (from the relativistic jet) off the inner edge of an accretion disk. The line broadening occurs from Doppler broadening, gravitational red shifting, and "blue shifting" from partially ionized Fe.

A rapidly spinning supermassive black hole at the centre of NGC1365*, G. Risaliti *et al*., Nature **494 (2013) pp. 449-451.

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Contacts :

Items for the Bulletin : **Ron Tosh, Larry Hudson**

Membership Enquiries : **Elaine Ryan**

Layout and distribution of the Bulletin : **Shirley McKeown**

Web Pages : **Shirley McKeown**

Contact addresses are listed in the IRPS information above.

Internet Address : http://www.canberra.edu.au/irps

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Contents of this Journal

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Elaine Ryan

email: **elaine.ryan@sydney.edu.au**

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Dr William L. Dunn
Department of Mechanical and Nuclear Engineering
Kansas State University
137 F Ward Hall, Manhattan, KS 66506, USA
Phone : 785 532 5628
email : **dunn@mne.ksu.edu**

From the Editors

Viewed from the relatively safe remove of 56 million light years, the relativistic violence inflicted on the inner edge of an accretion disk by a spinning black hole – as featured in our cover art for this issue – can be unambiguously discerned and analyzed in the x-ray emission spectrum. A stirring testament to the extraordinary interpretive reach of radiation physics occasioned by decades of basic and applied research that also calls to mind the debris cloud surrounding our own Sun and, in particular, how our relative ignorance of its inner edge made us helpless spectators to near disaster over the city of Chelyabinsk, Russia on the morning of February 15, 2013.

Only sixteen hours after this 11 Gigagram superbolide meteor inserted itself into our atmosphere, a 40 Gigagram asteroid (2012 DA_{14}) sauntered by just under the orbital paths of Earth's geostationary weather satellites. People around the world were suddenly mobilized to reflect upon the sorry state of space science that might otherwise enable such objects to be identified and deflected before impact. How this will unfold is hard to say, given an economic climate buffeted by financial institutions considered too big to fail and a scientific undertaking that some would consider too big to succeed.

The threat of catastrophe may work to galvanize public interest in such problems, but generating the sort of broader mandate needed to overcome initial skepticism about prospects for success in ambitious scientific quests requires more thoughtful engagement by the public with the underlying issues and opportunity costs. Spectacular success stories like detection of the Higgs particle are helpful in this regard, but perhaps more so would be outreach to the general public that fosters an appreciation of how connected the entire scientific enterprise is internally, within and across disciplines, and to the greater economy.

These are stories that many in our Society are equipped to tell, and one exemplary case is provided in these pages with a submission by former IRPS President Professor Dudley Creagh (Australia) that chronicles efforts by him and colleagues to establish and grow a community of synchrotron scientists in Australia who would ultimately conduct experiments at beamline 20B at the Photon Factory in Tsukuba, Japan. Immediately following that is an appreciation by one of those scientists, Professor Feng Wang (Australia), written upon conclusion of the final experiment conducted at 20B prior to its decommissioning. Reprinted (with permission) from Physics Today we have a short article on the Top Physics Stories of 2012, and, looking ahead, announcements pertaining to the 1st International Conference on Dosimetry and Its Applications (Prague, Czech Republic, June 23-28, 2013) and to the release of a new book, Experiments in Nuclear Physics: A Laboratory Manual, submitted by one of its authors, IRPS member Leif Gerward. This impressive lineup leads off with a personal tribute to a longtime NIST colleague of one of us (Larry Hudson).

The IRPS Bulletin regularly features spotlights on Society members and colleagues, institutions and specialized facilities, discoveries and topical reviews relevant to the radiation sciences. This issue includes all of the above and more. You, dear reader, are invited to contribute similar content that would be of interest to our community. Indeed, what is community without communication?

Ron Tosh & Larry Hudson

President's Column

Dear colleagues

Let me use this opportunity to draw attention to an anniversary that is less visible than some other important anniversaries of scientific discoveries, but which is not less important. In 1913, just 100 years ago, Henry Gwyn Jeffrey Moseley (1887 – 1915), a young British physicist, measured the X-ray spectra of various chemical elements and discovered the relation between the wavelengths of X-rays and the atomic numbers of the elements from which they are emitted. The formula expressing this dependence is known as Moseley's law. This discovery was one of the key steps toward understanding the physical structure of atoms and the meaning of atomic numbers. Moseley's experimental data thus supported Rutherford's concept of an atom consisting of a positively-charged nucleus surrounded by negatively-charged electrons, with nearly all the mass concentrated in the nucleus. The system of X-ray spectra measured by Moseley also showed gaps in the atomic number sequence at 43, 61, 72 and 75, two rare naturally-occurring stable elements discovered in the 1920s (hafnium and rhenium), and two elements with all isotopes radioactive, produced only after the discovery of artificial radioactivity (technetium and promethium). Moseley's measurements also demonstrated that there exist just 15 lanthanides. X-ray crystallography, X-ray fluorescence analysis and related methods are flourishing daughters of Moseley's discoveries.

Moseley would probably have been a strong candidate for a Nobel Prize, but the award is not made posthumously. When World War I broke out, he enlisted in the Royal Engineers in the British Army, and on 10 August 1915, at the age of 27, he was killed by a Turkish sniper in the Battle of Gallipoli. Isaac Asimov later wrote that "his death might well have been the most costly single death of the War to mankind generally".

Why am I telling this glorious and sad story? I want not only to draw attention to an interesting anniversary, but also to point out some lessons derived from it. The first lesson was taken up quite early by the British government: prominent and promising scientists were no longer allowed to enlist for combat duties in the British armed forces. This understanding of the importance of top science and top scientists should be a good paradigm for all present and future governments, not only in UK.

A second lesson is about fundamental and applied sciences. Many pragmatic politicians nowadays conclude that applied sciences should receive more intensive support from public sources than fundamental sciences, because they lead to rapid innovation and quick profits. In my view, support for applied science should be more a matter for the private sector, for the companies that want to use the results. The state budget, though always stressed, should be generous to fundamental research. The real moral of this story is something different. It shows that the key distinction is between good science and bad science, and not between immediate applicability and less certain, longer-term results. Fundamental research and applied research are close relatives, with no fixed boundary between them. Moseley's work is a nice example of fundamental research that has had long-term practical consequences for such apparently distant fields as criminology, environmental research, cultural history and many others, not to mention many industrial applications.

There is also a third lesson. Moseley carried out his outstanding scientific work between the ages of 24 and 27. Everybody who collaborates with young doctoral students and post-docs knows how many ideas and what great enthusiasm the best of them can contribute. At many universities, these young

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scientists contribute substantially to the quality of research, being the *spiritus movens* of non-traditional approaches and solutions. Moreover, their attention is not diverted away from research by teaching and administrative duties, family responsibilities, perhaps political ambitions, *etc.* Providing the best possible conditions for young scientists, with good access to the experience of older colleagues (Moseley was strongly influenced by Ernest Rutherford), is a well-proven way to promote outstanding scientific results.

Managers of science and education may understand this, but they do not always ensure that adequate measures are taken.

Now, down to business : this is the first issue of the IRPS Bulletin in 2013. I apologise for the delayed wishes, but let me nevertheless take this opportunity to wish you a good and successful year in 2013.

Ladislav Musilek

Calendar

2013

23rd - 28th June, 2013

1st International Conference on Dosimetry and its Applications

Full information on page 23

20th - 24th October, 2013

NUPPAC' 13
9th Conference on Nuclear and Particle Physics

Aswan, Egypt

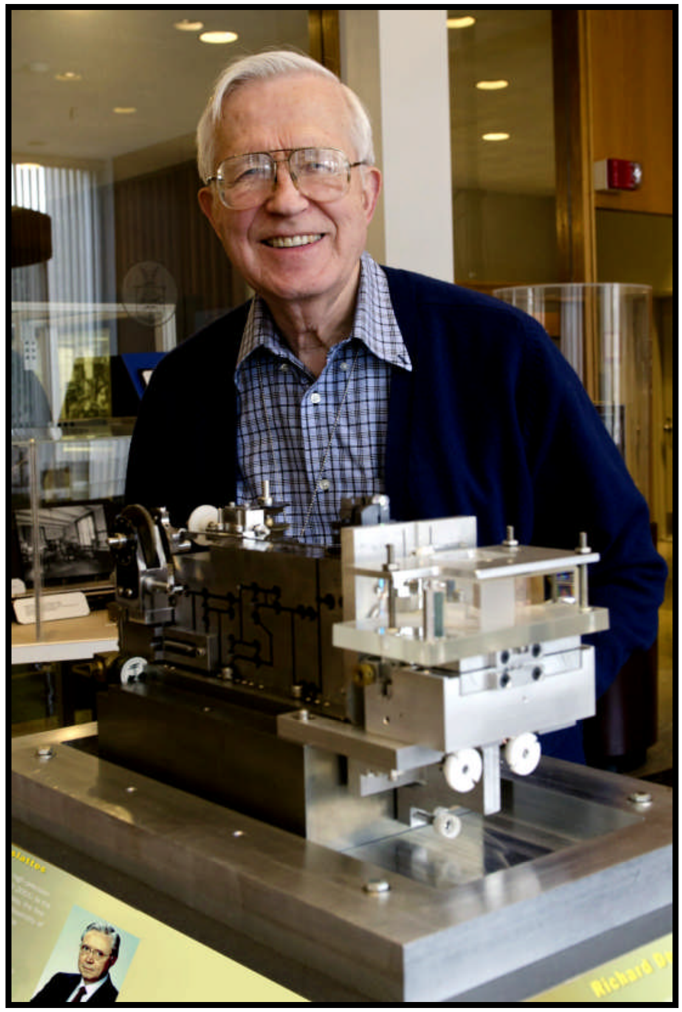
Full information on page 25

Dr Larry T Hudson
100 Bureau Drive, Stop 8460, Gaithersburg, MD 20899-8460, U.S.A.
Email : **larry.hudson@nist.gov**

Dr. Albert Henins

One of the most helpful and skilled persons at NIST is Dr. Albert Henins, a member of various international collaborations over the years with a number of IRPS members. Albert has kept alive the venerable (and disappearing) craft of instrument design and instrument making, *par excellence*.

Here he is pictured next to the NIST X-ray Optical Interferometer, a device that connects the lattice spacing of crystals to the definition of the meter.



Dr. Albert Henins in the NIST museum, with the NIST X-ray Optical Interferometer

Albert worked with the late Dick Deslattes to help make this most challenging demonstration instrument work.

He has also designed and constructed some of the most accurate and precise angle measurement devices in the world, namely angular optical interferometers, such as the one pictured below, that accurately determines diffraction angles in the NIST Lattice Comparator facility. This custom instrument allows industry and researchers to compare the lattice spacings of different crystals to a part in 10^8. This accuracy derives from both Albert's precision goniometry as well as the fine-structure wiggles in the crystal rocking curves, an interference phenomenon that Albert recognized and utilized when employing transmission diffraction with thin-crystal lamellae.

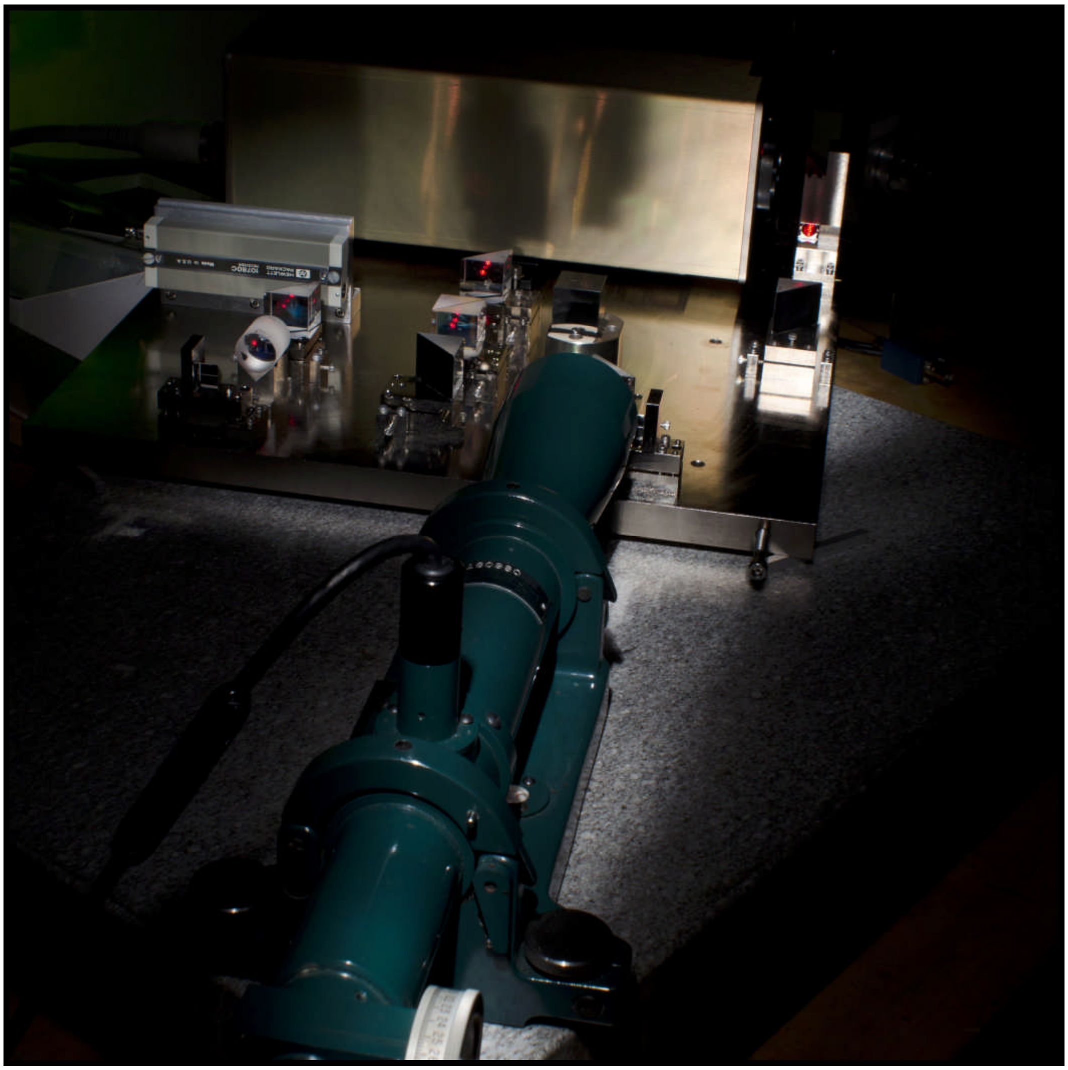
Albert aligns, cuts, and prepares all manner of reference diffraction crystals for a variety of purposes, both fundamental and applied. The X-ray Optical Interferometer and the Lattice Comparator mentioned above are key to defining the kilogram through Avogadro's constant by counting of the atoms in a silicon sphere.

../Continued

Dr Albert Henins *Continued*

Several orbiting satellites have borne Albert-crafted crystals, one of which was still in operation when it was intentionally destroyed in a low-earth-orbit "Star Wars" exercise (not appreciated!). Albert crystals are also used in a large number of bent crystal x-ray spectrometers used as diagnostics of medical, industrial, and exotic x-ray sources like laser-produced plasmas and electron-beam ion traps.

Albert turns 78 this year and has been retired for more than a dozen years, but he still shows up to work every day. You see, creative technical problem solving is actually his hobby and passion. Albert is also known for humility and frugality. For example, his CAD drawings painstakingly include thought for the machinist's time and the most effective use of available materials. Albert is also famous for being a packrat, which permits him to produce that rare material, unique tool, arcane epoxy, or odd fastener that is needed to meet the emergency of the moment. Seldom does he consider his own time and expense as he goes out of his way to volunteer to help others with some improvement to their project. And his generosity and accomplishments are absent attention or credit seeking. Exemplary.



Angular optical interferometer designed and built by Albert Henins and used in the measurement of crystal rocking curves.

THE DECOMMISSIONING OF THE AUSTRALIAN NATIONAL BEAMLINE (BL20B) AT THE PHOTON FACTORY KEK TSUKUBA JAPAN

Professor Dudley Creagh

University of Canberra, Canberra, A.C.T., 2601, Australia
Email : **dudley.creagh@canberra.edu.au**

On 25 February 2013 the last experiment was performed at the Australian National Beamline (BL20B) at the Photon Factory, KEK, Tsukuba Japan. The Australian National Beamline Facility (ANBF) will be shut down after more than 20 years' operation.

It is almost 30 years since moves were made to establish a synchrotron radiation (SR) science community in Australia.

In the beginning : Drinking a toast to the success of the recently opened BL20
Left to right : Jimpei Harada, Kasumasa Ohsumi, Dudley Creagh

At the International Union of Crystallography (IUCr) Congress in Hamburg in 1984, discussions occurred between Professor Jimpei Harada, Stephen Wilkins and Dudley Creagh on the possibility for Australia to find ways to become involved at the Photon Factory. Professor Harada proposed to organize a visit by Stephen Wilkins the following year that duly occurred under sponsorship of the Japanese Society for the Promotion of Science to further explore such possibilities for collaboration at the Photon Factory.

At that time the use of synchrotron radiation in scientific experiments was in its infancy. Most SR establishments were operated as parasitic attachments to accelerators conducting high energy physics experiments. In 1984 the Australian user community was tiny: Chris Howard (ANSTO), Frank Larkins (University of Melbourne), Peter Colman, Jose Varghese, Mike Lawrence (CSIRO), and Hans Freeman (University of Sydney) had used SR in their research. Dudley Creagh had been at HASYLAB, which was a parasitic facility on the High Energy Accelerator (DESY) in Hamburg, undertaking a project on X-ray absorption for the IUCr prior to its Congress. Richard Garrett, an Australian, took up a position at the Brookhaven National Laboratory in 1984, working on the VUV ring and later on the medical angiography beamline.

Growing the user community from this nucleus, raising the funding, and designing a beamline and instrument were to present significant challenges to Stephen Wilkins and Dudley Creagh in the coming years. Wilkins spent a month in Japan around November 1985 meeting scientists, and at the KEK he received a formal invitation from Professor Chikawa to establish an Australian beamline at the Photon Factory. Masami Ando played a significant role in these discussions.

On returning from his visit to the Photon Factory, Wilkins wrote to the Australian Government's Department of Industry Trade and Commerce (DITAC) seeking funding support for construction of the beamline [1].

This proposal was well received by officers from the bilateral relations department, but it took another five years of lobbying to obtain the necessary funds and, in the event, in a much less direct form.

An intensive education campaign was being undertaken to try to gain support for the construction of an Australian beamline at the Photon Factory. More than 20 invited lectures were given on the subject at Australian universities and research establishments. As well, many letters and approaches were made to politicians (including the Prime Minister), Australian Government departments, the CSIRO, and the Australian Research Council (ARC). In 1986 an ARC funding proposal was submitted with investigators Dudley Creagh (University College UNSW), John White (ANU), Stephen Wilkins (CSIRO), Terry Sabine (NSWIT), Fred Smith (Monash), Brian O'Connor (Curtin) and Zwi Barnea (Melbourne), but it was unsuccessful. Another ARC proposal in 1987 also failed. Later that year a well attended DITAC-funded workshop was held at Melbourne University in the presence of the Minister for Science, the Hon. Barry Jones, and attended by many leading synchrotron researchers from overseas. The outcome of this meeting was a general consensus that Australia should seek to build its own beamline based on the offer from the Photon Factory.

Wilkins and Creagh formed a new society, the Australian Beamline Users Group (ASBUG). Creagh was its first President and Wilkins its Secretary. Through this the user community grew significantly. As its Secretary, Wilkins sent a questionnaire to all university science departments, CSIRO Divisions, and industry. The results from the report were brought to the attention of the Australian Academy of Science by Professor John White (ANU) and Professor Hans Freeman (Sydney).

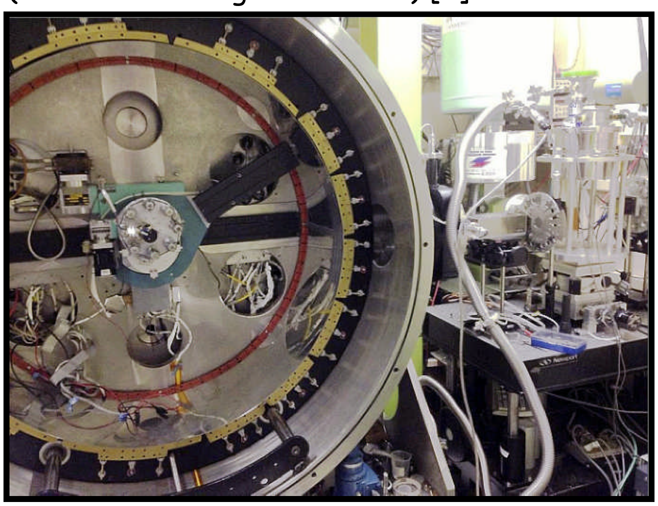
In 1988 Wilkins spent four months as a guest researcher at the Photon Factory under a Monbusho Fellowship to try to help progress Australian involvement at the Photon Factory. It was during this period that the conceptual design of BigDiff was developed in discussion with Professor Jimpei Harada. Key features were a Weissenberg-type camera operating inside a large vacuum chamber and using imaging plates as the X-ray detection medium.

In 1989 under the auspices of the Australian Academy of Science (AAS) an important review of Big Science needs was carried out under the chairmanship of Hans Freeman. This was soon followed by an Australian Science Technology and Engineering Council (ASTEC) enquiry chaired by Professor Don Nicklin. Over a period of a year the executive members of ASBUG met regularly with the ASTEC Committee to discuss the beamline plans, which were in a constant state of evolution. This enquiry led to a report to the Prime Minister entitled "Small Country Big Science" which recommended with highest priority the acquisition of a beamline at the Photon Factory and funding of $2.7M over 3 years in order to establish the beamline instrument and recruitment of three staff, all to be administered by ANSTO. With the strong support of the Minister of Science, the Hon. Simon Crean, the prospects looked bright, however no commitment was made in the 1990 Federal budget.

In August 1990 Professor Don Aitkin (Chairman, ARC) and representatives from government research bodies, some universities, and the Australian Academy of Science formed a consortium to fund the beamline (at the level of $1.1M per year for 3 years). The funding consortium consisted of DITAC, ARC, CSIRO, Ansto, UC-UNSW and ANU. The inaugural meeting was chaired by Dr David Cook, Executive Director of Ansto. Dudley Creagh was appointed to head the Technical sub-committee while Professor John White was appointed to head the Program and Review sub-committee.

The construction and access program was overseen by David Cook and Dr John Boldeman, Head of Physics at ANSTO, who became responsible for budgeting and expenditure and managed the International Access Program.

The photon delivery system, complete with monochromator and slit systems, was constructed in the Mechanical Workshop at the University College-University of New South Wales, again under contract with ANSTO, using designs by Dudley Creagh and Fred Johnson [2, 3]. As well Creagh was responsible for the provision of the experimental hutch and the infrastructure, including the 'container house' in which the beamline staff and experimenters were housed. The workshop at UC-UNSW later provided a number of accessories for BigDiff [4], including an eight position specimen stage designed by Creagh and Johnson, which, when used in conjunction with the Weissenberg slits of the diffractometer enabled eight different sample diffraction patterns to be acquired on the one set of imaging plates (without breaking the vacuum) [5].



Left to right:
BigDiff opened to the air. Its eight position specimen stage can be seen at the centre, The imaging plate clamps can be seen near the periphery. The XAFS stage with its transmission and fluorescence detectors. The daisy wheel system used to calibrate and characterize the X-ray beam can be seen to the left and right of the cryostat.

CSIRO (Materials Science & Technology) were contracted to design and build the multi-purpose diffractometer at their Clayton Workshops. The team was led by Stephen Wilkins and Chief Engineer Sandy Janky and supported by a local committee. In the final realization of the design a modification was made to enable the X-ray beam to pass through the diffractometer (BigDiff) into a second section of the experimental hutch [4]. The aim was not only to provide a highly precise powder diffractometer in which the diffraction patterns could be recorded in a vacuum, but also to provide for the mounting of x-ray absorption fine structure (XAFS) equipment at a second station placed behind the diffractometer.

Richard Garrett was recruited by ANSTO from NSLS Brookhaven as project scientist. He was responsible for the provision of the control and data acquisition software, which was based on that at the NSLS. As well, he was the supervisor for two beamline staff who were selected to be resident in Japan. They were Dr David Cookson who came from a research manager position at Kodak, and Dr Garry Foran, who came from Sydney University's Department of Inorganic Chemistry, where his research field had been Raman spectroscopy. Garry, besides being a very precise experimentalist, was also expert in written and spoken Japanese.

Without his presence the project in Japan would not have proceeded so smoothly.

In the initial stages the beamline, without the monochromator, the experimental hutch and all its safety interlocks, was placed in position at BL20B in the Photon Factory lattice and the container house and all its furnishings were completed. Because the monochromator was a complicated item to build it had been decided to operate initially using the "white beam" radiation from the bending magnets. Bending magnets produce a continuous spectrum of radiation which, in the case of the Photon Factory, ranges in photon energy from 4 to 20 keV. A number of unofficial tests of the system took place, including Laue diffraction. The first experiment AB-1 (*High pressure EDXRD study of materials in the earth's mantle*) was undertaken in October 1992 by Dudley Creagh and Lingun Liu (RSES-ANU).

After the monochromator was installed single-wavelength experiments could be undertaken. Before BigDiff was delivered a number of Xx-ray absorption fine structure (XAFS) experiments were undertaken to test the monochromator crystals for wavelength resolution. The water-cooled channel-cut monochromator crystals were provided by Professor Michael Hart.

BigDiff is essentially a Weissenberg camera of 573mm radius that operates in a vacuum and uses imaging plates (IP) for the recording of the X-ray scattering. Following its delivery it was immediately in high demand.

Throughout its life BigDiff underwent continual improvements and enhancements. No longer was it used only as a high-precision vacuum diffractometer for studying the x-ray diffraction (XRD) of crystals, but as envisaged in the original design, other modes of operation were exploited. Accessories were produced: an eight position sample spinning stage to enable eight specimens to be recorded on the same imaging plates; sample holders to enable reflectometry and grazing incidence diffraction (GIXD) to be performed [6, 7]; a subsidiary imaging plate changer to enable time-resolved GIDX to be undertaken; specimen heating stages to allow the study of phase changes; tensometers [8] for studying the effect of stress on the crystalline structure of materials; and electrochemical cells for the study of protective coatings on metals [9].

Meanwhile, the requirements of the user community were evolving rapidly, and we had to try to accommodate their requests for changes. Throughout, BigDiff continued to give excellent service. Some overseas scientists still regard it as the best XRD system in the world: it remained in active service until 25 January 2013. Its performance is equalled now only by systems operating with very large and expensive solid-state detectors. The fact that diffraction studies in BigDiff take place in a vacuum means that there is a very small amount of background scattering in the system. Instead of using its imaging plate system BigDiff could be adapted for operation with other detection systems for: triple-axis diffraction , solid-surface grazing incidence diffraction, small and wide angle x-ray scattering (SAXS/WAXS), x-ray imaging, and fluorescence experiments.

This does not tell the whole story about the way BL20B was being used. More and more users were requiring the use of the XAFS station, which was located behind BigDiff. Initially conventional transmission XAFS studies were undertaken. With the addition of a high-performance fluorescence detector in 1995, demand for experimental beam time for x-ray absorption spectroscopy (XAS) at the ANBF steadily grew and soon exceeded the demand for powder diffraction. Subsequent upgrading by the purchase of new detectors using ARC LIEF grants (Dr Mark Ridgway (ANU), Professor Peter Lay (Sydney)) has turned the XAS section of BL20B into a world-class facility.

But times were changing. In 1994, the Federal Government called for proposals for the development of Major National Research Facilities (MNRFs). It was agreed that the ANBF could not meet the burgeoning demands of the Australian community. A proposal to the MNRF Committee was prepared by John Boldeman, Richard Garrett and the ANBF staff with widespread input from the user community, including contributions from all the senior researchers. It was agreed that the ANBF should be folded into the new grouping that was to be called the Australian Synchrotron Research Program (ASRP). There was some debate concerning which international organisations should be selected for access, but it was finally agreed that the proposal should be focussed on the Advanced Photon Source (APS). The proposal recommended that Australia should join two Collaborative Access Teams (CATs): the Synchrotron Radiation Instrumentation (SRI) CAT and the Consortium for Advanced Radiation Sources (CARS) CAT. These two CATs were chosen to provide guaranteed access to a broad range of state-of-the-art synchrotron radiation research facilities for Australian science.

At the end of 1995 the successful proposals were announced and the ASRP was one of only seven funded from 57 proposals. Total funding for the ASRP was $12.2M over 5 years, and in addition to running the international access program the Minister, Senator Cook, specified that ASRP should set aside funds for a feasibility study to establish an Australian synchrotron.

The ANBF became part of the ASRP program, continuing its role in XRD and XAS. One consequence was that David Cookson left to work at the APS and was replaced at the Photon Factory by James Hester. All of the protagonists for the ANBF continued on the Board of the ASRP. Dudley Creagh remained the Chairman of the Photon Factory Committee until 1997.

During the period for which MNRF grant was active, work had been proceeding towards the design of an Australian Synchrotron using an accelerator lattice proposed by Dr John Boldeman. When, at the end of the MNRF Program the government once more called for proposals for a new MNRF Program, three separate proposals emerged, from Victoria, Queensland, and New South Wales. In the event, the Victorian Premier the Hon Steve Bracks short-circuited the proceedings by announcing that Victoria would build a synchrotron and had set aside $165,000,000 for the purpose. This stopped the MNRF proposal round as far as synchrotron radiation sources were concerned.

All of the chief proponents for the development of a synchrotron in Australia then became involved in the National Synchrotron Advisory Committee of the Australian Synchrotron. The construction of the Australian Synchrotron commenced in 2003. It had nine Beamline Advisory Committees. Dudley Creagh led the IR Beamline Advisory panel and designed the Infrared Spectroscopy Beamline which became operational in 2008 [10]. Stephen Wilkins was the instigator of the proposal for the Imaging and Medical Beamline which is only now operational.

The ANBF was incorporated into the Australian Synchrotron as an external beamline. It provided continuity whilst dedicated XRD and XAS beamlines could be constructed.

An index of how successful our endeavours have been is the extent to which there is involvement by universities and Australian Government instrumentalities. In 1990 only two universities were involved. In a recent proposal for a LIEF grant to support continuation of the ANBF ten universities were involved. Another proposal for Australian Government support included offers of financial support from forty institutions. The Australian Synchrotron has proved to be extremely successful. Since its XRD and XAS beamlines are now operational the management of the Australian Synchrotron has decided that the ANBF is no longer required.

We have now de-commissioned BL20B after some 900 experiments, 2500 visits by scientists, 3000 days of beam time, and more than 1000 publications in top-ranking journals. It has been a very productive facility, used for studies in materials science, chemistry, biological science, earth and environmental science, forensic science, and for tests of XAS theory. The principal techniques used were XAS (50%), and XRD (35%).

The contributions of some people who were unable to be present, and whose contribution to the success of the ANBF was significant, were recognized at the De-commissioning Ceremony.

Dr Stephen Wilkins: who, with Professor Jimpei Harada, was present at the start of our quest to create an Australian synchrotron radiation facility and who were instrumental in forging the link with the PF.

Dr Garry Foran: who was one of the original beam line scientists at BL20B, without whose experimental skills and command of the Japanese language the beam line development could not have proceeded so effectively.

Dr David Cookson: who was involved in the construction of the BigDiff, especially the control systems. Later he was involved in the day-to-day running of the ANBF at the Photon Factory until relocated to the Australian involvement at ChemMat CARS at the APS in Chicago.

Professor Hiroo Hashizume: whom Dudley Creagh had met in Paris in Professor Authier's laboratory and who was of great help to us in the initial stages of planning for the diffractometer.

Others who were unable to attend because they had to attend meetings elsewhere include Professor John White, Dr Youichi Murakami (present Director of the KEK), and Dr Tadashi Matsushita. As well, former Directors of the IMSS (Photon Factory), Soichi Wakatsuki, Hiroshi Iwasaki, and Junichi Chikawa were unable to be present. And Kasumasa Ohsumi, for many years the PF's liaison with the ANBF, is overseas. Without their help and encouragement the ANBF could not have succeeded.

Former Beamline Scientists, Dr Richard Garrett and Dr David Cookson were working in Australia. Other beamline scientists not present at this gathering were Michael Cheah and Jade Aitken. Their enthusiasm and competence contributed significantly to the success of the ANBF, and in the end, to the creation of an Australian synchrotron radiation community.

Happily, Professor Jimpei Harada, who started our quest, was able to attend. As well, Professor Masami Ando, who has been associated with our endeavours since 1985, was present. Dr Hiroyuki Oyanagi, former president of the International X-ray Absorption Society and a long-time collaborator attended. Dr Kenji Ito, the present Director of the IMSS was present, as was Dr Hiroshi Kawata, the scientist at the IMSS responsible for BL20B. Dr Ito had been associated with BL20B since 1992.

Having participated in the very first experiment, Dudley Creagh was also involved in the final experiment at BL20B (Proposal Number: 5893) which was a fluorescence XAFS experiment conducted by Professor Christopher Chantler and his team: *High accuracy X-ray absorption fine structure of iron, development of an understanding of fluorescence XAFS schematics, and investigation of the active centre of di-iron compounds.*

It is with regret that we, the Australian Synchrotron radiation community, say farewell to a faithful friend. One that has for many years performed significantly better than our expectations. One that has withstood the worst of earthquakes and bounced back.

Regrettably, equipment and funding for it cannot last forever. What remain are the enduring friendships we have formed.

And the satisfaction that a vibrant Australian synchrotron radiation community has been created.

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Australians and Japanese collaborating on this beamline for the last time, with the Japanese draping the Japanese flag over the upstream end of the large diffractometer BigDiff, and the Australians draping an Australian flag over the downstream part of the beamline.

***Rear**:* Prof Kawata and Prof Ito, draping the Japanese flag, and Prof Chantler with the Australian flag.

***Middle**:* Prof Ando, Prof Emeritus Harada, Prof Dudley Creagh, Kathryn Spiers (Beamline Scientist).

Front: Lachlan Tantau, Prof Oyanagi.

Participants in the last experiment at BL20B.

***Left to right**:*
Noel Excell, Lachlan Tantau, Feng Wang, Stephen Best, Dudley Creagh, Chris Chantler (Team Leader), Tauhid Islam, Kathryn Spiers (Beamline Scientist), Alexis Illig

Dedicated to

STEPHEN WILKINS

1946-2013

creative thinker, innovative scientist,

friend and mentor to many.

His untimely death is a great loss to

Australian science.

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../ Witness to "The Last Adventure"

WITNESS TO "THE LAST ADVENTURE"
ANBG KEK Beamline 20B

Professor Feng Wang

FAIP Professor of Chemistry,
Faculty of Life and Social Sciences,
Swinburne University of Technology, Australia

On 18 to 26 of February 2013, I joined a group of physicists and chemists (Prof. Chris Chantler and Dr. Stephen Best from University of Melbourne, Dr. Chan Tran of La Trobe University, Dr. J. Hester from ANSTO and a group of postgraduate students from University of Melbourne) for the last experiment (also called The Last Adventure) of BigDiff on beamline 20B. The measurements were high-accuracy X-ray absorption fine structure of ferrocene and di-iron compounds at the Australian National Beamline Facility (ANBF) at the Photon Factory, High Energy Accelerator Research Organization (KEK) in Tsukuba, Japan (http://pfwww.kek.jp/). The experiment is supported by the ARC and the Australian Synchrotron International Synchrotron Access Program. After six days of non-stop data acquisition, including nightshifts with staff and students, we successfully collected the data. At the conclusion of the experiment, I was invited to witness the "Closing Celebration Ceremony" of the ANBF at Photon Factory KEK Japan. It marks an end of 25 years of significant collaboration between researchers from Australia and Japan. The ANBF has been in operation and producing research publications since 1992. The closure of the ANBF in Japan is due to the availability of the Australian Synchrotron in Melbourne.

Molecular modelling is one of Swinburne's research strengths. As a theoretical chemist and molecular modeller, I was invited to join this "Last Adventure" at the ANBF. While dominated by experimental physicists, my participation indicates an awareness of the importance of the role that chemistry and theory play in such high-level synchrotron powered experiments for materials.

Prof. Dudley Creagh of University of Canberra, one of the original designers for the ANBF BigDiff (Diffraction) machine, travelled to Tsukuba Japan to join the historic moment, and also received an Award from Prof. Oyanagi for his contribution to XAS (X-ray Absorption Spectroscopy). At the closing ceremony, we witnessed a number of Australian and Japanese senior researchers who made significant contributions for the establishment and operation of the ANBF in this 25 year scientific collaboration. This collaboration has been mutually beneficial: the Australians appreciate the generosity of the Japanese people for offering us the beamline for experiments, and the Japanese appreciate bringing the Photon Factory to the world stage by the Australians and their scientific achievement.

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IRPS Vice President for Australasia,
Prof. Chris Chantler, picks up the account:

Professor Hiroyuki Oyanagi, recent Chairman of the International X-ray Absorption Society, took the opportunity of the Closing Celebration Ceremony at the end of the last experimental run at ANBF to present to Professor Dudley Creagh, one of the initiators of the ANBF from the Australian side, a prestigious medal to honor seminal contributions to XAFS, and to those who have coordinated advances, developments and conferences. In his speech he emphasised the following quote from TS Eliot's poem "Little Gidding":

"What we call the beginning is often the end.
And to make an end is to make a beginning.
The end is where we start from."

This summarised much of the mood of the Ceremony.

The citation reads:

"The 50th IXAS (International X-ray Absorption Society) Contribution Trophy goes to

Dr Dudley Creagh

Professor in Materials Conservation, University of Canberra, Australia.

Prof. Creagh representing the IUCr, contributed to the XAS community for a long time, through his active research, advising, encouraging and guiding many researchers in the field. His fair spirit and clear visions influenced the executive members of the two organizations, IXAS and IUCr XAFS Commission, toward their cooperative efforts in the promotion of XAS research."

We all join with the Japanese and the International XAS community – and the IRPS of course ! - in thanking Dudley and congratulating him on this recognition of some part of his contributions to the field.

Book

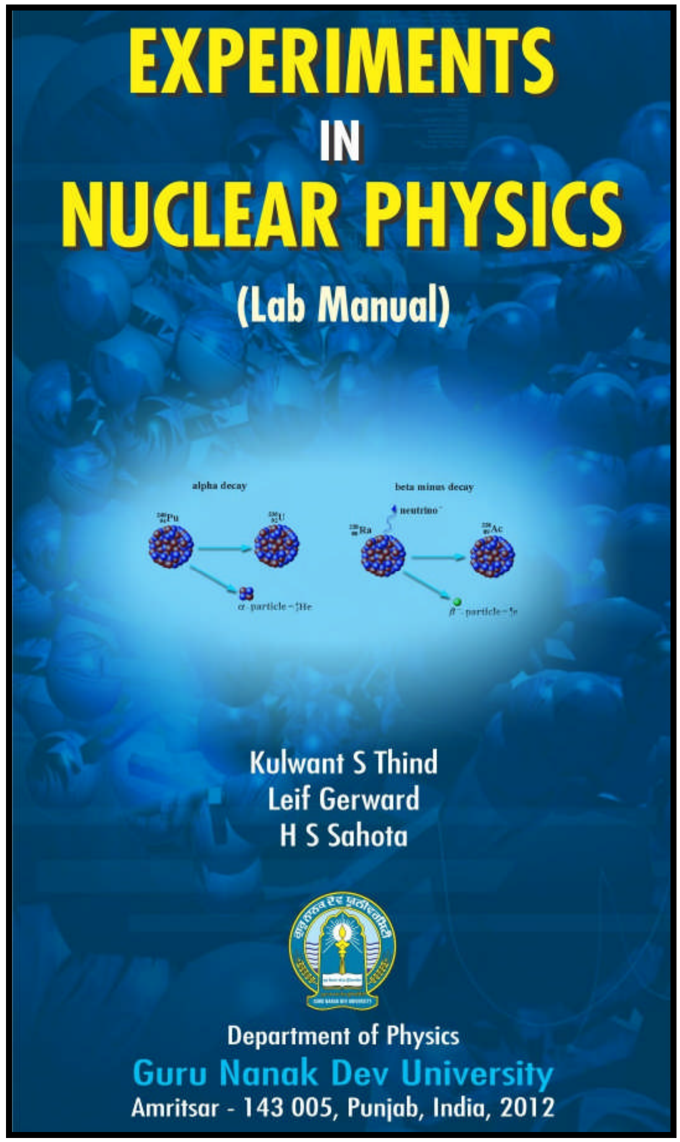
Experiments in Nuclear Physics – A Laboratory Manual

Kulwant S. Thind, Leif Gerward and H. S. Sahota

Guru Nanak Dev University, Amritsar – 143 005, Punjab, India, 2012.
ISBN-978-81-7770-172-2, 367 pp., price Rs. (INR) 400.00 (7.30 USD).

The need for a basic textbook in Radiation Physics has long been recognized, and the present book is perhaps a step towards that goal. The authors have taken a practical approach, carefully guiding the student through a large number of illustrative experiments in atomic and nuclear physics. The detectors are the classical ones: the scintillation counter and gas-filled detectors, including the Geiger-Müller and proportional counters. A short introduction to semiconductor detectors is included. The book is also kind of a textbook, including a first chapter on fundamentals of radiation physics. Moreover, a theoretical section precedes each experiment, explaining the underlying theory and principles. Questions, exercises and practical points are providing challenges for the interested student and hopefully clearing common misconceptions.

The authors hope that this book should be of value to teachers and students of university/college courses in radiation physics and chemistry, radiology, radioactivity etc. The book should also be useful for the practicing radiation physicist to get the most from his equipment.



Leif Gerward

Top Physics Newsmakers of 2012

Each February *APS News* looks back to see what physics news stories grabbed the most headlines in the previous year. The list is a compilation of not necessarily the most "important" advancements of the year, but the stories that captured the attention and interest of the world. In roughly chronological order, the Top Physics Newsmakers of 2012 are :

Exoplanets

2012 was a big year for the discovery of planets outside of our solar system, and many scientists believe that the discovery of a potentially habitable planet like Earth is not far away. **January** brought the announcement of the discovery of a system of planets around the star Kepler-42 with planets similar in size to Venus and Mars, the smallest discovered yet. In **February**, astronomers announced the discovery of Gliese 667Cc only 22 light years away, the first planet discovered inside of a star's habitable zone. The discovery of Alpha Centauri Bb, a planet orbiting the star closest to Earth, was announced in **October**, hinting that planets might be very common around stars. In **December** the five-planet system around Tau Ceti was discovered, which included two planets far enough away from their parent star that liquid water could exist on their surface.

Majorana Fermions

In **February**, physicists from Delft University found evidence of Majorana fermions, particles that are their own anti-particles, in the behavior of electrons in a semiconducting nanowire. The team did not observe the particles directly, but they were able to infer hints of their existence by detecting minute electrical currents that matched predictions. Scientists are excited because such particles could form the basis for a future quantum computer. Fermions that are their own antiparticles were first predicted by Ettore Majorana in 1937, just months before his mysterious disappearance at sea.

Daya Bay

The international Daya Bay Reactor Neutrino Experiment, announced in **March** the successful measurement of the neutrino mixing angle θ_{13}. Six detectors measured the neutrinos emitted by China's Daya Bay nuclear reactors, looking for differences in the number of electron antineutrinos detected. Neutrinos oscillate between different flavors, and θ_{13}, the parameter that governs the rate at which electron neutrinos morph into other flavors, was the last to be measured. The collaboration found the angle was relatively large, making it easier for physicists to investigate the origin of matter-antimatter asymmetry in the universe.

Pioneer

The "Pioneer anomaly" has vexed physicists since it was first noticed in the early 1980s. The two Pioneer probes, numbers 10 and 11, have been inexplicably slowing down more than expected on their way towards interstellar space. Numerous explanations have been put forward, ranging from leaking gas to a fundamental reworking of general relativity, but in **April**, an analysis by Slava Turyshev published in *Physical Review Letters* finally determined once and for all that pressure from uneven thermal radiation has been the culprit for all of these years.

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Traffic Ticket

In **April** Dmitri Krioukov argued his way out of a traffic ticket using physics. In a paper published on the ArXiv, Krioukov claimed that a confluence of coincidences, including his sudden deceleration and acceleration, an optical illusion making objects farther away seem to be moving faster, and an obstructing car made it appear that he drove through a stop sign, when in fact he had stopped. The judge seemed to agree and rescinded the traffic offense.

Elements

In **May**, the two most recently discovered elements were given names after the physics labs that discovered them. Number 114 is flerovium (Fl) after the Flerov Laboratory of Nuclear Reactions in Dubna, Russia, and number 116 is livermorium (Lv) after the Lawrence Livermore National Laboratory in Livermore, California. In September researchers at the RIKEN laboratory in Japan claimed to have successfully generated atoms of element 113. If confirmed, it would be the first new element to be discovered in East Asia, though researchers in the US and Russia have also claimed to have synthesized the element in the past.

Supercomputer

The title of the "World's Fastest Computer" returned to the United States this **June** when Lawrence Livermore National Laboratory's Sequoia machine topped out at 16.2 petaflops. Then in **November**, Oak Ridge National Laboratory one-upped them with its Titan supercomputer, which hit 17.59 petaflops. US computers now hold the top two slots for the first time since 2009, beating out Japan's K computer. Sequoia is used by the military to simulate nuclear detonations while Titan is an open machine leasable by the public.

Teleportation

Teams on opposite sides of the globe have been duking it out to hold the title of the farthest distance two quantum particles can be kept in an entangled state. In **May** a team in China shattered the existing record by teleporting a photon 97 kilometers, nearly 100 times the existing record. In **September** a team from Austria working in the Canary Islands was able to teleport a pair of photons 147 kilometers, between two islands, hoping to pave the way to teleport a pair between an orbiting satellite and the planet's surface sometime in the future.

Higgs

On the 4th of **July**, CERN announced that it had found what appeared to be the long sought-after Higgs boson. The laboratory was guarded in its original announcement, saying only that they had found a boson with Higgs-like properties. The accomplishment caps decades of work and billions of dollars building the Large Hadron Collider. The discovery confirms the existence of a "Higgs field" that gives matter its mass, first proposed almost 50 years ago.

New Physics Prize

Russian billionaire Yuri Milner is giving the Nobel Prizes a run for their money with his announcement in **July** of the new Fundamental Physics Prize. Each of the nine inaugural winners, primarily theoretical physicists in cosmology, mathematics and string theory, received $3 million. Milner personally chose the first round, but past recipients will in part choose future winners of the new annual award. In **December**, Milner made two special awards, one to Stephen Hawking, and another to be shared amongst top scientists at CERN for discovering the Higgs Boson.

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Maser

Researchers in England announced in **August** that they were able to build the first solid-state maser that works at room temperature. The very first masers were built in 1954 but were weak and required extremely low temperatures to operate. Soon thereafter, the first solid-state masers were built, which offered more power, but still required near zero temperatures to operate. The team from Imperial College in London developed a completely new technique to create a collimated beam of microwaves using p-terphenyl as a gain medium rather than traditional crystalline ruby.

Sea Ice

In **September**, the National Snow and Ice Data Center announced that 2012 broke the record set in 2007 for the lowest amount of sea ice ever. Ice only covered 1.32 million square miles of the arctic, 18 percent below the 2007 record, and 49 percent below the 1979 through 2000 average. Climatologists pointed to this as more evidence that climate change is a major concern and that rising global temperatures are having an impact on the environment.

Retractions

Physicists had to make two major retractions this year. In **February** CERN announced that the controversial claim a year before, that neutrinos appeared to travel faster than the speed of light, was likely the result of a loose cable. Two months later, the lead scientist of the team that made the announcement stepped down. In **October**, Moses Chan officially retracted his 2004 announcement of the discovery of supersolids. In an experiment designed to eliminate a source of error first identified in 2007, Chan was unable to recreate the effects observed in his first experiments, and subsequently published his new results in *Physical Review Letters.*

Water

Throughout the year, the news has been dominated by headlines about water being found in unexpected places throughout the solar system. In **June** an article in *Science* said that the Cassini spacecraft found evidence of a liquid ocean of water deep under the icy shell of Saturn's moon Titan. In **September**, scientists announced that NASA's Curiosity rover found beds of rounded pebbles, evidence that water likely once flowed in deep streams across the surface of Mars. Also in **September**, scientists announced that they unexpectedly found water on the asteroid Vesta. Rounding out a year of soggy discoveries in **November**, NASA's Messenger spacecraft found evidence of frozen water underneath the surface of the closest planet to the sun, Mercury.

–list compiled by Michael Lucibella

1st International Conference on Dosimetry and its Applications
Prague, Czech Republic, 23-28 June 2013

Together with various institutions all over the world, the International Radiation Physics Society co-organises International Symposia on Radiation Physics (ISRP) and Topical Meetings on Industrial Radiation and Radioisotope Measurement Applications (IRRMA) as triennial events. The aim is to bring together scientists and engineers from around the world who share an interest in measuring and applying ionising radiation. Aiming to cover the one-year gap between these scientific events, the IRPS Council has accepted a proposal to found a new triennial series of conferences, devoted to current trends and potential future issues in ionising radiation dosimetry.

TOPICS:

A. Basic Concepts and Principles in Dosimetry
B. Personnel Dosimetry
C. Accidental Dosimetry
D. High Dose Dosimetry
E. Dosimetry in Environmental Monitoring
F. Dosimetry in Medicine and Biology
G. Dosimetry in the Nuclear Industry and at Accelerators
H. Standardization and Intercomparison in Dosimetry
I. Monte Carlo Calculations in Dosimetry
J. Other Topics

VENUE:

The conference will be organised by and held at the Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University in Prague (Břehová 7, Praha 1). Situated on the bank of the river Vltava, in the centre of this ancient national capital, the Faculty enjoys unique views of the surrounding hilly landscape, looking towards Prague Castle. Prague, home to more than 1.2 million inhabitants, is an important industrial and business centre, but it is undoubtedly as a centre of history and of long cultural, social and political traditions that it is most famed. Many interesting museums, galleries, theatres and other cultural venues are located within a short walking distance of the conference site. Attending the conference will not only offer an opportunity to enjoy a full scientific programme, including discussions of state-of-the-art developments by leading figures, but will also provide a chance to discover the beauties of the city, its valuable historical monuments and rich cultural and social life.

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PRAGUE:

PAPERS:

A Book of Abstracts will be provided at the conference registration, together with other conference documentation. The text of papers recommended by the standard refereeing process will be published in the conference proceedings in a special issue of the journal Radiation Physics and Chemistry. Abstracts received after the deadline may still be accepted for presentation as posters.

CONTACTS:

Web page: http://icda.fjfi.cvut.cz ***E-mail:*** icda@fjfi.cvut.cz

Phone : (only in cases of inevitable need): +420 224358246 (Ms. Niederlová)

Chairman of the Organising Committee:

Ladislav Musílek
Czech Technical University in Prague
Faculty of Nuclear Sciences and Physical Engineering
Břehová 7, 115 19 Praha 1, Czech Republic

Call for Papers

Egyptian Nuclear Physics Association (ENPA)

Organizes its

9th Conferne on Nuclear and Particle Physics

NUPPAC' 13

20-24 Oct. 2013
Aswan, Egypt

Conference Chairman
Prof. Dr. M.N.H. Comsan

Conference Coordinator
Prof. Dr. K.M. Hanna

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9th Conference on Nuclear and Particle Physics

20-24 Oct. 2013, Aswan, Egypt

NUPPAC' 13

Registration Form

1. Surname:
   First name(s): M/F
2. Nationality:
3. Institution:
4. Address:
5. Phone:
   Fax:
6. E-mail:
7. Title of submitted contribution:
8. Author(s):
   (Please underline the name of the speaker)
9. Date of arrival:
   Date of departure:
10. For non- Egyptians, hotel class requested (in Euro): 40-60-80-120-150.

Date: Signature:

الإشتراك للمصريين بشيك باسم: الجمعية المصرية للفيزياء النووية
بنك مصر – فرع مدينة نصر حساب رقم ١٥٩/١/٤٨٩٩٣
رسوم التسجيل حتى ٢٠١٣/٨/٣١:
1500 جنيه مصرى

رسوم التسجيل المتأخر (اعتباراً من ٢٠١٣/٩/١) :
1600 جنيه مصرى

For participants the fee will cover the book of abstracts, conference printed material, attendance of scientific sessions, tea/coffee breaks, the official conference lunch, and the conference online proceedings. For Egyptians, the fee covers B&B accommodation in a 3-star hotel (shared in double-bed rooms). Other expenses as accommodation (for non-Egyptians), transportation and occasions (tours, excursions, etc) are financed personally. In case of written cancellations received by 15 Sept. 2013 only 80% of the prepaid amount will be refunded. No reimbursement can be made for cancellations received after this date. Fee for accompanying person is 400 LE for Egyptians (neither including transportation nor accommodation) and 100 Euro for non-Egyptians.

Correspondence

Prof. Dr. M.N.H. Comsan
Chairman of NUPPAC' 13
Atomic Energy Authority,
3 Ahmed Elzomor St., Elzohour District,
Nasr City, Cairo, Postal Code 11787, Egypt
Fax: +(202)22733515
Tel: +(2011)3226007
E-mail: comsanmn@hotmail.com , or comsanmn@gmail.com
Web site:
http://www.physicsegypt.org/nuppac13/

The working language of the conference is English.

Conference Topics

1- Nuclear Scattering and Reactions
2- Nuclear Models and Spectroscopy
3- High Energy and Particle Physics
4- Neutron and Reactor Physics
5- Plasma and Fusion Physics
6- Relativistic and Quantum Physics
7- Computer Codes (modeling, simulation, analysis)
8- Nuclear Analytical Techniques
9- Reactor and Accelerator Utilization
10- Detectors and Instrumentation
11- Radiation Measurement and Dosimetry
12- Applied Nuclear Physics

Participation

Participants are requested to make their registration fee payable to the account of "Egyptian Nuclear Physics Association No. 159/1/48993", Bank Misr, Nasr City Branch, Nasr City, Cairo, Egypt, Swift Code BMISEGCX159, according to the following:

* Early registration
(received up to 31 Aug. 2013):
1500 LE for Egyptians,
420 Euro (by bank transfer)- Non Egyptians.

* Late registration
(received after 31 Aug. 2013):
1600 LE for Egyptians,
460 Euro (in cash) for Non Egyptians.

Important Dates

Last date for:

* Submission of abstracts	30 June 2013
* Early registration	31 Aug. 2013
* Submission of contributed papers	15 Sept. 2011
* Submission of invited talks	7 Oct. 2011

Contribution

The organizing bodies of **NUPPAC' 13** invite scientists, technologists and interested persons to participate in the conference activities. They are invited to contribute with review articles, working papers and plans, and scientific papers in any of the conference topics, to take part in working group meetings and panel discussions. The presentation time will be 30-40 minutes for invited talks/ keynote contributions, and 15-20 min for contributed papers. Participants are requested to complete and return a copy of the NUPPAC' 13 registration form. Abstracts (not more than one A4 page) for all contributions should be received by 30 June 2013. Contributed papers will be refereed and those accepted will be published in the conference proceedings and distributed to registered participants. All scientific material should be laser printed 16 cm x 24 cm printed area on good quality paper ready for camera reproduction. NUPPAC Author Instructions should be followed. An electronic version written in Word or Latex source file should be provided on CD or 3.5" disc.

INTERNATIONAL RADIATION PHYSICS SOCIETY

The primary objective of the International Radiation Physics Society (IRPS) is to promote the global exchange and integration of scientific information pertaining to the interdisciplinary subject of radiation physics, including the promotion of (i) theoretical and **experimental research in radiation physics,** (ii) investigation of physical aspects of interactions of radiations with living systems, (iii) education in radiation physics, and (iv) utilization of radiations for peaceful purposes.

The Constitution of the IRPS defines Radiation Physics as "the branch of science which deals with the physical aspects of interactions of radiations (both electromagnetic and particulate) with matter." It thus differs in emphasis both from atomic and nuclear physics and from radiation biology and medicine, instead focusing on the radiations.

The International Radiation Physics Society (IRPS) was founded in 1985 in Ferrara, Italy at the 3rd International Symposium on Radiation Physics (ISRP-3, 1985), following Symposia in Calcutta, India (ISRP-1, 1974) and in Penang, Malaysia (ISRP-2, 1982). Further Symposia have been held in Sao Paulo, Brazil (ISRP-4, 1988), Dubrovnik, Croatia (ISRP-5, 1991) Rabat, Morocco (1SRP-6, 1994), Jaipur, India (ISRP-7 1997), Prague, Czech Republic (ISRP-8, 2000), Cape Town, South Africa (ISRP-9, 2003), Coimbra, Portugal(ISRP-10, 2006), Australia (ISRP-11, 2009) and ISRP-12 in Rio de Janiero, Brazil in 2012. The IRPS also sponsors regional Radiation Physics Symposia.

The **IRPS Bulletin** is published quarterly and sent to all IRPS members.

The IRPS Secretariat is : Prof. Jorge E Fernandez (IRPS Secretary),
Universita di Bologna, Laboratorio di Ingegneria Nucleare di Montecuccolino
I-40136 Bologna, Italy
Phone : +39 051 6441718
email: jorge.fernandez@unibo.it

The IRPS welcomes your participation in this "global radiation physics family."

INTERNATIONAL RADIATION PHYSICS SOCIETY

Membership Registration Form

1. Name : ____
(First) (Initial) (Last)

2. Date and Place of Birth : ______________________________

3. Business Address : ____________________________________

____
(Post Code) (Country)

Telephone:______________ Email: ______________________ Fax: ______________

4. Current Title or Academic Rank (Please also indicate if Miss, Mrs., or Ms.): ______________

5. Field(s) of interest in Radiation Physics (Please attach a list of your publications, if any, in the field:

____

____

6. Please list any national or international organization(s) involved in one or more branches of Radiation Physics, of which you are a member, also your status (e.g., student member, member, fellow, emeritus):

____

____

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7. The IRPS has no entrance fee requirement, only triennial (3-year) membership dues. In view of the IRPS unusually low-cost dues, the one-year dues option has been eliminated (by Council action October 1996), commencing January 1, 1997. Also, dues periods will henceforth be by calendar years, to allow annual dues notices. For new members joining prior to July 1 in a given year, their memberships will be considered to be effective January 1 of that year, otherwise January 1 of the following year. For current members, their dues anniversary dates have been similarly shifted to January 1.

Membership dues (stated in US dollars - circle equivalent-amount sent):

Full Voting Member: 3 years	**Student Member: 3 years**
Developed country $75.00	Developed country $25.00
Developing country $30.00	Developing country $10.00

Acceptable modes of IRPS membership dues payment, to start or to continue IRPS membership, are listed below. Please check payment-mode used, enter amount (in currency-type used), and follow instructions in item 8 below. (For currency conversion, please consult newspaper financial pages, at the time of payment). All cheques should be made payable to :

International Radiation Physics Society.

(For payments via credit card - http://www.irps.net/registration.html)

[ ] *(in U.S. dollars, drawn on a U.S. bank)*: Send to Dr W.L. Dunn, Dept. Mechanical and Nuclear Engineering, Kansas State University, 3002 Rathbone Hall, Manhattan, KS, 66506-5205. U.S.A.

Amount paid (in U.S. dollars) ____________________

[ ] *(in U.K. pounds):* Send to Prof. Malcolm J. Cooper, Physics Dept., University of Warwick, Coventry, CV4 7AL, U.K.. Bank transfer details:

Account number: 30330701. Bank and Branch code: Barclays, code 20-23-55.

Eurochecks in U.K. pounds, sent to Prof. Cooper, also acceptable.

Amount paid (in U.K. pounds) ____________________

8. Send this Membership Registration Form ***AND*** a copy of your bank transfer receipt (or copy of your cheque) to the Membership Co-ordinator:

Dr Elaine Ryan
Department of Radiation Sciences
University of Sydney
75 East Street, (P.O. Box 170)
Lidcombe, N.S.W. 1825, Australia
email: elaine.ryan@sydney.edu.au

9. ____ ____________________

Signature *Date*