IRPS BULLETIN

Newsletter of the International Radiation Physics Society

Vol 30 Nos 2/3 **September, 2016**

IRPS BULLETIN : ISSN 1328533

Printing and postage of the Bulletin, and support for the IRPS web pages, are courtesy of the University of Canberra, Canberra, A.C.T, Australia

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

Contents of this Journal

From the Editors : ..... *Page 3*

From the President : ..... *Page 4*

Vice President's Report – M.A. Gomaa, Africa and Middle East : ..... *Page 6*

ICDA-2 - 2nd International Conference on Dosimetry and its Applications
Reports by: David Bradley : ..... *Page 8*
Richard Hugtenburg : ..... *Page 9*

Participants at the July 3, 2016 IRPS Council Meeting : ..... *Page 15*

RAD 2016 4th International Conference on Radiation and Applications in Various Fields of Research : Report by Goran Ristić, Jugoslav Karamarković, Ines Krajcar Bronić *Page 16*

Marie-Curie's Last Radium Standard – Grand Challenge .:
Contributed by Bert Coursey and Ron Collé : ..... *Page 20*

Moon Bomb (courtesy of NASA): ..... *Page 24*

Calendar : ..... *Page 24*

Conferences : ..... *Page 25*

Contacts and Membership Payments information: ..... *Page 26*

Membership Registration Form : ..... *Last two pages*

From the Editors

One sometimes hears the quip that all philosophy is but a footnote to Plato, and maybe less often a variant of that about all novels being a footnote to Don Quixote. On the face of it, either seems amusingly glib – a cautionary tug on the reins, so to speak, to restrain our natural impulses toward oversimplification and reductionism. But, as the gadflies among us would not hesitate to point out, many of the questions posed by Socrates and predecessors still occupy philosophers today, and so why not indulge a playful whim every now and then to look for antecedents, quixotic though it might at first seem?

Technical meetings and conferences, where the focus tends to lie appropriately enough on immediate or future applications and novel insights, offer especially good opportunities for this sort of a backward glance. Tracing the lineage of a modern analytical technique to pioneering work by a Roentgen or Becquerel or Curie or Compton or … Shakespeare, keeps history alive and fresh, and reveals links among myriad applications whose relevance to more local concerns might otherwise elude us. That this would be especially true of the radiation sciences testifies to their great diversity and the concomitant challenge that poses for those among us who would seek unifying themes and points of reference to help make sense of it all. Within the ranks of the IRPS we are fortunate to have a few stalwarts who happily take this on and from time to time share their efforts through the IRPS Bulletin.

In the present issue, we gratefully acknowledge reports on the 2nd International Conference on Dosimetry and Its Applications (ICDA-2) – a synoptic by David Bradley and a panoramic by Richard Hugtenburg – and a summary of the 4th International Conference on Radiation Applications in Various Fields of Research (RAD 2016), by Goran Ristic, Jugoslav Karamarkovic and Ines Krajcar Bronic. We also thank Mohamed Gomaa for a regional Vice President's report from Africa and the Middle East.

Finally, we draw your attention to an article contributed by Bert Coursey and Ron Collé, both of NIST (US), that issues an urgent call to the radiation physics community to prevent the loss of a precious historical artifact left by Marie Curie. Read carefully enough and you'll find elsewhere in these pages an accidental reference or two to details contained within their Grand Challenge, further suggestive of the pervasive and enduring relevance of Curie's work.

So, let this be a prompt to seek new connections and find ties that bind, and partake a little more of the playful spirit of the Surrey Scholar, who amused attendees of ICDA-2 (p.15), or Alan Turing (p.15), whose contributions to the modeling of reaction-diffusion systems (and, indirectly, Monte Carlo) some readers may find unfamiliar or even surprising.

We'll close with this admonition often attributed to Plato, "Wise men talk because they have something to say; fools, because they have to say something," and let you decide which of those more aptly applies to us.

Ron Tosh and Larry Hudson, Editors

FROM THE PRESIDENT

Dear Friends and Colleagues,

Synchrotron research remains much in the news around Australia, whether from finding a Degas painting underneath a Degas, or some of the recent news about Amyloid beta sheets. The nation has just renewed funding for the Australian Synchrotron and this is a very good step in the right direction, and the principles of Radiation Physics remain important and increasingly so. Canada is also pursuing expansions of its synchrotron, and China has a very ambitious program of infrastructure development for advanced science and radiation physics and applications. Similarly, proposals of FELs and advanced detectors are continuing. All augurs well for the health of the international scientific community in this regard.

We enjoyed a successful ICDA meeting this past few months and a report on that is enclosed in this Bulletin. David Bradley and his team are all to be congratulated on an exciting program.

I mentioned the IRRMA series of conferences last Bulletin and indeed the next one, in Chicago next year, is being prepared and you can get to the website by the time you read this.

Finally, I would like to acknowledge members of the Society who are strongly involved in numerous high-profile international journals, including crystallographic journals with Acta Crystallographica, Journal of Synchrotron Radiation, Journal of Applied Crystallography, but especially Applied Radiation and Isotopes (ARI), Radiation Measurements (RM) and Radiation Physics and Chemistry (RPC). As it may be of interest to readers of the Bulletin to learn more about the respective emphases of these journals, I have contributed a brief overview of the scope of articles published in RPC, where I currently serve as an Editor-in-Chief.

I look forward to reports on ARI and RM in the next Bulletin or two, to provide Members with some background and outlook, and to our engagement on any and all topics in the future.

Chris Chantler

Radiation Physics and Chemistry: ,

Since the very beginning of Radiation Physics and Chemistry (RPC) as a Journal (and indeed the International Radiation Physics Society as a Society) the Editor-in-Chief of Radiation Physics has always seen Radiation Physics as broad-church. That is, the defining characteristics are just two-fold - that it communicates physics, and that ionizing radiation be a key tool, use or development.

Radiation Physics includes all physics involving ionising radiation, especially if it develops mathematical and theoretical models of ion or gamma-ray transport. So emphasising those categories is important. Equally we include biomedical applications, so long as there is a clear strong use of ionising radiation and an exposition or development of physics. *../Continued*

A fuller though not exhaustive list of topics that are considered for publication include:

Radiation Physics

Fundamental processes in radiation physics

- Interaction mechanisms for example scattering and absorption of photon and particle radiations
- Attenuation coefficients
- X-ray fluorescence
- Cherenkov effect
- Polarization
- Effects of periodic structures (Bragg diffraction, channeling, parametric x-radiation, etc.)
- Mathematical methods in radiation physics, reference data

Radiation sources and detectors

- Accelerator and radionuclide spectra and other properties
- Radiation fields from point and extended sources
- Detector response functions
- Basic physics of Dosimetry
- Radiation transport
- Buildup factors

Radiation Chemistry

- Ionizing radiation induced ionic *and radical reactions*
- Kinetics and mechanism of radiolysis reactions
- Pulse radiolysis technique and measurements
- Nanoparticle production by ionizing radiation
- Radiation induced chain reactions, polymerization
- Irradiation effects on polymers
- Dose and dose rate effects
- LET effects on chemical reactions
- Pollutant removal by ionizing radiation
- Computational models on radiation chemical reactions

Radiation Processing

- Radiation Sterilization
- Food irradiation
- Polymers
- Environmental
- Radiation effects
- Dosimetry and process control
- Radiation sources and facilities for radiation processing

Even within these categories, however, certain limitations apply. Papers on photochemistry, microwave chemistry and thermochemistry are believed to belong to the scope of RPC only if they have strong relevance to radiation chemistry. EPR papers will only be considered for publication when the method is used for clarifying radiation chemical processes, e.g. by determining the nature of the transient intermediates. Radiochemistry papers such as tracer technique, radon or other radionuclide measurements, isotopic constitutions fall outside the scope of the journal.

Further information – including helpful links for prospective authors and an enumerated classification list of keywords for publications – may be found at the following sites:

http://www.journals.elsevier.com/radiation-physics-and-chemistry

http://cdn.elsevier.com/promis_misc/Classification-for-EES-and-JHP.pdf

Vice President's Report, Prof. M.A. Gomaa

Africa and Middle East

1 - A one-day seminar organized by Egyptian Medical Physics Association held at Nasr Medical Institute, Cairo on 14th of August, 2016. The aim of the seminar was to review Medical Physics activity in Egypt. *(Photo next page)*

2 - During the period from 24 to 29 September 2016, the 7th conference on Environmental Physics was conducted at the beautiful city of SHARM ELSHEIKH, Sinai, Egypt.

3 - The first issue of the new Journal Radiation and Nuclear Applications was released. The journal website is at:

http://www.naturalspublishing.com/ContentTB.asp?JorID=54

../Photo next page

Participants at the seminar organized by the Egyptian Medical Physics Association held at Nasr Medical Institute, Cairo

2nd International Conference on Dosimetry and its Applications (ICDA-2)

University of Surrey, Guildford, United Kingdom
3rd – 8th July, 2016

Reports by David Bradley and Richard Hugtenburg and photos of the Conference

---

REPORT BY DAVID BRADLEY

As the Chair of this meeting I have to be honest and admit that it was an entirely daunting challenge in accepting to be the organizer of a meeting, particularly one that followed in the footsteps of the highly successful Prague ICDA1. I should add though that ultimately it was a highly rewarding experience from an academic point of view, even though the associated stresses have probably accelerated one's aging to a considerable extent.

While over the years I have been a member of a number of conference committees, typically as a member of Programme Committees, only now can I entirely appreciate how much work really goes into the real organization of an international conference. So, do I regret accepting the challenge? Well, first let me point you to the reality of greatly depending on the good will of one's colleagues, postgraduate students and previous PhD students; without their help and commitment I would not have survived the experience. The complete details of the meeting can be found at:

http://www.surrey.ac.uk/physics/news/events/icda-2/.

These arrangements were a result of a great many meetings and iterations of the plans now shown here. Questions we needed to confront included whether there were sufficient arrangement for accommodation, what are the plans for a professional Proceedings, how are the arrangements for submissions and refereeing, are there plans in place should there be volcanic eruption that prevents flights into Europe and the UK in particular at the time of the meeting, etc etc ? Aaaaghhh.

But then, finally I should happily refer you to a number of heart-warming statistics: 23 Invited talks successfully delivered, representation of work from scientists from 42 countries and 5 days of dry, even sunny weather out of a total of 5 and a half days, remaining comfortably warm throughout (you will of course know that the British always talk about the weather and for good reasons too).

Particularly welcome was the full programme of events, with state-of-the-art developments vigorously presented and well received, coordinated according to the various prevailing themes, and interspersed with a great concert event lead by the Juilliard School graduate Dr Shelley Katz (see :

http://www.symphonova.com/)

an excursion to London museums and a really interesting conference dinner in which we engaged a magician to amuse the diners. We show here various scenes from ICDA2:

https://www.flickr.com/photos/j-wbrown/28130943915/in/photostream/.

So what can be learned from the experience?

../Continued

First, as conference chair, I am unable to forget the fear visited upon me by our Administrators, with questions such as, what would I do to make good any financial loss (thankfully we did not), the need for such events to be insured against untoward events such as a volcanic eruption or perhaps terrorist activity in London etc that could well lead to many of the intending conferees being unable to attend. As a complete novice, from the outset I would have really appreciated active guidance from an institution that annually puts on a good number of such events. This was not forthcoming. Ah well, all's well that ends well.

D A Bradley

REPORT BY RICHARD HUGTENBURG

A Review of Technical Content (Speaker Contributions)

The second ICDA meeting proved to field an excellent range of speakers, with invited and proffered talks with good representation from standards laboratories, universities and the medical world. The quality of the talks was very high and organisation of the meeting was excellent, thanks no doubt to the helpful and cheerful local organisers (aka graduate work-force). Programme timings, for example, were kept perfectly up-to-date on the conference web page.

Standards and fundamental physics developments

Dosimetry standards have their underpinning in fundamental science, therefore a significant aspect of the programme was the presentation of studies in fundamental atomic and nuclear physics.

Chris Chantler, Melbourne, well known to the readership, presented new calculations of the inelastic mean-free-path for electrons that incorporate phonon interactions, achieving improved agreement with the latest X-ray absorption fine-structure work. Laila Gurgi of University of Surrey described her work with a large international team using in-flight fission of stripped ^{238}U nuclei to study the decay of neutron-rich nuclei in the vicinity of the valence maximum nucleus ^{170}Dy and further highlighting the basic science underpinning the enormous advances in radionuclide imaging and radiotherapeutics. Stephan Oberstedt from the JRC-IRMM in Geel, Belgium, described high-quality spectroscopy of fission fragments in response to a request from the OECD Nuclear Energy Agency for more accurate fission fragment yield data for safety assessments of Gen-IV reactor systems, including their position-sensitive, Frisch grid ionisation chamber.

In enhancing standards, Brian Zimmerman, NIST, described EU and US directives requiring practitioners to better quantify the dose imparted to patients during radionuclide imaging. NIST will build on earlier work that focused on radiotherapeutics and will encompass theranostic agents such as ^{223}Ra and ^{64}Cu. Jill Merrett of the University of Surrey, Royal Surrey County Hospital and the NPL are also developing calibration protocols for imaging as a method of dosimetry for radiotherapeutics, with ^{131}I used to treat

../Continued

thyroid and ^{177}Lu used to treat neuroendocrinal tumours as radionuclides of particular interest. Collaborators, Mayeen Khandaker of the University of Malaya, Kuala Lumpar, and Naohiko Otuka, IAEA, Vienna, discussed the evaluation of nuclear reaction cross-sections and routes of production, with ^{55}Co, a positron emitter with potential clinical applications, given as important examples. Larry Hudson, also of NIST, considered how ISO standard X-ray sources could be used to calibrate the energy-dependent response of detector systems. First principle and Monte Carlo-based models of absorption were described for the example of phosphor imaging plates.

The development of neutron dosimetry standards was also a focus of the meeting. Mitja Majerle, Nuclear Physics Institute of the Academy of Sciences in the Czech Republic, presented a method developed by the group for determination of the neutron spectrum from a d+Be source, using activation foils and the SAND-II unfolding code. Neil Roberts, of NPL, described the development of improved Bonner sphere spectrometry for the nuclear industry, describing a priori use of Monte Carlo calculated UF_6 spectra and the subsequent refinement of detail that would not be possible with measurements alone.

Steven Judge, also of NPL, described the role that primary radioactivity standards will play in nuclear decommissioning, detailing the size of the problem faced by the nuclear industry. Interest in the maintenance and use of such standards has always been profound, since the earliest days of nuclear research; Judge citing as an example the 38000 certificates that were issued for the radium standard between 1913 and 1946. Paddy Regan from the University of Surrey described the potential for teaching associated with the deep aspects of nuclear physics, such as the exceptionally long half-life of ^{40}K; it's a special case with a decay that is essentially forbidden. Or the question of whether we are living in Goldilocks universe, where the combination of existing isotopes is 'just right'; the exceptionally long half-life of ^{238}U; the short decay time of nearby ^{236}Pb. The value of speculative research was discussed, where baseline measurements of radioactivity in the Thai delta preceded recent disastrous flooding.

Calorimetry underpins most modern dose standards. Laurie Petrie of the NPL, discussed the use of the TOPAS extension to the GEANT4 Monte Carlo code in the development of the NPL proton calorimeter to determine gap and volume average corrections in the system. Josbert Mulder of University and Medical Centre in Groningen, Netherlands, discussed the development of a water calorimeter for primary dose standard in proton therapy. Methods were described to handle radiation induced reactions in water, which lead to a substantial chemical heat defect in the energy measured. Kamran Fathi NPL and Royal Surrey County Hospital have taken the idea one step further, developing a micro-calorimeter based on SQUID, where small changes in the temperature have a profound effect on the penetration depth of magnetic fields into the superconducting system. The device is designed from tissue-equivalent materials and it is anticipated that it will be able to measure energy deposition in volumes of less than 0.3 um diameter, thereby able to provide standards of ionisation density of cellular length scales.

Radiobiology

Kevin Prise, Queens University, Belfast, described their work with the use of gold nanoparticles in radiotherapy, and the excellent instrumentation they have developed

../Continued

for the topic. The picture was of a growing understanding of the effects leading to biological dose, which occur both inside and outside of the nucleus, with the work suggesting the possibility of mitochondria mediated damage. Fred Currell also described work from Queens University on the final day of the programme, showing that some success has been achieved with a local area effect model (LAEM) for cellular damage. Still, many aspects remain unexplained, though it appears that there is the enhancement of free radical formation due to nanoparticles. Measurements with Fricke dosimeters have been performed in order to better understand the dynamics of electrons and free radicals in solution.

Saher Darvich-Molla from McMaster University, Canada, described the development of the electronics of their two-dimensional thick gas electron multiplier (THGEM), as tissue-equivalent proportional counters, offering improvements on traditional TEPC designs for high dose-rate applications. Zara Anjomani, also of McMaster University, described the use of THGEMs in the spectroscopy of ^{244}Cm alpha source, observing some distortions to spectra due to electric field strength variations, likely to be improved with mass manufacture.

Radiation protection and environmental radioactivity

Iani-Octavian Mitu from the Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering, Bucharest, described the radiation protection requirements for the new Extreme-Light Infrastructure Nuclear Physics research centre, utilising Monte Carlo modelling to handle a variety of circumstances, such as at the time of a beam dump. Ihsan Al Affan, likewise discussed radiation protection issues for therapeutic LINACs. The use of scintillation detectors to obtain spectrometry of the LINAC spectrum was examined, with a NaI detector, which offers the ability to resolve LINAC scatter and leakage components, and a plastic scintillator, to accurately measure the dose. Strategies for addressing pulse pile-up were described. Patrick Kessler from PTB Braunschweig described how they were developing NaI and $CeBr_3$ scintillators as dosimeters, using monoenergetic sources to characterise the response relative to the ambient dose equivalence quantity, H*(10). Including using impurity peaks to correct for the effects of temperature on the spectrum; an important issue for field-work. Petr Švrčula from the Centrum Vyzkumu Rez described protection aspects of their 700 TBq hot-cell gamma irradiation.

Nigel Hawkes, NPL, described the development of pocket-sized neutron dosimeter, with the use of ^{6}Li enriched scintillating material, Cs_2LiYCl_6:Ce (or CLYC for short) and pulse-shape discrimination. Domiziano Mostacci from University of Bologna used Monte Carlo simulations with GEANT4 to model air sample radioactivity measurements in a Marinelli geometry. Najet Ali, from the University of Liverpool, described the use of gating and pulse analysis to improve the single-to-noise discrimination of broad energy HPGe detectors.

Protection in medicine featured with Hugo Schelin of the Pelé Pequeno Príncipe Research Institute in Curitiba, Brazil, describing dose reduction strategies for paediatric imaging, including barium meal examinations. TLD measurements and modelling with the CALDOSE_XCT code were discussed where age-based groupings as well body mass and height are used, due to extreme variations in size in children. Mariana Baptista of the Instituto Superior Técnico, Portugal examined doses associated with cone-beam CT

../Continued

in image-guided radiotherapy. Monte Carlo modelling with MCNPX and phantom studies were used to assess doses to the patient, which in the case of frequent image are cumulative and give significant doses to the healthy tissue surrounding the targetted tumour. Fernanda Rocha Cavalcante of the Federal University of Sergipe in Brazil described use of non-uniform rational B-splines (NURBS) to define subject anatomy and MCNPX to evaluate doses in interventional cardiology in newborns and adults.

Huda Al-Sulaiti from Doha, Qatar, examined natural radioactivity distributions in Qatar. A wide range of gamma peaks from the ^{238}U and ^{232}Th were used to significantly improve sensitivity. Levels were found to be normal throughout the State of Qatar, with the exception of NW Dukhan. Laura Harkness-Brennan of the University of Liverpool described the use of digital Compton suppression to identify components of low-level waste repositories; the technique requires nanosecond pulse shaping and analysis.

The nuclear accident in Fukushima, Japan, remained an important topic for the meeting. Jun Saegesa of the JAEA informed the conference that Cs-134 is not affected by weathering and demonstrated the significant heterogeneity in the distribution of the isotope in the Precinct. Krzysztof Starosta of Simon Fraser University, Canada, described how their laboratory resources had been been diverted to measurements of ^{134}Cs and ^{137}Cs in marine biota, for the Fukushima accident, addressing concerns of substantial seafood consumers, in particular aboriginal (*e.g.* Inuit) communities. Relatedly, José Ródenas gave an interesting talk on the application of the Monte Carlo method to estimate doses due to neutron activation of various materials in a nuclear reactor. This is to assess the activity generated and the dose produced that could be a risk to workers.

Radiotherapy dosimetry

Proton radiotherapy was a major point of discussion at the meeting. Stuart Green, University Hospital Birmingham, described PraVDA, a project developing technology to improve range uncertainties in proton therapy, involving researchers in the UK, Sweden, Germany and South Africa. The data processing requirements of the system are awesome, likely needing to handle 180 Gbits/s from the silicon trackers, used to determine the trajectory of protons, and 360 Gbits/s from the range telescope, used to determine the energy. Peter Thirolf from the Ludwig-Maximilian University of Munich described the development of a Compton camera for prompt-gamma imaging of proton and heavy ion-beams, involving researchers from Germany, Saudi Arabia, Portugal, the Netherlands and Italy. The method also tracks Compton scattered electrons thereby enabling gamma-source energy reconstruction from incompletely absorbed photon events.

Grazia Gambarini of the University of Milan described the quenching effects on radiochromic film of protons and high LET beams used in radiotherapy, suggesting a method for correction that would be feasible in clinical practice. Mike Taylor from Christie Hospital and University of Manchester described their utilisation of Monte Carlo modelling from proton beam therapy and MRI guided LINAC beams, including the development of biological modelling of the effects of radiation beams including DNA strand-breaks as a function of LET. The computational effort has been lessened with the use of XEON/PHI computing cards, that

../Continued

offer large numbers of additional processors, but do not require re-coding in arcane languages associated with GPU programming.

Sinéad O'Keeffe from the University of Limerick described the plastic optical fibre sensors that they are developing, along with researchers in Galway, Belfast and Harbin, China. High sensitivity is demonstrated for several of the embedded phosphors that they have considered, enabling a time resolution of 0.1 ms (sufficient to resolve individual pulses in a therapeutic LINAC) or reduction in the phosphor size in order to achieve better quality tissue-equivalence. Alex Dimitriadis from the University of Surrey, and also NPL, discussed the characterisation of plastic scintillation detectors for the dosimetry of stereotactic radiosurgery, in a multicentre study. The detectors offer excellent tissue-equivalence, including comparable density to that of tissue, in a relatively small form-factor. Richard Hugtenburg described microbeam radiotherapy which makes use of the high intensities associated with 3rd generation X-ray synchrotrons along with tissue-equivalent microdiamond detectors to measure dose profiles at micron resolution, but requiring corrections to measure clinically relevant parameters, due to the high density of diamond (3.51 g/cc) and extra-cameral components.

The use of thermoluminescent (TL) dosimeters has an important place in radiotherapy in *in vivo* dosimetry. Shakradokht Jafari of Queen Alexandra Hospital compared sensitivity of alanine, LiF and glass bead TL dosimeters, the latter offering a potential solution that would both simplify and greatly reduce the cost of *in vivo* dosimetry and achieved substantially better sensitivity per volume. Yusuf Abubaker of the University of Surrey also examined the use of thermoluminescent glass beads to characterise an isotopic neutron source. Comparisons were made to Cd shielded and unshielded He_3 proportional counter and features in percentage depth-dose measurements with the beads were discussed.

Summary

The second international conference on dosimetry and applications, held in Guildford, Surrey, successfully drew an extremely international delegation, whilst showcasing the best of local expertise in radiation science, from the hosts, Surrey University, and also the nearby, National Physical Laboratory.

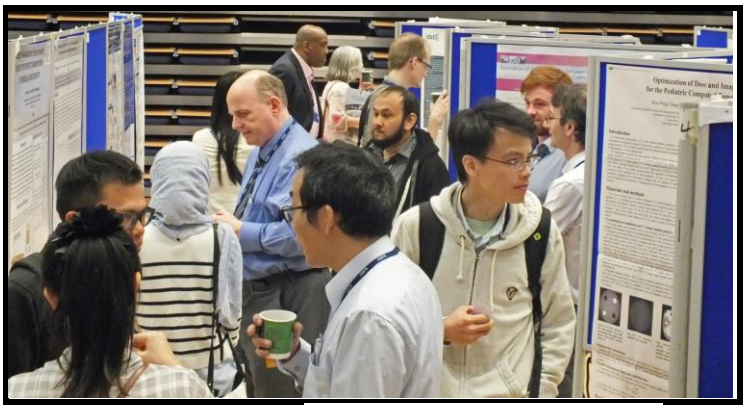
Richard Hugtenburg

Photos of the Conference on following pages :

Photos of the ICDA-2 Conference :

The Banquet

Valued Support Staff



The Posters

The Concert

../Photos Continued

ICDA-2 photos Continued

The Surrey Scholar Guildford High Street

IRPS Council Meeting July 3, 2016

Participants at the July 3, 2016 Council meeting of the International Radiation Physics Society, held at the University of Surrey, Guildford, UK.

Left to right: David Bradley, Chris Chantler, Richard Hugtenburg, José Ródenas, Alan Turing, a "towering" figure in theoretical computer science, Isabel Lopes, Ladislav Musílek, Tomáš Trojek, Jorge Fernandez, and Larry Hudson.

The Fourth International Conference on Radiation and Applications in Various Fields of Research (RAD 2016)

Report by : Goran Ristić, Jugoslav Karamarković, Ines Krajcar Bronić

RAD 2016 conference was organized by the RAD Association in cooperation with the Faculty of Electronic Engineering, University of Niš, Niš, Serbia from May 23 to May 27, 2016 as a Central European Initiative (CEI) activity. CEI is a regional intergovernmental forum committed to supporting European integration through cooperation among its Member States. This fourth conference in the RAD series gathered 214 participants from 36 countries.

The official opening of RAD 2016 was held on May 23, 2016. The participants were addressed by the Conference Chair, some members of the Organizing Committee and invited speakers. Traditionally, the awards for the best oral contribution (Nina Djordjević and Laura Basirico), best poster contribution (Nevenka Antović and Yuriy Demidov) and best student contribution (Gabriele Maria Grittani) for the previous RAD 2015 Conference were given to the awarded participants. At the end of the opening ceremony, the Dean of the Faculty of Electronic Engineering officially opened the conference, wishing all the participants a pleasant stay in Niš and a successful conference.

More than 500 abstracts and more than 100 full papers were received for consideration to be presented at RAD 2016 or published by the RAD Association. Consequently, the scientific program of RAD 2016 Conference included six invited talks presented in three plenary sessions. In the first session, Luisa Torsi from Italy presented state-of-the-art organic electronics biosensors while Ištvan Bikit from Serbia talked about the application of nuclear spectroscopy in environmental protection. In the second session, Martin Hauer-Jensen from the USA spoke about radioprotective properties of tocotrienols, and Marko Markov from the USA presented the biophysical basis of magnetotherapy. Finally, in the third session, Renata Longo from Italy talked about medical imaging with synchrotron radiation, whereas Kei Yamada from Japan presented new trends in medical imaging.

Chair persons at the Opening ceremony

Nina Djordjević, School of Medicine, Niš, received the award for the best oral contribution at the previous RAD 2015

../Continued

Dragan Janković, the Dean of the Faculty of Electronic Engineering, officially opened RAD 2016

Invited talk of Renata Longo

Audience during an Invited Talk

In addition to invited talks, two speakers presented a keynote talk (Jasna Mihailović, Serbia) and a special talk (Vladimir Jurišić, Serbia). The conference program also included about 100 oral presentations and about 120 poster presentations in 17 sessions dedicated to the following conference topics: Radiobiology; Radiochemistry; Radiation Physics; Radiation in Medicine; Radiation Measurements; Radiation Protection; Radioecology; Radon and Thoron; Radiation Detectors; Radiation Effects; Medical Physics; Radiology; Nuclear Medicine; Radiotherapy; Radiation Oncology; Electroradiology; Radiopharmacology; Cancer Research; Environmental Chemistry; Neutron and Heavy Ion Radiation; Microwave, Laser, RF and UV radiation; Medical Imaging; Medical Devices; Biomedicine; Biochemistry; Biophysics; Biomaterials; Biopharmaceuticals; Bioengineering; Biotechnology; Biomedical Engineering; Biomechanics; and Bioinformatics.

../Continued

The best contributions at the RAD 2016 conference were decided as follows.
Akos Banyasz (France) received the award for the best oral contribution and Jana Strišovská (Slovakia) for the best poster contribution, and both contributions were presented in the section Radiochemistry and Radiation Chemistry. Anna Selva (Italy) was awarded as the best student contribution for the excellent talk presented in the section Radiation Physics.

Oral presentations

Poster presentations

Vendors VF, a.s., Czech Republic; Ritec, Latvia and Theta Consult, Bulgaria took part in this event as exhibitors and presented their products and services to RAD 2016 Conference participants.

Exhibition

The RAD 2016 Conference was supported by Central European Initiative (CEI) and the Ministry of Education, Science and Technological Development of the Republic of Serbia through the conference co-organizer, University of Niš, Faculty of Electronic Engineering.

../Continued

Apart from the successful and interesting scientific sessions, participants were able to enjoy social events organized on each evening in various environments with different music and always good food. A whole day excursion to nearby Soko Banja spa with a lunch in the spectacular cave restaurant was also organized :

Cave restaurant in Soko Banja spa

Additional information can be found on the website

http://www.rad-conference.org .

For potential questions and proposals, please contact the Conference Secretariat by e-mail

info@rad-conference.org

The RAD Association also launched a new journal "Radiation and Applications in Physics, Chemistry, Biology, Medical Sciences, Engineering and Environmental Sciences" – an open access, peer-reviewed scientific journal that publishes a limited number of invited review papers, original research papers, and short notes. The journal is suitable for researchers from various fields of physics, chemistry, biology, medicine, electronics, environmental protection, *etc.*, involved with ionizing and non-ionizing radiation, as well as other related areas. The journal is published three times a year in electronic format only. The first issue of volume 1 can be found here

http://rad-journal.org/index.php

Marie Curie's Last Radium Standard – Grand Challenge

The last of the radium-226 standards that Marie Curie personally handled is destined for a radioactive materials waste dump. The challenge to the scientific community is to present a rationale for why this standard source, which 100 years ago was one of the most valuable standard artifacts in the world, should not face such an ignoble fate.

In 1910 the International Conference on Radiology and Electricity met in Brussels and a special committee including Marie Curie (Sorbonne University, Paris), Ernest Rutherford (Manchester University, Manchester) and Stefan Meyer (Academy of Sciences, Vienna) were asked to report on a means for establishing a standard for radium. Marie Curie prepared a standard source of 21.99 mg of radium chloride (the Paris Standard) and Stefan Meyer's institute prepared a set of three primary standards (the Vienna standards). The Vienna standards of 10.11 mg, 31.17 mg and 40.43 mg $RaCl_2$ were prepared by Otto Hönigschmid. In 1912 Rutherford and others arranged a comparison of the Paris and Vienna standard (the 31 mg source) with a gamma-ray comparison instrument built by his student James Chadwick. Following the successful intercomparison, Hönigschmid was asked to provide a set of seven secondary standards for use by national measurement laboratories around the world. Secondary Standard Number 6 was sent to the National Bureau of Standards (NBS) in Washington, DC. The mass of $RaCl_2$ on July 1, 1913 as measured by Curie was 20.28 mg and by Meyer 20.29 mg. The certificate, in French, English and German, was signed by Curie, Rutherford and Meyer.

The standard was received in the US in December 1913 and immediately placed in use for calibration of radium preparations for US medical and research applications and for export. During WWI and the immediate aftermath, the US industry had the global market for radium. Essentially all of the source material for export came through NBS as purified, sealed sources for gamma-ray comparison with the NBS standard. Standard No. 6 was the US primary standard and was used to calibrate other working standards of higher and lower mass.

The original 1913 standards were replaced in 1934 by a second set of standards prepared by Hönigschmid; Marie Curie died one month after their preparation. Her daughter, Irene Joliot-Curie, took her place on the International Radium Commission and supervised the intercomparisons of the 1934 standards with the Paris standard, which was then maintained at the Bureau International des Poids et Mesures (BIPM) in Sèvres, France. Irene Joliot-Curie retained two of the 1934 standards in her laboratory and took Standard No. 5430 to the BIPM in exchange for the original Paris standard. The US received standards No. 5440 (26.74 mg of $RaCl_2$) and No. 5437 (50.05 mg $RaCl_2$) in 1937. The NBS scientist, Leon Curtiss, who received these two sources had spent two years as a postdoctoral student with Rutherford at the Cavendish Laboratory in Cambridge. He spent much of 1935-1936 corresponding with Lord Rutherford to ensure that the sources were properly calibrated in Paris and Vienna prior to shipment to the US.

The three standard sources that came to the US were used to calibrate tens of thousands of sources for medical applications – principally for cancer therapy – and industry.

From 1914 to 1942, the NBS performed about 38,000 certification measurements on radium sources that totaled about 390 g, and an estimated commodity value of $21 M (1928 US dollars), which corresponds to over $300 M in 2015 dollars. The last recorded usage of the 1934 Hönigschmid standards was

../Continued

in 1956 when Wilfrid Mann used a microcalorimeter to compare the US standards with those of Germany and Canada.

Following these measurements, Mann designed brass containers with screw cap lids – equipped with glass tops to allow visualization of the glass ampoules. The glass tops were soon blackened by the radiation from the sources.

The containers were last closely inspected in 1995, although the lead storage cave where they are stored is checked periodically for any sign of radon leakage from the sources.

The fate of the Curie radium sources. Radium-226 was quickly replaced after the discovery of artificially-produced radiation sources. Sealed sources of radium for interstitial and intracavitary treatments gave way to radionuclides such as iridium-192. The higher-energy gamma-ray teletherapy sources (cesium-137 and cobalt-60) that replaced radium were replaced in turn by electron and proton accelerators. The NBS, now named the National Institute of Standards and Technology (NIST), discontinued calibrations of radium sources for medical applications in 1989, and the medical calibration laboratories in the US continued to offer calibrations for only a few years after that. One by one, the research centers that had retained the original 1913 and 1934 standards moved on to other pursuits and disposed of the sources as radioactive waste. At present, it is believed that the three sources retained at NIST are the last of those certified by Marie Curie and Irene Joliot-Curie.

Beyond their value as historical artifacts, what can be said of these sources that is of scientific interest? At the time of their preparation, elemental radium was separated from pitchblende from St. Joachimstal in the present Czech Republic (1913 standards) and from pitchblende from the Belgian Congo (1934 standards). They were certified to be low in barium, from the chemical separation, and low in mesothorium (although the radium-228 would have long ago decayed). Radium-226 has a half-life of 1600 years, and the 1913 standard has essentially achieved secular equilibrium with all the daughter products including the lead-210 and daughters. Lead-210 has a half-life of 22.3 years, and 5 half lives is usually considered sufficient for equilibrium. Using a value of about 160 $\mu W\ mg^{-1}$ for the power of radium-226 in equilibrium with its daughters, Source No. 6 has a power of about 3.2 mW. The five alpha particles emitted in the decay chain become helium-4 atoms. One can calculate from the 102 year decay of source No. 6 this would amount to 78 μg of helium-4, but the permeation rate of He through glass is sufficient to prevent a significant internal pressure. The alpha-particle radiation damage to the glass ampoules, however, must be significant, and this alone has led to the trepidation in handling the sources over the past half century.

The Marie Curie Grand Challenge to the scientific community is to present reasons why these sources should be retained for perhaps another 100 years. Institutes interested in receiving these standard sources for historical or investigative research purposes must have regulatory approval to receive such sources, as well as a source transportation plan and project plan approved by the institution director and an authorized Radiation Safety Officer.

Suggestions should be sent to

Michael Unterweger
(Michael.unterweger@nist.gov)
Leader, Radioactivity Group
or
Lisa Karam (lisa.karam@nist.gov)
Chief, Radiation Physics Division,
Physical Measurements Laboratory, NIST.

Bert M. Coursey and Ronald Collé

Gaithersburg, MD
September 2016

../Sources and photos

Sources:

Brown, A., The Neutron and the Bomb: A Biography of Sir James Chadwick, Oxford University Press, Oxford, 1997.

Coursey, B.M., Collé, R., Coursey, J.S., Applied Radiation & Isotopes, **56**, 5 -13, 2002.

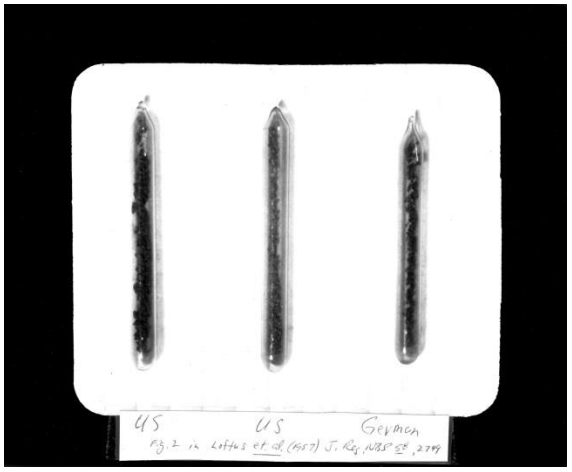
Coursey, B.M., Coursey, J.S., http://nist.gov/pml/general/curie/index.cfm

Curie, M., J. Phys., **2**, 795 (1912).

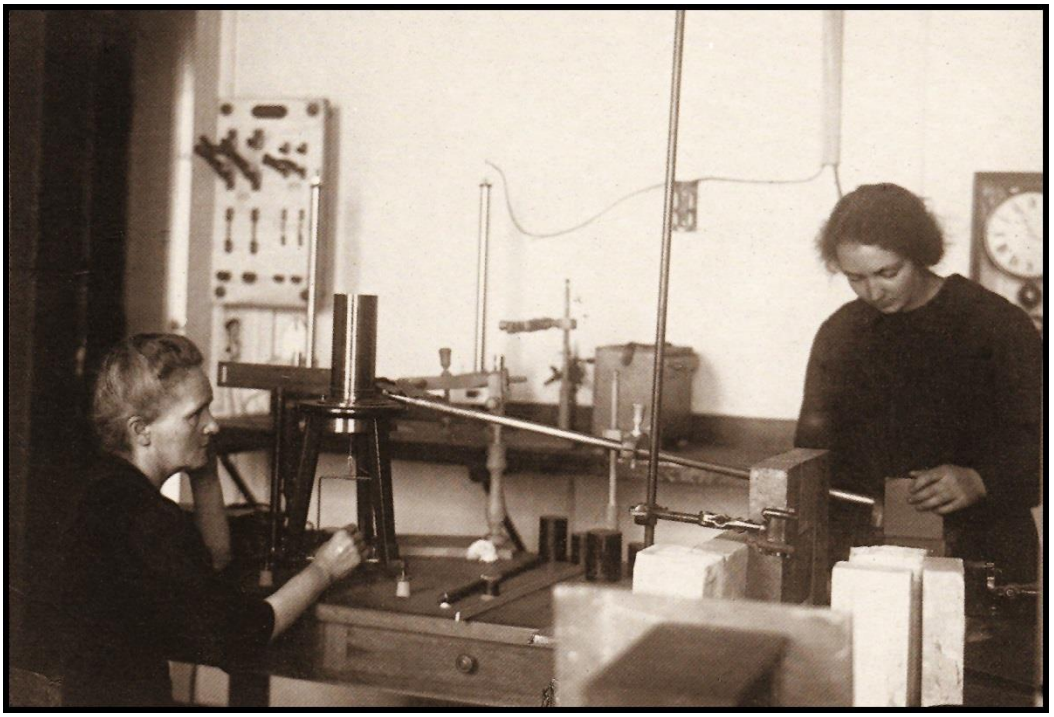
Honingschmid, O., Anz. Akad.Wiss, Wien, **82**, 30 (1945).

Loftus, T.P., Mann, W.B., Paolella, L.F., Stockman, L.L., Youden, W.J., Jour. Research National Bureau of Standards, **58**, 169 – 174, 1957.

Rutherford, E., Chadwick, J. A balance method for comparison of quantities of radium and some of its applications, Proceedings of the Physical Society, **24**, 141 – 151, 1912.



1934
Hönigschmid
Standards,
Loftus *et al.*, 1957



Marie Curie and her daughter Irene Joliot-Curie in their Paris Laboratory

../Continued

Secondary Standard No 6 v2

COMMISSION INTERNATIONALE DES ÉTALONS DE RADIUM.

CERTIFICAT.

Das als Chlorid dargestellte Radiumpräparat Nr. 6 entstammt St. Joachimstaler Uranpechblende und ist demnach praktisch frei von Mesothor.

Es enthält 21·50 Milligramm Salz.

Es wurde am 1. Juli 1913 eingeschlossen in ein Glasröhrchen (Thüringer Glas) von 0·27 mm Wandstärke, äußerem Durchmesser 3·2 mm, Länge 22 mm, an dessen Ende ein feiner Platindraht eingeschmolzen ist.

Dasselbe wurde als **Secundärer Standard** an den Wiener Etalons und an dem internationalen Standard in Paris nach mehreren γ-Strahlungsmethoden unabhängig voneinander geeicht.

Der γ-Strahlung nach ist es im Jahre 1913 äquivalent 20·28 mg $RaCl_2$. (Die jährliche Abnahme beträgt etwa 0·4 Promille.)

Unter Zugrundelegung der Atomgewichte von

226	für Radium
35·457	für Chlor
79·916	für Brom

entspricht dies

15·44 mg Ra-Element,
20·28 mg $RaCl_2$,
26·36 mg $RaBr_2$.

Die Genauigkeit dieser Angabe wird auf 0·2 % für gesichert gehalten.

Für die Wiener Messung:
Stefan Meyer

La Préparation de Chlorure de Radium contenue dans l'ampoule Nr. 6 provient de la pechblende de St. Joachimsthal. Elle est donc pratiquement exempte de Mésothorium.

Elle contient 21·50 Milligrammes de sel.

Le sel a été enfermé le 1/VII 1913 dans un tube de verre (Verre de Thuringe.) Epaisseur du verre 0·27 mm; Diamètre extérieur 3·2 mm; Longueur 22 mm. Un fil de platine fin a été soudé à l'extrémité du tube.

En qualité **d'Étalon secondaire** l'ampoule a été comparée à l'Étalon de Vienne et à l'Étalon International de Paris, au moyen de méthodes de mesures basées sur le rayonnement γ. La comparaison a été faite indépendamment à Vienne et à Paris.

D'après son rayonnement γ, la Préparation équivaut en l'année 1913 à 20.28 mg. $RaCl_2$. (La diminution par année est de 0·4 pour mille.)

En adoptant les poids atomiques suivants:

Radium . .	226
Chlore . . .	35·457
Brome . . .	79·916

on déduit la teneur correspondante en Radium élément et en Bromure de Radium:

Ra 15·44 mg,
$RaCl_2$ 20·28 mg,
$RaBr_2$ 26·36 mg.

La précision de ces résultats est considérée comme assurée à une approximation de 0·2 %.

Pour les mésures faites à Paris:
M. Curie

Specimen No. 6 of Radium is prepared as chloride from pitchblende of St. Joachimstal and is consequently practically free from Mesothorium.

It contains 21·50 Milligrammes of salt.

It was enclosed the 1/VII 1913 in a glass tube (Thuringian glass) of 0·27 mm thickness, exterior diameter 3·2 mm, length 22 mm, a thin platinum wire being fused into the end of the tube.

It is calibrated as **Secondary Standard** by comparison with the Vienna-Standard and with the International Standard at Paris, several independent γ-raymethods being used.

Measured by the γ-radiation, it is in the year 1913 equivalent to 20·28 mg. $RaCl_2$. (The yearly decay is about 0·4 per mille.)

Taking the atomic weights

226	for Radium
35·457	for Chlorine
79·916	for Bromine

this corresponds to

15·44 mg Ra-element,
20·28 mg $RaCl_2$,
26·36 mg $RaBr_2$.

These statements are considered correct to 0·2 %.

President of the Commission
E. Rutherford

Moon Bomb - Courtesy of NASA

Calendar - 2017

11 – 16 June, 2017 **RAD 2017**

The Fifth International Conference on Radiation and Applications in Various Fields of Research

Slovenska Plaža, Budva, Montenegro

Further information and web contact details in Conferences on the following page of this Bulletin

10 – 12 July, 2017 **IRRMA-X**

10th International Topical Meeting on Industrial Radiation and Radioisotope Measurement Applications

Swissotel, Chicago, IL, USA

Further information and web contact details in Conferences on the following page of this Bulletin

Conferences - 2017

RAD2017

FIFTH INTERNATIONAL CONFERENCE
ON RADIATION AND APPLICATIONS IN VARIOUS FIELDS OF RESEARCH
12. 06. - 16. 06. 2017 | Slovenska Plaža | Budva | Montenegro

The Fifth International Conference on Radiation and Applications in Various Fields of Research (RAD 2017)

will be held at the Slovenska Plaža Complex in Budva,

which is the most famous place at the Adriatic Sea coast in Montenegro,

in the period from June 11 to June 16, 2017

http://www.rad-conference.org/preRegistration.php

RAD Conferences gather people from various fields of research (natural science, medicine, environmental protection, engineering, as well as social sciences and humanities), representing the right choice for biologists, chemists, physicists, medical doctors, environmental protection specialists, electrical engineers and many others who are in a way connected with ionizing and non-ionizing radiations, as well as other areas related to them.

IRRMA-X will be held July 10-12, 2017 in Chicago, IL

with an optional tour to Champaign-Urbana on the 13th to visit HIDRA, the new stellarator-tokamak on the campus of the University of Illinois

http://cpmi.illinois.edu/2016/04/26/hidra-hybrid-illinois-defice-for-research-applications/

The conference will be held at the Swissotel Chicago

http://www.swissotel.com/hotels/chicago/

which is steps from the Magnificent Mile, Navy Pier, several museums,

and all the best Chicago has to offer.

The conference website will go live on or about October 1st with abstracts due by February 1st.

We look forward to welcoming you to Chicago!

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 for the above are listed in the IRPS information on page 2.

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

New Memberships, Membership Renewals

Membership form for new members, and details for payments by cheque for new and renewing members are on the last 2 pages of this journal and information for payment by credit card is below

If you are unsure when your renewal is due, contact

Elaine Ryan

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

Membership Payments by Credit Card

Internet payments by credit card (Visa, Mastercard, AMEX, Discover) can be made via the IRPS website

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

You do not need a PayPal account to use this method of payment

Go to the Home Page on our website (as above)

click on Membership, scroll down to the selection of buttons and click on the one that suits your membership.

If you have any queries or problems contact :

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**

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), Rio de Janiero, Brazil (ISRP-12, 2012) and Beijing, P.R.China (ISRP-13, 2015) 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),
Laboratory of Montecuccolino, Department of Industrial Engineering (DIN)
Alma Mater Studiorum University of Bologna
Via dei Colli, 16 40136 Bologna, Italy
Phone : +39 051 2087 718 *Fax:* +39 051 2087 747
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):

_____

../Continued

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*