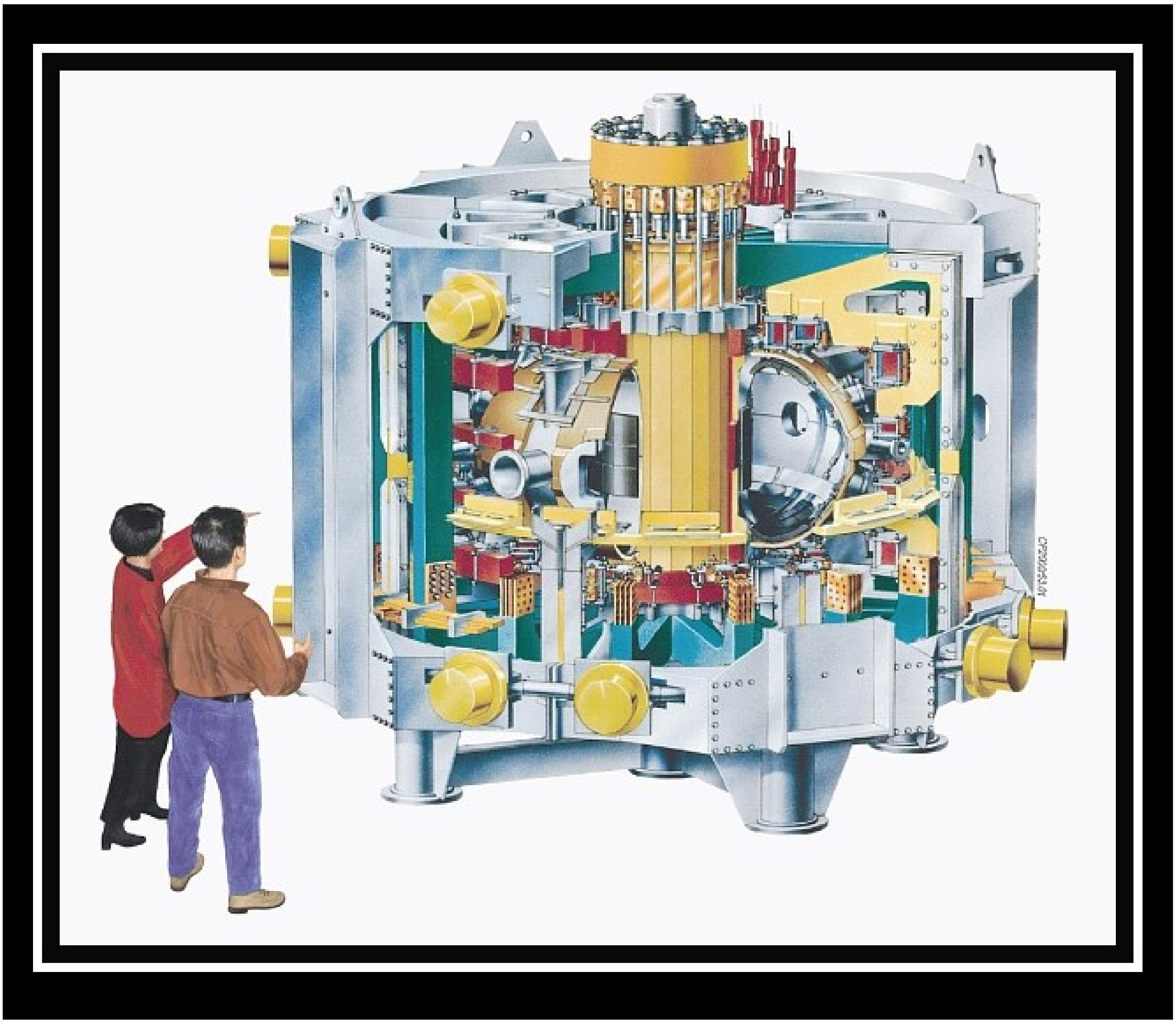
I R P S BULLETIN

Newsletter of the International Radiation Physics Society

Vol 23 No 1 **April, 2009**



The COMPASS Tokamak in Prague, Czech Republic

(Article on page 8)

Drawing from website of the Institute of Plasma Physics, Prague, Czech Republic

In this Issue

President's Report

As I write, final preparations are being made by David Bradley for the next IRPS Council Meeting which will be held at the University of Surrey in early April. David, who is currently Secretary of our society, steps down from that position at the Annual General Meeting of our IRPS in Melbourne in September.

I want here to thank him for the years of dedicated service he has rendered to our Society. He is a former Editor of the IRPS Bulletin and Councillor and has worked hard to make our Society prosper.

At the Council Meeting final details of the ISRP-11 Symposium (20 to 25 September) and its Associated Workshop (26 and 27 September) will be settled. I urge you to attend ISRP-11. As usual there will be a long list of international speakers, and the topics covered in the lectures will include almost the whole gamut of radiation physics. The workshop will give both basic and advanced lectures in the use of radiation in fields such as geology and mineralogy, forensic science, conservation science, and X-ray imaging. Remember that some financial assistance can be given to bona fide students from developing countries who present, and have accepted, an abstract for the symposium.

Register now. There will never be a better time to come to Australia.

As well, the time has come to vote in the election of Office Bearers and Council members of IRPS. Please make the effort to vote. The ballot form and profiles of members standing for election are in the previous IRPS newsletter (Vol 22 No 4) as well as the web, and the ballot form is included in this newsletter on page 4.

I hope to meet with many of you in Melbourne in September.

Dudley Creagh

CORRECTIONS

- The last issue of the Bulletin was accidentally numbered "Vol 23 No 4" and should have been Vol 22 No 4 (Computer's fault, of course !!)
- And another error in the last issue, for which I apologise - on the ballot form. Marcelo Rubio is a member in Argentina, not Brazil. (Corrected in the ballot form in this issue.)
  (Shirley McKeown)

From the Editors

Greetings all. We hope everyone is managing despite difficult circumstances that continue to affect economies around the globe. Perhaps as never before, confidence in the value of basic and applied research to short- and long-term economic stability and growth is being tested at the highest levels of government, presenting the scientific community with opportunities to participate in the shaping of policies that may well determine the course of government funding over the next decade or more.

For some of us, this has meant direct participation in government agencies as advisors or committee chairs; others have been asked to submit proposals for ambitious, even audacious, projects that show sufficient promise or merit and align with long-term strategies for economic impact; still others are looking across disciplinary lines for fresh ideas or application domains that fit new priorities. At the IRPS Bulletin, we are eager to hear how the present circumstances are unfolding in your part of the world, how you are weathering the times, how investments in R&D in your country and region are being affected.

Some of this news is actually encouraging, as the featured regional report provided by Ladislav Musilek, VP from Eastern and Central Europe, attests: the Czech Republic is forging ahead with initiatives in fusion research and education.

We would also like to thank Raul Mainardi (Facultad de Matemática, Astronomía y Física, Universidad Nacional de Córdoba, Argentina) for his technical contribution on the formal equivalence of "direct" and "inverse" Compton effects, and are grateful to Chris Chantler (University of Melbourne, Australia) for a report he prepared on the International Forum on Future Directions in Atomic and Condensed Matter Research and Applications, held last September in Melbourne.

As momentum builds toward ISRP-11 and its associated Workshop on Advances in Analytical Techniques in Geology, Conservation Science, Forensic Science, Border Technology, Biomedical & other Applications, we hope you'll consult the Announcement herein as you plan your calendar. Similarly, we have a Second Announcement for the 11th Neutron and Ion Dosimetry Symposium (NEUDOS-11), to be held 12-16th October, 2009, in Cape Town, South Africa. Other conference information and an election ballot, as Dudley noted above, are provided as well.

We thank you for your continued attention and encourage you to let us know how we're doing, what topics of interest you'd like to see in the Bulletin, what you're up to, interesting highlights in the literature and/or from conferences you've attended and outreach activities. 2009 is shaping up to be an historic, if somewhat uncertain or even turbulent, year, so let us continue to educate and learn from one another!

Ron Tosh and Larry Hudson

Election Ballot Form

For all posts, except those of executive councillors, vote for one by marking the appropriate box. For executive councillors, you may vote for up to four candidates who are running for the full six-year term and up to two candidates for three-year slots that have arisen due to vacancies. For all positions you may write in names of other members of the Society and cast your ballot for them.

President (vote for one)

Odair D. Gonçalves (Brazil) ☐

________________________ ☐

Secretary (vote for one)

Michael J. Farquharson (UK) ☐

________________________ ☐

Treasurer (vote for one)

Malcolm J. Cooper (UK) ☐

________________________ ☐

Vice Presidents:

Western Europe (vote for one)

Jorge E. Fernandez (Italy) ☐

________________________ ☐

Central & Eastern Europe (vote for one)

Ladislav Musílek (Czech Rep.) ☐

________________________ ☐

F.S.U. (vote for one)

Alexander P. Potylitsyn (Russia) ☐

________________________ ☐

North America (vote for one)

William L. Dunn (USA) ☐

________________________ ☐

South & Central America (vote for one)

Marcelo Rubio (Argentina) ☐

________________________ ☐

South East Asia (vote for one)

Suprakash C. Roy (India) ☐

________________________ ☐

North East Asia (vote for one)

Wu Ziyu (P.R. China) ☐

________________________ ☐

Africa & Middle East (vote for one)

Mohamed Gomaa (Egypt) ☐

________________________ ☐

Australasia (vote for one)

Chris Chantler (Australia) ☐

________________________ ☐

Executive Councillors:

Six years term (vote for four)

Isabel Lopes (Portugal) ☐

Francesc Salvat (Spain) ☐

Larry Hudson (USA) ☐

P.K. Sarkar (India) ☐

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Three years term (vote for two)

Raul Mainardi (Argentina) ☐

Peter K.N. Yu (Hong Kong) ☐

________________________ ☐

Please use this ballot to vote. Instructions for return:

1) <u>regular mail</u>: use the double-envelope system (place ballot in a small, unsigned envelope, and enclose the latter in a larger envelope, signing and printing your name and return address on the latter to authenticate your anonymous ballot), and send to:

David Bradley, IRPS Secretary
Centre for Nuclear and Radiation Physics, Department of Physics, University of Surrey
Guildford, Surrey GU2 7XH, UK

2) <u>electronic submission</u>: scan your completed ballot and email the image to: D.A.Bradley@surrey.ac.uk

Ballots must be received by the Secretary by 15 September, 2009.

The results will be announced at ISRP-11 in Melbourne, Australia, 20 – 25 September, 2009

11th International Symposium on Radiation Physics

20-25 September, 2009, Melbourne

Workshop on *Advances in Analytical Techniques in Geology, Conservation Science, Forensic Science, Border technology, Biomedical & other Applications*
26-27 September, 2009, Melbourne

We have great pleasure in inviting you to attend the upcoming International Symposium on Radiation Physics (ISRP-11) and the associated Workshop on Advances in Analytical Techniques in Geology, Conservation Science, Forensic Science, Border Technology, Biomedical & other Applications. This conference presents a valuable opportunity for the exchange of knowledge, including discussion of development of Australian Synchrotron programs and beamlines, contacts with leaders in the fields and potential research using Australian and overseas synchrotron facilities, accelerator facilities including ANSTO, ANU and CSIRO and the OPAL neutron facility.

Registration now available on-line

Call for Abstracts Now Open

Go to www.mcmconferences.com/isrp11/ for more information or to submit abstracts and/or register. Note the exchange rate makes visits to Australia more affordable!

Accommodation is significantly limited due to a major cultural event in Melbourne, so book early via your registration form!

Conference topics will be presented in oral and poster format. Oral sessions will include invited and contributed papers. A prize for the best young researcher paper presented orally will be given.

A small number of bursaries exist for early career researchers. Just Register (now up and on-line) and then submit your abstracts. In the Abstract submission, tick the 'Early Careers Researcher' box - i.e. student or first few years post-doc. Then you are automatically considered for the IRPS funds for Early Career Researchers.

Conference topics include :

A. Fundamental processes in radiation physics
B. Quantitative X-ray and particle analytical techniques
C. Absorption and fluorescence spectroscopy (XAFS, XANES, XRF Spectroscopy, Raman, Infrared)
D. Sources and detectors and simulation of radiation transport
E. Materials Science and applications to minerals, mining and processing
F. Medical applications and biology
G. Applications to space, earth and environmental sciences
H. Cultural heritage and art
I. New technologies and industrial applications

Think Business Events, Suite 6, 19-23 Hoddle Street, Richmond, VIC 3121
Tel. +61 3 9417 1350 Fax. +61 3 86102170 Email: isrp@thinkbusinessevents.com.au

Currently accepted invited speakers include :

- Prof. Andris Stelbovics on electron-atom interactions in radiation physics [A]
- Prof Moshe Deutsch on experimental and theoretical characteristic spectra in X-ray sources and synchrotrons [A]
- Prof. Gordon Drake on the theory of few-electron QED [A]
- Prof. John Rehr on developments of XAFS and FEFF for local structural identification [B]
- Prof. Yves Joly on developments of XANES and quantitative X-ray analytical techniques [B]
- Prof. Martin Feiters on analysis of catalysts and chemical reactive intermediates [C]
- Prof. Pieter Glatzel on high-accuracy experiments [C]
- Dr John Seely on laser-produced X-ray plasmas and spectroscopic diagnostics [D]
- Prof. Isabella Ascone on XAS pharmaceutical applications [F]
- Prof. Soichi Wakatsuki on medical applications and biology [F]
- Prof. Don McNaughton on medical imaging [F]
- Prof. Liming Chen on high-brightness table-top laser sources for high-energy radiation and advanced medical physics [F]
- Prof. Eric Dooryhée on Cultural Heritage and Art analysis [H]
- Prof. Annemie Adriaens on Stablisation of Cultural Heritage Objects [H]

For detailed information on the Program, Call for Papers guidelines and submission form, please go to www.mcmconferences.com/isrp11/

The 2009 conference is organized by the International Radiation Physics Society (IRPS) and supported by the Australian Government's Department of Education Science and Technology, the Australian Synchrotron and the Victorian Government. The meting is devoted to current trends in the broad area of radiation physics research. It is endorsed by the IUCr Commission on XAFS.

We look forward to welcoming you to ISRP-11 in Melbourne 20-27 September.

Yours sincerely

Christopher Chantler, Associate Professor & Reader
Symposium Chair
School of Physics, University of Melbourne
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Telephone: (061) 3 8344 5437

Dudley Creagh, President, IRPS

Larry Hudson, Co-chair, Scientific Program Committee

For further information about the symposium, sponsorship or workshops, please contact the Conference Office at :

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I S R P – 11

Symposium and Workshop

STUDENT BURSARIES

Student bursaries are available !!

$10,000 for 10 bursaries

Student/Early Career Researchers

Eligibility :
- chosen on quality of abstract presented on registration
- PhD student/Post Doctoral student certified by the Head of the Department of the Institution

STUDENTS

DIDIER ISABELLE AWARD

This award will be made to the postgraduate research student who makes the best oral presentation in the conference; the award consists of an engraved plaque and the sum of US$500.

Didier Isabelle was a leading French radiation physicist and one of the small group of scientists from around the world who established the International Radiation Physics Society several decades ago.

We are delighted that Didier's widow, Rosine Isabelle, will join us to present the first Didier Isabelle Award.

Vice President's Report, Eastern Europe

Ladislav Musilek

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Faculty of Nuclear Sciences and Physical Engineering
Prague, Czech Republic

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The COMPASS Tokamak in Prague

The decision to build ITER, the next generation of tokamaks, in Cadarache (France) has sparked interest in working on nuclear fusion all over the world. At the same time as the decision was being made on ITER, interesting progress was being made in the infrastructure for fusion research in the Czech Republic.

The Institute of Plasma Physics of the Czech Academy of Sciences worked for many years with a small CASTOR tokamak, designed and constructed in the Soviet Union (Kurchatov Institute in Moscow) and acquired in 1977.

In recent times, opportunities for fusion research have been substantially enhanced by the transfer to Prague of the British COMPASS tokamak (Fig. 1). The COMPASS (COMPact ASSembly) tokamak was constructed in the 1980s at the UKAEA Science Centre in Culham as a highly flexible, medium-size tokamak mostly for studying plasma physics in circle and D shape. The first plasma was "burnt" in 1989.

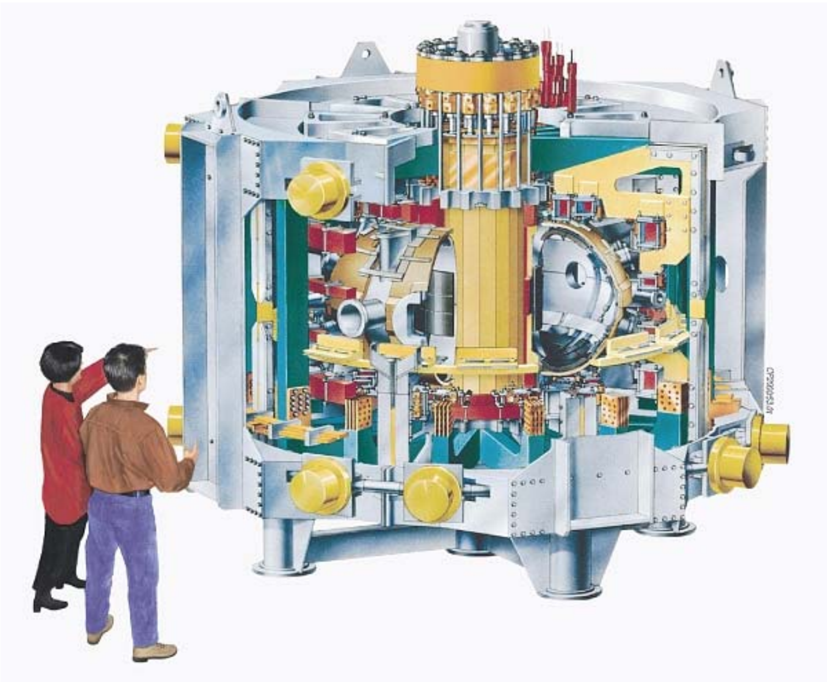

Fig. 1: The COMPASS tokamak [1]

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The programme of experimental work on COMPASS is divided into a number of related topic areas:

- Control of instabilities: this is vital to tokamak development, as instabilities reduce the confinement properties of the plasma and/or create disruptive plasma behaviour.
- Impurity control: low impurity levels and control of plasma exhaust are critical prerequisites for efficient tokamak operation.
- "H-mode" (i.e. High energy confinement mode) operation: the characterisation and control of Edge Localised Modes (ELMs), which are a feature of H-mode operation, are important for power exhaust and impurity control optimisation [2].

The COMPASS tokamak has a ring radius of 0.6 m and a vessel height of 0.7 m. It corresponds in size and plasma shape to one tenth of the dimensions of ITER. This similarity to the concept of ITER is a great advantage in the context of current directions in nuclear fusion research.

The UKAEA has also started alternative research on "circled" tokamaks (the MAST tokamak). The operation of COMPASS was discontinued due to lack of personnel and financial resources for the operation of two tokamaks at the same time, though the physical programme planned for COMPASS had not been completed. Recognition of its relevance for the ITER project led to the offer in the framework of EURATOM to relocate the facility free-of-charge to the Institute of Plasma Physics of the Czech Academy of Sciences. The tokamak was transported from the UK to the Czech Republic in October 2007 and its operation was launched on 19 February 2009. The experimental work of the Institute is also performed, in parallel, at other (larger) European tokamaks (e.g., JET in Culham, ASDEX in Garching, Tore Supra in Cadarache). Research is focused on edge plasma physics and wave-plasma interaction.

In relation to this development, the Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University in Prague opened a new study programme in "Physics and Technology of Nuclear Fusion" in 2006. The small CASTOR tokamak has been moved from the Institute of Plasma Physics to the Faculty for teaching purposes. As the Faculty is also equipped with a small VR-1 fission nuclear reactor, both fission and fusion teaching are now based on proper equipment. The strong basis of mathematics and physics in the programme leads on to special courses in Principles of Plasma Physics, Theory of Plasma, Diagnostics of Plasma, Physics of Inertial Fusion, Physics of Tokamaks, Materials for Reactors, etc., and also to practical exercises on plasma physics [3]. Students can profile themselves more to theoretical, experimental or technological aspects of nuclear fusion by selecting optional courses, and by selecting topics for their projects and MSc thesis. The programme is built in such a way that graduates can work in international research and development on nuclear fusion, while the scope of their knowledge is broad enough to enable them to work on other topics in the border area between physics and engineering.

References:

[1] http://www.ipp.cas.cz/Tokamak/compass

[2] http://www.fusion.org.uk/culham/compass.

[3] Study Programmes 2008-2009, Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Prague 2008.

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GENERALIZED COMPTON EFFECT

The Compton effect equations were derived and verified experimentally in 1922 when analyzing the collision of x-ray photons, with energies around several kilo electron volts (keV), and conduction electrons with energies of a few electron volts (eV). For many years this was considered to be the only case of interest; that is, where the incident energy of the photons exceeded that of the electrons. It was during the second half of the last century that the so called "inverse Compton effect", involving the collision of relativistic electrons with laser light photons, was developed. It is interesting to regard both situations above as limiting cases of a unique equation which is derived from the relativistic equations for energy and momentum conservation in their general form. The generalized Compton effect is thus appropriate for describing the collision of a photon and an electron (or, for that matter with any charged particle) regardless of their energies.

The occurrence of the Compton effect in astrophysical scenarios or in the laboratory is presented here for ranges of photon and electron energies spanning twenty-two orders of magnitude, in order to illustrate the importance of this generalized effect. Examples include the generation of high-energy gamma photons (of order TeV) and electrons as observed in cosmic radiation, the experiments of photonuclear reactions with gamma ray photons with hundreds of MeV, and the conversion of laser photons to x-ray photons. The beams thus produced inherit certain properties of laser beams, such as high intensity and collimation and high degrees of monochromaticity and polarization.

Key Words: electrons, photons, Compton effect.

I. INTRODUCTION

Synchrotron radiation, or electron bremsstrahlung radiation, is produced abundantly in circular accelerators (synchrotrons) where electrons are kept accelerated to ultra-relativistic energies. These accelerators have been named "synchrotron light sources" and there are a number of them around the world in countries such as the USA, Japan, Germany, France, Brazil, Australia, etc., where they are in high demand for basic and applied research. Synchrotron radiation has outstanding properties for research in chemistry (ultrafast reactions), biology (cell structure), material science (structure of compounds), medicine (diagnostic and therapy treatments), etc.

Almost simultaneously and independently in 1922(1), Arthur H. Compton in the USA and Peter Debye in Germany studied the collision of electrons with photons, assuming that both behaved as particles. Due to the significant experimental effort of Compton,

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this effect bears only his name and he was awarded the Nobel Prize in Physics for its discovery in 1927.

For many years the Compton effect (CE) was considered to be the transfer of energy from a photon to an electron of lower energy. In this context, in 1929, Dumond[2] developed a theory to interpret the relation between the experimental broadening of Compton lines and the distribution of the electron's momenta in atoms, thereafter named "Compton profiles". M. Cooper[3], in England, revived interest in these studies in the sixties and numerous applications to condensed matter problems were made and are being carried out to this day by Pratt[14] and others.

In the early fifties, with the development of energy dispersive gamma ray photon detectors, the CE made it possible to explain some details of the gamma ray spectra emitted by radionuclides. In 1948, twenty six years after discovery of the CE, physicists proposed the inverse process, that is, energy transfer from an electron to a photon (of lower energy), in order to explain the existence of photons of extremely high energies in the primary cosmic radiation flux.[5], but it was in 1965 that the term "inverse Compton effect" (ICE) was coined[6]. Another fifteen years lapsed before this effect was used to produce high energy gamma rays in high energy electron accelerators[7]. It should be stressed that the gamma ray beam produced by ICE inherits the properties of high intensity, monochromaticity, collimation and polarization of the laser beam, properties which have enabled studies of nuclear structure with high detail, including studies that harness the nuclear CE[4] to probe for stable structures, such as alpha particles, within heavy nuclei[8].

During the last several years many laboratories around the world have started to build compact sources based on ICE, so called "table-top synchrotron radiation sources"[9]. Improvements in linear accelerator technology, spurred by potential applications in cancer therapy and elsewhere, have resulted in higher currents, shorter pulses, greater stabilities and repetition rates of electron beams, which in conjunction with commercially available table-top terawatt (T^3) lasers, has made it possible to obtain x-ray beams with similar, or better, properties than is generally available from synchrotron radiation produced by electron synchrotrons operating at much higher energies.

Such sources could be adapted for addressing several critical applications. For example, intense x-ray beams with energies within 10 to 100 keV are important for diagnostic image quality and dose reduction, and would be applicable to a broad range of basic studies in applied physics. Gamma ray beams with energies around several MeV might be used for improved cancer therapy treatments. Finally, the use of these gamma beams in the treatment of radioactive wastes from nuclear power plants is being explored, since it has been observed that they accelerate the radioactive decay[15].

Nowadays, there are three alternatives to the conventional x-ray tube to generate x-rays with special characteristics: synchrotron radiation, free electron lasers (wigglers and undulators) and inverse Compton effect. All of them have significantly increased the use of x rays in all sorts of applications.

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II. COMPTON EFFECT GENERALIZATION.

Derivation of the general equation.

It is a rather simple exercise of relativistic kinematics to write down the equations of energy and momentum conservation for the collision of a photon and electron in the general case. The result of solving these equations is[7]:

$$\frac{h\nu'}{h\nu} = \frac{1+\beta\cos\alpha}{1-\beta\cos\theta + \dfrac{h\nu\cdot[1+\cos(\alpha-\theta)]}{m_i c^2}} \qquad (1)$$

where hν is the energy of the incident photon , hν' is the energy of the scattered photon, β is the velocity of the electron in terms of the velocity of light, p_i and p_f are the initial and final linear momenta of the electron, θ is the scattering angle of the electron and α is the incident angle of the laser beam (see Fig. 1).

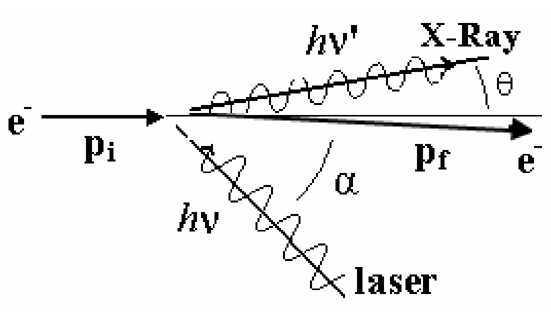

Figure 1. Schematic representation of the Generalized Compton effect.

When the incident electron is not relativistic (β→0), and instead of a laser photon it is an x-ray that collides with an electron, Eq.1 reduces to the familiar equation for the CE:

$$\frac{h\nu'}{h\nu} = \frac{1}{1+\dfrac{h\nu}{m_i c^2}(1-\cos\theta)}$$

Example 1. The photon beam, in Fig. 1, is incident from the right and the electron beam from the left collinearly. Then α = 0 and θ ≈ 0 (as we shall see) in Eq. 1. After the collision, we are only concerned with the photon beam which bounces to the right. If incident electrons have large kinetic energies such that $m_i c^2 \gg h\nu$, the scattered photon energy will be:

$$h\nu' \approx (1+\beta)\, h\nu/(1-\beta) \approx 4\gamma^2 h\nu \qquad (2)$$

where $\gamma = (1-\beta^2)^{-1/2}$ and $\beta = v_e/c$.

Let us consider γ = 41 (E_e = 20MeV) and hν = 1.9 eV (red laser light), then hν' ≈ 13 keV. Currently there are available ultraviolet light lasers (hν > 5eV) which will allow one to obtain x-rays with energies over 30 keV. Note that in synchrotrons radiation sources, it is necessary to keep electrons continuously accelerated to 25 GeV to produce synchrotron radiation of energies of up to a few tens of keV.

By making use of the Klein-Nishina formula (see below), we can calculate that for $I_\nu = 10^7$ photons/s and $I_e = 10^{10}$ e^-/s, then $I_x = 10^7$ photons/s[11].

Example 2. The momenta of the incident electron and photon are orthogonal, that is, α = 90° and θ = 0°. Again, if the electron energy is large, equation 1 can be written as:

$$h\nu' \approx 2\gamma^2 h\nu,$$

which implies that the energy of the recoiling photon is a factor of two lower than in the first example (see equation 2). While this arrangement would be less efficient with respect to x-ray yield and collimation of the x-ray beam, the outgoing x-ray beam would not strike the laser apparatus.

The Klein-Nishina differential cross section.

We will mention briefly the collimation properties of the x-ray beam produced as a

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consequence of the collision of well collimated electron and laser photon beams. To consider the other important property of the x-ray beam, its degree of polarization, exceeds the scope of this note. The Klein-Nishina equation holds for both relativistic and non-relativistic electrons and allows one to calculate the scattering cross sections in terms of the angular arrangement of the beams in a Compton collision, the respective energies and the angular aperture of the beam [13].

If $E_e \gg m_0c^2$ the Klein-Nishina equation has the form:

$$\frac{d\sigma_{KN}}{d\Omega} = \frac{1}{2} r_0^2 \frac{(\nu')^2}{\nu^2} \left(\frac{\nu'}{\nu} + \frac{\nu}{\nu'} - \sin^2 \theta \right)$$

where r_0 is the "classical radius" of the electron. Figure 2 shows calculated results of the angular distribution of the x-ray photon beam produced in a head-on collision of laser light photons with high energy electrons. The aperture is defined as the angle where the intensity of the x-ray beam drops to 50% of the intensity at 0°. The beam aperture is approximately given by $\theta \approx \gamma^{-2}$, as calculated by Chouffani[10], and in this range of energies it is a few milliradians, i.e., the beam has a diameter of one centimeter ten meters away from the collision region.

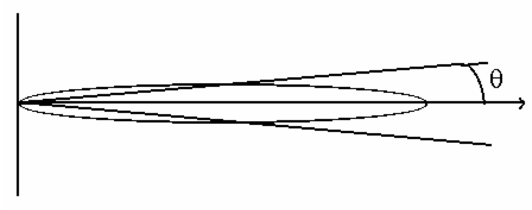

Figure 2. Calculated polar distribution of x-ray beam intensity emitted in the "forward direction", that is, along the incident electron beam propagation direction.

In Figure 3 there are depicted regions, spanning a range of 24 orders of magnitude in energy, where the Compton effect has its most striking consequences.

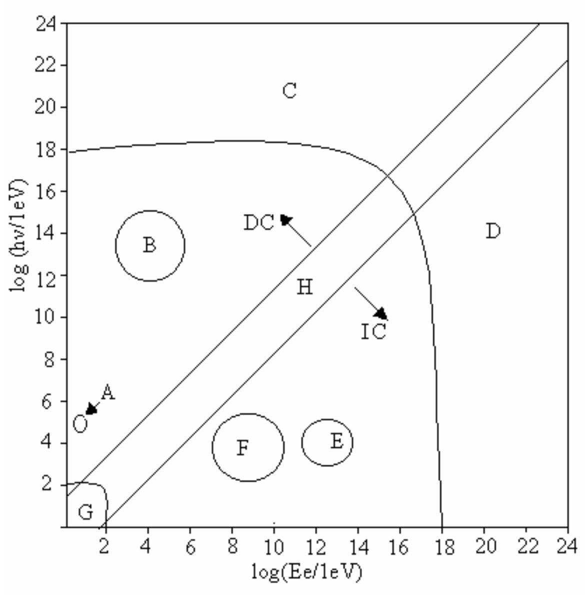

Figure 3. Main regions of interest of the generalized Compton effect. Vertical and horizontal axes indicate the scale of the incident energies of photon and electron, respectively.

In order to be complete, it would be necessary to draw this figure in 4-D, with axes representing initial and final energies of the electron and the photons. However, for purposes of illustration, we will consider only the initial energies of the electron and the photon, and in each different region we will refer to the characteristics of the outgoing particles.

Region "A" contains the range of electron and photon energies where A.H. Compton carried out his groundbreaking experiments.

Region "B" is where "nuclear Compton" effects have been and are currently performed, including Compton scattering with quarks inside nucleons.

Regions "C" and "D" are where astrophysical processes everywhere in the universe produce electrons and photons of the highest energies, and the generalized Compton effect is responsible for producing the highest observed energies for electrons and photons arriving to the earth.

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In regions "E" and "F" inverse Compton experiments of high and low energies take place. In zone "G" Compton collision effects are unobservable because $\lambda \ll \lambda_C$, where λ is the photon wavelength and λ_C is the Compton wavelength of the electron, given by $h/m_o c$.

Finally, along the diagonal "H", photons and electrons have roughly the same energy, so that energy transfer between them is negligible. The top arrow indicates the region of the direct Compton (DC) and the lower arrow the region where inverse Compton effect (ICE) are dominant.

III. CONCLUSIONS

Several textbooks and countless research articles treat the "direct" and "inverse Compton effects" as two separate effects, as if the physical phenomena involved were different. As equation 1 shows, it is one and only one effect with different outcomes depending on the relative energies of the particles. It must be noted that in Eq. 1 the photon is considered a particle and that electrons need to be treated with the relativistic kinematical expressions for conservation of energy and momentum. It is seen that a joint treatment has a greater teaching value and exposes the consequences and applications beyond the usual ones so frequent in radiation detection and measurement.

Finally it is worth mentioning that there are research efforts being made to produce the inverse Compton effect with an arrangement such that the outgoing x-ray beam does not impinge on the laser.

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Report on International Forum on Future Directions in Atomic and Condensed Matter Research and Applications

September 22nd & 23rd 2008, School of Physics, University of Melbourne

Organised by International Radiation Physics Society and School of Physics, University of Melbourne.

Endorsed by the IUCr International Commission on XAFS (X-ray Absorption Fine Structure) for the development of links & teaching with the wider community.

Sponsored by DEST (Australia) in part as a coordination and communication opportunity and in part as a preparation for the International Symposium on Radiation Physics –11 in Melbourne, September 2009.

We are gratefully supported by the Australian Synchrotron for direct relevance to existing and up-coming opportunities in synchrotron research and applications

Registered attendees: 49; Plenary Lectures: 16; one Poster session; one Forum;

Opening by Prof. Frank Larkins, Deputy Vice-Chancellor (International), University of Melbourne and Prof. Liz Sonenberg, Dean of Science, University of Melbourne

Attendance: Free

Book of Abstracts: 31pp.
Conference Proceedings: in advanced stage of publication (Radiation Physics and Chemistry).

The Forum was a great success in terms of the interactions and communications it fostered, and in terms of the discussions in a wider cross-section of important developments of interest to all. The speakers and forum showed links between some of the key threads across disciplines from Physics and Chemistry through Synchrotron Science, Diffraction, Biophysics, Biomedicine and Engineering.

The Forum began with experts on the fundamental side in theory and experiment and led towards diverse critical applications, finishing off with a forum to discuss key recent advances, personnel & possible future linkages & efforts. The thread of Atomic & Condensed Matter theory & Science is crucial to several developing applications and opportunities across these fields, and this was a key focus. The number of international invited plenaries gave critical reviews of diverse areas and linked up to wider issues than their particular fields of expertise.

Presentations began with developments and challenges in (fundamental) scattering theory and experiment (Prof. R.H. Pratt), followed by coherent scattering interactions in resonant X-ray diffraction studies (Prof. M. J. Cooper). Another plenary related to recent dramatic developments in electron-atom scattering (Prof. A. Stelbovics). Several talks on new detectors and sources (lasers, synchrotrons) and their applications were followed by discussions of theory and experiment of characteristic X-ray spectra. Crystallography without crystals was the subject of a review by Prof. P. Colman.

../Continued

Interleaved with this theoretical and experimental basis were the strong thread of XAFS basic theory and advanced applications, including the new XAFS technique of XERT developed by the team of the author of this report, *'Biomedical applications Of X-Ray absorption and vibrational spectroscopic microscopy in obtaining structural information from complex systems' (Prof. P. Lay), 'Recent and future developments in the use of radiation for the study of objects of cultural heritage significance' (Prof. Dudley Creagh), 'Synchrotron-based techniques in mineral exploration' (Prof. Joel Brugger), 'Latest developments and opportunities for 3D analysis of biological samples by confocal micro-XRF' (Prof. Marcelo Rubio), 'Applications of condensed matter understanding to medical issues and disease progression: Elemental analysis and structural integrity of tissue scaffolds' by Dr David Bradley and 'Application of XAFS to biologically-relevant metal-based chemistry' by Dr Stephen Best.*

The Forum at the end then brought these superficially disparate threads together, and looked towards other potential future developments and exciting areas, which in part will be foci of the coming International Symposium on Radiation Physics in 20-25 September 2009 and the associated Workshop 26-27 September (see www.mcmconferences.com/isrp11/).

The Workshop will be particularly focussed on XAFS and related synchrotron analytical techniques and applications.

My acknowledgements and thanks to all international and national Speakers, Session Chairs, and attendees, and especially to Justin Kimpton (Secretary) and Stephen Best (Chemistry) and my students for their assistance in preparing the program.

Chris Chantler, FAIP, Chair of Symposium, Vice-President (Australasia) IRPS,
Secretary IUCr International Commission on XAFS.

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11th Neutron and Ion Dosimetry Symposium (NEUDOS-11)

SECOND ANNOUNCEMENT AND CALL FOR PAPERS

iThemba LABS (Laboratory for Accelerator-Based Sciences) is hosting the 11th Neutron and Ion Dosimetry Symposium (NEUDOS-11) in Cape Town, South Africa from 12-16 October 2009. The Symposium is being held under the auspices of the European Dosimetry Group (EURADOS).

A comprehensive scientific program, encompassing a full range of neutron and ion dosimetry topics, will be offered. Delegates will enjoy an interesting and varied social program. Accommodation will be available in or near the impressive Victoria and Alfred Waterfront shopping, hospitality, and entertainment complex.

All information regarding registration, accommodation and submission of abstracts is now available on the website (www.neudos11.tlabs.ac.za). Note that in order to prevent the necessity of parallel sessions, papers for oral presentation will be selected by the Scientific Committees. Those not selected will have to be presented as posters. The proceedings of NEUDOS-11 will be published in a special edition of the journal *Radiation Measurements.* Full information regarding the submission of manuscripts will be available on the website once the abstract refereeing and oral presentation selection processes are complete.

The deadline for both abstract submission and application for financial support (African delegates only) is 15 March 2009 and for early registration it is 30 June 2009. Online registration will be available from 15 March 2009.

Dr D T L Jones
Chair: NEUDOS-11 Organizing Committee

If you wish to receive further information on NEUDOS-11 kindly provide your contact information to:

Ms N Haasbroek (NEUDOS-11 Logistics Manager)
iThemba Laboratory for Accelerator Based Sciences
P O Box 722
Somerset West
7129 SOUTH AFRICA
Tel: +27-21-843 1259
Fax: +27-21-843 3525
Email: neudos11@tlabs.ac.za
Website: www.neudos11.tlabs.ac.za

Calendar

2009

September **21 - 27** : ISRP-11

11th International Symposium on Radiation Physics

University of Melbourne, Melbourne, Australia

Early Announcement

For further information :

Chris Chantler : chantler@ph.unimelb.edu.au or David Bradley : d.a.bradley@surrey.ac.uk

Details on page 15 of June Bulletin and pages 5 - 7 of this Bulletin

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October **12 - 16** : **NEUDOS-11**

11th Neutron and Ion Dosimetry Symposium

iThemba LABS, Cape Town, South Africa

For further information : Neudos11@tlabs.ac.za

Details on Page 17 of June Bulletin and page 17 of this Bulletin

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2010

November **26 - 30** :

10th Radiation Physics and Protection Conference

Al-Menia University, Al-Menia, Egypt

Early Announcement

For further information :

Dr Mohamed Gomaa
Conference Scientific Secretary
3 Ahmed El Zommer St
Nasr City, Cairo, Egypt

Fax : 002-02-22728813 *Email :* radmedphys@yahoo.com
Web site : www.rphysp.com

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Membership Enquiries : **Michael Farquharson**

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 1.
Society information, membership application form, and arrangements for payment of membership fees are shown on the back pages of this Bulletin (credit card payments via internet are given below).

IRPS Promotional Material

The IRPS Poster and an accompanying leaflet, describing the activities of the Society, is posted on the website http://www.canberra.edu.au/irps. The members of IRPS are encouraged to distribute the poster and the leaflet at their home institutions and at meetings; in correspondence with colleagues and whenever possible, for promoting the Society.

The poster, which originally was designed by Dan Jones, is now the responsibility of Leif Gerward. Suggestions for improving the promotional material are most welcome. Please, send your comments to the e-mail address :

gerward@fysik.dtu.dk

(The poster was included in the December 2007 issue)

Membership Renewals

If you are unsure when your renewal is due, contact Mic Farquharson

Fax: +44 (0)207 040 5697 *email:* mfarquhm@mcmaster.ca

Details for payments by cheque are on the back page of this journal and information for payment by credit card is given below.

Membership Payments by Credit Card

Arrangements for internet payments by credit card have now been organised.
(Visa, Mastercard, AMEX, Discover).

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Just go to the Home Page on our website (http://www.canberra.edu.au/irps)
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If you have any queries or problems contact :

Professor Malcolm Cooper
Department of Physics, University of Warwick
Coventry CV4 7AL, U.K

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

(the www.irps.net address no longer connects)

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

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) and ISRP-11 will be in Melbourne, Australia in 2009. 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. D.A. Bradley, (IRPS Secretary),
Centre for Nuclear and Radiation Physics, Department of Physics, School of Electronics and Physical Sciences
University of Surrey, Guildford, Surrey GU2 7XH, U.K.
Phone : +44 1483 683771 *email:* d.a.bradley@surrey.ac.uk

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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../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 :

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[ ] *(in U.S. dollars, drawn on a U.S. bank)*: Send to Prof. Richard H. Pratt, Dept. of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA 15260 USA.

Amount paid (in U.S. dollars) ____________________

[ ] *(in U.K. pounds):* Send to Prof. Malcolm J. Cooper, (IRPS Treasurer), 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) ____________________

[ ]*(in Indian rupees):* Send to Prof. S.C. Roy, Department of Physics, Bose Institute, 93/1 Acharya Prafulla Chandra Road, Calcutta 700 009, India. Bank transfer details: Account number: SB A/C No. 9922, Canara Bank, Gariahat Branch, Calcutta.

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[ ]*(in Hungarian forints)*: Send to Prof. Denes Berenyi, Dir., Institute of Nuclear Research of the Hungarian Academy of Sciences, Bem ter 18/C, PF. 51, H-4001 Debrecen, Hungary.

Amount paid (in Hungarian forints) _______________

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

Prof. M J Farquharson
Department of Medical Physics and Applied Radiation Sciences
McMaster University
1280 Main Street West, Hamilton, Ontario, Canada L8S 4K1

email: farquhm@mcmaster.ca

9. ________________________________ ________________________

(Signature) *(Date)*