IRPS

IRPS BULLETIN

Newsletter of the International Radiation Physics Society

Vol 21 No 2/3 September, 2007

Vale, John Hubbell ...

John Hubbell delivering his acceptance speech in 1996 at the "Degree Hall", an impressive and beautifully decorated XV century room at the University of Córdoba, Argentina.
John's talk was translated into Spanish, for the benefit of the audience, by Professor Rosario Nicolás-Taneda.

(From Raoul Mainardi's memories, page 8)

Photo : Raoul Mainardi

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In this Issue

Regular Information :

President's Report

I recall someone remarking to me at the Mixer at the ISRP-10 in Coimbra last year that the young students were queuing up to have their photographs taken with John Hubbell, to whom this issue is a memorial.

John had a very strong influence on the development of many young scientists from many countries during his long scientific career. I, myself, received encouragement from him, more than thirty years ago, when he invited me to give a plenary lecture at the Ferrara ISRP conference. That led to the decision of the Commission on Crystallographic Apparatus of the International Union of Crystallography to invite me to organize an international project to determine the most accurate experimental technique for measuring X-ray absorption coefficients.

This is but one of the many projects, performed by young scientists, which John Hubbell initiated, and nurtured. Others will describe the influence John had on their life and work in other sections of this volume of the Bulletin.

This issue is a memorial to John Hubbell, his life and work.

But the most fitting memorial would be if the International Radiation Physics Society of which he was a co-founder should grow ever stronger with time, thus providing a living memorial of his service to Radiation Physics.

Dudley Creagh

From the Editor

Greetings to all and welcome to the present issue of the IRPS Bulletin, volume 21, no. 2/3. The sad news of the death of John Hubbell last March, coming so suddenly and unexpectedly and to such a central figure within our Society, left an impact whose reverberations, from around the world, are still being felt today: just this morning I received an email with multiple attachments documenting cherished correspondence with John dating back several years.

Coming when it did, we were not yet prepared to offer a fitting tribute to him in the IRPS Bulletin; however, it was decided shortly thereafter that our next issue would be so dedicated, and we put out a call for submissions from our membership. And answers came from several continents. Many wrote brief messages of condolence, intended as expressions of grief and appreciation of John's friendship; others contributed detailed reminiscences, some with pictures, that illuminated one or another aspect of John's influence and personality, his uncanny ability to recall innocuous details from decades-old correspondence, his energetic and conscientious attention to requests for reference literature, his graciousness in offering hospitality to guest researchers, the enthusiasm with which he anticipated visiting people in his various travels. These contributions make up the first part of this issue.

I was interested to learn that many IRPS members who responded to our request had met John in their student years, citing his interest and involvement in their early careers as being pivotal. The inclusion of a student's paper in the present issue, summarizing initial work in her PhD research, might therefore be an appropriate tribute as well: one can well imagine John encouraging students to consider the Bulletin as a vehicle for sharing details of their work in radiation physics.

We hope that what we have put together stirs some memories of John, if you were fortunate enough to have met him, or arouses curiosity about an extraordinary man who inspired great respect and admiration among colleagues. I knew him for just a few short years. His office, which remains today as he left it, is just a few doors down from mine at NIST, and I remember with some amazement the work schedule he maintained – 6 days a week, typically – right up until he was taken ill. He seemed a perpetual presence. As Prabhakar Kane observes in his tribute to John, "It will be difficult…to realise that he is really no more with us."

Ron Tosh

WELCOME TO NEW MEMBERS

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Society information, membership application form, and arrangements for payment of membership fees are shown on the back pages of this Bulletin.

Membership Renewals

If you are unsure when your renewal is due, contact Mic Farquharson :
Fax: +44 (0)207 040 5697 *email:* m.j.farquharson@city.ac.uk

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

Memberships – new and renewed – can be paid by credit card (Visa, Mastercard, AMEX, Discover).

Go to our website http://www.irps.net/registration.html
and choose the *"by email/internet"* button. Follow the instructions for the type of membership you desire. (It is not necessary for you to have a PayPal account). Send a copy of your payment receipt and a completed membership form (accessed from the PayPal payment page) to the Membership Secretary : m.j.farquharson@city.ac.uk.

Obituary

John Howard Hubbell

April 9, 1925 - March 31, 2007

The International Radiation Physics Society (IRPS) lost one of its major founding members, and the field of radiation physics one of its advocates and contributors of greatest impact, with the death this spring of John Hubbell.

John was born in Michigan in 1925, served in Europe in World War II, and graduated from the University of Michigan with a BSE (physics) in 1949 and MS (physics) in 1950. He then joined the National Bureau of Standards (NBS), later NIST, where he worked during his entire career. He married Jean Norford in 1955, and they had three children. He became best known and cited for National Standards Reference Data Series Report 29 (1969), "Photon Cross Sections, Attenuation Coefficients, and Energy Absorption Coefficients from 10 keV to 100 GeV". He was one of the two leading founding members of the International Radiation Physics Society in 1985, and he served as its President 1994-97. While he retired from NIST in 1988, he remained active there and in the affairs of IRPS, until the stroke that led to his death this year.

This account is an attempt to give some description of John Hubbell's life and activities.

CHRONOLOGY

John was born in Ann Arbor, Michigan April 9, 1925, the third child of Howard Adams and Mildred Jeanetta (Lipe) Hubbell. After living some years in Jackson, Michigan John's father died (1932), and the family returned to the family home area of Manistee, where John grew up, five blocks from a beautiful beach on the shore of Lake Michigan. He became Treasurer of his Manistee High School class and graduated in 1943.

By then he had been drafted to serve in World War II. After basic training at Camp Hood, Texas, he began Army Specialized Training Program engineering studies at Hope College, MI. But due to the impending D-Day operations he was sent to Europe as a machine gunner in the 304th Infantry Regiment of the 76th Division. He served in the Ardennes, Rhineland and Central Europe Campaigns, for a time under General Patton. He later received the Bronze Star for his service in WWII.

When the war ended, John returned home and attended the University of Michigan under the G.I. bill, graduating with a BSE (physics) in 1949 and MS (physics) in 1950. He then accepted a job as physicist at the National Bureau of Standards, Washington, D.C. (later NIST in Gaithersburg, MD.), where he worked his entire 56 year career. He was in the group organized under Ugo Fano (later distinguished Professor at the University of Chicago), serving in the X-ray Crystal Diffraction and Thermodynamics Group (1950-51) and the Radiation Theory Group (1951-62), as Director of the X-ray and Ionizing Radiation Data Center (1963-1981), in the Center for Radiation Research (1982-88), and as a consultant in the Photon and Charged Particle Data Center (1988-2007).

John married Jean Garber Norford June 11, 1955. They had three children (Anne Virginia of Moorpark, CA, Shelton Eric of Dhahran, Saudi Arabia, and Wendy Jean of Colesville, MD) and eventually nine grandchildren: Lisa, Sarah, Jenny, Roger and Alan (by Anne and Glen Cooper), Jonathan, Wesley and Laura (by Shelton and Dorothy), and Vanessa (by Wendy and Steven Carballo). They lived 48 years in Rockville, MD, in their house on Rocking Horse Road, and the last three years in the Asbury retirement community in Gaithersburg, MD.

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John officially retired from NIST in 1988. However he remained active there (going in daily, five and a half days per week) and also in the affairs of IRPS, until the massive stroke that led to his death this year (of aspiration pneumonia), March 31, 2007, in Bethesda, MD.

PROFESSIONAL ACCOMPLISHMENTS

John's career resulted in more than 120 articles, encyclopedia contributions and book chapters, including "citation classics".

John became best known and cited for National Standards Reference Data Series Report 29 (1969), "Photon Cross Sections, Attenuation Coefficients, and Energy Absorption Coefficients from 10 keV to 100 GeV". The data tabulated here proved to be extremely useful in many fields of activity, and the Report set records for numbers of citations.

He also worked out the analytical solution to the Rectangular Source Problem, published in NBS Journal of Research 64C (1960), the Hubbell Rectangular Source Integral, as well as the Epstein-Hubbell generalized elliptic-type integral. His early career also included work utilizing the Monte Carlo transport method.

John served for many years as an editor, for "Applied Radiation and Isotopes" (1988-92) and for "Radiation Physics and Chemistry" (1992-2007), for which he was Editor-in-Chief (1993-2001).

He was a consultant and a member of various special committees and task forces, including the International Union for Crystallography Task Group on X-ray Absorption Coefficients.

CONTRIBUTIONS TO IRPS.

John Hubbell was one of the two leading founding members of the International Radiation Physics Society. John's contacts in radiation physics were world wide, and they often led to personal friendships. His correspondence was extensive, and visitors to the United States sought him out.

John's association with Professor Ananda Ghose of the Bose Institute, Calcutta (now Kolkata), eventually led to the formation of the International Radiation Physics Society (IRPS), founded in Ferrara, Italy in 1985. This grew out of the First International Symposium on Radiation Physics (ISRP), held in Calcutta in 1974, which John attended.

The Tenth Symposium was held last year in Coimbra, Portugal; John was the only person to have attended all ten of the meetings. John also attended many of the subsequent Council meetings of the Society. He served as President of IRPS 1994-97, as Secretary to its Advisory Board, and as Regional Vice President for North America. In recognition of their fundamental contributions to the Society Ananda Ghose and John Hubbell were designated lifetime members of the Society, the only individuals who have been so designated.

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PERSONAL

John joined Foundry United Methodist Church, Washington, DC (on the recommendation of his Manistee church pastor) on his arrival there, and the Hubbells were lifelong participants in its activities. John served for seven years as Scoutmaster of Foundry Troop 17, taking the Scouts on 100 mile hikes on the Appalachian Trail, snow camping, etc. He was a member of the Foundry Players. The Hubbells taught Sunday School and more recently served as communion stewards.

John initiated a family project of seeing that each of their children was in all fifty states before high school graduation. This included a 1969 drive from Washington to Fairbanks, Alaska and on by air to Point Barrow.

The Hubbells traveled to solar eclipses. In the winter of 1979 he drove north of Winnepeg for the last total solar eclipse in North America until 2017. In 1983 he and Jean celebrated their anniversary with the solar eclipse in Indonesia. And last year they saw the solar eclipse in Libya.

The yearly meetings of the Hubbell Family Historical Association were another of their activities.

John was a fine player of the harmonica, taking it with him around the world, and he played it at the ISRPs.

MEMBERSHIPS AND HONORS

John was a member of the American Nuclear Society, American Physical Society, Health Physics Society, Radiation Research Society, Society of Nuclear Medicine, and of course the International Radiation Physics Society.

He was also a member of the Potomac Appalachian Trail Club, the Appalachian Trail Conference, and the American Forestry Association.

John received the Faculty Medal from the Technical University of Prague (1982), the Paul C. Aebersold Award (for outstanding achievement in basic science applied to nuclear medicine) of the Society of Nuclear Medicine (1985), the Radiation Industry Award (1985), and the Professional Excellence Award from the American Nuclear Society (1990). He was named Outstanding Alumnus of the University of Michigan Nuclear Engineering Department (1995), and he was awarded Doctor Honoris Causa, University of Cordoba (1996). He received the Distinguished Scientific Achievement Award from the Health Physics Society (2001). He became a Fellow of the American Physical Society (2002).

As already noted, John was designated a lifetime member of IRPS, one of only two people who have been so designated.

(Material taken from April 15, 2007 Memorial Program at Foundry United Methodist Church, Washington, DC. also as provided by Paul Bergstrom, and also from Who's Who in the World 2006.)

Richard Pratt

Members' memories of John Hubbell

From Raoul Mainardi, Argentina

John Hubbell – Doctor Honoris Causa

John Hubbell visited the University of Córdoba (Argentina) in October of 1996 to receive the degree of "Doctor Honoris Causa", the maximum distinction conferred by this university.

The University of Córdoba is the fifth oldest in the Americas and was founded by the Spaniards 430 years ago. It is not only older but also is larger than any other university in North America, for example, having more than 120,000 undergraduate students.

During his stay in Cordoba city, John visited several places such as the Department of Physics of the Faculty of Mathematics, Astronomy, Physics and Computer Science, the National Astronomical Observatory and the Secretariat of Science and Technology of the Province of Córdoba. In picture (3) below, Dr. Marcelo Rubio, undersecretary of Science and Technology of the Province at the time, is giving details to John and me about the projects of CEPROCOR, our research and technology center. Dr. Rubio is now a Council Member of IRPS.

This Faculty was founded in 1956 by astronomers from the observatory. This observatory, created by President Sarmiento in 1871, is the oldest scientific institution in Argentina and its first director was Benjamin Gould, a North American astronomer whom Sarmiento met while visiting the USA.

John Hubbell delivered his acceptance speech at the "Degree Hall", an impressive and beautifully decorated XV century room, as surely Jean Hubbell remembers. John's talk was translated into Spanish, for the benefit of the audience, by Professor Rosario Nicolás-Taneda.

The pictures below, taken by Jean, show the "Degree room" with John delivering his talk and a white rectangular screen where he showed several pictures of his lifetime *(1)*; John and Rosario at that special moment *(the cover photo)*; John receiving his diploma from the President of the University *(2)* and the last picture referred to above *(3)*.

We were highly honored when John accepted the degree we offered him. It was the first Doctor Honoris Causa for our Faculty (although not the first for the University). After the university authorities glanced at his impressive curriculum vitae, I found no objections to confer upon him that degree.

I am sure he was very happy and honored as well. He afforded the travel expenses and Dr. Rubio's office the housing expenses. He once told me that he had received many prizes, but this was his first honorary degree.

Scattered throughout our x-ray spectroscopy laboratories are countless tables, papers and assorted information John sent us for more than a quarter of a century. I still keep a literature review he made and sent me in the pre-web times.

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From Raoul Mainardi Continued

We all will miss him very much. He was the strongest force that kept the IRPS members connected in so many ways. At the time of his unexpected departure he was being proposed for the Sievert award that he would surely have received in Buenos Aires, the capital city of Argentina, later this year.

Photo 1

Photo 2

Photo 3

From Neal Carron, U.S.A.

I first encountered John Hubbell in the early 1970's. I wrote him (an old fashioned paper letter) about some cross sections, and he answered quickly and remarkably thoroughly.

I had no occasion to interact with him again until the 1990's, when I wrote him again for other information. I had forgotten that I had contacted him 26 years earlier. His response was classic: "Glad to hear from you again!" He remembered me, had kept my earlier correspondence, and referred to it by exact date. That's something I had never seen before, and only later came to recognize as typical of John.

I've never known anyone friendlier or more helpful; and he was a help to me in preparing my recent book on the passage of energetic particles through matter. He sent me many of his (and colleagues') papers, each one with a personally handwritten note. The best paper he sent was his "What did you do in the war, grandaddy?" that outlined his wartime activities for his grandson.

He was the kind of person you felt you knew intimately, even when you didn't. I am saddened by his sudden death; we've all lost a good friend.

From David Fleming, U.S.A.

I was surprised and very pleased to receive an e-mail from John Hubbell in 2004 following a publication of some of our work in radiation physics. I had known of his research for many years, but had never before had any communication with him.

In the correspondence which followed from his initial note, John took the time to send a package of reprints by mail, along with a written account of his experiences during the Second World War. He also included a personal invitation to join the IRPS.

The following year, I had the honour to finally meet John, at the Industrial Radiation and Radioisotope Measurement Applications meeting at McMaster University.

I was very saddened to hear of his passing.

From B R Kerur, India

The Indian Society for Radiation Physics, Dharwad Chapter, expresses great sadness upon hearing the news of the death of Professor John H Hubbell, Radiation Physicist, NIST, USA. A moment of silence was observed by all members of the chapter, and prayers said for God to give strength to Mrs. Jean Hubbell and to their family members on the occasion of this great loss.

Dr John Hubbell was a great humanist, co-operative and helpful especially to radiation physicists in developing countries. He was helpful to the research community, sending research articles and asking us to initiate this kind of work. With his guidance only, I initiated my research curricular activity in the field of Radiation Physics.

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From B.R. Kerur, Continued :

Dr. Hubbell was one of the founders of the International Radiation Physics Society, and he worked tirelessly so that it would develop into an organization that would be of great benefit to all humankind. I must emphasize that the death of Dr. Hubbell is not only a loss to his family, but is felt throughout the community who knew him directly or indirectly

The contributions made by him to Radiation Physics are enormous, hence we may feel that, in spite of our loss, Dr. John H. Hubbell remains with us.

From Chris Chantler, Australia

John was a constant source of encouragement for many young researchers, and supported my theoretical and experimental research from early post-doctoral days. His own research and work on tabulations, databases and bibliographic analyses have been reference tools used by many researchers around the world in a wide range of fields.

He was always on hand to give positive feedback and pass on highlights and recent work to many others so that we could become and remain both a collegial community and to assist one another where possible. Perhaps this was particularly true for colleagues from developing nations; but as I could be counted as a peculiar mixture of Australia / UK / USA, I was also extremely grateful for this relationship.

You could argue that this was simply a professional relationship; but if so, it is a professional relationship of a superlative kind, an example to us all as we become more busy with our own research, our own priorities, and perhaps our own self-interest. Of course, this self-less attitude was a key foundation of the IRPS & ISRP and one of my particular reasons for being attracted to it, in addition to the science!

John fostered interactions in both directions, so in many cases he helped me to help other young researchers or researchers coming from other fields. Sometimes our interactions were simply discussions of theory or experiments or coordination of schedules, or particularly the great opportunities he took to view eclipses, including those in Australia !

He was a supporter of much noble and collegial work and outreach throughout his life. He will be remembered as a kind, thoughtful and above all collegial figure who fostered relations between disparate individuals and communities and helped to provide an ethical perspective whenever called upon. We will miss him but think of his influence often.

From P.P. Kane, India

It is with a great sense of sorrow and loss that this piece has been written in memory of the late Dr. John H. Hubbell who passed away at the age of 82 on 1st April 2007 after a relatively short illness following a stroke.

John and I got to know each other in 1970 through correspondence concerning two papers, namely, one of his [(1)] and the other [(2)] from my group in Mumbai (then called Bombay). The work of Hubbell (1969) was a distinguished sequel of earlier reports [(3), (4)] concerning attenuation coefficients for

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From P.P. Kane Continued :

gamma rays. During the sixties and seventies, I had received funding from the National Bureau of Standards (NBS) of the USA under the so-called PL-480 programme. The funded research work was concerned with elastic and Compton scattering of gamma rays, topics very close to John's research interests. He visited us in early 1972 in connection with the above mentioned research grants from NBS.

I visited the USA in early 1973 to attend the photonuclear conference held at Asilomar in California. He was instrumental in encouraging me to meet Professor Richard H. Pratt of Pittsburgh during my short stay in USA. That meeting and several subsequent ones resulted ultimately in two extensive Co-operative Research Programmes funded by the National Science Foundation (NSF) of the USA during the eighties and nineties. John and his wife Jean were very hospitable and entertained my wife and me in their own home, where we also got to know their children Anne, Shelton and Wendy who are all doing well in their respective spheres of activity.

Later in 1974, John came to Kolkata (then called Calcutta) and along with Dr. A. M. Ghose began work towards organizing the succeeding International Radiation Physics Symposia and also the International Radiation Physics Society (IRPS). The tenth in the series of those symposia was held recently in Coimbra in Portugal. Remarkably, John was perhaps the only scientist able to attend all of the first ten symposia. I stayed with John and Jean again in 1981 and 1984. They stayed with us in Mumbai during the nineties. Thus, our contacts were both at the professional and personal level. I think that was typical of most of John's contacts with people from all over the world. He also persuaded me to accept the responsibility of being one of the Editors of Radiation Physics and Chemistry. He was extremely helpful to me and to many others during the course of his long professional life. In collaboration with many well-known scientists, he published a landmark paper concerning form factors and incoherent scattering functions,[5] which has become a citation classic and is used even today by physicists, chemists and medical scientists. I will not comment here on extensions of his early work on different topics published in the recent past by him and also by several other scientists. The above mentioned paper even pointed out the importance of electron correlations in relation to incoherent scattering functions for small momentum transfer in the case of targets of small atomic number. John's work was usually of direct relevance to the interpretation of experiments in radiation physics. For example, at an early date, he and his coworkers had developed an analytical formulation for the evaluation of radiation field intensities from rectangular sources.[6]

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From P.P. Kane Continued

The year 1987 was full of turmoil for John on account of the need for his formal retirement from the National Institute of Standards and Technology (NIST). Many physicists including myself, appalled by this development, wrote supportive letters to the authorities of NIST for reconsideration, but did not succeed in the attempt. However, he did not allow this development to come in the way of his contributions to radiation physics. He decided to work as a consultant, as a promoter of international co-operation and as an Editor-in-Chief (Physics) of Radiation Physics and Chemistry. During the last five years, he worked as a consulting Editor. That journal became much better known in the community of radiation physicists during his tenure.

In a quiet way, John was a deeply religious person and out of strong convictions abstained from smoking and alcohol. At the same time, he was very tolerant of other peoples' faiths and/or failings. During the second world war, he was a draftee and was present at some of the last victories of US troops in Germany. A pacifist by nature, he was not very comfortable in describing his forced participation in the war and used to say that perhaps because of his known poor eyesight he was kept away from active shooting by the officers in charge!

John had lasting friendships with scientists from Australia, Brazil, Canada, China, India, Russia and many other countries. He was a great human being and an internationalist par excellence. It will be difficult for me and many others to fill the void left by his passing away and to realise that he is really no more with us.

(1) J. H. Hubbell, National Standard Reference Data Series, NBS (USA), 29 , 85 pages (1969).
(2) G. Basavaraju and P. P. Kane, Nucl. Physics A149, 49-62 (1970)
(3) C. M. Davisson and R. D. Evans, Rev. Mod. Phys. 24, 79-107 (1952).
(4) G. R. White-Grodstein, NBS (USA) Circular 583, 54 pages (1957).
(5) J. H. Hubbell, Wm. J. Veigele, E. A. Briggs, R. T. Brown, D. T. Cromer and R. J. Howerton, J. Phys. Chem. Ref. Data 4, 471-538 (1975).
(6) J. H. Hubbell, R. L. Bach and J. C. Lamkin, J. Res. NBS 64C, 121-138 (1960).

From Wilbroad Edward Muhogora, Tanzania

"Jean thanks you also for your remembrance of her. With best regards from both of us and hoping our paths will cross with yours again."

These are John Hubbell's words, as he ended an e-mail message sent to me on 27 October, 2006. These words will never be fulfilled in the physical world, but spiritually, we meet daily in prayers and through the treasury of literature he left us in radiation physics.

But who is Dr. John H. Hubbell to me? I first came across his name during my M.Sc study program in physics at the University of Dar es Salaam, Tanzania in the mid 1990s. My academic advisor at the time, Professor John Kondoro, informed me about the journal *"Radiation Physics and Chemistry"*, whose editor was Dr. Hubbell. Prof. Kondoro advised me to join the International Radiation Physics Society (IRPS), taking advantage of nominal membership subscription fees for scientists from developing countries. This connection triggered subsequent e-mail communications between Dr. Hubbell and me, roughly over 50 per year on average. After learning that my study was focused on radiation shielding, he mailed me many hard-copy

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From Wilbroad Edward Muhogora Continued

reference materials he authored or co-authored on radiation interaction coefficients, which were very useful in my M.Sc Thesis.

An important development in our relationship came during the 9th International Symposium on Radiation Physics (ISRP9) in Cape-Town, South Africa in October 2003. I met him then in person for the first time, but I was surprised by his humble look and demeanour as well as the caring attitude he displayed toward our conversations. At first, I could not believe I was talking with a World Class Physicist! I was overwhelmed. He was also happy to meet me and, in fact, after introducing myself he recalled my name and wanted to know more about my progress in radiation protection physics researches. A few days later, he introduced me to his wife, Jean.

Our friendship grew stronger and this gave me the opportunity to be connected to other important people among his friends or colleagues, as Dr. Hubbell was assisting me in professional career development. They include Prof. Andy Karam (Rochester Institute of Technology) and Dr. Joseph Alvarez, who have guided me in development of National Standards on Ionizing Radiation (which are not yet issued). Others are Lisa Karam, Steve Seltzer, Ron Tosh, Larry Hudson and Shirley McKeown, Dr. Joseph McDonalds (Editor, Radiation Protection Dosimetry), Prof. Michael J. Farquharson (Institute of Health Sciences, City University-UK) and Prof. Gomaa (Egyptian Atomic Energy Authority). (I must admit, however, that other than Jean and Prof. Gomaa, I have not yet met the other persons.)

Apart from professional career life, Dr. Hubbell used to share with me issues concerning his family by sending photographs of social occasions with his family, children and grandchildren. He shared with me memories of his travels inside and outside the United States and related experiences. Through these interactions, he appeared to me to be a wonderful, caring husband to Jean and similarly a good father and good grandfather to his children and grandchildren, respectively.

I received a final email from Dr. Hubbell in early February 2007, encouraging me to attend the Second All-African International Radiation Protection Association (IRPA) congress that was held in April 2007; and also advising me as to how I could solve the problem of being unable to pay IRPS membership subscription fees because of the difficulties in transferring such fees from a developing country. He mentioned he would not go to Egypt, but wished me good luck as it could be an opportunity to meet other African colleagues. Unfortunately, I did not participate in the event, as it was difficult to make travel arrangements from outside Tanzania. Almost 2 months later, I learnt of his death! I was shocked and felt very sad. I thanked God for bringing Dr. Hubbell into this world and for Dr. Hubbell's many important accomplishments - our knowledge of interaction coefficients owes much to his efforts.

To his family, relatives, colleagues and neighbours, I extend my condolences and wish them all the best in coping with this very sad occasion.

May Almighty God rest his soul in eternal peace. Amen!

From Servo Kasi, Finland

On the following page is a collage of photos which John had sent - "Hubbells on the Move, 2004" :

HUBBELLS ON THE MOVE IN 2004

Christmas '03/New Year's '04 with daughter Anne's family in California. Clockwise - Roger, Jean, Sarah, Lisa, Jenny, Anne, Alan.

Glen returned from his family Christmas in Ohio in time for New Year's hike and view of fire damage that came uncomfortably close in and around Moorpark.

May 15-22 Ocean City, MD this year included a visit to Assateague Island where lots of the famous ponies had come to water's edge.

May 9, Mother's Day, and June 20, Father's Day BOTH celebrated with Wendy, Steve, and Vanessa at their home nearby. Vanessa's other grandparents were there too plus an uncle or two.

May 31 - off to Copenhagen for a day hosted by Leif and Gulian Gerward starting with sightseeing including the famous Little Mermaid, taking the ferry past Hamlet's Castle across to Sweden and a visit in their home and nearby beautiful park with banks of azaleas in bloom.

May 28-29 - grandson Wesley graduates from Phelps (high) School in Malvern, PA

Shelton's family together for the occasion.

Granddad John
Wesley
Shelton
Dottie
Laura
Jonathan

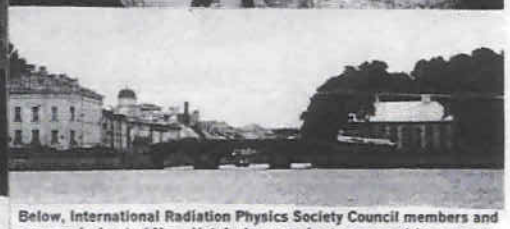
The ladies enjoyed special tours during the meetings but everyone toured the Hermitage and went on the all day excursion to the Peterhof, Peter the Great's magnificent palace and grounds on the Gulf of Finland.

John also enjoyed seeing two more friends from his 1979 visit - Nikolai Cherepkov and Sergei Kruglov.

Two days after our return home, we signed a contract for a new home. And thus began a very busy summer.

On to St. Petersburg June 2 for Council Meeting of IRPS held in House of Scientists - Grand Duke Vladimir's Palace just a short walk down the waterfront from the Hermitage Palace/Museum

John and Elena Cherenkova with her father's Nobel Medal she donated to the Hermitage, here shown to John (who felt very honored to hold it) by special arrangement with the curator.



Below, International Radiation Physics Society Council members and spouses in front of Neva Hotel where our hosts arranged for our stay. In beautiful weather the group walked from hotel across the bridge above, past the Summer Garden and Palace a short distance to the G.D. Vladimir's palace.

Walter Gilboy, host Andrei Korol, Ladia Musilek, Malcolm Cooper, Dan Jones, Ann and Dick Pratt, Joan Cooper, David Bradley, representing U.K., Russia, Czech Republic, South Africa and USA. Jean took the picture.

From Leif Gerward, Denmark

John H. Hubbell and mass attenuation coefficient measurements

At our Laboratory we entered high-accuracy measurements of mass attenuation coefficients in 1976, and we immediately realized the great importance of John H. Hubbell's contributions to this scientific field. His publications as well as his continuing interest and encouragement have been extremely useful and inspiring for our work.

I first met John in person at the 5th European Crystallographic Meeting in Copenhagen in 1979, and we have been in close contact ever since. Soon after our first meeting, I was enrolled in the X-ray Attenuation Project of the *International Union of Crystallography* (IUCr). That project, instigated by John Hubbell and chaired by Dudley Creagh, had as its principal aim the determination of which, if any, of the existing experimental techniques that could be relied upon to produce accurate attenuation data. A secondary aim was the evaluation of existing theoretical and semi-empirical compilations of mass attenuation coefficients and atomic cross section data. Three sets of specimen materials were sent to twenty-five laboratories worldwide for measurement of the mass attenuation coefficient. The materials were chosen because they posed problems, which would test both equipment and techniques used by the experimenters. Creagh and Hubbell (1987, 1990) have summarized the results of the Attenuation Project in two papers.

Over the years, John has supplied us with his own compilations and other useful publications, e.g. Hubbell and Seltzer (1995) and the very convenient computer program XCOM (Berger and Hubbell, 1987/99). The latter program, in John's own concise formulation, "can be used to calculate, with a personal computer, photon cross sections for scattering, photoelectric absorption and pair production, as well as total attenuation coefficients, in any element, compound or mixture, at energies from 1 keV to 100 GeV." The program XCOM is working in the classical DOS mode, but recently I had the pleasure of reengineering it for the Windows platform in order to secure its future use by the radiation physics community (Gerward et al. 2001). In line with John's intentions, the modified program, WinXCom, is distributed free of charge. For a copy of the program, please e-mail to gerward@fysik.dtu.dk, or contact me under the address given above.

John's pride and joy were the *International Radiation Physics Society* (IRPS) and its Global Radiation Physics Family. I joined the Society at the remarkable Symposium in Dubrovnik, former Yugoslavia, in 1991 (two weeks after the symposium, war broke out and many historical sites were destroyed, including the original medieval bridge of Mostar, over which we had walked). Later, my wife and I attended several memorable and mind-stretching symposia in Rabat, Prague and Cape Town, not to speak of numerous delightful Council Meetings, the latest one being held at John's home base at NIST, Gaithersburg (*photo below*).

My interest in the history of radiation physics arose in 1995, in connection with the centenary of Röntgen's discovery of X-rays. I wrote a small paper (Gerward 1995) which John was so kind as to put as a leading article in the September 1995 issue of *Radiation Physics and Chemistry*. Very appropriately, in the same issue Arne Miller wrote an Editorial in recognition of John Hubbell's 70th birthday (Miller 1995). Also in that same issue, John himself had a note on "1995 and Some Anniversary Reflections" (Hubbell 1995). In passing, I may perhaps mention that later I had the very great pleasure of serving as Editor of *Radiation Physics and Chemistry* with John as competent and inspiring Editor-in-Chief.

John's deep knowledge in radiation physics, his ability to communicate, and his great generosity have been of immense importance to me, professionally as well as personally, over the years. Only a few months ago, John

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was so kind as to copy a couple of papers from his file for an article I was about to write. That article, by the way, was published in the March 2007 issue of the *IRPS Bulletin* under the title "The Bouguer-Lambert-Beer Absorption Law" (Gerward 2007). John would have been amused to read it.

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IRPS Council Members gathered under descendant of Newton's apple tree at NIST, Gaithersburg in April 2006.

From left to right: Malcolm Cooper, Dan Jones, Richard Pratt, William Dunn, John Hubbell, Isabel Lopes, and Leif Gerward.

From Richard Pratt, U.S.A. *(To John and Jean I am "Dick Pratt")*

I believe I first met John Hubbell in the spring of 1959 at the old "Bureau" (National Bureau of Standards) in Washington, D.C. I was a graduate student at the University of Chicago, completing my thesis on the high energy limit of atomic photoelectric effect, and Ugo Fano, then at NBS, had invited me to visit to describe my work. It was my first professional trip, and I was actually paid to fly to Washington (the second time I had flown) and stay overnight. John Hubbell was part of the group Ugo Fano had assembled there, and I remember their mysterious quarters, perhaps reached by a freight elevator, on top of a large Van de Graaff machine.

Most recently Ann and I had seen John and Jean when we flew together last September from Philadelphia to Lisbon and participated in ISRP-10 (International Symposium on Radiation Physics) in Coimbra, Portugal. They had the usual trials and tribulations of frequent travelers, with a cancelled flight and a lost bag, and yet in the first hours after arrival in Coimbra, after the overnight flight, we met them out walking, exploring the area, and later we went with them to dinner.

Thus John and I were in personal and professional contact for some forty eight years, a significant portion of our lifetimes. I saw John more after I came to Pittsburgh in 1964, and for a while consulted at NBS (now NIST) and visited regularly. We shared common interests in photo attenuation, and we shared them with Nancy Del Grande at Livermore, with whom I was consulting, who had related interests. John of course was making a distinguished career providing the definitive tabulations of these processes (setting records in numbers of citations of his work), while I was involved in the basic theoretical predictions utilized in the data bases.

In the years that followed, John's continuing comprehensive work on the photoabsorption processes was important in focusing my attention on needs for better understanding of these fundamental processes. On many occasions he called problems and discrepancies to my attention. This led me initially to studies (including with the new computers) of photoeffect at lower energies, relevant to experiment, then work in pair production and bremsstrahlung, and still later in x-ray atom elastic and inelastic scattering. In a similar way I believe John's work had an important influence on a very wide range of investigators, both in basic science areas and in an extremely diverse range of applications. John's accomplishments were in synthesis, in communication, in presentation. He was gifted in establishing interdisciplinary contacts and connections. He was tireless in his promotion of these efforts and activities. John had extensive correspondence around the world and established many personal scientific connections. Wherever I went abroad people were aware of him, and had great respect for his work. Similarly, when visitors came from abroad, visiting John at NIST was often one of their two or three priorities for a visit.

We both became more involved with the international interests in our fields, with contacts and activities around the world. We exchanged information and advice about our travels; I remember asking him about travel to India. I then traveled to Calcutta early in 1974, meeting Professor Anu Ghose whom John already knew. John attended the first ISRP there later that year, and they discussed the concept for what later became the IRPS (International Radiation Physics Society). The second ISRP was organized by Professor Ghose in Penang, Malaysia in 1982, and they have been held on a regular three year schedule ever since. (It was in Penang that we first met David Bradley, who had just arrived to work as a graduate student with Professor Ghose.) John was proud that he attended all ten ISRPs that have been held to date, the only person able to make that statement.

../Continued

From Richard Pratt, Continued :

John Hubbell and Anu Ghose are universally regarded as the two founders of IRPS, and IRPS subsequently recognized that by designating them as its only Lifetime Members. In the years after Penang David Bradley and I met with John at his house in Rockville, and at John and Jean's dining room table we drafted what became the Constitution of IRPS. At the third ISRP in Ferrara, Italy in 1985, the IRPS was formed, with John and Anu foremost among the founding initial members. In 1994 John became the third President of IRPS.

The IRPS meant much to John, and in these last twenty some years John worked hard on its behalf. That included his official roles, as President, as Vice President for North America, as Chair and later Secretary of the Advisory Board, etc. But it also included his many letters, his indefatigable correspondence, and the opinions he communicated on the many issues the IRPS has faced. His concern was always to see the IRPS grow and prosper - it was like one of his children.

I have written mainly about the aspects of John's life with which I am personally acquainted. But one is aware of many other important aspects of his life. His devout attitude and belief come immediately to mind, likewise his unity with Jean. His children were important, and we heard about them. We know of his astronomical interests, and of John and Jean's many travels to see total eclipses of the sun. We know that John also had an important career as Editor of the journal Radiation Physics and Chemistry. And we heard about the Hubbell Family Historical Association.

In closing I would like to join with Walter Gilboy and David Bradley in testifying to John Hubbell's grace and humility, his gentle and humble mien, his generous attitude toward people and toward the world.

From Walter Gilboy, U.K.

John H Hubbell : A Tribute

Via some gamma-ray attenuation measurements being carried out in 1970 by one of my MSc students, S.P.Zaparde, my attention was brought to Report NSRDS-NBS 29 entitled "Photon cross-sections, attenuation coefficients, and energy absorption coefficients from 10 keV to 100 GeV", which became my first contact with its author John H Hubbell. In the following years we corresponded and I later visited his office in Gaithersburg where he kept his enormous filing system about all information on photon cross-sections and related matters published throughout the world. From time to time he would send me copies of papers of special interest and the margins were always full of relevant comments in John's hand writing.

I first met him in the flesh in 1982 during the Second International Symposium on Radiation Physics at Penang (Malaysia), and again three years later in Ferrara (Italy) when the International Radiation Physics Society (IRPS) was formally founded with key input from John who has always figured prominently in the life of the society, becoming its President in later years. After the Ferrara meeting many of us took the opportunity to visit nearby Venice and I remember well rounding a corner in that unique city to find John squatting on the marble sidewalk playing his mouth organ to entertain passers-by. No doubt he was hoping to defray some of his travel costs by this means! It was my pleasure to meet him accompanied by his wife Jean at subsequent IRPS symposia in Rabat (Morocco), Prague (Czech Republic), and last September in Coimbra (Portugal).

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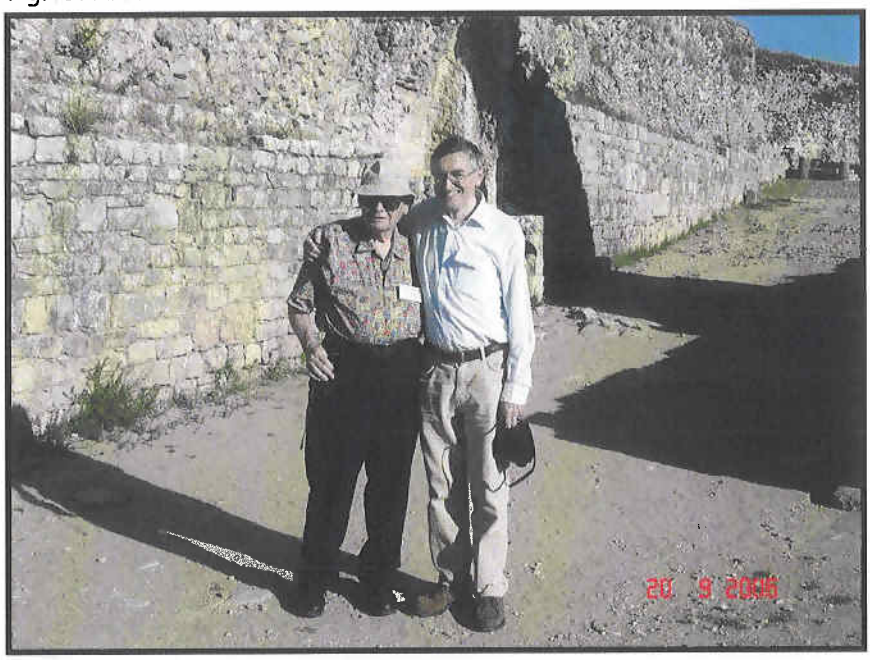
From Walter Gilboy, Continued :

I happened to visit NBS in the year that John entered formal retirement and I was a guest at his retirement party held at the "Golden Bull" in Washington where he served us his appropriately non-alcoholic punch. I was privileged to stay overnight several times at John and Jean's house in Rocking Horse Road. Living conveniently close to NIST/NBS enabled John to continue his work well into his retirement sustained only by his pension. I have recommended this method of staffing a department to several hard pressed group leaders trying to cope with financial stresses. On one visit to Washington John and Jean drove David Bradley and myself down to an IRRMA (International Radiation and Radioactive Materials and Applications) conference in Raleigh, North Carolina and we met them both again two years ago at a similar meeting in Hamilton, Ontario. At other times we met them on IRPS business meetings in England at the universities of Warwick (close to the Hubbell family's historic roots south of Birmingham) and Exeter. John also occasionally visited Oxford while he was Editor of Radiation Physics and Chemistry and this gave my family several opportunities to offer John and Jean hospitality in our home in Hampshire.

John Hubbell served in the US army in World War 2 and he once told me of his experience as a machine gun operator driving across the German border into the bomb damaged wreckage of Aachen close to the end of the war. With his respect for life and gentle personal manner it is difficult to imagine a less warlike individual. The IRPS, which is largely of John's creation, lays particular stress on all peaceful applications of radiation science, and through its triennial symposia it has endeavoured to bring the benefits of radiation physics to less favoured parts of the world wherever possible. John's hard work in gathering and organising photon cross-section data, and scholarship in helping to interpret it, has benefited thousands of workers throughout the world involved in pure research, industry and medicine, and this large body of knowledge represents a fitting memorial to his life's work.

John's life has been shaped and sustained by his Christian faith and he was called to a new adventure close to Easter Sunday when Christ's victory over death was signalled to everyone, which will bring some comfort to his family in their grievous loss.



At Conimbriga, 2006

From Dan Timus, Romania

20 years after John's letter reached me (as below) I had the chance to meet him for the first time in Hamilton, Canada, at IRRMA-2005. In *Photo 1*, John is with Rex Keddy and in *Photo 2*, with me.

UNITED STATES DEPARTMENT OF COMMERCE
National Bureau of Standards
Gaithersburg, Maryland 20899

March 14, 1985

Dr. Dan Timus
Institute of Physics and Technology
of Radiation Devices (IFTAR)
Central Institute of Physics
C.P. 5206
Bucharest - Magurele R-76900
Romania

Dear Dr. Timus:

Thank you for the reprint of your useful work "On the Flux Density Distribution from a Disk-Shaped, Uniformly Emitting Source in Nondispersive Media," Report IFTAR-FT-224 (March 1983) I requested, recently received. I have a long-standing keen interest in this subject area, and I will much appreciate receiving your further works relevant to radiation fields from extended sources.

In describing your key equation (2) I note that you refer to the relatively recent work Gusev et al (1961) for the establishment of this expression. In any formal publication of this work, you should perhaps also refer to the enclosed work by Sievert in Acta Radiol. (Stockholm) 1, 89 - 128 (1921) in which your eqn. (2) is seen on page 101 as eqn. (50,1). and the special cases $\phi(0,z)$ and $\phi(x,0)$ appear to be given also.

Your Table 1 giving $\phi(x,z)/q$ is indeed the most extensive numerical tabulation of this quantity I have seen. I have verified your numerical values by comparing them with my more limited set of values in Table 2 of the enclosed J. Res. NBS 65C, 249 (1961) in which my $q_0(\rho,h) = 4\pi$ $[\phi(x,z)/q]$ where $\rho = x$ and $h = z$ to relate our notations, and the Sievert expression (your eqn. (2)) is given in my eqn. (37), page 257.

Your expression for the iso-flux density lines are very nice. I had not seen this done before.

With best regards, also to your colleagues Lucian Brandus, Mircea Oncescu, Prof. M. Petrascu, and Florian Rebigan and others at your Institute with whom I have been in correspondence.

Sincerely,

John H. Hubbell
Radiation Physics Division
Center for Radiation Research

Enclosures

Photo 1

Photo 2

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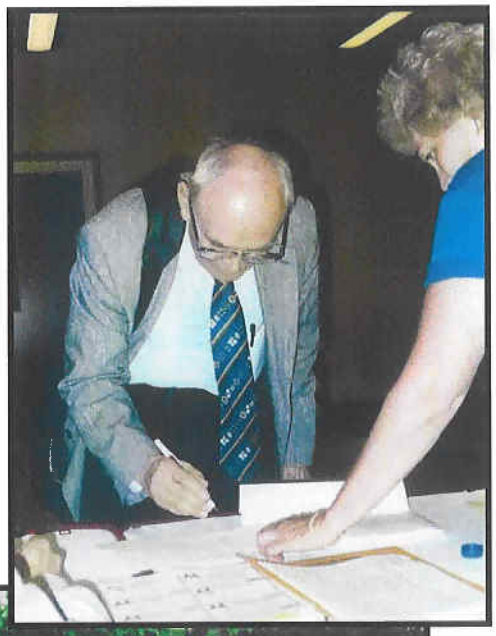
A little bit from John's story - some more of my photos from IRRMA 2005 :



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From Dan Timus Continued :

In April, 2005, I emailed John - " Best and sincere wishes of health and happiness for his eight decade of life to the founder of the "RADIATION PHYSICS HOUSE" and great man, John H. Hubbell. Happy Birth Day, John! " and received the following, very interesting, reply :

Dear Dan:

Many thanks, for your birthday greetings for my 80th. I am happy to still be "above ground," since my Dad died of cancer at age 39, when I was too young to have a living memory of him, so I tell people "I am twice as old as I am supposed to be." His death was at the height of the Great Depression in the early 1930's, in which he lost his job (civil engineer, design of power dams) and had to work in a distant city (Chicago, building a new Post Office) the last years of his life. Our house in Jackson, Michigan was foreclosed, so my Mother and we four kids had to go to Manistee, Michigan to "live with Grandma," not a happy experience for either side, until my Mother could find an independent situation on the other side of town. Hence my boyhood was lived well below the poverty line, right up until I was drafted into World War II military service immediately following graduation from High School in June 1943, thus beginning my "Granddaddy" WW-II story I think I sent you. However, due to my Mother's buoyant and enterprising spirit, we all remember reasonably happy childhoods, and we all four managed to obtain college educations by one means or another. Although my Mother died in 1973, we four siblings are all still up and running, although my two older sisters are getting very fragile, and my younger brother is also having heart and leg problems. Now, I have told you more than you want to know, about my early life. I would be interested in hearing something about yours.

John

From Shirley McKeown, Australia

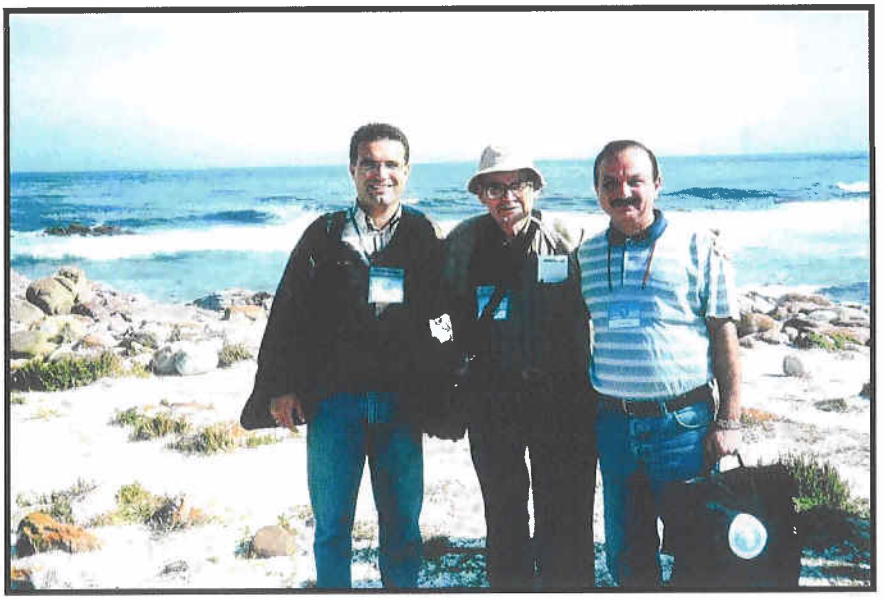
Eclipses .. yes !!! My first meeting with John and Jean was at Melbourne University, Australia, in 2002 after solar-eclipse-viewing at Ceduna, South Australia. I watched from a paddock in Ceduna and John and Jean were further north (possibly also in a paddock!), and our reactions to this amazing event were identical. We vowed to catch up again at the next solar eclipse in Australia (Cairns) in 2012. Sadly, he will not be there in person to see this event, but he will certainly be in the minds of those of us who have shared these events with him, as we watch the 2012 eclipse. If Jean can continue the eclipse-viewing, it will be wonderful to catch up in Cairns.

Jean Hubbell, Chris Chantler, John Hubbell, Bill Mathew and Rod Webster at the University of Melbourne

John had also helped me with my geological studies by sending me copies of papers concerning radiation release and earthquakes, and he was always supportive and helpful with our IRPS Bulletin .. sending information and providing answers and advice to the many (often weird!) queries I landed him with.

From Sezai Yalcin and Orhan Gurler, Turkey

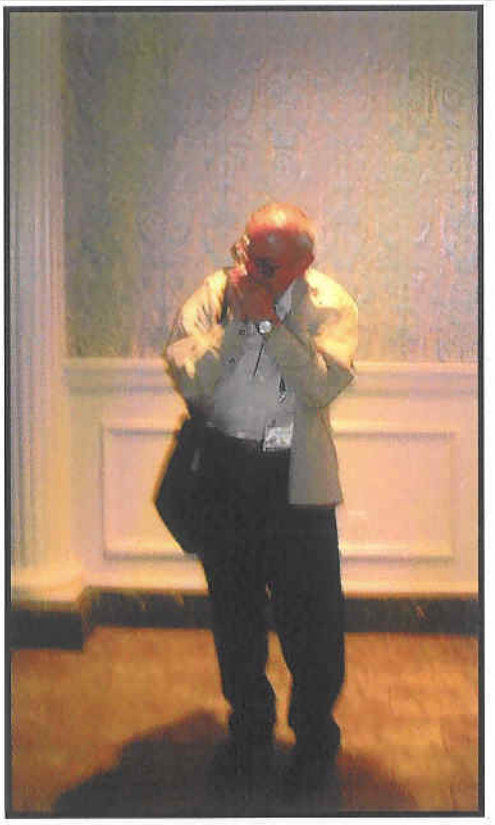
John with Sezai and Orhan at ISRP-9 :



From Jose Rodenas, Spain

John playing his harmonica after the IRRMA VI dinner.

John always played his harmonica at dinners !



Student's Paper

Multiple Scattering of Gamma Rays through Water at 59.5 and 661.6 keV

CH. KRISHNA KANTH, P. HIMA BINDU, B. SARITHA and A.S. NAGESWARA RAO.

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Ms. P. Hima Bindu is a Research Scholar, pursuing a PhD under the supervision of Prof. A. S. Nageswara Rao, in the Department of Physics at Kakatiya University, in Warangal, India. After completing a study on spectroscopic aspects of polystyrene over the previous summer, she has selected for her dissertation research the topic "Gamma Ray Attenuation in Different Oils."

Abstract:

Multiple-scattering peaks resulting from the passage of low-energy gamma rays from ^{137}Cs through water are recorded with a multichannel analyser. The process of softening of photon energy due to multiple scattering on passage through the water medium has been confirmed from the plots drawn. Also, it is clear from the plots that the energy of the peak does not depend on the thickness of the medium. The intensity of the peak decreases exponentially with the thickness of the medium.

Introduction:

The chemical nature of water is one we must examine as it permeates living systems and has diverse uses: drinking, cleaning, cultivation, energy production, etc. More than 95% of the nuclear power in the world is derived from water-cooled reactors. In nuclear power plants water is used in primary circuits, secondary circuits and in a number of auxiliary systems. Water may be an aggressive medium especially at high temperature when in contact with structural materials [1]. Knowledge of the transmitted gamma ray spectrum allows an estimate of health hazards due to transmitted radiation [2]. It also helps to understand the process of transport and the lowering of energy of the primary photons [3].

When a gamma ray photon passes through matter, it is dissipated by the following processes: Compton scattering, photoelectric effect and pair production. Low-energy secondary photons are produced in these three processes, which operate successively within the medium until the energy of the primary photon is divided into several photons. The Compton cross section of a medium increases slowly with increasing photon energy, while the photoelectric cross section decreases sharply. Where these two cross sections balance each other defines the multiple-scattering regime, which gives rise to a low-energy peak in the spectrum. This peak is called the multiple-scatter peak [4] of the medium.

Here, the dissipation of the primary energy of a gamma photon due to multiple scattering when passed through water has been studied. Measurements of transmitted spectra available in the literature have been carried out from the viewpoint of shielding against the high-energy radiations from a nuclear installation, as they are for primary energies higher than 660 keV. The need for standardizing transmission spectra which are continuous in nature, to calibrate radiation monitors has not been appreciated so far. The following observations

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with low-energy primary source ^{137}Cs are reported with a view to generate interest in this direction, especially for environmental monitoring applications.

As water is a lighter medium, the primary-photon energies (less than 1.02 MeV) are successively lowered mainly by Compton scattering until they reach approximately 80 keV. At this energy, the Compton process is not very effective in attenuating the photon, giving way to the photo effect mechanism of attenuation. At energies below 40 keV, photoelectric absorption becomes more effective; the cross-section at 40 keV is 0.055 cm^2/g and rises steeply to 4.78 cm^2/g at 10 keV energy. Below 10 keV, the photon is eliminated from the medium producing low energy fluorescence x-rays of much smaller energy in the process. A broad peak around 60 keV is, therefore, seen in the transmitted spectra of this medium irrespective of the primary energies, as also reported by Swarup [4]. According to Kazanskii [5], the multiple-scatter peak at 60 keV becomes sharper with an increase in level (thickness) of water.

In air, the peak was reported at 72 keV [6] and in a semi-infinite aluminium medium [7], it is at 92 keV. Existence of the peak in an ice medium also confirms that the energy of the multiple-scatter peak is a characteristic property of the medium rather than its physical state. The energy of the multiple-scatter peak increases with the effective atomic number [8] of the medium as the photoelectric cross section at the same energy increases.

The multiple-scattering energy, however, cannot go on increasing indefinitely with increasing effective atomic number of the medium because with increasing photon energy, Compton scattering becomes effective in absorbing the photons, and the scattered photon is quickly absorbed by the photoelectric process. There are, therefore, no multiple-scatter peaks reported in the literature for media of effective atomic number greater than 25. An energy of 92 keV for aluminium appears to be the highest energy attainable for the multiple-scatter peak. The medium should be thick enough so that an appreciable number of primary photons may undergo five Compton events in the medium for the multiple-scatter peak to be detected in transmitted or reflected spectra [9]. Irrespective of primary γ-ray energy, the medium contains photons of multiple-scatter energy moving in all possible directions. This leads to the observation that the low-atomic-number media have a preferential transmission band around this energy.

Experimental Details:

The geometry of the experimental setup is shown in Fig.1. A NaI(Tl) detector setup has been used for the experiment. The setup consists of a galvanized iron drum (61 cm x 5 cm x 1 cm) kept on a wood stand with a circular hole of 9 cm diameter in its centre, below which a NaI(Tl) (5.1 cm x 5.1 cm) detector is housed in a cylindrical lead shield which is lined on the inside with lead, aluminium, copper and tin sheets (Fig. 1). Pulse-height spectra were recorded with a 4K multichannel analyser.

Transmitted-photon spectra containing multiple-scatter pea were obtained by positioning the source ^{137}Cs at the top surface of various levels of water and recording pulse-height distributions between 20 keV and 100 keV energies. First, 661.6 keV gamma rays from ^{137}Cs were passed through water, where a multiple scatter peak of 60 keV was observed (Fig. 2). Next, the source was placed on the surface of water poured into the drum at levels of 10 cm, 40 cm, 50 cm and 60 cm, and different transmitted photon spectra were recorded (Fig. 3).

Results and Discussion:

The transmission spectrum recorded at a water level of 10 cm, plotted in Fig. 3 shows a broad multiple-scatter peak in the vicinity of 60 keV. As the water level was increased to 40 cm, a decline in the multiple-scatter peak of nearly 40-50% was observed.

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Further decline of the peak was observed for water levels of 50 cm and 60 cm, with the overall decline of the multiple-scatter peak showing an exponential dependence on water level. The value of the multiple-scatter coefficient '*d* for ^{137}Cs was found to be 0.017 cm^{-1}. A similar relationship was reported earlier [10, 11].

In this process of lowering of energy of the photons in a low atomic number medium, higher energy primary photons produce a the greater number of multiple scatter photons for thickness nor physical state of the medium. It same thickness of the medium. Energy of the multiple-scatter peak depends neither on is a characteristic property of the medium and increases with its effective atomic number. For the peak to be detected, it must undergo successive Compton scatterings in the medium. The value of 'a' is smaller for the sources on the surface than for immersed sources [2]

In summary, the gamma ray transmission spectra of certain, low atomic number media may exhibit a broad peak, called the multiple-scattering peak, that is due to a minimum in the total scattering cross section for photons. The minimum is caused by opposing trends in the energy dependence of the Compton and photo-effect cross sections; thus, an incident photon whose energy is above the location of this minimum will undergo successive Compton scattering events with a relatively high probability until its energy falls within the region of the minimum. Accordingly, the energy of the multiple-scattering peak is determined by the scattering medium, not the energy of the incident photon. On the other hand, because the number of inelastic collisions necessary to bring the incident photon into the multiple-scattering regime depends very much upon its initial energy, the attenuation constant is expected to depend on the latter. We have presented measurements of both the peak energy distribution and attenuation for the case of 663 keV gamma rays from ^{137}Cs passing through water.

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../Diagrams

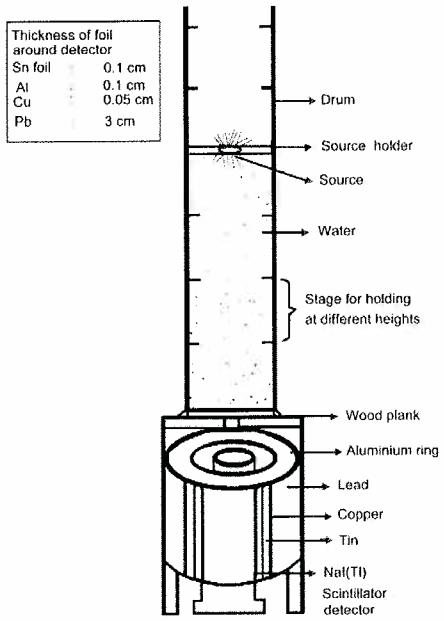

Fig. 1: Schematic diagram of experimental setup for the source above the medium

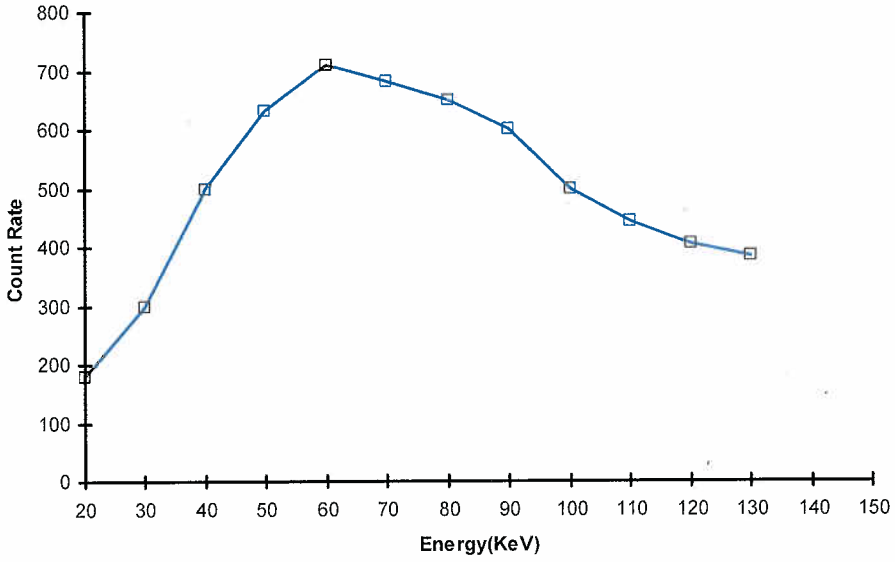

Fig.2: General transmitted photon spectrum of ^{137}Cs through water medium

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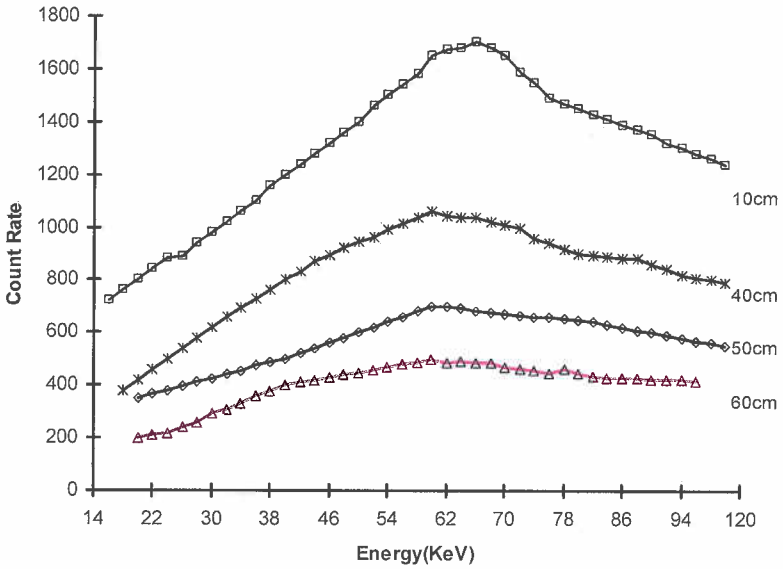


Fig.3: Transmitted photon spectra of ^{137}Cs source through different thicknesses of water

Calendar

2007

November 14 – 16 : NSRP-17 - Seventeenth National Symposium on Radiation Physics

Kolkata, India

For further information : http://www.saha.ac.in/cs/www/conf1.htm, http://www.saha.ac.in/cs/nsrp17.cs/

Details on page 26 of the March 2007 Bulletin

November 17 – 21 : NUPPAC '07 - 6th International Conference on Nuclear and Particle Physics

Luxor, Egypt

For enquiries please email : mnhcomsan@menanet.net

Web Site : http://www.geocities.com/Athens/library/7348/NUPPAC_07.html

Details on page 19 of the December 2006 Bulletin

../2008

2008

April 13 - 18 : ICRS-11 and RPSD-2008

11th International Conference on Radiation Shielding

15th Topical Meeting of the Radiation Protection and Shielding Division of ANS

Callaway Gardens, Pine Mountain, Georgia, U.S.A.

For further information : Michael Shannon

Email : mshannon3@gatech.edu *Web Site :* http://icrs11.me.gatech.edu

Details on following pages 32 and 33

June 16 - 20 : EXRS-2008

European Conference on X-Ray Spectroscopy

Cavtat, Dubrovnik, Croatia

European Conference on X-ray Spectroscopy, the thirteenth biennial conference for sharing the challenge and excitement of research using x-rays, is continuing the series in June of 2008

For further information :

EXRS-2008 Secretariat

Rudjer Boskovic Institute, P.O. Box 180, 10002 Zagreb, Croatia

Email : exrs2008@irb.hr *Web Site :* http://exrs2008.irb.hr

August 24 - 29 : NRC-7

Seventh International Conference on Nuclear and Radiochemistry

Eötvös Loránd University, Budapest, Hungary

The Nuclear and Radiochemistry Conference series aims to promote worldwide scientific collaboration among scientists involved in various aspects of nuclear chemistry and radiochemistry. The first conference in the series was held in Lindau, Germany in 1984.

For further information :

Beatrix Bödy

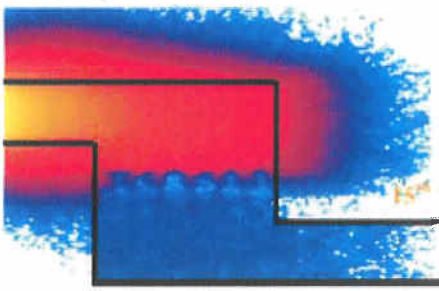
Phone : +36 1 201 6883 *Fax :* +36 1 201 8056

Email : nrc7@mke.org.hu

Web Site : http://www.nrc7.mke.org.hu/

Conference Information

Preliminary Conference Announcement and Call for Papers



ICRS-11

11th International Conference on Radiation Shielding

&

RPSD-2008

15th Topical Meeting of the Radiation Protection & Shielding Division of ANS

• April 13-18, 2008 • Callaway Gardens, Pine Mountain, Georgia, USA •

CONFERENCE ORGANIZERS

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Georgia Institute of Technology, USA

GENERAL CO-CHAIR
PEDRO VAZ
ITN, Portugal

HONORARY CHAIR
ENRICO SARTORI
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SARAH BRASHEAR
Georgia Institute of Technology, USA

Check the website http://icrs11.me.gatech.edu for further conference information and committee contacts.

Conference Scope

This conference is a collaboration of the 11th International Conference on Radiation Shielding (ICRS-11) and the 15th Topical Meeting of the Radiation Protection and Shielding Division (RPSD-2008) of the American Nuclear Society.

With this conference we celebrate the first 50 years of the International Conference on Radiation Shielding. The first meeting was held in 1958 at Cambridge, UK. During the past 50 years much progress has been made in the understanding and modeling of particle and ionizing radiation shielding issues. With the increasing range of radiation applications, the need for continually addressing emerging issues exists. The increased scope of this conference over the years is clearly shown in the published proceedings.

This conference explores the scientific, technological and engineering issues associated with particle and ionizing radiation shielding in its broadest context, including nuclear energy systems, accelerator facilities, space and other radiation environments. It is one of the premier international radiation shielding events, regularly drawing hundreds of the world's top scientists and engineers.

The technical program will be comprised of plenary sessions, parallel oral technical sessions and poster sessions.

Callaway Gardens

The conference will take place at the Mountain Creek Conference Center at Callaway Gardens in Pine Mountain, Georgia, USA. Pine Mountain is located 60 minutes southwest of Atlanta, Georgia. Callaway Gardens is a man-made landscape in a unique natural setting. Conceived and created by Cason J. Callaway and his wife Virginia Hand Callaway, Callaway Gardens is a wholesome family environment where all may find beauty, relaxation, inspiration and a better understanding of the living world. With many of the native trees and shrubs in bloom, April is a great time to visit Callaway Gardens.

http://www.callawaygardens.com/

http://icrs11.me.gatech.edu

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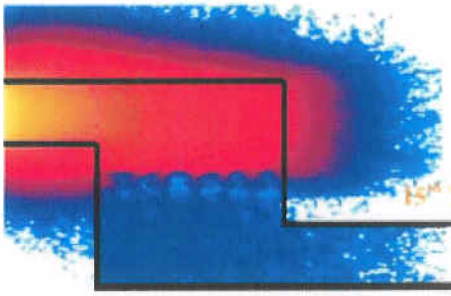
Preliminary Conference Announcement and Call for Papers



ICRS-11

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Important Dates

March 20, 2007
Call for Papers

September 1, 2007
Electronic Abstract Submission Opens

October 1, 2007
Abstract Deadline

December 15, 2007
Author Notification

March 1, 2008
Early Registration Deadline

April 13-18, 2008
Meeting

April 18, 2008
Final Papers Due

Call for Papers

Abstracts are solicited on the conference topics as listed below. Abstracts may cover technical accomplishments, but should represent information that has not been previously reported or published.

Anticipated Technical Session Topics

- Accelerator Shielding
- Aircraft Dosimetry Issues
- Shielding Benchmarks
- Electron-Photon Data
- Monte Carlo Methods and Applications
  - Electron-Photon
  - Neutrons
- Radiation Physics for Medical Applications
- Methods and Applications
  - Electron Facilities Accelerators
  - High-Energy Accelerators
  - Intermediate-Energy Facilities
  - Lower Energy Facilities
- Nuclear Data
- Radiation Detection and Measurements
- Radiation Metrology and Regulations
- Radiation Protection
- Regulations and Reactor Shielding
- Shielding of Spallation Sources and Related Facilities
- Space Radiation
- Transmutation and Storage of Radioactive Materials
- Deterministic Methods
- Hybrid Methods
- Dosimetry Issues

Author Information

Electronic submission will open on September 1, 2007.

Complete details and templates will be posted soon at http://icrs11.me.gatech.edu

The authors of contributed work, presented at the Conference will be invited to submit a manuscript for inclusion in special issue(s) of American Nuclear Society (ANS) journal, ***Nuclear Technology***. All submitted papers will be subject to full peer review.

http://icrs11.me.gatech.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) 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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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 Prof. Richard H. Pratt, Dept. of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA 15260 USA.
Amount paid (in U.S. dollars) _____

[ ] *(in Swiss francs or Euros)*: Send to IRPS Account No. C7-111.441.0, Swiss Bank Corporation N, CH-1211 Geneve 11, Switzerland. If you prefer, you may instead send a Eurocheck in Swiss francs or Euros to: Prof. Ante Ljubicic, Institute Rudjer Boskovic, P.O. Box 1016, 41000 Zagreb, Croatia.
Amount paid (in Swiss francs/Euros) _____

[ ] *(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.
Amount paid (in Indian rupees) _____

[ ] *(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
City University, Rutland Place, Charterhouse Square, London EC1M 6A U.K.
Fax: +44 171 505 5691 **email : M.J.Farquharson@City.ac.uk**

9. _____ _____
(Signature) *(Date)*