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Secretariat: R.H. Pratt **Dept. of Physics** **Univ Pittsburgh, PA** **15260 USA** **Tel: (412) 624-9052** **Fax: (412) 624-9163**	***South and Central America:*** R. T. Mainardi (Argentina)	D.C. Creagh (Australia)
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Main

FROM THE EDITOR

Dudley Creagh

When I commenced my studies, research in Australia was limited to a relatively few fields of Physics, viz. ionospheric physics, atmospheric physics, astronomy (including radio astronomy), atmospheric physics, some small scale plasma physics and low energy nuclear physics. To study any other kind of physics one had to study overseas.

These were times in which funding for science was scarce: times before the transistor, before electronic computing; well, absolutely prehistoric in modern terms.

When I look back and see what was achieved with few resources, but a lot of persistence and imagination, I wonder what we might have achieved had we the opportunities and tools of the present, not just in Australia: in the world at large.

I am not writing this with regrets: there are few things of any consequence that I would change. Rather, I write to recognize that life, and facilities, and opportunities were different in those days.

Regrettably present society has a remarkable penchant for 20-20 hindsight. It asks: 'why did you do it that way?' It says: 'you ought to have seen this phenomenon; you should have taken these precautions against exposure to radiation; you should have been aware of these environmental consequences of your actions; you should have been aware of the social implications of that course of action.' All the time, now, yesterday's decisions are being evaluated using today's set of mores: and the generation I belong to is being found wanting.

I do not wish here to apologize for any of the presently perceived wrongdoings of my generation. What was done was done for the most part using the best advice and understanding of the day. Political and national considerations, themselves representing the values and customs of society, sometimes overrode the best scientific advice. What exists today could not have existed unless someone, back then, had had the foresight and imagination to achieve great things with limited research capabilities.

I think the time has come for us once again to focus on the future, and the creation of a new peaceful, harmonious world. Let us not expend scarce resources seeking recriminations for perceived injustices of the past. .

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PRESIDENT'S COLUMN Bikash Sinha

EXPLORING THE MICRO COSMOS

The quest for the ultimate constituent of matter, around us, and indeed in the universe, has been an integral part of the intellectual history of mankind. The Greeks believed that fire, water and air were the fundamental constituents. The Hindus, somewhat more profound extended the canvas and thought air, water, fire, sky (space) and energy made up everything.

It was not until Francis Bacon that an approach of positivism and scientific rationale came into being. Bacon argued the truth in scientific thought process could have validity, only with evidence and demonstration of that truth. Clearly, this was the first step from mythological past to a rational future. Theological uncertainties gave way to positivistic rationalism.

Dalton, towards the end of the 19th century, took the first step in the direction of understanding all the matter around us in terms of being made up of real atoms. His question was what exactly is the structure, particularly the microstructure, of the atom? Like most creative, people he had a brilliant insight, but experimental evidences and details were inadequate to rationalize his intuition.

Towards the beginning of the twentieth century, the pursuit to pin down the fundamental constituents of matter came of age with Lord Rutherford of the Cavendish Laboratory, Cambridge, stepping in.

The atomic nucleus was discovered. Shooting positively charged helium particles on to a target, Rutherford was attempting to decipher the structure and nature of Dalton's atom. He found an atom was typically one hundredth of a millionth of a centimetre in size. Negatively-charged particles called electrons circle around the tiny nucleus.

Rutherford was not known for his modesty. He got a scholarship from New Zealand to come to England, only after the first candidate selected declined. However, he was quite a charismatic character.

By the time I arrived in Cambridge, many moons ago from now, the legend of Rutherford was still perceptive in Cavendish, his pomposity accepted in a sort of legendary fashion. Indeed the legend goes that he used to drive his colleagues out of Cavendish sharp at 5 pm to play games, and indeed there has been no dearth of sports fields at Cambridge, even now. Rutherford, however, insisted that they should come back after an early supper in the Lower hall of Cambridge Colleges, over by 8 pm at the latest, to the Cavendish. The rumour goes that by the time he discovered the nucleus, he was naturally so jubilant - and that goes for his clear insight - that the tables of Cavendish Laboratory were cleared for an impromtudance on the top of the laboratory table! This part of the history was fairly well documented at the Cavendish. Being privy to it, at least as an undergraduate in my time, it appears that the document does not reveal whether champagne was served.

Rutherford became a legend, of the entire British Empire at that time; his tomb lies in the Westminster Abbey, like Paul Maurice Dirac of Cambridge rather more recently. Rutherford was eventually asked "Your lordship, we presume you've found whatever is there to find in natural sciences, but do let us know, is there any possibility to utilize your nucleus for anything purposeful like energy?" "It's moonshine," Rutherford replied, "all that has to be discovered."

The pompous discovered proved wrong, again and again. The search for elementarity, despite the first world war and the threats of the second great war looming large in the horizons, went on with much vigour. Meanwhile, two of the greatest conceptual discoveries were made by one of the greatest of all greats, Albert Einstein.

The first milestone is the special theory of relativity, identifying energy and mass as one entity E = mc2 - a distant echo of the Hindu philosophical perception that the continuity of transfer of mass (humans!) and energy (khiti, aap, tej ....) is the essence of maya (a strictly personal perception, please don't mind, readers, if you're reading this at all). And the second, in the year 1916, was even more fundamental and spectacular, the General Theory Relativity, putting Newtonian concepts of gravity as a different and, indeed, finer scale of understanding. Light particles, called photons, massless but carrying a finite energy, bend, Einstein proclaimed, under the influence of gravity.

By 1930s, with the dreams of peace a la Chamberlain and Hitler already fading away into oblivion, the nucleus of Rutherford did shine once more and that was no moonshine. James Chadwick, another British physicist, discovered that the kernel of the nucleus has a distinct internal structure. He found that there are "elementary" particles within the nucleus which carry no electric charge.

The positive charge was due to protons, carrying with them exactly the same amount of charge as the electrons, negatively charged, spinning around the nucleus. The neutral particles were a great puzzle, ultimately named as neutrons (neuter!) and the positively charged particles came to be knows as protons.

So, by 1936 or so, the nucleus, of the size of a millionth of a centimetre, consisted of neutrons and protons, held together, at least so it appeared, by a rather "strong" force.

What exactly is the mechanism by which neutrons and protons are held together so strongly? Japanese physicist Yukawa solved the riddle. He proposed another set of elementary particles, called mesons, rather like the shuttlecock in a badminton game, going to and fro from one neutron to another proton, from one proton to another proton and indeed from one neutron to another neutrons. A young Indian physicist at Cambridge, Homi Jehangir Bhabha coined the name mesons.

With the idea of this shuttlecock of the nucleus, an entirely new and novel chapter in theoretical physics was ushered in. Also, by that time the mathematical tools essential to unlock the mystery of these tine "elementary" particles were sharpened. Quantum mechanics, as opposed to classical mechanics, was established with a firm foundation. The unchallenged mechanics of all micro systems, it had its ingredients, cooked by giants like Werner Heisenberg, Dirac, Erwin Schrödinger (the compulsive and legendary seducer, egged on by his own wife - as is well documented by now), Max Plank, Wolfgang Pauli, Nields Bohr and others.

A far shot attempt way back in 1924 with a touch of incredulous genius was suggested, in the beginning and indeed towards the end, by a very handsome but modest and incredibly young Indian physicist, S.N. Bose, working in a relatively unknown (word sense) university at Dacca, proposed a statistical law, governing the behaviour pattern of light particles or photons. The so-called Bose statistics was fine tuned by the greatest living physicist at the time, Albert Einstein, and thus Bose statistics in due course came to be known as Bose-Einstein statistics. Curiously, however, the particles obeying Bose-Einstein statistics have always been referred to as Bosons, even today and most certainly many tomorrows to come.

S.N. Bose's classmate and friend Meghnad Saha had by then thrown his sight to the stars of the sky, discovered the famous Saha equation of ionisation. During rather an unpleasant encounter with India's first Prime Minister, Jawaharlal Nehru, Saha supposedly reported (something to that extent), "Prime Ministers will come and go, Presidents will come and go but my equation will last forever."

Dirac, who successfully merged special theory of relativity with quantum mechanics, was rather an unusual person. He was still very much around, already Nobel laureate, but more importantly a Fellow of the St. John's College, Cambridge, in the sixties. An incredibly shy person, he loathed to look at a person, walked among the narrow lanes of Cambridge, avoiding the glance of people, sort of drifting from one pillar to another, forever trying to hide himself from public gaze. The legend goes that he spoke, on an average, one sentence a day. He wrote a book called Principles of Quantum Mechanics. We read that title with much interest, if not passion. The question paper of the Tripos examination was set (so we understood by Dirac). Markings, however, were gracious and relativistically proper.

The strong force building the neutrons and protons together can in turn be the source of tremendous energy, both destructive and constructive. By late thirties it was clear to the allied military and political pundits that Adolf Hilter was well in the process of getting German scientists together for an atomic bomb, capable of destroying large cities with its inhabitants almost instantly. Under the leadership of Robert Oppenheimer, the great American physicist, all the stars brighter than thousand stars from Europe and America gathered in New Mexico for the famous Manhattan Project. Niels Bohr with his son Aage Bohr arrived there following a rather adventurous route taking great risks. A bunch of young British physicists also crossed the Atlantic.

The fission bomb or the atom bomb, as it is commonly known, exploited the idea that nuclei such as Uranium-235 or Plutonium-239 under some suitable conditions fission into two fragments, releasing an enormous amount of energy, stored within the nucleus. Under critical conditions, this device will be most effective, so they found, to destroy everything one wants to destroy.

However, the phenomena of fission can also be exploited in a more controlled fashion, the first nuclear pile, the mother of nuclear power station, went critical in the early forties in the backyard of the Chicago University. The leader this time was the enigmatic genius, Italian physicist Enrico Fermi. He demonstrated that under suitable conditions the energy released from fission can be controlled in such a manner that eventually electricity can be produced for industrial and other applications.

Within 15 years or so from that event, India was well on her way to become self-sufficient, both in human resources and technology for the nuclear power programmes under the unique leadership of Bhabha.

By 1960s it became clear that neutrons and protons, along with the mesons, are not really the fundamental constituents of matter. There were surprising that neutrons and protons and indeed mesons belong to a much larger family of elementary particles. Is there any fundamental link among these so-called elementary particles? Do they have an internal structure more elementary that in some way may explain the large family of the elementary objects just mentioned? Can there be an internal structure of the neutrons and protons, explaining rather similarly the existence of now more "elementary" objects?

The concept of elementarity within a century has gone through a revolution - from Dalton's atom to Rutherford's nucleus, the concept of elementarity went in order of magnitude more microscopic. The macro universe is but a synthesis of the micro, at least so it seems.

REPORTS FROM VICE PRESIDENTS AND COUNCILLORS

Malcolm Cooper, Vice President, U K

FIGHTING CRIME WITH X-RAYS

The detection of contraband - drugs and explosives - at international borders and elsewhere relies heavily on the application of radiation techniques, notably x-ray imaging systems. At recent conferences of scientists and enforcement agencies from the European Union and the USA the relative merits of detection systems have been reviewed and future developments previewed. The x-ray transmission scanner will surely endure as the generic technique, representing the best combination of sensitivity, unit price per inspection, low false alarm rate etc. at airport gateways. Today's x-ray scanners can be sophisticated devices using dual energy detection, achieved with filters, to discriminate a wide range of densities and angled views to give quasi three dimensional images. Even full 3-D imaging from tomographic reconstruction is possible, if not entirely practicable for airport screening. One advance that has been detailed in the open scientific literature is the use of low angle diffraction to provide a finger print of contraband materials. Most explosives, for example, have sufficient long range order to produce diffraction patterns that are not exactly as sharp as those we see illustrated in undergraduate text books, but nonetheless sufficiently well-resolved and different from each other to provide a "signature" of the material. The way this might work is that each item in the image of suspect density (basically nitrogen rich items) could have its diffraction pattern recorded and compared with a data base of patterns of prohibited materials. This would avoid the Christmas "pudding problem" which airports face every December. Conventional x-ray machines find it difficult to tell the difference between christmas puddings and explosives! The incorporation of Compton/elastic scattering into the scanners is something very close to this correspondent's heart and our own feasibilitiy studies show that it has a role to play in a multi-method approach to non-destructive x-ray examination.

On-the-road the screening of large containers requires high energy, expensive sources, but these are cost effective compared with the ultimate alternative of emptying containers for physical searches. In both cases it is relatively easy to locate contraband in lightly filled objects and relatively difficult in fully packed containers.

The screening of people is another problem. Metal detectors may be fine for detecting metal but are clearly useless for drugs or explosives concealed on the body. Will we all have to endure physical body searches and the consequent delays, or is there a practical alternative? There are certainly alternatives in principle. For example one could use x-rays to image the passenger via a tomographic reconstruction. X-ray images have much better resolution than longer wavelengths. X-raying people is likely to meet objections on health grounds but in fact it could be accomplished in 30 seconds using a dose equivalent to living for 10 minutes almost anywhere, i.e. the background dose. It is more likely to meet objections on grounds of the infringement of privacy since the image can be "perfect in every detail", as it were. In fact a considerable amount of effort is being channelled into de-personalising the images to remove certain anatomical features! The objections to this kind of technology will diminish with the explosion of each airport bomb.

And if we cannot x-ray people may be we should spend more time sniffing them. You cannot beat a trained dog and its handler. Scientists have estimated that trained dogs achieve a vapour phase detection sensitivity for drugs of between one part in 1015 and 1018.

That simply cannot be matched by scientific sniffers. Unfortunately there are just not enough resources to employ "man's best friend" at every gateway, so perhaps we shall have to get used to starring in our own version of the famous British film "The Full Monte" if we want be sure that we never star in yet another real airport disaster movie

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Ladislav Musílek, Vice President, Czech Republic

PRAGUE - THE VENUE OF THE ISRP-8

Prague, the historical capital of the Czech Republic, was chosen as the venue of the 8th International Symposium on Radiation Physics, 4-9 June 2000. Let me say a few words about the city and about some nuclear and radiation physics related events recently organized here or prepared in the near future.

Prague is the largest city in the Czech Republic, having the area of 496 km2 and approximately 1.2 million inhabitants. It lies in the hilly landscape on both banks of the Vltava River in Central Bohemia, being not only the political but also geographical centre of the region. It has been the centre of Czech culture and state for the last thousand years.

Prague Castle was founded in about 880 A.D. by the first historically documented Czech duke Borivoj; in 973 it became also the bishop's residence and in 1344 the centre of archiepiscopate. Emperor Charles IV made Prague, the capital of the Czech Kingdom, also the capital of the "Holy Roman Empire". Founding the Prague New Town, he changed Prague into one of the largest and most important cities of medieval Europe. The first university in Central Europe, the Charles University, was also founded by him in 1348. Another great period in the development of the city was the end of 16th century during the rule of Rudolf II. Though after the Thirty-years War it declined to a mere provincial centre, its building development was still quite rapid. In 1707 another university was founded, which is now the Czech Technical University in Prague. It was the first non-military engineering university in Central Europe. In 1918 Prague became the capital of Czechoslovakia and in 1993, after separation of Slovakia, the capital of the Czech Republic.

As Prague was only slightly damaged during the fights and bombing in World War II, it still has a large and well preserved historical centre, in which, if we do not take into consideration several remains of Romanesque architecture, many important Gothic, Renaissance and Baroque monuments have survived. The last vast reconstruction of some parts of the city centre was undertaken in the period of historic styles and Art Nouveau. Therefore, Prague is also an excellent "textbook" of art periods from the Middle Ages up to the modern times. This can be also seen in Prague's most important monuments like the Castle, National Gallery, National Museum, Old Town Square with the Town Hall, many churches, etc. The historical centre of Prague is on the UNESCO List of the World Heritage. National Theatre with its two historic theatre buildings, the State Opera and many concert halls, music clubs and old restaurants give the possibility to spend one's leisure quite pleasantly. A lot of historic castles and smaller towns nearby the city gives an opportunity of nice excursions.

In the last years Prague has become also the centre of important international meetings in nuclear sciences, mostly due to the activities of the Faculty of Nuclear Sciences and Physical Engineering (FNSPE) of the Czech Technical University in Prague, the Institute of Nuclear Physics of the Academy of Sciences of the Czech Republic, the Institute of Nuclear Research, plc., and the Czech scientific societies. We will summarise some of these events from 1997 to 2000.

On 2-6 June 1997 the European Conference on Protection against Radon at Home and at Work was held in Prague, at the FNSPE. It was organised in collaboration of the Czech institutions engaged in radiation protection with the Belgian Association for Radiation Protection as a follow up of a similar conference held in Liege in 1993. It was orientated towards radon measurements in dwellings, in workplaces, at schools, etc., to methods of radon measurements and devices, precautionary measures and techniques, and to national radon programmes. Prague is an ideal venue for such meeting not only because it is a beautiful city, but also because the Czech Republic is one of the European countries facing the most serious radon problems due to the geological character of the area.

On 1-5 September 1997 the Training Course on Optimisation of Radiological Protection in the Design and Operation of Nuclear Power Plants was organised with the European Commission and the International Atomic Energy Agency. The aim of this course was to present tools and structures that can help in implementing the concepts of optimisation of radiation protection (the ALARA principle) at the practical level, in particular at the managerial level. It was targeted mainly to the countries of Central and Eastern Europe.

On 8-12 September 1997 the IRPA Regional Symposium on Radiation Protection in Neighbouring Countries of Central Europe was held in Prague. In fact, it was the all-European conference on radiation protection with about 200 participants. The main topics were: General aspects of radiation protection, Natural radiation exposure, Radiation protection at workplaces, Environmental aspects of radiation protection, Instrumentation and methods, and Non-ionising radiation protection.

The 13th Radiochemical Conference is to take place not in Prague but in the popular spa Marianske Lazne (Marienbad) on 19-24 April 1998. This well established international conference is being prepared by the FNSPE and four Czech scientific societies (chemical, spectroscopic, radioecological and nuclear) and will cover the following topics:

- chemistry of natural radionuclides, discovery of radium and polonium,
- radionuclides in the environment, radioecology,
- activation analysis and other radioanalytical methods,
- ionising radiation in science and technology, chemistry of actinide and trans-actinide elements,
- separation methods, speciation,
- production and application of radionuclides,
- radiochemical problems in nuclear waste management.

It is easily seen that the scope of the conference is much wider than "traditional" radiochemistry.

Another event is being prepared for 7-11 June 1999. It is the 3rd International Conference on Accelerator-Driven Transmutation Technologies and Applications (ADTTA '99). The main aims of the Conference are the presentation and exchange of experience on the present state of the art and the future, as well as the expected development of the ADTT, namely on:

- national and laboratory R&D programmes and existing collaboration,
- collection and improvement of basic nuclear data,
- engineering aspects of the accelerator part,
- engineering aspects of the subcritical reactor part,
- reprocessing of fuel,
- safety aspects of ADTT,
- economical aspects of the closed fuel cycle.

The conference is co-organised with the International Atomic Energy Agency and will be held in the European Educational and Congress Centre FLORET in Pruhonice, a satellite town of Prague. More detailed information can be found on:

http://www.fjfi.cvut.cz/con_adtt99.

And, last but not least, in June 2000 the 8th International Symposium on Radiation Physics will take place in Prague; we hope it will be the highlight of scientific meetings for the family of radiation physicists from all over the world. However, more detailed information will be available only after the spring meeting of the IRPS Council in Ancona, where all the details will be discussed.

Prasanta Sen, Vice President, India

CONFERENCE ON PHYSICS AND TECHNOLOGY OF ACCELERATORS (CPTA '98)

CALCUTTA, FEBRUARY 11-13 1998

This is a report on a recent Conference on Physics and Technology of Accelerators (CPTA'98) held in Calcutta during February 11-13, 1998. This conference was organised by Saha Institute of Nuclear Physics (SINP), Variable Energy Cyclotron Centre (VECC) and The Indian Physical Society as a part of celebration of the Golden Jubilee of India's independence. CPTA'98 was sponsored by the Department of Atomic Energy (DAE), Department of Science & Technology (DST), Atomic Energy Regulatory Board (AERB) and Inter University Consortium for DAE-facilities (IUC-DAEF).

There were several invited talks and contributed papers. The topics covered were Development of ECR ion source at VECC; Status report of 14 UD BARC/TIFR Pelletron at Mumbai; Accelerator development at NSC, New Delhi; Upgradation of 15 UD Pelletron accelerator at NSC; Physics with heavy ion accelerators; Atomic and surface physics with highly charged ions; Analytical application of 3 MV Van de Graaff at Dhaka, Bangladesh; Accelerators programmes at VECC and SINP; Institute of Physics (IOP), Bhubaneswar 3 MV 9SDH-2 Pelletron-present status; Present status and future programme of the 2 MeV Van de Graaff accelerator at IIT, Kanpur; Microtron at Mangalore University-present status and future projections; Status of the superconducting cyclotron project at VECC; Status of the Synchrotron Radiation Source INDUS-2 at CAT, Indore; Radioactive ion beam (RIB) programme at VECC; Ion optics of the RIB facility at NSC; Neutral beam injector in IPR Tokamak; The role of accelerators in Nuclear Energy; New accelerator programmes at BARC; A national facility for isotope separation & ion implantation; Augmentation of the IOP facility for AMS work; Medical cyclotron and its uses; Synthesis of materials by ion implantation; Electron linac for medical use; Application of x-ray synchrotron sources in condensed matter physics; India-CERN collaboration on LHC; India-CERN collaboration on ALICE; and Safety aspects related to Accelerators. In addition there were several contributed papers covering various aspects of radiation physics and accelerator physics.

A large number of experts and distinguished scientists from India and abroad participated at the CPTA'98. To summarise the conference provided a forum for exchange of information among scientists, technologists and industrialists on recent advances in the area of accelerators and their future applications.

Rex Keddy,Vice President, South Africa

LETTER FROM AFRICA No. 2

Since my last letter I have been travelling again in Africa. Most of this travelling has been to do with the activities of new radiation oncology centres. I say mostly, as doctors in some of the countries approached us requesting us to run workshops of clinical oncology management, particularly thyroid related malignancies - also prevalent in Africa. Thyroid tumours have a more or less standard protocol of treatment, of course depending upon the extent of the tumour and how well differentiated it is, but a radical thyroidectomy is often followed by an administration of a very large dose of radioactive iodine to ablate any remaining thyroid tissue. This management practice lends itself perfectly to Nuclear Medicine diagnostic imaging and the localisation of any wayward thyroid tissue is readily seen. The physics involvement? Well the iodine ablation activities that are administered can be and are frequently as high as 37 GBq and in some cases nearly twice that value. A quick calculation using a value of 0.034 mGy.m2/hr/GBq for the Air Kerma rate for I-125 shows that radiation doses in excess of 1000Gy can be and are delivered at selected sites in the body. Of course it is not as simple as this. The ingested activity is also subject to the excretion mechanisms of the body and herein lies the physics contribution. Not only is the dose to be calculated using a biological half life, but the patient has also, with these large doses, to be isolated and all utensils, bed linen, toilets and bath/shower must be monitored. It is essential that the team of Nuclear Physician and Physicist are experienced in the administration of these therapeutic doses. It is these techniques of high dose thyroid therapy that we have been exporting to some excellent doctors in our neighbouring states. These doctors for many reasons, often lack of funds, have had limited contact with modern radiotherapy treatment protocols. It was our experience that they soaked up what we could offer them like a sponge and their appreciation and interaction was overwhelming. A very worthwhile endeavour we thought. Four doctors from South Africa and I participated in the workshop in Harare, Zimbabwe.

Talking of sponges. The six year old daughter of a friend of mine, wanted to know how deep the oceans would be if there were no sponges.

I was also in Ghana. A wonderful country populated by the most delightfully friendly people. The IAEA are participating in the establishment of two radiation therapy centres in that country. The first, at the State Hospital in Accra, has now started treating patients. The main therapy facility is a Chinese Cobalt Unit. I have not had any experience with the Chinese Unit, the totality of my experience has been with Theratronics Units from Canada. I have been informed by the IAEA that the early Chinese Units had some problems but that the Accra Unit is very satisfactory and every one is pleased with its performance. A whole new wing to the hospital has been built to accommodate the radiotherapy equipment. They also have a conventional (300 Kvp) X-ray machine as well as the necessary Simulator and Planning Systems. Another success story for the IAEA involvement in advancing radiotherapy in Africa. A second facility is well on the way to being completed. The siting of this facility is at the State Hospital in Kumasi a distance of about 250 km to the north of Accra. Again a whole new separate building is being built to accommodate the therapy centre. We are expecting it all to become operational during the second half of this year. My vivid impression of the road trip to Kumasi from Accra was the way the forests are being levelled for the timber. I am sure there is more to it than meets the eye but I saw truckloads of newly felled tree trunks with diameters of well over a meter. One wonders about this sort of exploitation of the resource. I hope to travel back to Ghana in August/September for two reasons. Again to become involved in the Kumasi project and secondly to initiate an MSc programme at the University of Accra for the Ghanaian Medical Physicist who spent two years training with me. We were working on a High Dose Rate After loading Brachytherapy project. We have put a paper together which we hope to publish soon and we wish to continue with the project for his post-graduate project. He had to return to Ghana last month as he was needed for their Radiotherapy facilities. During my stay in Ghana, besides forming close contacts with many prestigious Ghanaian physicists from the Ghanaian Atomic Energy Commission, I had the great privilege of making personal acquaintance with one of our Society's Ghanaian members, Dr John Fletcher who is known also to John Hubbell. John Fletcher is initiating a Radiation Physics programme at the University of the Cape Coast in Ghana. He and I talked about his ideas and he showed me a draft of what he envisages as the course content. It will be a good course when he gets it going but he needs funding. He was working on that problem when I left him. We have communicated since and I have sent him some addresses of International groups that might become involved. Perhaps he would like to write a 'letter from Ghana' for our Bulletin informing us of his progress in this endeavour. I was really impressed with his enthusiasm and dedication to radiation physics.

Private enterprise is also looking at establishing radiotherapy units in Africa. Interested parties are taking a hard look at Zimbabwe; Harare in particular. There are, of course, Therapy Centres at the State Hospitals in Harare and Bulawayo but the State Health Service in Zimbabwe is going through lean times at present. This has affected the treatment of patients and a more certain avenue for treatment is being sought. Many of the Zimbabwe patients come to South Africa for treatment at, of course, additional cost. The University of Zimbabwe is also having its troubles. Recently the students staged a large but peaceful demonstration against the Government. They were protesting about the fact that their financial support packages have not been increased for a number of years in contrast to the Government Ministers voting themselves large increases. The lecturing staff were not permitted onto Campus by the police during the days of protest. There are some fine physicists, mathematicians and computer scientists at the University, friends of mine, and I am truly disturbed that academic life in Zimbabwe is being badly hindered by politics. Inflation in Zimbabwe is running at present around 30% p.a. and many people cannot now afford the basic necessities of life. This last week the students have called for the resignation of Robert Mugabe as President of the country. Zimbabwe is a really beautiful country also with wonderfully friendly people. I was the external examiner for Physics at the National University of Science and Technology in Bulawayo for the last three years and know the country well. It would be really nice if things could settle down so that the country could move forward, it has so much potential. If ever any of you reading this get the opportunity to visit the country, don't miss a stopover at the Victoria Falls. It is quite spectacular. It is truly one of the world's wonders. A boat trip on the Zambesi River above the Falls, quaffing Gins and Tonics, or whatever, at sundowner time, viewing the animals, is an unforgettable experience, perhaps a taste of paradise.

I will be hosting the November meeting of the Council of our Society here in Johannesburg this year. I am looking forward to this meeting keenly and will certainly try to persuade everyone at the Ancona meeting of Council next month to come to Johannesburg with spouse and/or travelling companion. I would like to show them something of Africa. I hope also that those members of Council unable to attend the Ancona meeting will find it possible to come to Johannesburg. I would also like to know about any members of our Society who for some or other reason pass through Johannesburg. Please contact me.

'Till the next time.

(e-mail : 109ker@cosmos.wits.ac.za)

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MEMBERS' CONTRIBUTIONS

THE FEBRUARY 26, 1998 TOTAL SOLAR ECLIPSE

John Hubbell, Past President, 1994-1997

In IRPS Bulletin 9 (4) (December 1995/January 1996) p. 5 we had a report by Suprakash Roy on the October 29, 1995 total solar eclipse over India, on the observations of the team of astrophysicists he led from the Eastern Centre for Research in Astrophysics to study the amount of solar gamma radiation in the earth's atmosphere at Diamond Harbor. The team reported a drop of about 25% in the gamma-ray flux from all sources including cosmic rays and the earth's natural radioactivity, during the totality, when the moon completely blocks the visible light from the sun except for the dramatic naked-eye apparition of the red prominences jutting from the limb and the silvery, shimmery outer corona. Hence we can conclude that the sun contributes a significant fraction (25%) of our naturally occurring environmental background gamma radiation.

A somewhat less scientific expedition was recently mounted by myself and my wife Jean, to observe and photograph the February 26, 1998 total solar eclipse from shipboard in the south Caribbean. This eclipse started in the Pacific, darkening first the northernmost Galapagos Islands, then southernmost Panama, a swath across Colombia, continuing across the Caribbean including under its shadow (umbra) the islands of Aruba, Curaçao, Montserrat, Antigua and Guadelupe. My previous eclipses included the February 26, 1979 from Winnipeg, Canada, June 11, 1983 from Surabaya, Indonesia and July 11, 1991 from San Jose del Cabos, Baja, Mexico, Jean accompanying on the latter two.

On a cruise ship (the Veendam) loaded with 1300 fellow "eclipse chasers" we departed Ft. Lauderdale, Florida February 23, and two days of steaming brought us to a point on the eclipse-path centerline, midway between Aruba and Curaçao, off the coast of Venezuela, to await the totality which would occur there a few minutes after 2:00 pm February 26, 1998. For an hour and a half prior to and following the totality, we would see the partial phases, from "first contact" when the moon takes its first nip out of the sun's blindingly bright disk, to "second contact" when the moon first completely covers the sun, then the totality which would last 3 minutes and 43 seconds (if we stayed on the centerline) and the "third contact" (end of totality) and finally the "fourth contact" when the sun resumes its normal round shape.

During the partial phases, to avoid burned retinas, one must look through filters which attenuate the light by factors of 10-5 to 10-6. Cameras, binoculars and other optical devices must be similarly equipped with such filters. Then when "second contact!" is called out, all filters are removed from eyes and cameras, and the unearthly naked-eye spectacle begins, starting with the beautiful "diamond ring" effect if a tiny smidgen of sun (the chromosphere) is still peeking around the limb of the encroaching moon.

As we were approaching first contact, a large cloud bank, a refugee from El Niño, I suppose, threatened to cover us. Our ship's captain, with the guidance of our on-board meteorologist, found a large clear-sky area to the north of us, and straightway moved the ship to position us there. During the totality, we would be moving somewhat parallel to the centerline, at 5 knots (motion necessary for the stabilizers to function) with a tailwind of 10 knots, for a net effective breeze on the decks of 5 knots which would not shake the forest of tripods too much.

For my photos I used a Meade 4" mirror (Schmidt-Cassegrain) 1000 mm focal-length f/10 telescope, with a 1.4X teleconverter added, for 1400 mm effective length, coupled to an Olympus OM-4T camera body with the necessary totally-manual exposure-time controls. This gave an image of the sun (or moon) on my 35 mm slide film (ASA 400) spanning about 2/3 of the narrow dimension of the slide picture area. This assembly was mounted on a center-braced tripod to which had been added a "slow-motion control" with knobs on long floppy arms to help track the sun. From shipboard, the usual astronomical clock-drives are useless, and some of the visitors to my station commented that they hadn't seen any other slow-motion controls on the ship, even though this seemed to be an obvious solution to the tracking problem.

Based on experience with previous eclipses, I had prepared a written program of exposures to follow, which I had practiced with an empty camera many times both at home and during our two-day voyage prior to the eclipse. In this way, one can afterward write on the cardboard of the slide the exposure and other particulars, otherwise it is all guesswork. My exposures from first contact up through second contact were at 1/500 second. Then, with my sun-filter removed for the naked-eye totality, I marched my exposures from 1/2000 second, two clicks at a time, down to 1/2 second. At this point, as instructed in my program, I departed my camera/telescope eyepiece and I LOOKED AT THE ECLIPSE.

This LOOK is very important. Many people keep looking only though the narrow fields of their camera optics, and miss all the planets (Jupiter and Mercury, closest to the sun, for this one) and stars, which display their glory in the middle of the day, during the totality. The eclipsed sun itself, against this ethereal dark background, is a ruby-jewelled medallion set in the silvery outer corona, a halo-shaped effusive sparkler, dazzling and rattling the mind of the viewer. The viewing is indeed akin to a religious experience, with a feeling that our cosmos is trying to tell us something very special. It is fortuitous, as one of our shipboard astronomer/lecturers Prof. Fred Hess told us, that the sun is 409 times bigger across than the moon, and is also 409 times farther from the earth, resulting in this magnificent soul-stirring visual extravaganza.

After I LOOKED AT THE ECLIPSE, I marched my exposures from 1/2 second back to 1/2000 second, and was about to interpose a 2X additional teleconverter into my optical path, to better capture a prominence with 2800 mm of focal length, but the totality was suddenly over. Since we had moved off the centerline to escape the clouds, our totality was just over three minutes, preventing me from completing my program. However, all in all, it was a grand eclipse, including the camaraderie with the other eclipse aficionados, admiring each others' equipment and recalling previous eclipses.

My slide photos captured the eclipse well, with the short exposures revealing the prominences (video cameras never seem to catch these) and the longer exposures showing the corona with "polar brushes" and other features. The major prominence for this eclipse had the shape of a "floating bottle," not so dramatic as the "scorpion" and "spitting gargoyle" prominences of the July 11, 1991 Baja eclipse.

There is a total solar eclipse somewhere in the world on the average about once a year, with the next one August 11, 1999 crossing Lands End, England, then across Western Europe (Reims is in the path) heading for Bucharest the midpoint, across Turkey (clear skies more probable than in Western Europe), winding up finally in India. However, its maximum duration (Bucharest) is only 2 minutes and 22 seconds. The next two will cross Africa, with the June 21, 2001 eclipse having a maximum duration of 4 minutes and 56 seconds, and the December 4, 2002 eclipse only 2 minutes and 4 seconds. Turkey in 1999 would be nice, but for our next eclipse, June 21, 2001 more-likely will find Jean and me in Africa.

NEWS ITEMS

IAEA Regional Expert Workshop Held in Indonesia

A. Ikram, Indonesia
(From Neutron News, Vol. 9, No. 1, 1998, p7-8)

As a continuation of the regional workshop on Small Angle Neutron Scattering (SANS) organized at Bhabha Atomic Research Center Trombay in 1995 BATAN (the Na-tional Atomic Energy Agency of Indonesia) hosted the IAEA Regional Expert Workshop on Neutron Scatter-ing and Applications from June 16-20 1997 in Serpong Indonesia. The main purposes of this workshop were to address the practical difficulties faced

by the RCA member countries towards improving their reactor utili-zation and to explore the possibilities of utilizing BATAN's small angle neutron scattering spectrometer at the Neutron Scattering Laboratory (NSL) Serpong.

Participants were present from China, South Korea, Pakistan , Philip-pines, Thailand, Vietnam, and Malaysia, as well as Indonesia. The opening ceremony conducted by the Deputy for Director General of BATAN, Prof. A. Djaloeis was immediately followed by the country presentations. Nguyen Nhi Dien (Vietnam) addressed the plan for having a SANS spectrometer at Dalat Nuclear Research Institute. The 500 kW research reactor in Dalat has 100 hours continuous operation monthly for radioisotope production and neutron activation analysis. Up to now there is still no neutron scattering facility in Dalat. Chang-Hee Lee (South Korea) talked about the HANARO reactor (30 MW) and its neutron beam research program in-cluding the plan for installing a cold source in the next century. Collabora-tions with universities and industries were also mentioned. A. Sangariya (Thailand) described the activities in neutron scattering research and the program for upgrading the existing

double-axis neutron spectrometer. Establishment of the new Nuclear Research Centre in Nakhon Wayok Province (60 km northeast of Bangkok) was also introduced. Mr. Bashir (Pakistan) explained the Pakistan Research Reactor (PARR-I) and its programs related to neutron scat-tering. Present activities include up-grading the existing instruments and developing a multi-counter system and a PC-based data acquisition system. S. Radiman (Malaysia) who was ap-pointed as the caretaker for the SANS facility at MINT (Malaysian Institute of Nuclear Technology) in the begin-ning of June 1997 discussed his current activities at the Dept. of Nuclear Science UKM (Malaysian National University) and his plan to overcome some shortcomings (fast neutron con-tamination bad biological shielding low vacuum level) at the SANS facil-ity. Prof. Marsong-kohadi and Mr. Sutiarso from Indonesia explained the neutron scattering facilities in Serpong (see Neutron News Vol. 7 Issue 2, 1996 for detailed description) and emphasized the SANS and HRSANS spectrometers. In response to all of those country presentations mentioned earlier V. Dimic (IAEA) suggested a collabora-tion in sharing and utilizing the neu-tron facilities in Serpong amongst member countries with IAEA provid-ing financial support where it is applicable.

The next two days were occupied with lectures from P.S. Goyal (BARC) and A. Wiedenmann (HMI-Berlin) on neutron scattering with a special em-phasis on SANS (polymer and alloys). On the third day, all participants had a chance to visit the RSG GAS 30 MW reactor and then run an experiment on the SANS spectrometer with sample from A. Wiedenmann. After lunch, the data reduction was carried out using routines modified for BATAN by K. Mortensen earlier.

On the final day of the conference, the morning sessions were dedicated to some suggestions from P.S. Goyal on collaborative programs and from A. Wiedenmann on the results of the experiment, which were comparable with the results from the SANS spectrometer at HMI Berlin. This gave a big push and opened a new era in Serpong on neutron scattering. BATAN expects that after some small improvements, the SANS spectrometer will be competitive to other SANS spectrometers and attract more users, not only from the Asia Pacific :Region, but also from other countries with established SANS experience. In the afternoon the participants enjoyed the excursion to Bogor Botanical Gardens and had a tea-walk in a plantation area.

Fifty Years of Publishing Physics

Peter Robinson, Editor, Australian Journal of Physics
(From Australian & New Zealand Physicist, Vol. 35, No. 1 1998, p25)

In March 1998 the Australian Journal of Physics celebrates its fiftieth year of publication. The first issue of the journal, Volume 1, Number 1, was in fact published early in 1948 under the name of the Australian Journal of Scientific Research. The journal was a cooperative effort by the Council for Scientific and Industrial Research (later to become the CSIRO) and the Australian National Research Council (the forerunner of the Australian Academy of Science), both of which saw the need for Australia to have its first truly national journal for scientific research. As announced in a foreword to the first issue: 'The aim is to encourage scientific endeavour in the Commonwealth and it is believed that both quality and quantity of material available for publication will justify the step now taken.'

In its style and appearance the Australian Journal of Scientific Research was modelled directly on the famous Proceedings of the Royal Society of London, not surprising given the very close relationship between Australia and Britain at the time, especially in science. Initially the journal was published in two series covering papers in the physical sciences (Series A) and the biological sciences (Series B). The first issue of Series A (see the Contents page) reflects this broad sweep with papers ranging from nuclear physics to the chemistry of a certain species of gum tree! There is also a paper on cosmic radio emission from a source in the region of Cygnus, which can be said to mark the beginning of radio astronomy in Australia. Over the next few years the journal grew steadily and, by 1953, had become large enough to split into two distinct journals, the Australian Journal of Physics and the Australian Journal of Chemistry, both of which continue to prosper.

Much has changed since these early years, not least the technological innovations which are revolutionising journal publishing. The AJP has kept pace with these changes and in 1997 we began an experimental electronic edition of the journal on the world wide web. Following the success of this trial, we are proud to announce the launch of a full electronic service for our readers in 1998. We invite you to celebrate our fiftieth birthday, and to help take our journal into the future, by making sure your institution subscribes to both the print and electronic editions of the Australian Journal of Physics.

SPIRAL debuts to mixed fortunes

Emma Sanders, Geneva
(From : Physics World, Vol .11, No. 2, 1998, p7)

France's newest nuclear physics facility the SPIRAL, facility for radioactive nuclear beams in Caen has accelerated its first beams. However, this good news comes at a time when the budget for nuclear physics is shrinking, and more cutbacks to accelerator facilities are likely in the future. The Saturne accelerator in Saclay has already been closed, with the. majority of users taking their experiments to Germany. SPIRAL, is an extension to the GANIL heavy-ion accelerator, France s largest nuclear physics facility with around 700 users per year. SPIRAL will re-accelerate radioactive ions produced when the GANIL beam strikes a fixed target. The laboratory is jointly run by the French research council (CNRS) and the atomic energy commission (CEA) and has an annual budget of FFr 14 m (about £4.4 m).

The first radioactive beams are due to come on-line in November, when the facility will be made available to users. "There has been strong interest from the international community of nuclear physicists and also from astrophysicists and solid-state physicists, says project director Marcel Lieuvin.

Detectors planned tor SPIRAL include EXOGAM, a gamma-ray detector for experiments on exotic nuclei, and VAMOS, a variable mode spectrometer. These detectors are expected to cost FFr 34m and FFr 14m, respectively.

The November opening date depends on approval from the French directorate for the safety of nuclear installations and the government. However, Lieuvin is confident. "We are not in any doubt about the decison," he says.

Although SPIRAL is undoubtedly good lews for the French nuclear physics community, the government's policy of cutting back on large facilities is hitting the field hard. The director of the CNRS, (Catherine Bréchignac) has identified accelerators and neutron facilities as the two areas where there may be more cuts in the future (Physics World, December l997 p9). "The question that we are asking committees at the moment," Bréchignac told Physics World, "is what do we need to keep?"

GANIL director Daniel Guérreau is well aware of the dangers, having already suffered budget cuts this year. "Projects for 1998 are now safe," he says, "but I have no guarantee for the following years."

Sydney Galès, director of the Institute for Nuclear Physics at Orsay, near Paris, is more pessimistic. "The politics of concentration are already in place," he says. "We can't go any further without leaving the field altogether; this would be a catastrophe."

Plans for new French facilities all involve contributions from other European countries. Later this year, Euroball, a gamma-ray detector for the study of super--deformed nuclei, will be moved to the Vivitron accelerator in Strasbourg. In the face of increasing budget cuts, greater European involvement seems the only route possible.

France Closes Neutron Source

Emma Sanders, Geneva
(From : Physics World, Vol .11, No. 2, 1998, p8)

The closure of the Siloé nuclear reactor in Grenoble has deprived French researchers of one of their two national neutron sources. Although plans for a new source – which would come on-line in 2005 – are advanced, many scientists believe that it is now time to review the country's neutron scattering facilities.

Until the end of last year, the French atomic energy commission (CEA) operated two research reactors: Osiris in Saclay, near Paris, and Siloé in Grenoble. (The Institute Laue-Langevin neutron source, also in Grenoble, is a joint venture with Germany, the UK and other European partners.) The CEA uses the reactors to improve the performance of France's nuclear power stations by testing different nuclear fuels and materials. Neutron beams from the reactors are also used for fundamental research in condensed matter, and to produce radioactive isotopes for medicine and electronics.

"Economic reasons led us to choose between Siloé and Osiris," says Jean-Paul Langlois, head of the CEA's experimental reactor programme. However, the savings, expected to amount to several tens of millions of francs per year, will not come into effect for another five years.

The closure will also contribute to Europe's looming neutron drought. Only two or three of the research reactors currently operating in Europe are expected to still be working in the early years of the next century. "The future is a big problem," says Jean-Marie Loiseaux of the University of Grenoble.

The CEA is currently designing the Jules Horrowitz Reactor (RJH) to replace Osiris and Siloé. The agency hopes that the Fr 2 bn (about £200 m) pressurized-water reactor will open at its Cadarache site in 2005. A final decision by the government is expected in about a year. If the RJH is given the go-ahead, the CEA intends to seek money from the French electricity board and possibly from other European sources.

Not everyone, however, agrees that a reactor-based neutron source is the best way forward. Indeed, most of the next- generation neutron sources currently being planned are spallation sources based on accelerators rather than reactors. "There is a lot of passionate debate at the moment," says Loiseaux. "If you want to relaunch the nuclear programme, continuing to do the same thing is not necessarily the best solution," he says.

Heavyweight joins neutrino search

Peter Gwynne, Boston, MA
(From : Physics World, Vol .11, No. 2, 1998, p9)

The mystery of the missing solar neutrinos could be solved shortly by physicists in Canada. For the first time, physicists at the Sudbury Neutrino Observatory - which is due to start taking data at the end of the month - will test whether solar neutrinos can change flavour. Whatever the outcome,]it will have big implications for physics.

Neutrinos are uncharged particles, with little or no mass, that come in three flavours – electron, muon and tau. According to present theory, the Sun's thermonuclear reactions are energetic enough to produce electron neutrinos but not muon or tau neutrinos. However, the number of electron neutrinos detected on Earth falls far short of that predicted. One possibility is that the neutrinos can oscillate from one flavour to another as a result of their tiny, but non-zero, masses (Physics World September 1996 pp41-45).

"If the readings show that neutrinos change from one type to another, it would be the first new physics beyond the standard model of the electroweak interaction," says Art McDonald, director of the Sudbury Neutrino Observatory. "In order for neutrinos to change flavour, they must have a rest mass. So depending on the size of that mass, neutrinos could be a major part of the dark matter in the universe," he says. Alternatively, if the experiment disproves the concept of changing flavours, it will force physicists to seek a fresh explanation of the low numbers of solar neutrinos.

The key to the experiment's promise is that it can differentiate between neutrino flavours by measuring the break up of the deuterium nuclei in its heavy water detector. An electron neutrino can interact with a deuterium nuclei to produce two protons and an electron. A second interaction, in which a neutrino splits a deuterium nuclei into a proton and a neutron, can be caused by all three neutrino flavours. By detecting the different decay products, it should be possible to measure both the electron neutrino flux and the total neutrino flux.

"By looking at the ratio of reactions specific to electron neutrinos and reactions sensitive to all neutrinos, we will have a very precise measurement of whether neutrinos are changing their flavour on the way from the Sun to the Earth," says McDonald.

Discriminating – the SNO detector

The new observatory also offers more accuracy than previous measurements. "The count rate will be significantly higher than has been possible in the past, as the cross-section for the two reactions is about 20 times larger than you can observe with the scattering of neutrinos from electrons, observed typically with normal water," says McDonald. "We will count about one event per hour in each of these reactions, with essentially no radioactive background events. We will get very good statistical accuracy over the course of even half a year."

The observatory is more than 2 km underground in the Creighton nickel mine near Sudbury, Ontario. It is housed in a cavity 34 m high and 22 m wide; normal water inside this cavity supports a 12 m diameter acrylic vessel that is 5 cm thick and holds 1000 tonnes of heavy water. (The heavy water is on loan from Atomic Energy of Canada Ltd, from stocks not required for its CANDU reactors.) To detect the flashes of light produced by the neutrinos, called Cerenkov radiation, 10,000 photomultiplier tubes surround the heavy-water vessel in an 18 m diameter sphere.

The Sudbury Neutrino Observatory will not live and die with solar physics, however. "It really is an observatory that can use neutrinos rather than light as the conveyors of information for other things," says McDonald. "Those include supernovae, how variations in neutrino fluxes from the Sun correlate with, say, solar cycles, and variations in the interactions of different neutrino types with the Earth."

The Sudbury collaboration consists of groups from Carleton University, Laurentian University, Queen's University and the universities of British Columbia and Guelph in Canada; the universities of Pennsylvania and Washington, and the Brookhaven, Lawrence Berkeley and Los Alamos National Laboratories in the US; and Oxford University in the UK. It hopes to have made its first observations of solar neutrinos by the end of May.

Previous	Main