# Pretoria Branch $S_2A_3$ News
**February 2002**

*A newsletter of the Pretoria Branch of the Southern Africa Association for the Advancement of Science*

## *Our forthcoming talk:*

**Date:** **Monday, 4th March 2002**

**Time:** **17h15** (to 18h15)

**Venue:** **Transvaal Museum,** Paul Kruger St. (Entrance to secure parking from Minnaar Street, on the south side of the Museum)

**Speaker:** **Eben J Mulder**
Chief Scientific Officer
PBMR (Pty) Ltd

**Topic:** ***PEBBLE BED MODULAR REACTOR Safe Nuclear Source of Sustainable Energy – Oxymoron or Achievable Goal?***

Refreshments will be served after the talk.

**Talk Summary**

*The Pebble Bed Modular Reactor (PBMR) is a small, safe, clean, cost efficient, inexpensive and adaptable nuclear power plant. It uses coated uranium particles encased in graphite to form a fuel sphere, 60mm in diameter. This design differs in a number of ways from Pressurised Water Reactors. These design differences result in PBMR being an inherently safe and economical power plant.*

*With its continuous thermal power rating of only 302 MW, the PBMR is hardly any threat to current electricity supply side options. Growing interest from the world's nuclear leaders, such as the US, the UK, Japan, and China in this novel concept has left local critics stunned as they watch an interesting process unfolding...*

*An overview will be provided of this interesting South African concept, current status of development, the reasons for it being considered and the projected way forward. Given a nuclear reactor with the acclaimed inherent safety characteristics of the PBMR the challenge is focused on proving the operational proof of a closed-loop, direct-cycle power conversion unit. South Africa is on the brink of commercialising such a small-sized nuclear reactor for the purposes of power generation locally, but with immense potential internationally.*

---

***S2A3 Celebrates its 100th birthday!***

*The year 2002 is the centenary year for S2A3. This year S2A3 is exactly 100 years old.*

*The idea for such an Association originated in 1901 with Theodore Reunert, an engineer. The original idea was to hold an annual congress of South African engineers. After initial deliberations it was decided to form an Association similar to the British Association for the Advancement of Science (founded in 1831).*

*The first official meeting, where the council was elected, was held on 20 January 1902 in Cape Town. This date is accepted as the official founding date of S2A3. The first meeting of the Council took place a week later. At this meeting the first President of the Association was elected. He was David Gill, who was His Majesty's Astronomer at the Cape. From that date on S2A3 has played a significant role in the scientific environment of South Africa.*

*The current Council of S2A3 has decided that the centenary year should be commemorated with various activities, such as:*

- *publishing a special commemorative publication containing a historical overview of S2A3 and the role it played in South African science;*
- *The establishment of a website with a bibliographical database of South African scientists from the earliest time. This project was proposed by Prof Kerneels Plug, who has a special interest in science history. He has, over a long period of time, collected a vast amount of information about early and later South African scientists. This information will now be made available to scientists and the general public as a special contribution to the advancement and promotion of science in South Africa;*
- *Assisting other scientific societies, in a cooperative venture with universities and technikons, to obtain grants from the Department of Education to fund their scientific journals;*
- *Recruiting firms and other bodies as corporate members of S2A3;*
- *Organizing a special commemorative awards evening at the end of the year.*

*An Association is a group of people with the same interests. We want you, the member, to be part of the celebrations and to be proud, with us, to be a member of an Association that has done, (and is still doing), so much for the improvement and promotion of science in the interest of all our peoples.*

*Dr Phil Minnaar*
*Chairman, Pretoria Branch*

---

## *S2A3 Website & Listserver*

Visit our **website** at http://s2a3.up.ac.za. Any comments or suggestions are welcome.

By subscribing to the $S_2A_3$ **Listserver** you will be notified via e-mail of forthcoming popular scientific lectures and other events of interest presented by the $S_2A_3$. See http://s2a3.up.ac.za/ for more details.

To join this list, send an e-mail message to **majordomo@kendy.up.ac.za**, with the following command in the body of your message:

**subscribe s2a3_announce <your e-mail address>**

The listserver will respond with a message checking the validity of your e-mail address. Please follow the instructions in that message to complete your subscription. If you have difficulty insubscribing or unsubscribing from this list, or you have questions about the list itself, you may contact the list owner at: **owner-s2a3_announce@kendy.up.ac.za.**

---

***Join the $S_2A_3$:***

- Membership fee: R50 per annum. (Students R25)
- Contact Dr Phil Minnaar
  *e-mail*: philminn@iafrica.com
  *www:* http://s2a3.up.ac.za/
  *cell*: 083 273 3593

# Pretoria Branch $S_2A_3$ News
**March 2002**

*A newsletter of the Pretoria Branch of the Southern Africa Association for the Advancement of Science*

## *Our forthcoming talk:*

**Date:** **Monday, 8th April 2002**

**Time:** **17h15** (to 18h15)

**Venue:** **Transvaal Museum,** Paul Kruger St. (Entrance to secure parking from Minnaar Street, on the south side of the Museum)

**Speaker:** **Dr Lynne Webber**
University of Pretoria

**Topic:** **The biological behaviour of *HIV:***
*Why is this virus so diabolically successful and will we ever beat this adversary?*

Refreshments will be served after the talk.

**Talk Summary**

*The biological behaviour of HIV, and the adaptations that make this virus so successful will be explained on a non-specialist level. The following points will be specifically addressed:*

- *A concise breakdown of the current status of HIV and the disease burden of AIDS in Southern Africa.*
- *Biological data on the diversity of the virus and its ability to evade the immune response of the host.*
- *How the virus rapidly becomes drug resistant and why it is taking so long to find an effective vaccine.*
- *Will we ever have an effective vaccine against HIV?*
- *Reasons why Southern Africa is experiencing the fastest growing HIV epidemic in the world.*
- *The impact of HIV on aspects of day to day life.*
- *Strategies to beat this virus and the future of individuals infected with or potentially exposed to the virus.*

***S2A3 Membership fees***

S2A3 membership fees were due at the end of January 2002 (R50-00 ordinary, students R25-00).

SA Journal of Science subscriptions (due January 2002) not received by the end of April will not be renewed by the S2A3.

Please send cheques made out to *S2A3* to: S2A3, P.O. Box 366, IRENE 0062, or pay at the monthly lecture.

## *Interesting news from the world of science*

**ORNL researchers observe "table top" nuclear fusion.** Researchers at Oak Ridge National Laboratory, Rensselaer Polytechnic Institute and the Russian Academy of Sciences have reported results that suggest the possibility of nuclear reactions during the explosive collapse of bubbles in liquid, a process known as cavitation.

The bubbles, which grow in the presence of sound waves, collapse to produce locally high pressures and temperatures. These pressures and temperatures can be sufficiently high to result in light emissions, called sonoluminescence, from the collapsing bubbles.

The collaboration was led by Rusi Taleyarkhan, a senior scientist in ORNL's Engineering Science and Technology Division, and Richard Lahey Jr., the Edward Hood professor of engineering at Rensselaer. The team used 14 million electron volt (MeV) neutrons shot into the liquid by a pulsed neutron generator to nucleate the bubbles.

These special conditions are believed to result in a significant increase in the final pressure of the collapsing bubbles. This suggests the possibility of producing densities and temperatures necessary for nuclear reactions. In particular, a long-sought goal of sonoluminescence research has been the possibility of achieving nuclear reaction conditions.

Experiments suggest the presence of small but statistically significant amounts of tritium above background resulting from cavitation experiments using chilled deuterated acetone. This tritium could result from the nuclear fusion of two deuterium nuclei. Tritium was not observed during cavitation of normal acetone, which does not contain deuterium.

Attempts to confirm these results by looking for the telltale neutron signature of the deuterium fusion reaction have yielded mixed results. While there are indications of neutron emission in the newly published results, subsequent experiments with a different detector system show no neutron production.

Theoretical estimates of the conditions in the collapsing bubbles are consistent with the possibility of nuclear fusion, under certain assumptions concerning the relevant hydrodynamics.

These results suggest the need for additional experiments, said ORNL's Lee Riedinger, deputy director for Science and Technology. In particular, the difference in the two sets of neutron measurements must be clarified. Additional tritium experiments would also allow a better understanding of the tritium observations.

Until confirmatory experiments are completed, a cautionary view is appropriate, according to Riedinger, who said, "The manuscript has been through external peer review, but the scientific record shows that tritium and neutron measurements at these levels are difficult, and one must do further tests before firm conclusions can be drawn."

The work is being reported in the March 8 issue of the journal Science.

**Some Questions related to "Evidence for Nuclear Emissions during Acoustic Cavitation" :**

*What exactly was measured in this experiment?*

Evidence for tritium production and neutron emission was observed during the collapse of bubbles in cavitation experiments using deuterated acetone. If correct, and this is a very important "if," the results suggest that nuclear reactions may have occurred. This would be a significant discovery in physics.

*Why do you say "if?"*

These are very challenging measurements. The tritium and neutron levels are small, and experience has shown that measurements at these levels are difficult to interpret. In addition, an attempt to confirm the neutron data using a different detector and counting system yielded results that are not in agreement with the published data. The preliminary measurements are potentially very interesting, but it is premature to conclude that nuclear reactions have been achieved.

*What is the nuclear reaction mechanism?*

The proposed mechanism is the fusion of two deuterium nuclei. This reaction has two pathways with approximately equal probabilities. The first pathway produces helium and a 2.5-MeV neutron. The second pathway produces tritium and protons. In this experiment, the 2.5-MeV neutron and tritium production were investigated as signatures for the reaction.

*Is this related to cold fusion?*

No. In cold fusion, an entirely new fusion mechanism was required. The interpretation of the present experiments is based on the premise that pressures and temperatures required for known fusion reactions can be achieved under special conditions in cavitation experiments.

---

**Science close to viewing the beginning of time, UW cosmologist says.** New research tools promise tantalizing glimpses of characteristics in the universe that until now have gone unseen. In the March 22 edition of the journal Science, University of Washington cosmologist Craig Hogan writes: "We might, in a technical sense, soon observe the beginning of time."

It was just a decade ago that a National Aeronautics and Space Administration project called the Cosmic Background Explorer, or COBE, began returning data aimed at mapping the universe's background radiation, which was first observed in 1965. That radiation is residual heat from the Big Bang, the event that sparked the beginning of the universe some 13 billion years ago.

COBE produced a map that included ripples, or amplitude fluctuations, in the structure of space-time across billions of light years. Those ripples are the largest structures humans ever will be able to see, Hogan said. But they also are greatly magnified images of the smallest structures ever visible – the same fluctuations that started out smaller than a subatomic particle at the Big Bang, then were frozen into the fabric of space-time and stretched as inflation expanded the universe to its current size.

Upcoming projects promise even more-detailed information, said Hogan, a UW physics and astronomy professor.

In a Perspective article for Science, he discusses the possibility that new experiments will shed clues about subatomic particles called gravitons and perhaps bring enough information to unite quantum mechanics and relativity, the two great theories rooted in the work of Albert Einstein. These new experiments include a NASA mission called Microwave Anisotropy Probe, or MAP, that was launched last year with a mission to collect information to chart the microwave light left over from the Big Bang.

Unlike subatomic particles that make up matter and energy as we know them, gravitons are elementary particles that compose the fabric of space and time.

"No one has ever seen a graviton, but with these new efforts we might," Hogan said. "If you can see gravitons in these maps, then you'll start to see the essence of space and time and matter."

Hogan also believes the next generation of research might shed light on other cosmological puzzles. One of these involves the holographic principle, which states that everything that happens three-dimensionally can actually be specified by the amount of information it would take to project it two-dimensionally, like a hologram. If that turns out to be true, Hogan speculates that all the information needed to show the entire universe during early inflation, shortly after the Big Bang, could have fit on a compact disc.

Whatever is learned from the new research, Hogan said, will lend to the basic scientific understanding of time, space, matter and energy. And while that might sound terribly esoteric, he said, it could turn out to have very practical applications.

He noted that Einstein's theory of space-time and gravity, called general relativity, was long regarded as something of an elegant ornament for the science of physics, but nothing with any realistic usefulness. However, it turns out there are practical applications. For instance, without relativity, backcountry hikers, drivers and pilots – let alone smart bombs – couldn't use global positioning technology.

"If you want to hit a cave in Afghanistan, you need general relativity," Hogan said. "And why is that? It's all based on light traveling through space, and precisely timing the pulses of light."

---

## *S2A3 Website & Listserver*

Visit our **website** at http://s2a3.up.ac.za. Any comments or suggestions are welcome.

By subscribing to the $S_2A_3$ **Listserver** you will be notified via e-mail of forthcoming popular scientific lectures and other events of interest presented by the $S_2A_3$. See http://s2a3.up.ac.za/ for more details.

To join this list, send an e-mail message to **majordomo@kendy.up.ac.za**, with the following command in the body of your message:

**subscribe s2a3_announce <your e-mail address>**

The listserver will respond with a message checking the validity of your e-mail address. Please follow the instructions in that message to complete your subscription. If you have difficulty insubscribing or unsubscribing from this list, or you have questions about the list itself, you may contact the list owner at: **owner-s2a3_announce@kendy.up.ac.za.**

---

***Contributions to this newsletter*** will be greatly appreciated. Please forward any news (in electronic format please – and less than 200 words) which might be of interest to members, whether scientific, professional or personal, to Walter Meyer ***wmeyer@postino.up.ac.za***.

Members are also strongly encouraged to make suggestions for potentially interesting speakers for our monthly talks.

---

## *What is the $S_2A_3$?*

The ***$S_2A_3$*** aims to stimulate a broad public interest in science and its applications, research, discoveries, history, ethics and philosophy. To do so, the $S_2A_3$ arranges regular meetings, with speakers who are both entertaining and knowledgeable, as well as field trips, excursions and other interesting events.

Being added to our **e-mail address list** is *free.* Anyone wishing to receive ***$S_2A_3$*** announcements via e-mail but who has difficulty using the listserver service, is welcome to send their address to: **owner-s2a3_announce@kendy.up.ac.za**

---

## *Join the $S_2A_3$:*

- Membership fee: R50 per annum.
  (Students R25)
- Contact Dr Phil Minnaar
  *e-mail***:** philminn@iafrica.com
  www: http://s2a3.up.ac.za/

# Pretoria Branch $S_2A_3$ News
**April 2002**

*A newsletter of the Pretoria Branch of the Southern Africa Association for the Advancement of Science*

## *Our forthcoming talk:*

**Date:** **Monday, 6th May 2002**

**Time:** **17h15** (to 18h15)

**Venue:** **Transvaal Museum,** Paul Kruger St. (Entrance to secure parking from Minnaar Street, on the south side of the Museum)

**Speaker:** **Dr Etienne Barnard**
Molo Afrika Speech Technologies

**Topic:** **Can Artificial be Intelligent?**

Refreshments will be served after the talk.

**Talk Summary**

*Our intelligence has given humanity a unique role in nature, and it has been the dream of philosophers, scientists and engineers through the ages to develop automata with this same distinctive capability. Although several impressive machines have resulted from this dream – ranging from industrial robots and chess-playing computers to systems that understand speech and perform accurate medical diagnosis – truly intelligent behaviour has remained elusive.*

*In this talk, I will briefly review the long and chequered history of artificial intelligence. This will allow us to understand some of the very successful computer programs described above. On the other hand, it will also give insight into the fact that none of these systems should be considered "intelligent" despite their impressive capabilities.*

*Finally, we will consider the future prognosis of the quest for intelligent machines. Our failure to produce artificial intelligence to date has convinced some prominent philosophers that Artificial Intelligence is a contradiction in terms, and the strengths and weaknesses of their arguments will be examined.*

---

## *Extracts from the $S_2A_3$ Bibliographical Database of South African scientists*

*Prof Kerneels Plug*

*As part of its the centenary celebrations, the $S_2A_3$ is setting up a database of South African scientists from the earliest times. The project was proposed by Prof Plug, who has collected a vast amount of information about early and later South African scientists. In this column, Prof Plug will focus on the contributions made by various South African scientists. –Ed.*

## *The first use of X-rays in South Africa*

The earliest use of X-rays (or röntgen rays) in South Africa was completely lost sight of and has only recently been researched and published in the Adler Museum Bulletin (March 2001). The main points of the story are presented here.

**Röntgen's discovery**

Wilhelm C. Röntgen (1845-1923), professor of physics at the University of Würzburg in Germany, was investigating electrical discharges through rarefied gases in 1895. His apparatus consisted of an evacuated glass tube with a metal electrode at each end. Pulses of high voltage electricity caused a weak current to flow through the tube. Röntgen first suspected that his apparatus emitted a hitherto unknown kind of radiation on 8 November 1895. He soon established that the rays originated where electrons strike the anode, travelled in straight lines, and could be recorded on a photographic plate. Furthermore, the X-rays (as he called them) penetrated paper, wood, and other light materials. He demonstrated their penetrating power by taking shadow photographs of coins in a purse, and the bones in his wife's hand.

Röntgen first published his discovery on 28 December 1895, and early in January 1896 the news was spread by telegraph all over the world. It started an unprecedented wave of theorising, experimenting, and speculation, leading to numerous publications during 1896 and subsequent years. Various applications of the rays were enthusiastically investigated. For example, an item in The New York Times of 16 February 1896 describes the investigation of a small Egyptian mummy in the Vienna Museum, swathed to resemble a human infant but suspected of being an ibis. As it was too precious to open up an X-ray photo was taken, which plainly revealed the skeleton of a large bird.

**X-rays generated in Johannesburg**

The only known published report of the very first experiment with X-rays in South Africa appeared in the Cape Times in the form of a brief news flash received from Johannesburg on 8 July 1896: "Experiments made by Mr. [C.H. Perrins] with the Röntgen rays process of photography have been eminently successful, and his services have been called into requisition by the medical profession. A shadowgram was lately taken of the foot of a patient of Dr. Robertson, in which a growth of bone had formed, and the result of the experiment has facilitated the operation necessary for its removal."

More is known about a subsequent demonstration, which took place at a meeting of the Chemical and Metallurgical Society of South Africa on 15 August 1896. Perrins put a photographic plate on the table beneath his apparatus and asked one of the ladies present to place her hand on it. The hand was irradiated for 15 minutes and the plate developed, showing a splendid photograph of the bones. A purse of gold coins was also photographed successfully. Perrins then exhibited plates he had taken on previous occassions. There was a photograph of the wrist of Mr. Michael Ray, showing the injuries to the bone caused by an old bullet wound. Also a photograph of the wrist of a jockey who was injured in a fall a few months earlier, showing a fracture of the arm close to the wrist and the displacement of some of the wrist bones.These examples indicate that Perrins's plates were of a sufficiently high quality to be medically usefull.

**Our pioneer radiographer**

Perrins was not a prominent person and little is known about him. On the basis of documents in the National Archives he can be identified as Charles Henry Perrins (1861-1946) from Birmingham, England. He was in Johannesburg by 1891 and gave his occupation as manufacturing chemist. During 1899 and 1900 he tried to develop weapons for the government of the South African Republic. He remained in Johannesburg for the rest of his life.

**Perrins's X-ray machine**

Few details of Perrins's apparatus are provided in the reports of his demonstration, but a rough reconstruction is possible. Electrical power was provided by a rechargeable lead-acid battery, which was connected to the primary windings of an induction coil. The power was regularly interrupted by a mechanical or electromechanical device, thus creating pulses of current. A suitable capacitor bridging the interruptor helped to increase the voltage of pulses induced in the secondary windings of the coil. The high voltage pulses were fed via un-insulated copper wires to the electrodes of a glass tube as used by Röntgen. The stream of electrons emitted from the cathode produced a beautiful pale green light and a slight crackling noise, and of course some X-rays. The minimum wavelength of radiation produced in this manner depends on the voltage of the electrical pulses, but in Perrins's tube with its cold cathode and relatively poor vacuum the output and penetrating power of the rays were limited by the residual gas. An advantage of the tube's low output was that the radiation had no noticeable deliterious effects. The tube was mounted on a stand some 30 cm above the table. The photographic plate, enclosed in a light-tight envelope, was placed on the table directly under the tube, with the object to be photographed on top of it.

**X-rays in Port Elizabeth and Cape Town.**

In Port Elizabeth X-rays were first generated by Albert Edward Walsh (1853-1930), a British born pharmacist and president of the Photographic Society of Port Elizabeth. His demonstration, reported in the local paper, took place on 13 August 1896. In Cape Town X-ray photography was demonstrated at a meeting of the South African Philosophical Society on 26 August 1896 by James Holm, professor of applied mathematics and physics at the South African College.

**Conclusion**

Although X-rays were actively investigated in both Port Elizabeth and Cape Town very soon after their first use in Johannesburg, Perrins's first experiment was earlier and his work demonstrated the medical applications of the rays most clearly. He therefore deserves recognition for the introduction of radiography into South Africa. His experiments do not appear to have been followed up at the time. Almost two years later the Johannesburg branch of Siemens and Halske obtained an early commercial X-ray machine from its parent company in Germany. One of the company's electrical engineers, Robert H. Gould used it during 1898. Thereafter the technique was used by several doctors during the Anglo-Boer War.

---

## *S2A3 Website & Listserver*

Visit our **website** at http://s2a3.up.ac.za. Any comments or suggestions are welcome.

By subscribing to the $S_2A_3$ **Listserver** you will be notified via e-mail of forthcoming popular scientific lectures and other events of interest presented by the $S_2A_3$. See http://s2a3.up.ac.za/ for more details.

To join this list, send an e-mail message to **majordomo@kendy.up.ac.za**, with the following command in the body of your message:

**subscribe s2a3_announce <your e-mail address>**

The listserver will respond with a message checking the validity of your e-mail address. Please follow the instructions in that message to complete your subscription. If you have difficulty insubscribing or unsubscribing from this list, or you have questions about the list itself, you may contact the list owner at: **owner-s2a3_announce@kendy.up.ac.za.**

---

***Contributions to this newsletter*** will be greatly appreciated. Please forward any news (in electronic format please – and less than 200 words) which might be of interest to members, whether scientific, professional or personal, to Walter Meyer ***wmeyer@postino.up.ac.za***.

Members are also strongly encouraged to make suggestions for potentially interesting speakers for our monthly talks.

---

## *What is the $S_2A_3$?*

The ***$S_2A_3$*** aims to stimulate a broad public interest in science and its applications, research, discoveries, history, ethics and philosophy. To do so, the $S_2A_3$ arranges regular meetings, with speakers who are both entertaining and knowledgeable, as well as field trips, excursions and other interesting events.

Being added to our **e-mail address list** is *free.* Anyone wishing to receive ***$S_2A_3$*** announcements via e-mail but who has difficulty using the listserver service, is welcome to send their address to: **owner-s2a3_announce@kendy.up.ac.za**

---

## *Join the $S_2A_3$:*

- Membership fee: R50 per annum. (Students R25)
- Contact Dr Phil Minnaar
  *e-mail*: philminn@iafrica.com
  www: http://s2a3.up.ac.za/

Pretoria Branch $S_2A_3$ News
**May 2002**

*A newsletter of the Pretoria Branch of the Southern Africa Association for the Advancement of Science*

## *Our forthcoming talk:*

**Date:** **Monday, 3rd June 2002**

**Time:** **17h15** (to 18h15)

**Venue:** **Transvaal Museum,** Paul Kruger St. (Entrance to secure parking from Minnaar Street, on the south side of the Museum)

**Speaker:** **Dr Etienne Barnard**
Molo Afrika Speech Technologies

**Topic:** **Can Artificial be Intelligent?**

Refreshments will be served after the talk.

**Talk Summary**

*Our intelligence has given humanity a unique role in nature, and it has been the dream of philosophers, scientists and engineers through the ages to develop automata with this same distinctive capability. Although several impressive machines have resulted from this dream – ranging from industrial robots and chess-playing computers to systems that understand speech and perform accurate medical diagnosis – truly intelligent behaviour has remained elusive.*

*In this talk, I will briefly review the long and chequered history of artificial intelligence. This will allow us to understand some of the very successful computer programs described above. On the other hand, it will also give insight into the fact that none of these systems should be considered "intelligent" despite their impressive capabilities.*

*Finally, we will consider the future prognosis of the quest for intelligent machines. Our failure to produce artificial intelligence to date has convinced some prominent philosophers that Artificial Intelligence is a contradiction in terms, and the strengths and weaknesses of their arguments will be examined.*

---

*SCIENCE AND THE QUALITY OF LIFE -*
*The 2002 BA Festival of Science*
*Date: 9 - 13 September 2002*
*Venue : Leicester, UK*

** This Festival, formerly known as the British Association's Annual*
*Meeting, comprises a large number of presentations, debates and*
*discussions on a wide range of topics in science, social science,*
*engineering, mathematics and medicine. * If you are to be in the United*
*Kingdom at that time and would like more information about this event,*
*further details of the programme can be found on the website*
*www.the-ba.net*

---

## *South African innovation: The pebble bed nuclear reactor*

*Prof Cornelis Plug*

The generation of electricity by means of nuclear reactors has led to much controversy over the past fifty years. Initially it was expected to provide almost unlimited cheap energy and so enhance economic development, but increasing public opposition has severely curtailed the expansion of the nuclear industry during the past two decades. Most commercial nuclear power plants operating today use pressurized water reactors (including that at Koeberg) or boiling water reactors. To restore the social and political acceptability of nuclear power a radically new type of reactor is required that is demonstrably safe and economically viable. South African scientists and engineers at a local high-technology organisation funded partly by ESCOM and with the approval of government are attempting to meet this challenge by developing the pebble bed modular reactor (PBMR). The project was recently described in the South African Journal of Science (January/February 2002) by D.R. Nicholls, Chief Executive Officer of PBMR (Pty) Ltd. In the same issue its economic viability was assessed by T. Auf der Heyde and S. Thomas. The following summary is based on these two articles.

What is a pebble bed reactor?

The PBMR is basically a high temperature gas-cooled reactor, a type that was developed by the UK Atomic Energy Authority. Its distinguishing characteristic lies in the construction of its fuel elements. Small particles of enriched uranium-235 are coated by layers of graphite and silicon carbide to form millimeter sized pellets; thousands of these are packed into a graphite shell to form spherical pebbles, each looking like a smooth, tough billiard ball. The graphite acts as a moderator, slowing down the fast neutrons released by the fission of the uranium to sufficiently low energies for them to initiate the fission of additional uranium atoms, thus maintaining a chain reaction. The graphite also retains the radioactive fission products, which is the key to the reactor's safety. In contrast to conventional reactors, no melt-down of the PBMR's core can occur in a loss-of-coolant accident (as happened at Three-mile Island in the US).

The heat generated by nuclear fission will be carried off by helium gas flowing through the core of the reactor, raising its temperature to 900ºC. The heated gas will drive turbines to generate electricity. The PBMR is called "modular" because individual reactors will be small - delivering about 100 MW of electricity, compared to the 600-1500 MW output of most currently operating reactors. The developers regard such units as more versatile, as they can either operate singly in remote locations, or in groups if more power is required.

The case for the PBMR

The developers of the PBMR argue that their work is at the forefront of international efforts to construct a safe and flexible nuclear reactor that will supply electricity at a competitive price with minimal environmental damage. The project is partly financed by British Nuclear Fuels, Ltd. and the American utility company Exelon. A detailed feasibility study has recently been completed. An environmental impact assessment and a study of nuclear safety aspects are under way. Given the necessary approvals by government and the National Nuclear Regulator, construction of a first module can start in 2003. After extensive testing commercial operations could start in 2007. It is envisaged that about twenty reactors per year will be exported, or built under licence overseas, thus reducing unit costs.

Will the PBMR be economically viable?

Critics of the PBMR project have expressed several concerns:

# When assessing the risks associated with the PBMR the possibility that radioactive materials may be released as a result of a terrorist attack cannot be ignored. Safeguarding the reactors against such events will increase their construction costs.

# The problem of nuclear waste disposal has not yet been satisfactorily solved. It affects all nuclear reactors, including the PBMR.

# Attempts to commercialise high temperature gas-cooled reactors overseas have not been successful.

# The complex industrial process for manufacturing the fuel pebbles has not yet been fully developed and may pose considerable technological challenges.

# An assessment of the economic viability of any power plant depends critically on the assumptions made with regard to its expected lifetime, the percentage of its lifetime during which it will actually produce electricity (called its load factor), the construction cost, the number of years over which this capital expenditure will be recovered, the interest rate on the capital, and the running costs of the plant. The projections made by the developers of the PBMR are based on the assumption that, owing to its inherent safety and reliability, construction costs will be low (eventually about US$1000 per kW), and its load factor high (95%). Fuel costs should be comparable to those of coal-fired power stations situated near coal mines. With an expected plant life of forty years electricity can be supplied at competitive prices. However, critics question the assumptions underlying this projection on the basis of experience with high temperature gas-cooled reactors in other countries. They argue that construction costs are likely to be higher than anticipated, particularly the cost of protective measures, licencing, and possible modifications to meet regulatory requirements. The load factor is likely to be lower than expected, the running costs probably as high as those of the more efficient plants currently operating in Europe and America, and the overseas market for the reactor smaller than projected. In addition, obtaining operating licences in other countries is likely to be difficult and time consuming. Hence the PBMR project is seen as a high-risk venture to be paid for in part by South African tax payers and electricity consumers.

Conclusion

Developing and marketing a new type of nuclear reactor is a costly and time consuming project with an uncertain outcome. Considering the limited success of such ventures in technologically advanced countries such as the US, Britain, France, Germany and Japan, is South Africa rushing in where angels fear to tread? The Department of Minerals and Energy has recently initiated an independent review of the PBMR project. The panel's report is awaited with interest.

Cornelis Plug <plugc@mweb.co.za>

---

## *S2A3 Website & Listserver*

Visit our **website** at http://s2a3.up.ac.za. Any comments or suggestions are welcome.

By subscribing to the $S_2A_3$ **Listserver** you will be notified via e-mail of forthcoming popular scientific lectures and other events of interest presented by the $S_2A_3$. See http://s2a3.up.ac.za/ for more details.

To join this list, send an e-mail message to **majordomo@kendy.up.ac.za**, with the following command in the body of your message:

**subscribe s2a3_announce <your e-mail address>**

The listserver will respond with a message checking the validity of your e-mail address. Please follow the instructions in that message to complete your subscription. If you have difficulty insubscribing or unsubscribing from this list, or you have questions about the list itself, you may contact the list owner at: **owner-s2a3_announce@kendy.up.ac.za.**

---

***Contributions to this newsletter*** will be greatly appreciated. Please forward any news (in electronic format please – and less than 200 words) which might be of interest to members, whether scientific, professional or personal, to Walter Meyer ***wmeyer@postino.up.ac.za***.

Members are also strongly encouraged to make suggestions for potentially interesting speakers for our monthly talks.

---

## *What is the $S_2A_3$?*

The $S_2A_3$ aims to stimulate a broad public interest in science and its applications, research, discoveries, history, ethics and philosophy. To do so, the $S_2A_3$ arranges regular meetings, with speakers who are both entertaining and knowledgeable, as well as field trips, excursions and other interesting events.

Being added to our **e-mail address list** is *free.* Anyone wishing to receive $S_2A_3$ announcements via e-mail but who has difficulty using the listserver service, is welcome to send their address to: **owner-s2a3_announce@kendy.up.ac.za**

---

## *Join the $S_2A_3$:*

- Membership fee: R50 per annum. (Students R25)
- Contact Dr Phil Minnaar
  *e-mail*: philminn@iafrica.com
  www: http://s2a3.up.ac.za/

---

# Pretoria Branch $S_2A_3$ News
**August 2002**

*A newsletter of the Pretoria Branch of the Southern Africa Association for the Advancement of Science*

## *Our forthcoming talk:*

**Date:** **Monday, 2nd September 2002**

**Time:** **17h15** (to 18h15)

**Venue:** **Transvaal Museum,** Paul Kruger St. (Entrance to secure parking from Minnaar Street, on the south side of the Museum)

**Speaker:** **Prof Derck Smits**
Departent of Mathematics, Applied Mathematics and Astronomy, UNISA

**Topic:** **Solar Eclipse 2002**

Refreshments will be served after the talk.


**Talk Summary**

*On 4 December 2002 a total solar eclipse will be visible along a narrow path in northern Limpopo province. Total solar eclipses are spectacular events but relatively rare. Fortunately, the time and path of eclipses can be predicted with great accuracy. The motions of the Earth and Moon relative to the Sun need to be understood to make these predictions. The ancient Greeks and Chinese knew enough about astronomy to predict eclipses, but the motions of celestial bodies are poorly understood these days. This talk will explain some of the simpler motions of our celestial neighbours.*


## *The beginnings of astronomical photography: Cape Town, 1882.*


*Prof Cornelis Plug*


Photography of the night sky has been used extensively for more than a century to obtain a permanent record of the stars. Particularly during the first half of the twentieth century substantial resources were devoted to systematically photographing the whole celestial sphere and measuring the photographic plates. This work resulted in the publication of extensive catalogues listing the position and brightness of stars, galaxies, and other astronomical objects and forming a vitally important database for subsequent research. Pioneering work in this programme of photography was carried out at the Royal Observatory at the Cape of Good Hope (established in 1820) under the direction of Her Majesty's Astronomer at the Cape, Dr. (later Sir) David Gill (1843-1914).

**Gill and his work**

Born in Scotland, Gill had already distinguished himself as an observational astronomer before he was appointed to the top post in astronomy at the Cape in 1879. He remained the director of the Royal Observatory in Cape Town untill his retirement in 1906. During these 27 years he became a scientist of international repute, publishing numerous articles in professional journals. He made an extensive series of observations of the positions of the minor planets Iris, Victoria, and Sapho in order to determine a more accurate value of the solar parallax (from which distances between all bodies in the solar system may be derived). His final value for this important astronomical constant was adopted internationally for many years. In 1897 he commenced the design of a reversible transit circle which incorporated many refinements that allowed instrumental errors to be measured and corrected. After completion of the instrument in 1905, his improvements were adopted by the designers of similar instruments. Gill was also active in related fields. In 1883 he initiated the geodetic survey of South Africa and directed the work until his retirement. This project provided an accurate positional framework on which the later more detailed triangulation of South Africa and all subsequent maps of the territory are based.

Gill was president of the South African Philosophical Society (forerunner of the Royal Society of South Africa) from 1879 to 1881 and served on its council for many years. He was also a member of the Meteorological Committee and a trustee of the South African Museum. In 1902 he participated actively in the formation of the South African Association for the Advancement of Science ($S_2A_3$) and was elected as its first president. He furthermore played the leading role in arranging the joint meeting of the British Association for the Advancement of Science and $S_2A_3$ in South Africa in 1905. After returning to Britain in 1906 he wrote A history and description of the Royal Observatory, Cape of Good Hope, a detailed account of the research conducted at the observatory since 1820. It was published in 1913.

**The "Great Comet of 1882"**

In September 1882 the brightest comet observed during the nineteenth century appeared in the southern skies. This "Great Comet of 1882" was visible even during the day. Several photographs of it were obtained by local amateur photographers. However, the scientific value of these efforts was limited because the cameras did not make provision for the rotation of the earth during the exposure time, thus producing blurred images. For the same reason photographs of the stars had been of no use to astronomers, because the rotation of the earth stretched the stellar images into short lines. Gill was keen to obtain clear photographs of the comet and conceived the idea of mounting a camera on one of the observatory's telescopes and following the movement of the comet while a photographic plate was exposed. However, the necessary photographic equipment and expertise was not available at the Royal Observatory at the time. Gill therefore approached a professional photographer in Cape Town, Edward H. Allis, for assistance. Allis responded with great enthusiasm. He supplied a camera with a suitable lens (focal length 279 mm) and the necessary dry plates and chemicals to develop them. The camera was mounted on a small equatorial telescope so that the two pointed to the same spot in the sky. While an observer followed the comet through the telescope a number of plates were exposed for periods of 30 to 140 minutes. The resulting images were sharp and of good quality. Gill sent prints to various overseas colleagues, who immediately recognised the scientific merit of the technique. He donated Allis's negatives to the Royal Astronomical Society in England. They are now in the Science Museum in London.

**The photographer E.H. Allis**

Allis had worked as a professional photographer in England before emigrating to the Cape around 1880 when he was in his late twenties. He practiced as a photographer in Rosebank until about 1894, concentrating on landscape photography. A collection of photographs ascribed to him are in the picture collection of the National Library in Cape Town.

In a letter to the Photographic Journal in England, Allis gave the impression that the idea of mounting a camera on a telescope to compensate for the effect of the earth's rotation had originated with him, and that he had obtained Gill's help to carry it out. Gill responded by explaining in a letter to the Royal Astronomical Society that he was himself the originator of the concept and that Allis had merely acted as a most able assistant. Gill's version of the event is generally accepted.

**The origin of stellar photography**

Allis's plates showed not only a sharp image of the comet, but also sharp images of stars in the background, thus demonstrating for the first time the value of photography for charting the star sphere. As a result Gill initiated a project to obtain a photographic record of all the southern stars with a view to compiling a catalogue of their positions and magnitudes. This project, known as the Cape photographic Durchmusterung, was pursued for many years and was eventually completed in 1900. The plates were taken at the Royal Observatory in Cape Town, while their measurement was carried out under the direction of Prof. J.G. Kapteyn of Groningen in the Netherlands. The resulting catalogue lists over 450 000 stars down to magnitude 9,5 and between a declination of 18ºS and the celestial south pole. Gill was also active in promoting a similar survey of the rest of the star sphere. This was carried out as a collaborative effort between many observatories, leading to the International Astrographic Chart and Catalogue.

*Cornelis Plug, plugc@mweb.co.za*

---

## *S2A3 Website & Listserver*

Visit our **website** at http://s2a3.up.ac.za. Any comments or suggestions are welcome.

By subscribing to the $S_2A_3$ **Listserver** you will be notified via e-mail of forthcoming popular scientific lectures and other events of interest presented by the $S_2A_3$. See http://s2a3.up.ac.za/ for more details.

To join this list, send an e-mail message to **majordomo@kendy.up.ac.za**, with the following command in the body of your message:

**subscribe s2a3_announce <your e-mail address>**

The listserver will respond with a message checking the validity of your e-mail address. Please follow the instructions in that message to complete your subscription. If you have difficulty insubscribing or unsubscribing from this list, or you have questions about the list itself, you may contact the list owner at: **owner-s2a3_announce@kendy.up.ac.za.**

---

***Contributions to this newsletter*** will be greatly appreciated. Please forward any news (in electronic format please – and less than 200 words) which might be of interest to members, whether scientific, professional or personal, to Walter Meyer ***wmeyer@postino.up.ac.za***.

Members are also strongly encouraged to make suggestions for potentially interesting speakers for our monthly talks.

---

## *What is the $S_2A_3$?*

The ***$S_2A_3$*** aims to stimulate a broad public interest in science and its applications, research, discoveries, history, ethics and philosophy. To do so, the $S_2A_3$ arranges regular meetings, with speakers who are both entertaining and knowledgeable, as well as field trips, excursions and other interesting events.

Being added to our **e-mail address list** is *free.* Anyone wishing to receive ***$S_2A_3$*** announcements via e-mail but who has difficulty using the listserver service, is welcome to send their address to: **owner-s2a3_announce@kendy.up.ac.za**

---

## *Join the $S_2A_3$:*

- Membership fee: R50 per annum. (Students R25)
- Contact Dr Phil Minnaar
  *e-mail*: philminn@iafrica.com
  www: http://s2a3.up.ac.za/

---