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# mnassa

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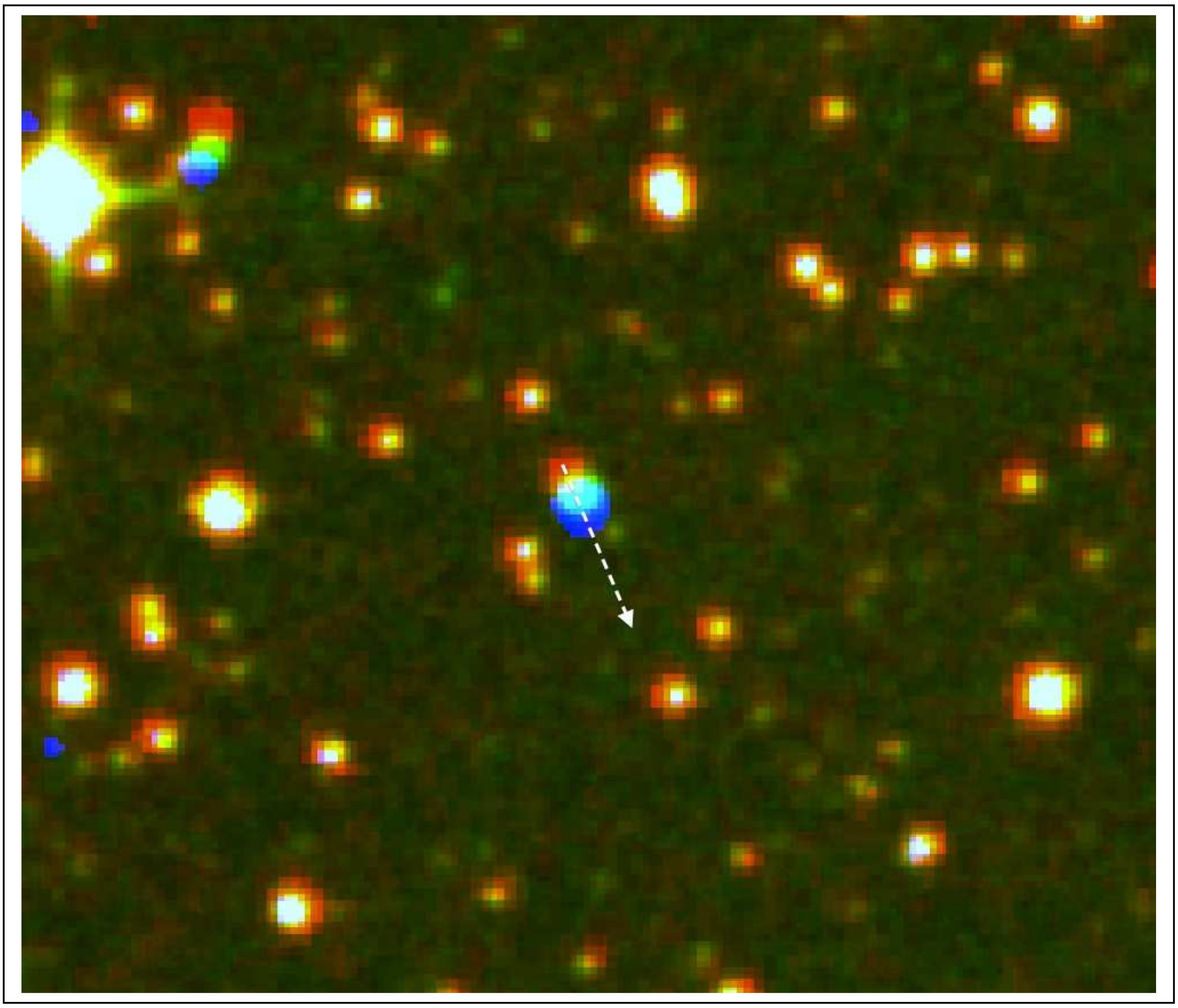

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**Cover: Scholz's star was once the nearest star to us. The red image at centre shows it 60 years ago. The blue one is where it is now. The arrow tells how it will move in 200 years. Its low proper motion and high radial velocity imply that it passed by 70 000 years ago. See *News Note* inside.**

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# ASSA News: Scholarships

## The Bad News

The SAAO-ASSA scholarships for undergraduate studies were initiated in 2007 with one scholarship awarded that year. Funding was provided by the SAAO and all processing of applications and administration was carried out by ASSA. The number of scholarships available annually grew to three and the value of each scholarship grew to R12 000 in 2014. The scholarship has been awarded fifteen times to twelve recipients. The list of recipients may be viewed on the ASSA website and in *Sky Guide Africa South*.

It was with great dismay that ASSA learnt that SAAO will not be able to provide funding for these scholarships from 2015 onwards because of budget constraints. Thus the SAAO-ASSA Scholarships are no longer available. On behalf of the recipients, ASSA thanks the SAAO for providing scholarship funding for eight years.

## The Good News

ASSA is pleased to announce the HartRAO-ASSA scholarships for 2015. There are three scholarships available for undergraduate studies in 2015, each with a value of R14 000. The scholarships are funded by the Hartebeeshoek Radio Astronomical Observatory (HartRAO), and recipients may be offered vacation work at HartRAO. Further details may be found on the ASSA website at http://assa.saao.ac.za/about/scholarships/

Thanks are due to Professor Ludwig Combrinck (Acting Managing Director, HartRAO), Professor Nithaya Chetty (Deputy CEO: Astronomy, NRF) and the Astronomy Advisory Council for their support in the establishment of these new scholarships.

*Maciej Soltynski*
*ASSA Scholarships Committee Convenor*

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## News Note: The star that narrowly missed the Earth

In 2013 an apparently very cool nearby star was discovered by Ralf-Dieter Scholz of the Institut für Astrophysik in Potsdam among faint objects detected by the NASA WISE infrared survey satellite. In spite of its proximity to us this unusual object has very small proper motion but a high radial velocity, according to a team from various institutions worldwide including Alexei Kniazev and Petri Vaisanen of SAAO. By working back from the current data, they found that it must have passed the Solar System about 70 000 years ago at a distance of only about 0.8 light years. This is much closer than the nearest star known currently, Proxima Cen (at 4.23 light years) and is within the outer reaches of the Oort Cloud.

Scholz's star is actually a binary consisting of two subluminous stars with masses of 86 and 65 times that of Jupiter. One is a very late-type (cool) M dwarf and the other is a brown dwarf (a star insufficiently massive to ignite the usual thermonuclear reactions). Its proper motion is shown on the cover picture.

For details, see Mamajek et al http://arxiv.org/abs/1502.04655.

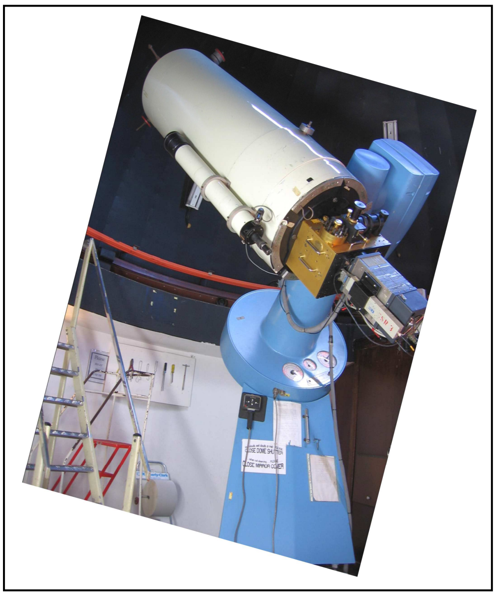
## News Note: SAAO donates 0.5-m and 0.75-m telescopes

The South African Astronomical Observatory (SAAO) in Sutherland was abuzz with excitement and celebration on February 4-5 as SAAO handed over the 0.5 and 0.75 metre telescopes to their proud new owners, the University of KwaZulu Natal (UKZN) and the University of Free State (UFS), Boyden Observatory, respectively chosen by the SAAO as having provided the best motivations for why the telescopes should be donated to them. After sending out a letter inviting bid proposals to all South African institutions and interested parties who would be keen in utilising the two telescopes for research, SAAO received several motivations expressing enthusiasm in accepting the donation. However, the donation could only be awarded to institutions whose proposals incorporated SAAO's clearly laid out requirements of ensuring that the telescopes would be used for student training, advancing scientific research and public engagement, which the two chosen institutions met. Representatives from both (UFS) Boyden Observatory and UKZN were in Sutherland to witness the lifting off of the telescopes from their domes.

The 0.5-m and 0.75-m telescopes were two of the first instruments that were erected in Sutherland after the merger of the Royal Observatory in Cape Town and Republic Observatory in Johannesburg to form what is now known as the South African Astronomical Observatory.

*(Left) The 0.75-m (30-inch) telescope*

The mounting part of the 0.75-m was located from 1964 in Cape Town in what is currently the IT building, where it was called the Multiple Refractor Mount (MRM) because it carried three refractors or lens telescopes. According to Ian Glass, a retired SAAO astronomer with a keen interest in preserving and documenting the history of the Observatory, from 1964 to 1970 some 7 000 photographic plates were taken with the largest of these refractors for the Southern Reference Star Programme. The 0.75-m telescope itself, a reflector (or mirror) telescope, was specially built for installation in Sutherland by Grubb Parsons of Newcastle on Tyne, England, in 1974. It was used for many important infrared and visible light studies of stars, including the supernova that exploded in 1987 in our nearest neighbouring galaxy, the Large Magellanic Cloud.



*(Left) The 0.5-m (20-inch) telescope.*

The 0.5-m was constructed by Boller & Chivens of Pasadena, California, for the Republic Observatory in Johannesburg at the end of 1968. Its main function while at the Republic Observatory was photometry and planetary photography. It was the only telescope ready for use around June 1972 at the Sutherland location. At first, it was used with the Texas designed UCT high-speed photometer connected to a Nova minicomputer with software by R.E. Nather. The "People's Photometer" designed by Richard Bingham, built at the Greenwich Observatory, later became the main instrument used with this telescope. Many papers about rapid variables such as dwarf novae resulted from this telescope.

Dr Ramotholo Sefako, head of Telescope Operations at SAAO says, "Once the 0.5-m and 0.75-m telescopes are moved to their future homes, the domes will be modified to accommodate two new robotic telescopes. One of these telescopes is the 0.65-m MeerLICHT that will be used to simultaneously observe the same part of the sky at night as the MeerKAT, to provide real time optical view of the radio transient sky as observed on MeerKAT.  MeerLICHT is jointly owned by the University of Cape Town (UCT, South Africa), SAAO (South Africa), the Radboud University Nijmegen (RU, The Netherlands), the Netherlands Organisation for Scientific

Research (NWO, The Netherlands) and University of Oxford (United Kingdom). The second dome will house the new SAAO 1.0-m telescope with modern instrumentation that will have an added advantage of a wide field, which none of the current SAAO telescopes have. It is expected to be installed later this year or early 2016”.

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## News note: Hydrogen Epoch of Reionization Array – HERA

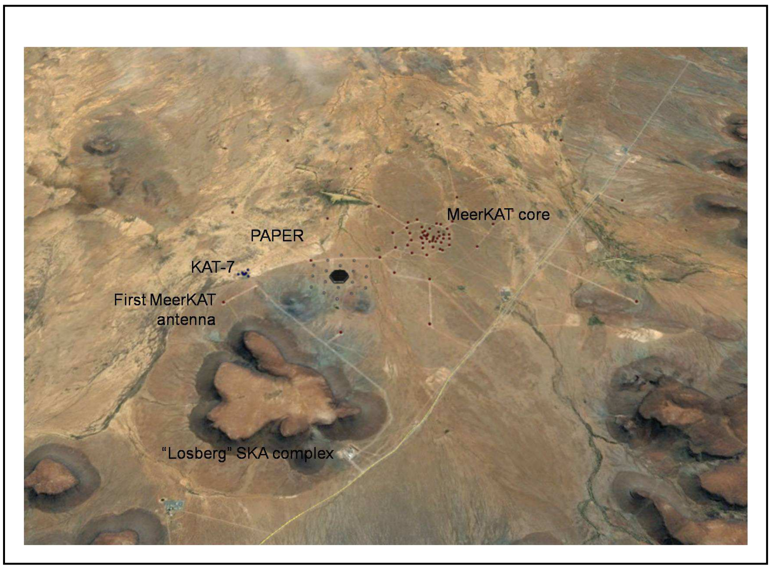
### Peering back into the Epoch of Reionization

*By Lia Labuschagne*

**Introduction**

The HERA array is a collaborative project being built by US, UK and South African research bodies in the Karoo Astronomy Reserve near Carnarvon. It has a very specific science objective in mind: detecting the signature of the period in the early history of the universe known as the Epoch of Reionization (EOR). An extremely important observational signature for cosmology will come from the time when the young universe came out of its Dark Ages – and HERA is being built exactly to find this signal.

**Why HERA?**




*(Left) HERA will be close to the PAPER site shown in this aerial view.*

By the end of the cosmic Dark Ages, which lasted from about 400 000 years to a few hundred million years after the Big Bang, the universe had changed from being opaque to being transparent, and its structures became visible to optical observation. It had become the young version of the universe as we know it today.

The scientific understanding of exactly what happened during those Dark Ages is currently still limited. During that period, there were no light sources other than the cosmic microwave background radiation (CMB). Most of the photons in the universe were interacting with electrons and protons and could not ‘travel’ freely and the universe was opaque as a result.

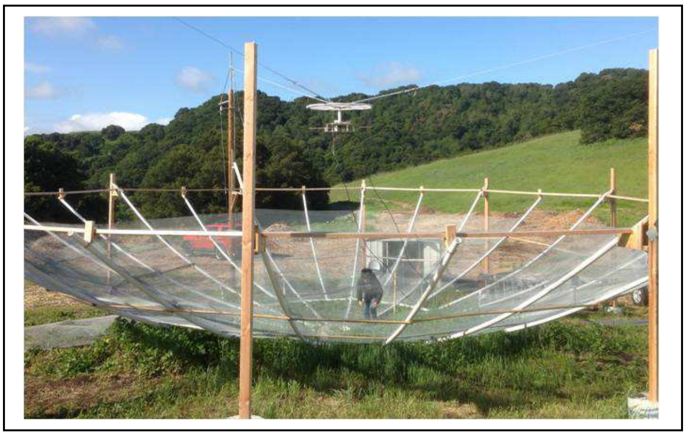
But whereas the CMB has been well studied though hundreds of experiments and mapped among others through the COBE and WMAP satellite missions, current theoretical understanding and modelling of the EOR and of the processes occurring during the Dark Ages still have to be backed by observational evidence from very far back into time, measured at highly red-shifted distances. When the first stars, quasars and galaxies formed through gravitational collapse, highly energetic processes emitted intense radiation and converted neutral hydrogen back into an ionized state.

This is significant, because neutral hydrogen (HI) leaves traces of these processes: it emits an amount of energy equivalent to a wavelength of 21 cm during the spin-flip transition (which occurs when an excited electron with its spin aligned with that of its associated proton in due course flips its spin to re-enter its lower energy neutral hydrogen state). The 21 cm wavelength falls in the microwave region of the electromagnetic spectrum, and in astronomy can be observed via radio telescopes, since they collect can penetrate the clouds of cosmic dust.

However, looking that far back and finding the highly red-shifted HI signature is so difficult that its successful detection at those distances will open up a completely new scientific field of study. The discovery and early advancement of this science would be a likely candidate for a Nobel Prize.

Small wonder then, that dedicated low frequency instruments are being conceived as an important international collaborative effort to solve the puzzles of the EOR. Two pilot experiments were the Precision Array for Probing the Epoch of Reionization (PAPER - a US-SA collaboration situated near Carnarvon) and the Murchison Widefield Array (MWA - a US, Australia and India collaboration located at the Murchison Radio-astronomy Observatory in Western Australia). These are now being followed by HERA, which will be a significantly bigger instrument than PAPER in terms of collecting area (and therefore sensitivity) and cost.

"HERA will be the most sensitive SKA pathfinder at low frequency. It has enough sensitivity to detect the signal from the EOR, when the first galaxies when formed and started to shine - a cutting edge research field in modern cosmology and one of the main science cases for the SKA. We expect that HERA will take the field one leap forward and will able to inform the SKA (in both scientific and technological ways) in terms of searching for the HI signal at very high redshift," explains Dr Gianni Bernadi, SKA SA Senior Astronomer.



*(Left) Concept design for a HERA dish.*

"HERA is an array of dishes that will operate at low frequency (50-220 MHz approximately). The final plan is to have an array of about 350 dishes in the Karoo, close to the current PAPER experiment. The deployment will start with 19 dishes next year and PAPER will be decommissioned over the HERA construction period."

Whereas PAPER and the MWA with their thin, spider-like construction and apparently simple antennas look very different from the domes and mirrors that people traditionally associate with telescopes or the dishes of familiar radio telescopes, HERA will appear more recognizable.

“The dishes are paraboloids although, as they observe at much longer frequencies, they do not need the surface accuracy of, for instance MeerKAT,” says Dr Bernadi.

“The choice of having them not steerable was made mostly to contain costs, as they can be deployed directly on the ground (no expensive concrete foundations, or moving parts). The feeds (i.e. the receptor of the electromagnetic waves) will be the dipoles used for the PAPER experiment, simply suspended over each dish. The receptors are different from those on MeerKAT due to the different wavelength, but fairly common to other low frequency radio telescopes. For the rest, it is just an array that works like any other array, as it correlates the signal coming from each pair of dishes. It has an instantaneous observing bandwidth that is larger than a typical array,” Dr Bernadi continues.

**International funding, local expertise and support**

The US National Science Foundation is the primary funder of the current HERA prototype phase. Significant funds come from the University of Cambridge Cavendish Laboratory (UK), as well as the University of California Berkeley and the National Radio Astronomy Observatory (NRAO – US). South African scientists from SKA-SA and various universities (notably the universities of KwaZulu-Natal, Cape Town and the Western Cape) are significantly involved with the science, while researchers and engineers from SKA-SA, Stellenbosch University and the Durban University of Technology will also be heavily involved in the design and production of the array.

Choosing South Africa to host a project such as HERA confirms the confidence of the international scientific community in South Africa as a partner in big science projects. It also brings economic opportunity: the construction is expected to be fully sourced and constructed from within South Africa.

Much of the South African contribution to HERA in the first, pilot phase of 37 antennas comes in the form of in-kind contribution through people's expertise, explains Anita Loots, Engineering Consultant leading the African Very Long Baseline Interferometry Network (AVN). "Some of the SKA infrastructure team will help with things like design drawings, site layout, procurement and quantity surveying. Importantly, the HERA project will want to procure everything if possible from the local communities."

Loots also points out that "there is a difference between designing a telescope for a lifetime of fifty years and one that is designed specifically for an experiment with a lifetime of around five years. MeerKAT is a kind of Rolls Royce, because that is designed for fifty years of different experiments and surveys. HERA is optimized for this specific experiment. This does not mean that the dishes are more 'basic' – their electronics are as advanced as those of the big telescopes like MeerKAT. However, the structures will not be quite as robust and highly engineered, and will not withstand fifty years of ultraviolet radiation in the Karoo. They will start decaying after the experiment, and we will have a decommissioning plan in place."

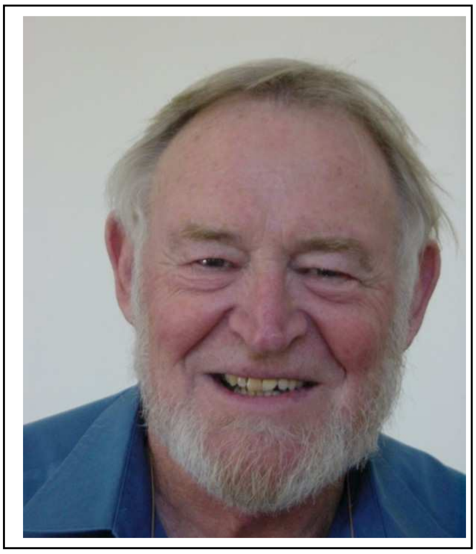
She continues: "Because this could open up a completely new field of science, the idea is that once the scientists have identified the signal they are looking for, they will follow up with other instruments with longer term science missions."

Loots also underlines the fact that "these global science projects are being established in South Africa because of the track record we have built up over the past ten years in terms of radio astronomy. It is important also to acknowledge the vision of government to support and fund the development of capacity that makes this possible."

## Obituary: Prof Eddie Baart

6 September 1933 – 23 December 2014

Professor Emeritus Eddie Baart, a respected teacher, researcher and intellectual leader of the Rhodes community, died in the early hours on the morning of 23 December 2014, in the Aurora Hospital, Port Elizabeth.



Eddie Baart was born in Kimberley on 6 September 1933 and attended Christian Brothers College (CBC) until he matriculated in 1950. He enrolled as a student at Rhodes University in 1951 where he majored in Physics, Mathematics and Applied Mathematics, and graduated with a BSc with distinction in 1953 and a BSc (Hons) also with distinction in 1954. He obtained a Doctorate in Nuclear Physics at Liverpool University in 1959, before returning to Rhodes University as a Senior Lecturer in the Physics Department in 1960, after a brief period as a geophysicist in Rhodesia. He was appointed Professor in 1969 and succeeded Professor Jack Gledhill as Head of Department in 1984, a position he held until 1993.

Professor Baart built up the very successful Radio Astronomy Research Group in the Physics Department. His involvement dates back to the time when he was a member of the group appointed in 1960 to restart radio astronomy after the work on solar emissions by Prof Stack-Forsyth was concluded. Prof Baart became a leader in this venture. Their major achievement was a unique radio survey of the southern skies, using the 26-m radio telescope at Hartebeesthoek near Pretoria. It is fair to say that these origins of radio astronomy in South Africa here at Rhodes University ultimately led to the winning of the bid for hosting the Square Kilometre Array (SKA) telescope in 2012.

Prof Baart was a rated researcher under the programme of the Foundation of Research Development, the predecessor of the National Research Foundation. Between 1971 and 1991 he was a member of the Advisory Board of the South African Astronomical Observatory and served as President of the Astronomical Society of Southern Africa in 1981 and 1982. Professor Baart also published numerous papers throughout his career.

His publishing work continued into this year, in the form of a chapter written by him on contributions at Rhodes University to South African physics, for a book on the History of Physics in South Africa, published by the SA Institute of Physics.

With the current crisis in education in South Africa topical, it is worth noting that Rhodes University was one of the earliest institutions to take Physics Education seriously as a legitimate research area. Against the grain, Prof Baart took the courageous route of using practical research findings directly in his teaching methodology and testing them. Rhodes became known for the quality of its Physics teaching and its high level of interaction with the students. For his efforts in teaching, Prof Baart was recognised with a Carnegie Fellowship in Physics Education and awarded the first Vice-Chancellor’s Distinguished Teaching Award in 1991.

Prof Baart served Rhodes in an extensive range of capacities. He was a Senate representative on Rhodes University Council for 21 years (1973 – 1994), served as the Dean of Science in 1976 and 1977 and between 1980 and 1982. He also acted a Pro-Vice-Chancellor on numerous occasions. Records show that Prof Baart founded the Electronic Services Unit, which now serves the whole University. He was Chairman of Computer Steering Committee for many years during which time there was a significant expansion of the network at Rhodes University. These were the formative years of the Internet in South Africa and we are proud to say, Rhodes

University did the pioneering work. For many years Professor Baart was in charge of equipment for lecture theatres and helped introduce the University to photocopying, offset-litho printing, overhead and other projectors and word processors and spreadsheet packages for academic departments and the Library. He acted as a Sub-Warden, House Warden and Hall Warden, counselling and mentoring generations of students. Prof Baart was also the founding Chairman of the Rhodes University Bequest Association.

However, it was not all work for Eddie as many of his colleagues recall. He played rugby for Rhodes as a student and excelled at squash. He became the Administrative Secretary of the local Shakespeare Society, was involved in amateur drama at Rhodes well before there was a Drama Department, and played many leading parts in productions of the Grahamstown Amateur Dramatic Society (GADS). Mixing fun with work, he put in considerable time and effort in demonstrating “The Fun of Physics” as the “Mad Professor” to school children of all ages, at schools, at SciFest and at the Albany Museum. Before and since retirement Prof Baart made a name for himself and brought considerable respect to Rhodes University for his expertise as “Expert Witness” in cases involving the physics of motor- and other accidents.

In October last year, Professor Baart was acknowledged by his close colleagues in the Physics Department at their year-end function, for his long and influential service to Physics at Rhodes. Many of the processes and values within Teaching and Learning and research processes in the department carry evidence of his leadership and influence.

In December 2014 Professor Baart was honoured with the Distinguished Old Rhodian award in recognition of his exceptional contribution to Rhodes University and to the discipline of Physics.

Professor Baart is survived by his wife, Janine, and his extended family. He contributed much in his life, with enthusiasm and good humour, and will be remembered with respect and fondness.

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## Editorial (concerning the next article)

The ASSA has undergone substantial growth in the last few years. One of the growth areas is the establishment of several active discussion groups. These groups share news of members' activities, meetings and so on, but also discussed are press releases and popular articles communicating the latest developments and breakthroughs in physics and astronomy.

The development of many large telescopes on Earth, aided by several of space telescopes and probes has led to a number of exciting discoveries such as the CMB radiation and Dark/Matter Energy. These types of discoveries have generated many models, hypotheses and theories to try and explain them. These in turn draw on the many diversified topics that are highly specialized and include particle physics, quantum mechanics and theoretical physics amongst others. Cosmology too, has become an observational science, and draws on these specialized topics as well.

In addition, all these new instruments gather vast amounts of data that needs to be processed and interpreted. In order to explain new data, many interesting hypotheses and theories have been put forward, often highly speculative ones that in turn need observational verification. Remember that astronomy and physics, in the broadest sense, are both empirical sciences where theory and experiment/observations play an interactive role.

Much modern science research involves large teams of scientists, and there is a need to publish, often prematurely, leading to conclusions that question some fundamental laws of science. Some recent examples of this are *faster-than-light* neutrinos, the detection of *gravitational waves* in the

CMB and when the constancy of the *speed of light, c,* was questioned. These were eventually settled when the experimental methods were found to be in error or the data was misinterpreted.

But what is also becoming more common is the large number of highly speculative ideas/theories that are highly sophisticated, technically/mathematically challenging and have no way of being tested. The media exploit these and often sensationalize them leading to poor communication for two reasons:

- the piece has been oversimplified (and poorly written) leading to readers misunderstanding the science,
- it has been well written but the material is really difficult.

Unfortunately this plethora of speculative material has flooded some of the discussion groups leading to members drawing invalid conclusions, especially when some experimental evidence goes beyond accepted science. So we get the situation that because a very speculative idea/theory is announced by a scientist from a reputable research facility or university, it must be true or factual, even if there is no experimental evidence. I'm not saying such speculative ideas cannot be true, but to argue/discuss them requires a deep and thorough knowledge and understanding of the topic. Many leading researchers around the world also struggle with some of these very new and speculative ideas, and it is thus understandable that neither the layperson, nor the non-specialist, can really come to terms with many of these new ideas: where does speculation end and science begin?

It is hoped that the following article, by two of the world's leading scientists, will help to clear the air! It is published here in its entirety with permission from ***Nature***.

# Scientific method: Defend the integrity of physics

**George Ellis & Joe Silk**

Illustration by Vasava

*Attempts to exempt speculative theories of the Universe from experimental verification undermine science, argue George Ellis and Joe Silk.*

**Subject terms**: Physics, Philosophy, Astronomy and astrophysics

This year [2014], debates in physics circles took a worrying turn. Faced with difficulties in applying fundamental theories to the observed Universe, some researchers called for a change in how theoretical physics is done. They began to argue — explicitly — that if a theory is sufficiently elegant and explanatory, it need not be tested experimentally, breaking with centuries of philosophical tradition of defining scientific knowledge as empirical. We disagree. As the philosopher of science Karl Popper argued: a theory must be falsifiable to be scientific.

Chief among the ‘elegance will suffice' advocates are some string theorists. Because string theory is supposedly the ‘only game in town' capable of unifying the four fundamental forces, they believe that it must contain a grain of truth even though it relies on extra dimensions that we can never observe. Some cosmologists, too, are seeking to abandon experimental verification of grand hypotheses that invoke imperceptible domains such as the kaleidoscopic multiverse (comprising myriad universes), the ‘many worlds' version of quantum reality (in which observations spawn parallel branches of reality) and pre-Big Bang concepts.

These unprovable hypotheses are quite different from those that relate directly to the real world and that are testable through observations — such as the standard model of particle physics and the existence of dark matter and dark energy. As we see it, theoretical physics risks becoming a no-man's-land between mathematics, physics and philosophy that does not truly meet the requirements of any.

The issue of testability has been lurking for a decade. String theory and multiverse theory have been criticized in popular books[1, 2, 3] and articles, including some by one of us [*Nature*] that the theory of inflationary cosmology is no longer scientific because it is so flexible that it can accommodate any observational result. Theorist and philosopher Richard Dawid[6] and cosmologist Sean Carroll[7] have countered those criticisms with a philosophical case to weaken the testability requirement for fundamental physics.

We applaud the fact that Dawid, Carroll and other physicists have brought the problem out into the open. But the drastic step that they are advocating needs careful debate. This battle for the heart and soul of physics is opening up at a time when scientific results — in topics from climate change to the theory of evolution — are being questioned by some politicians and religious fundamentalists. Potential damage to public confidence in science and to the nature of fundamental physics needs to be contained by deeper dialogue between scientists and philosophers.

## String theory

String theory is an elaborate proposal for how minuscule strings (one-dimensional space entities) and membranes (higher-dimensional extensions) existing in higher-dimensional spaces underlie all of physics. The higher dimensions are wound so tightly that they are too small to observe at energies accessible through collisions in any practicable future particle detector.

Some aspects of string theory can be tested experimentally in principle. For example, a hypothesized symmetry between fermions and bosons central to string theory — supersymmetry — predicts that each kind of particle has an as-yet-unseen partner. No such partners have yet been detected by the Large Hadron Collider at CERN, Europe's particle-physics laboratory near Geneva, Switzerland, limiting the range of energies at which supersymmetry might exist. If these partners continue to elude detection, then we may never know whether they exist. Proponents could always claim that the particles' masses are higher than the energies probed.

*"The consequences of overclaiming the significance of certain theories are profound."*

Dawid argues[6] that the veracity of string theory can be established through philosophical and probabilistic arguments about the research process. Citing Bayesian analysis, a statistical method for inferring the likelihood that an explanation fits a set of facts, Dawid equates confirmation with the increase of the probability that a theory is true or viable. But that increase of probability can be purely theoretical. Because "no-one has found a good alternative" and "theories without alternatives tended to be viable in the past", he reasons that string theory should be taken to be valid.

In our opinion, this is moving the goalposts. Instead of belief in a scientific theory increasing when observational evidence arises to support it, he suggests that theoretical discoveries bolster belief. But conclusions arising logically from mathematics need not apply to the real world. Experiments have proved many beautiful and simple theories wrong, from the steady-state theory of cosmology to the SU(5) Grand Unified Theory of particle physics, which aimed to unify the electroweak force and the strong force. The idea that preconceived truths about the world can be inferred beyond established facts (inductivism) was overturned by Popper and other twentieth-century philosophers.

We cannot know that there are no alternative theories. We may not have found them yet. Or the premise might be wrong. There may be no need for an overarching theory of four fundamental forces and particles if gravity, an effect of space-time curvature, differs from the strong, weak and electromagnetic forces that govern particles. And with its many variants, string theory is not even well defined: in our view, it is a promissory note that there might be such a unified theory.

**Many multiverses**

The multiverse is motivated by a puzzle: why fundamental constants of nature, such as the fine-structure constant that characterizes the strength of electromagnetic interactions between particles and the cosmological constant associated with the acceleration of the expansion of the Universe, have values that lie in the small range that allows life to exist. Multiverse theory claims that there are billions of unobservable sister universes out there in which all possible values of these constants can occur. So somewhere there will be a bio-friendly universe like ours, however improbable that is.

Some physicists consider that the multiverse has no challenger as an explanation of many otherwise bizarre coincidences. The low value of the cosmological constant — known to be 120 factors of 10 smaller than the value predicted by quantum field theory — is difficult to explain, for instance.

**More related stories**

Earlier this year, championing the multiverse and the many-worlds hypothesis, Carroll dismissed Popper's falsifiability criterion as a “blunt instrument” (see go.nature.com/nuj39z). He offered two other requirements: a scientific theory should be “definite” and “empirical”. By definite, Carroll means that the theory says “something clear and unambiguous about how reality functions”. By empirical, he agrees with the customary definition that a theory should be judged a success or failure by its ability to explain the data.

He argues that inaccessible domains can have a “dramatic effect” in our cosmic back-yard, explaining why the cosmological constant is so small in the part we see. But in multiverse theory, that explanation could be given no matter what astronomers observe. All possible combinations of cosmological parameters would exist somewhere, and the theory has many variables that can be tweaked. Other theories, such as unimodular gravity, a modified version of Einstein's general theory of relativity, can also explain why the cosmological constant is not huge[7].

Some people have devised forms of multiverse theory that are susceptible to tests: physicist Leonard Susskind's version can be falsified if negative spatial curvature of the Universe is ever demonstrated. But such a finding would prove nothing about the many other versions. Fundamentally, the multiverse explanation relies on string theory, which is as yet unverified, and on speculative mechanisms for realizing different physics in different sister universes. It is not, in our opinion, robust, let alone testable.

The many-worlds theory of quantum reality posed by physicist Hugh Everett is the ultimate quantum multiverse, where quantum probabilities affect the macroscopic. According to Everett, each of Schrödinger's famous cats, the dead and the live, poisoned or not in its closed box by random radioactive decays, is real in its own universe. Each time you make a choice, even one as mundane as whether to go left or right, an alternative universe pops out of the quantum vacuum to accommodate the other action.

Billions of universes — and of galaxies and copies of each of us — accumulate with no possibility of communication between them or of testing their reality. But if a duplicate self exists in every multiverse domain and there are infinitely many, which is the real ‘me' that I experience now? Is any version of oneself preferred over any other? How could ‘I' ever know what the ‘true' nature of reality is if one self favours the multiverse and another does not?

In our view, cosmologists should heed mathematician David Hilbert's warning: although infinity is needed to complete mathematics, it occurs nowhere in the physical Universe.

**Pass the test**

We agree with theoretical physicist Sabine Hossenfelder: post-empirical science is an oxymoron (see go.nature.com/p3upwp and go.nature.com/68rijj). Theories such as quantum mechanics and relativity turned out well because they made predictions that survived testing. Yet numerous historical examples point to how, in the absence of adequate data, elegant and compelling ideas led researchers in the wrong direction, from Ptolemy's geocentric theories of the cosmos to Lord Kelvin's 'vortex theory' of the atom and Fred Hoyle's perpetual steady-state Universe.

The consequences of overclaiming the significance of certain theories are profound — the scientific method is at stake (see go.nature.com/hh7mm6). To state that a theory is so good that its existence supplants the need for data and testing in our opinion risks misleading students and the public as to how science should be done and could open the door for pseudoscientists to claim that their ideas meet similar requirements.

What to do about it? Physicists, philosophers and other scientists should hammer out a new narrative for the scientific method that can deal with the scope of modern physics. In our view, the issue boils down to clarifying one question: what potential observational or experimental evidence is there that would persuade you that the theory is wrong and lead you to abandoning it? If there is none, it is not a scientific theory.

Such a case must be made in formal philosophical terms. A conference should be convened next year to take the first steps. People from both sides of the testability debate must be involved.

In the meantime, journal editors and publishers could assign speculative work to other research categories — such as mathematical rather than physical cosmology — according to its potential testability. And the domination of some physics departments and institutes by such activities could be rethought[1, 2].

The imprimatur of science should be awarded only to a theory that is testable. Only then can we defend science from attack.

## References


1. Woit, P. Not Even Wrong (Cape, 2006).
2. Smolin, L. The Trouble with Physics (Penguin, 2006).
3. Baggott, J. Farewell to Reality (Constable, 2013).
4. Ellis, G. F. R. Sci. Am. 305, 38–43 (2011).
5. Steinhardt, P. Nature 510, 9 (2014).
6. Dawid, R. Phil. Sci. 73, 298–332 (2007).
7. Ellis, G. F. R. Gen. Rel. Grav. 46, 1619 (2014).


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**Author information**


George Ellis is professor emeritus of applied mathematics at the University of Cape Town, South Africa.
Joe Silk is professor of physics at the Paris Institute of Astrophysics, France, and at Johns Hopkins University in Baltimore, Maryland, USA.



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# Outburst of the Binary System PSR J1723-2837

Andre van Staden
South Africa
andre@etiming.co.za

**Abstract:**
CCD photometric measurements were obtained from the compact binary pulsar system, PSR J1723-2837 in the visual optical band from August to October 2014. Anomalies were observed in the Light Curve (LC) and are probably a result of modulation changes during an outburst. An argument is presented that irradiation in the form of a pulsar wind may be linked to the observed event.

## Introduction

A previous letter [van Staden, 2014], presented a phased light curve of the compact binary system, PSR J1723-2837. The light curve of the companion was well described by ellipsoidal variations due to tidal distortion. In this case, there was no evidence of irradiation, similar to PSRJ1740-5340, which was described as a surprising result by the researchers [Orosz JA, et al, 2003]. The irregularities reported in the observed LC were not conclusive at that stage.

This letter reports additional observations in support of an outburst of the binary pulsar system. A further look is taken at the modulation of the observed flux and how this may relate to irradiation in the form of a pulsar wind.

## Notes

In the context of this letter, “Variations” refer to the fact that the observed signal varies (in phase and/or in amplitude) relative to the expected sinusoidal light curve produced by ellipsoidal variations.
The frequency of the ellipsoidal variations is $2f_0$ where $f_0$ is the orbital frequency.

## Data analysis

Data were obtained from 3 August 2014 to the 20 October 2014 with a total of 797 photometric measurements. The longest continued observation (referred to as datasets in the remainder of this letter) was approximately 66 samples with a 5 minute sampling period that relates to about 40% covering of the 14.8 hour orbital period. All photometric data were corrected for atmospheric refraction and sampling times were converted to Heliocentric times. The light curve magnitude was scaled to approximately ±1.

The photometric data covering the period of observation are shown here as a folded phase light curve diagram in figure 1. The datasets that contain the least variations are shown here with blue markers (+). The blue line is a sinusoidal function ($2f_0$) that best fits these data samples. The datasets regarded as variations are shown with fitted red lines. The Companion-Pulsar relation is shown at the top of the diagram with associated phases. (The bottom of the page can be regarded as the viewpoint from earth, assuming the pulsar-companion orbit is in the plane of the surface of the page.) The maxima coincide with Ø ~ 0.0 and Ø ~ 0.5 when the distorted star presents the longest axis of its ellipsoid to the observer.

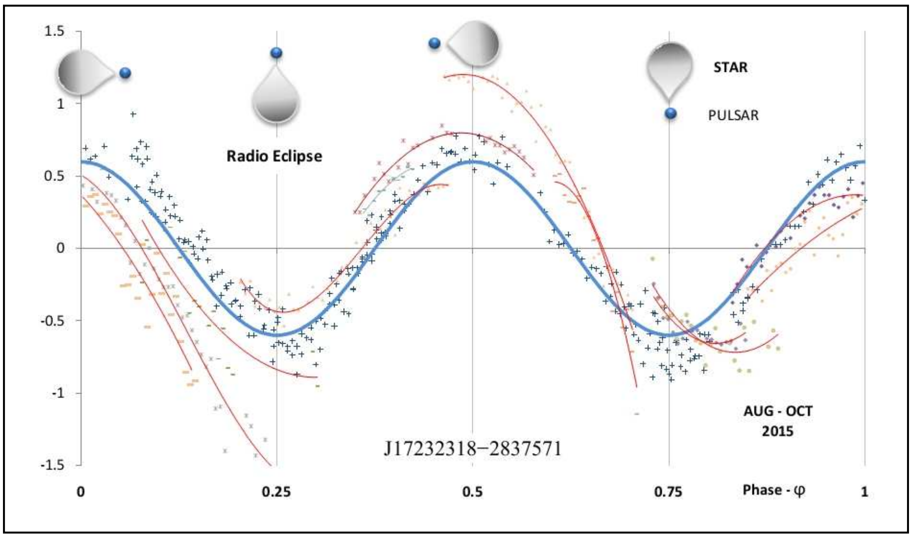



*Fig 1. Light curve of the companion to PSR J1723-2837 from August to October 2015. The star at phases 0 and 0.5 exposes slightly larger surfaces to the observer therefore producing an*

*increase in light intensity. If irradiation played a role, we would expect asymmetry of the minima at phases 0.75 and 0.25 when the start alternatively exposes its "hot" and "cold" surfaces towards earth.*

In order to investigate the observed variations in the frequency domain, the data samples were interpolated with a cubic spline to create evenly spaced samples. The best fitted sinusoidal function (blue curve in figure 1) was subtracted prior to a FFT in order to reveal the remainder of the frequency components. The results from the Fourier Analysis were not particular successful, probably due to the large spaces between datasets and much effort was spent looking at various datasets for prominent signals. However, the observations towards the end, revealed frequency components at f≈1.624 and a weaker signal at f≈1.0. Of particular interest is the frequency at 1.624 that is equal to the orbital frequency (see figure 2).

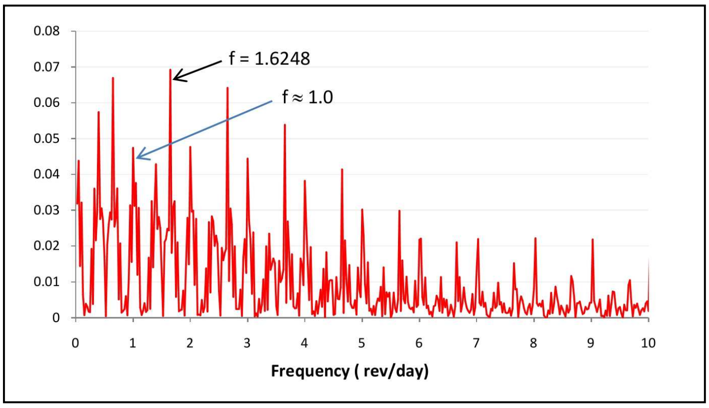



*Fig. 2. Fourier Transform with the main frequency ($f_0$) removed.*

If the 1.624 frequency component can be confirmed there are theories to support this particular modulation. [Stapper B.W., et al, 1998, Reynolds M.T., et al, 2007, Bogdanov, et al, 2013, Wang Z., 2013, Li M. et al, 2014]. Binary pulsar system that revealed this particular modulation is believed to be the consequence of irradiation cause by a pulsar wind. This will have the effect brightening and dimming once per orbit as the companion faces the "hot" and "cold" side towards Earth. It is further postulated that material blown off the companion star may also block and reduces light transmission while facing the "cold" side of the star.

However, if this is the case, the phase of the modulating signal at peak brightness would have to be synchronized to coincide with Ø= 0.75 when the pulsar is between the Earth and the companion star. Consequently, the minimum is expected around Ø= 0.25

To further investigate the phase and amplitude, an approach was followed where the signal $S$, measured was the sum of two terms,

$S = S_{2fo} + X_{fo}$

where $S_{2fo}$ is the contribution due to ellipsoidal variations and agrees well with a sinusoidal function and $X_{fo}$ is the modulating signal in question. From studies in other binary pulsar system we can assume with reasonable confidence that $X_{fo}$ may be approximated by a sinusoidal function [Stapper B.W., et al, 1998, Reynolds M.T., et al, 2007]. Therefore we can estimate $S$ mathematically as

$$S \approx a_0 \cdot \sin(\varphi_0 + \omega_0 \cdot t) + a_1 \cdot \sin(\varphi_1 + \omega_1 \cdot t) \qquad [1]$$

The first term represents ellipsoidal variations where $a_0$ is the amplitude, $\emptyset_0$ is the phase, $\omega_0 = 4\pi f_0$ and $f_0$ is the orbital frequency. The second term represents the modulating signal where $a_1$ is the amplitude, $\emptyset_1$ the phase and $\omega_1 = 2\pi f_0$. By applying the rule of linear combinations we can expand the 2nd term and rewrite (1) to be

$$S \approx a_0 \cdot \sin(\varphi_0 + \omega_0 \cdot t) + [\alpha \cdot \sin(\omega_1 \cdot t) + \beta \cdot \cos[(\omega_1 \cdot t)]] \qquad [2]$$

To be consistent with the published time of the ascending node, we can change the first term to a cosine function and set the phase to zero, $\emptyset_0$ = 0. Therefore equation (2) reduces to,

$$S \approx a_0 \cdot \cos(\omega_0 \cdot t) + \alpha \cdot \sin(\omega_1 \cdot t) + \beta \cdot \cos(\omega_1 \cdot t)$$

By using multiple linear regression analysis, the method of least squares was used to estimate the regression coefficients that best fits the data and can be written in a more general form as,

$$S_i = a_0 \cdot \cos(\omega_0 \cdot t_i) + \alpha \cdot \sin(\omega_1 \cdot t_i) + \beta \cdot \cos(\omega_1 \cdot t_i) + e_i, \qquad i = 1,2 \ldots, n \tag{3}$$

and finally in a matrix form as:

$$\begin{bmatrix} S_1 \\ S_2 \\ \vdots \end{bmatrix} = \begin{bmatrix} \cos(\omega_0 \cdot t_1) & \sin(\omega_1 \cdot t_1) & \cos(\omega_1 \cdot t_1) \\ \cos(\omega_0 \cdot t_2) & \sin(\omega_1 \cdot t_2) & \cos(\omega_1 \cdot t_2) \\ \vdots & \vdots & \vdots \end{bmatrix} \begin{bmatrix} a_0 \\ \alpha \\ \beta \end{bmatrix} + \begin{bmatrix} \epsilon_1 \\ \epsilon_2 \\ \vdots \end{bmatrix} \tag{4}$$

The amplitude and phase of the modulating signal were then determined by the coefficients α, β, obtained from equation (4)

$$a_1 = \sqrt{\alpha^2 + \beta^2} \qquad \text{and} \qquad \varphi_1 = atan2(\beta, \alpha) \tag{5}$$

To explore the propagation of $a_0$, $a_1$ and $\emptyset_1$ during the full period, a set of 300 samples ($S_i$) were calculated according to above procedure while stepping through the full dataset of 797 samples, $S_{1+k \ldots 300+k} \rightarrow a_{0k}, a_{1k}, \emptyset_{1k},$ k = 1,2…,n

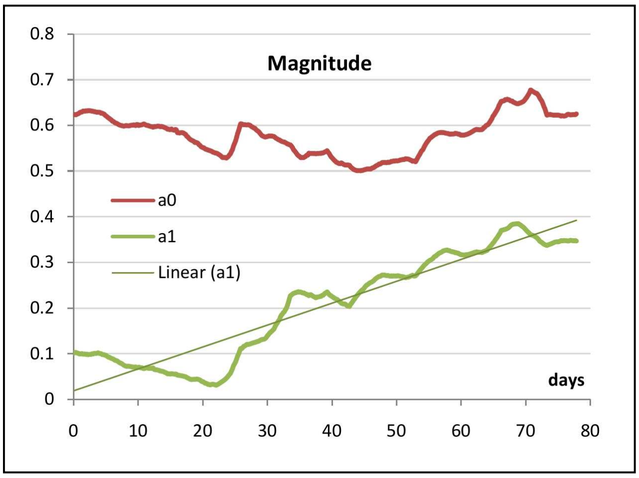



*Fig 3. Magnitudes. Ellipsoidal variations (red) and the derived modulating signal (green). The results are similar to a moving average.*

From the results obtained, graphs were plotted for magnitudes and phase. In figure 3 we see that the amplitude $a_0$ from the effects of ellipsoidal variation remains reasonable constant during the full period of 80 days. However, the amplitude $a_1$ of the modulating signal shows a distinct increase in amplitude with a steady slope.

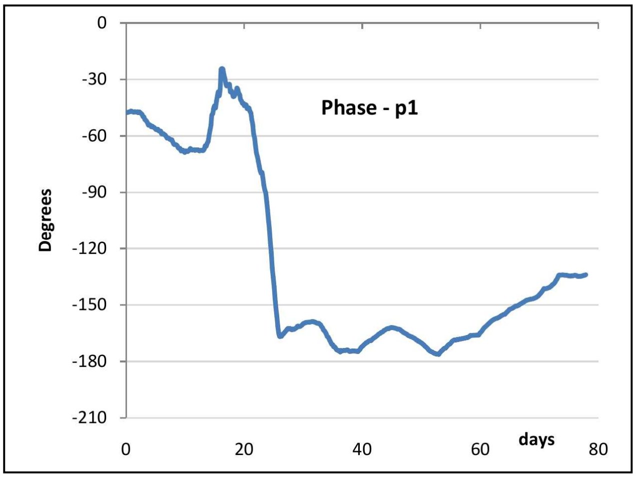
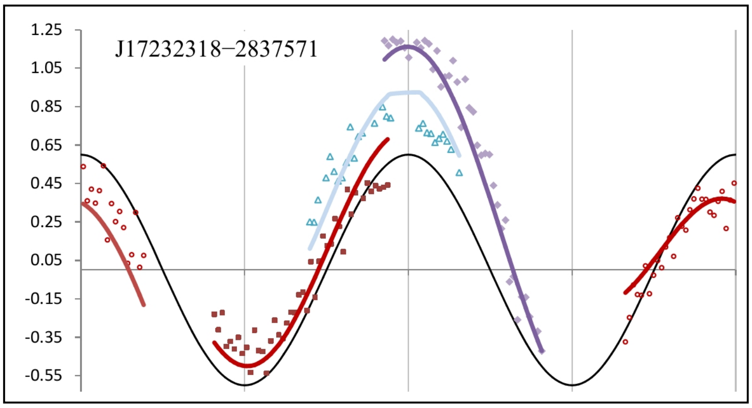



*Fig. 4. Phase of the modulating signal*

Figure 4 represents the modulating signal phase results. With sufficient signal strength and enough data samples we see that the phase orientated itself to approximately -160°. A phase of +180° or -180° is needed to synchronize the peak brightness of the modulating signal exactly with the Ø= 0.75 point. This result is within good limits consistent with the proposed theory.

To see how the calculated composite signal $S_i$ compared to the real data, two sections of data were used. Magnitudes and phases were calculated according to the least squares method described above but with an extra term to incorporate the less prominent 1 rev/day frequency component which is simply the sum of three sinusoidal functions,

$$S_i \approx a_0 \cdot \cos(\omega_0 \cdot t_i) + a_1 \cdot \sin(\varphi_1 + \omega_1 \cdot t_i) + a_2 \cdot \sin(\varphi_2 + \omega_2 \cdot t_i) \quad [6]$$




The calculated phases and magnitudes were substitute in equation [5] to determine the best estimated solutions for *S*. Figures 5 and 6, illustrate the results from four neighbouring datasets presented as a folded light curve. The markers show the actual samples while the solid lines are the calculated signal *S*, obtained from equation [6].

*Fig. 5. (above) The raw samples are shown here with markers. The curve-fitting lines produced from two modulating signals illustrate the correlation on the data sets.*

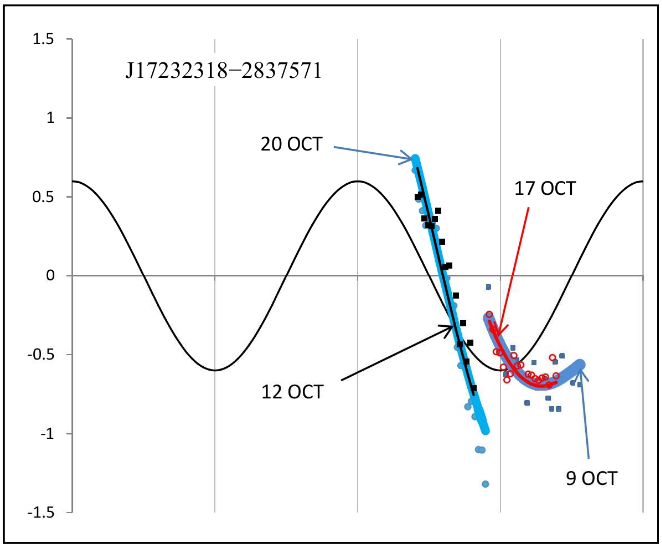



*Fig. 6. Four datasets with curve fitting. Notice that the data obtained on 9 & 17 Oct are almost coincident and so the data on 12 & 20 Oct which were both separated by 8 days agree with the periodic nature of the signal. Coincidentally, 8 days are equal to 13.998 orbits, thus observing nearly the same phase of the companion star.*

From both figures it is clear that the fitted model agrees well with the observed data. It is interesting to note that a recent research found PSR J1628-3205 lags in phase about 0.05 at the Ø=0.75 minimum point [Li. M., 2014]. This is in close agreement with the measured lag at minimum of about 0.07 in phase, from measurements on 9 & 17 Oct (see figure 6).

**Discussion**

Building on the results obtained from the previous letter and the additional data captured, it becomes evident that the binary pulsar system must have started with an outburst late in August 2014. The possibility to identify a modulating signal in the outburst was examined. Discontinuity in the data and variability of the modulating signals made analysing a challenging task.

Phase and magnitude coefficients were derived for the assumed modulating frequency $f_0$ by multiple linear regression. The results, in particular the trending data over a large span, were in favour of the argument that irradiation may have played a role in the outburst. The modulating frequency component at 1 rev/day seems to be suspicious by general standards with a connection to terrestrial origin. However, the comparison star (covered the previous letter) did not show this modulation, thus leaving this as an open question.

PSR J1723–2837 is regarded as a candidate for a transitional object that could experience switching between Radio and Gamma radiation (and vice versa) for example the famous state change of PSR J1023+0038 that was observed in 2013. [Bogdanov S, 2014]. PSR J1723–2837 is the nearest such system and provides the best-suited target for studying the transition process of MSPs from accretion to rotation power (and vice versa) and the circumstances surrounding [Papitto, 2013].

## References


Bogdanov S., et al., 2014, ApJ, 781, 6

Li M., Jules P., Halpern P., 2104, http://arxiv.org/abs/1409.3877

Orosz JA., van Kerkwijk MH., 2003, A&A, 397,1

Papitto A., Ferrigno C., Bozzo E., et al. 2013, Nature, 501, 517

Reynolds M.T., et al, 2007, http://arxiv.org/abs/0705.2514

Stapper B.W., et al, 1998, http://arxiv.org/abs/0705.2514v1

van Staden A., 2014, MNASSA, 73, 9&10, 223

Wang Z., et al., 2013, http://arxiv.org/abs/1108.4745

Related titles from references with arXiv links

X-ray and γ -ray studies of the millisecond pulsar and possible x-ray binary/radio pulsar transition object PSR J1723–2837.
http://arxiv.org/abs/1311.2024

Optical counterparts of two fermi millisecond pulsars: Psr j1301+0833 and psr j1628−3205
http://arxiv.org/abs/1409.3877

The eclipsing millisecond pulsar PSR J1740−5340 and its red straggler companion.
http://arxiv.org/abs/astro-ph/0210009

Swings between rotation and accretion power in a binary millisecond pulsar.
http://arxiv.org/abs/1310.7803

The light curve of the companion to PSR B1957+20
http://arxiv.org/abs/0705.2514

The light curve of the companion to PSR J205120827
http://arxiv.org/abs/0705.2514v1

Irregularity observed in the Light Curve of the companion of PSR J1723-2837.
http://www.mnassa.org.za/

Multiband studies of the optical periodic modulation in the x-ray binary sax j1808.4−3658 during its quiescence and 2008 outburst
http://arxiv.org/abs/1108.4745

## Comet Chaser

Guy Ellis

William Mclean Johnston was an engineer, draughtsman, artist and passionate amateur astronomer. Born in the town of Newton Stewart, Scotland in 1880, where his father was a doctor, he went on to study engineering. Newly qualified he travelled to South Africa where he was employed by the Post Office in Cape Town.

There he joined an enthusiastic group of astronomers, one of whom, William Reid, became a renowned 'comet chaser'. Born in Scotland in 1861, Reid moved to South Africa in 1901 for health reasons. Already interested in astronomy, after seeing the Coggoa comet (C/1874 H1), he became a foundation member and long-standing Council member of the Cape Astronomical Association. He was also the founding Director of the Association's Comet Section; later serving as President of the ASSA becoming the first amateur astronomer to achieve this honour.

Initially his observatory was equipped with a 10.2-cm refractor, but in about 1921 he replaced this with an excellent (15.2-cm) Cooke 6-inch f/15 Apochromatic telescope.

These famous telescopes were made by Thomas Cooke and Sons of York. Cooke, the son of a shoemaker went to work in the family business after only two years at an elementary school. He disliked shoe making and inspired by the tales of James Cook's voyages he decided to go to sea. To prepare himself for a life at sea, he spent all his free time teaching himself mathematics, navigation and astronomy. As he was about to leave home, his mother persuaded him to stay ashore. He found employment teaching local farmers' children, eventually moving to a school in Ogleforth.

Again in his spare time he began to study optics and made his own first rudimentary telescope, grinding a lens by hand out of the bottom of a glass whisky tumbler, and mounting it in into a frame made from tin that he had soldered together.

Although he continued to spend long hours teaching mathematics, he devoted his spare hours to making bigger and better telescopes. Finding a ready market, Cooke's instruments quickly established a reputation as being the best and cheapest in the country.

On his death in 1868 two of his sons ran the Buckingham Works and continued to produce high quality telescopes, prismatic compasses and theodolites. Cooke instruments were selected to fit out the Royal Observatory at Greenwich, and their telescopic sights were purchased by the Royal Navy.

Dennis Taylor, a craftsman at Cooke's, in 1892 designed the first triple apochromat refractor fitted to the Cooke Photo Visual telescope objective. This refractor uses exotic glass types that produce colour free images in focus, providing high contrast views which are ideal for lunar and planetary work and all types of deep-sky astrophotography. In 1930 these instruments were priced at £40 for a 4-inch model, while the 12 – inch was selling for £720.

One of the telescopes that William Reid used to become a world renowned astronomer was the Cooke 6" that he purchased in 1921. He identified six comets, five of which he found using the Cooke instrument.

| | | | |
|---|---|---|---|
| C/1918 L1 | 1918 II | 12 Jun 1918 | Cape of Good Hope. |
| C/1921 E1 | 1921 II | 13 Mar 1921 | Cape Town. 16-cm comet-seeker scope. |
| C/1922 B1 | 1921 V | 20 Jan 1921 | Cape of Good Hope. |
| C/1924 F1 | 1924 I | 25 Mar 1924 | Rondebosch. |
| C/1925 F2 | 1925 III | 24 Mar 1925 | Rondebosch. |
| C/1927 B1 | 1926 VII | 25 Jan 1926 | Cape Town |

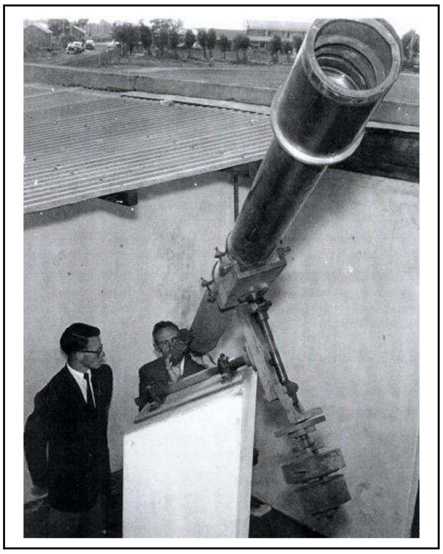
Reid was not only interested in comets; his knowledge of the Southern skies was unrivalled. With his son and two other astronomers he discovered that Saturn's A ring was translucent. He received international recognition when awarded the Jackson-Gwilt Medal by the Royal

Astronomical Society shortly before his death in 1928. This medal is awarded for the invention, improvement, or development of astronomical instrumentation or techniques; for achievement in observational astronomy; or for achievement in research into the history of astronomy.

Sometime after Reid's death, William Johnston purchased or was given Reid's telescope and he began to teach astronomy at Parow High School. Initially he lent the telescope to the school but soon donated it and even helped build the wooden shed used to house the telescope. Constructed from packing cases, the building had a roof that could be opened to the sky through ten hinged flaps and the telescope was mounted on a concrete pillar

Johnston provided the prizes for the annual astronomical competition at the school and assisted with the organisation of a school trip for 750 pupils from various Cape Town high schools to Klaver on 1 October 1940, to view the total eclipse of the Sun.

When in 1946 the wooden building had to be broken down for drainage work, Johnston lent his 4 inch portable telescope to the school so that the pupils could continue their studies.



*The Cooke 6-inch telescope, photographed with the sliding roof open on Thursday 31st March 1960 by Mr. JS Labuschagne. From left; Butch Cassidy and, behind the telescope eyepiece, Mr. PI Rossouw, then-Senior Science Master. (Butch Cassidy collection)*

Before the new building was completed, William Johnston was knocked down by a car (on 8 July 1947) and succumbed to his injuries 3 days later. Known as a retiring man he had gained the regard of all he came across. He had been a committee member of the Astronomical Society of South Africa and in 1923 was awarded first prize for his design of a postage stamp, while his detailed large posters of the universe and the solar system were greatly admired.

In 1948 the telescope was moved into the new building. It was mounted on a 6ft high pillar which was about 15 inches in diameter. The telescope is mounted equatorially but without its setting circles. It was shipped to England in 1955-56 to be refurbished and was reinstalled in 1957. That same year astronomy was dropped from the school curriculum, but for many years it was used informally by a few teachers and pupils.

It is reported that around 1987 it was sold to Mr Joe Churms (Spencer Jones, 1995), who had recently retired as Deputy Director of the South African Astronomical Observatory, SAAO. He had intended to set it up at his home in the Karoo, however he died (1) before the telescope could be re-assembled in the special observatory room that he and some of his ex-colleagues had built.

After many years, on 28 November 2001, 'Butch' Cassidy managed to track the telescope to the home of Rainer Noack, an amateur astronomer from Blaauwberg. Mr Noack told Cassidy that the scope was in a poor state at the time, with a bent tube, a chip in the front lens and that the eyepieces were in bad condition. He had the optics tested, the tube repaired and the telescope was ready for use, with the exception that somewhere along the line its equatorial mount had been lost.

In early 2014 the telescope entered a new phase when Hannes van der Merwe purchased it with the intention of constructing or finding the correct mounting and restoring this old veteran to its former glory.

## Acknowledgements and Bibliography

Thank you to Butch Cassidy for his original 1960 article on the telescope, then for tracking it down in 2001 and again in 2014. Thanks to Hannes van der Merwe for his emails and interest.

Spencer Jones, J.H., 1995. *MNASSA,* **54**, 54.

**Other sources:**
Orchiston Wayne, J.F. Skjellerup: A forgotten name in South African cometary astronomy, Anglo-Australian Observatory, and Australia Telescope National Facility, PO Box 296, Epping, NSW 2121, Australia
English, Neil A Guide to Collecting, Restoring, and Using Telescopes of Yesteryear Series: The Patrick Moore Practical Astronomy Series 2013

http://pdhs-jjdupreez.co.za/telescope_history.htm
http://www.thefreelibrary.com/History+of+the+Cape+Astronomical+Association.-a0353321627
https://www.repository.cam.ac.uk/handle/1810/217718
http://www.pocklingtonhistory.com/archives/people/famous/thomascooke/
http://pds-smallbodies.astro.umd.edu/comet_data/comet.catalog
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http://articles.adsabs.harvard.edu/cgi-bin/nph-iarticle_query?bibcode=1949MNSSA...8...64H&db_key=AST&page_ind=3&plate_select=NO&data_type=GIF&type=SCREEN_GIF&classic=YES
PDHS-JJ du Preez High School, Parow, Cape Town.
Two photographs of a large (8-inch?) refractor in the workshops of Thomas Cooke of York, circa 1891. Telescope is mounted on a German equatorial.
https://www.repository.cam.ac.uk/handle/1810/217718

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# Amateur Optical Tracking in South Africa during 1957-2014. Part 6.

Greg Roberts

## Introduction

This article covers the activities of the various MOONWATCH teams in the Pretoria area. One name is common to all the stations, that is the late Roy Smith with whom I had the pleasure of finally making contact in the last year of his life. Most of this article was culled from e-mail correspondence.

Roy Smith started work at the CSIR, National Physical Laboratory(NPRL), in 1948 being involved (amongst other things) mainly with the development and maintenance of the National Measuring Standards (NMS) of Mass, Pressure and Length.

He was a member of ASSA from about 1954 to about 2007 and a Fellow of the Royal Astronomical Society, elected May 1974, proposed by Dr A.D. Thackeray (ADT). During the 1950s he became known at Radcliffe through ASSA meetings etc., and stored his 10-inch telescope (mirror made and signed, *Calver '02*) in Mike Feast's garden. ADT asked if he would assist at Radcliffe. To earn extra pocket-money, on occasions, he assisted Dr Wesselink, usually up to midnight (sometimes all night at weekends!).

Since he could start-up and drive the 74-inch telescope, he was asked to help American astronomer Dr Tom Gehrels during his three week visit to the observatory in July 1956.

**Station 0404**

In ~1957 the CSIR approached the ASSA re amateurs and optical satellite tracking. ADT gave Roy permission to set up a tracking station at Radcliffe Observatory, which he did, based on the original SAO design, meridian marker, etc. He took three weeks leave, during which he built about 15 telescopes (based on the Union Observatory design) and spent a lot of energy setting up the site.

In late June 1957 Roy issued an appeal for volunteer Moonwatch observers in the local press as follows:

**Recruitment of Moonwatch Observers**

Towards the end of 1957 the USA will launch an artificial satellite from Florida, U.S.A. The first land-mass from which observations of the satellite can be made is South Africa. A satellite fired at midnight from Florida should be observable in the dawn twilight from Pretoria a few minutes later. It would be of immense value to the project if the first report of the position of the satellite in flight could be received back in the U.S.A within half an hour of launching. For the later stages of the flight, the latitude of the Union of South Africa is such that routine observations of the satellites position will be of special value. South Africa thus occupies a position of great importance in the artificial satellite project.

In order to observe the satellite, three stations have been organized in South Africa - one in Pretoria, one in Johannesburg and one in Cape Town.

The Pretoria "Moonwatch" station will be situated in the grounds of the Radcliffe Observatory with at least 15 special telescopes, and an accurate timing apparatus.

During the flight of the satellite, observations will be possible according to the following schedule:-

(1) Observations on 15 successive days in morning twilight
(2) Intervals of 15 days when the satellite will not be observable
(3) Observations of 15 successive days in the evening twilight
(4) Intervals of 15 days when the satellite will not be observable .................... and so on

The average duration of a watch will be 1.5 – 2 hours, depending on the height of the satellite. The length of time that the satellite will be in flight is not known, but it is hoped will be considerable and may extend up to six months.

**Duties of an Observer**.

(1) To attend any meetings or practice observations which may be organised. When the apparatus is set up there will be at least one practice session each week, before the satellite is launched.

(2) To hold himself ready to be at the Radcliffe Observatory at short notice. It is expected that the "Moonwatch" stations will be alerted a short time before the satellite is to be fired. The group leader of each station will then contact the observers and make arrangements for them to be at the Radcliffe Observatory at least one hour before the arrival of the satellite.

(3) To attend all observations for the period that the satellite is in flight (unless unable to, owing to illness) or vacation leave.

It is hoped to recruit at least 30 observers, thus allowing for the observers who for some reason cannot attend an observational session.

Transport will be arranged for those observers who do not have any available.

If you are interested in assisting in this project, would you kindly complete the attached form and return it to the above address, before 1 July 1957.

R. F. Smith
Group Leader

Roy managed to recruit 12 observers, all from the ranks of the Pretoria branch of ASSA. He was hoping to build up a full complement of 30 observers, needing about 15 observers per observing session. It is not known what response he received from the general public.

**Pretoria Moonwatch** initially had the following details:

Station Code = 0404
Location Radcliffe Observatory grounds
Longitude 28d 13m 43.5s East
Latitude 25d 47m 18s South
altitude 1542 metres
with Moonwatch Team Leader Mr Roy F. N. Smith and Deputy Mr N. van der Vlist

*Fig 1. Radcliffe Observatory Station 0404. From left, the back of Joe Churms, then back of Roy Smith at the console. The remaining observers are unknown.*

When Sputnik went up, some visual observations were made by Roy and the Radcliffe astronomers. Joe Churms took some photos.

Radcliffe, in those days, being on the outskirts of Pretoria, involving dirt roads, etc. was simply too far out to expect early morning or evening attendance on a regular basis. It was only equipped with the standard 2-inch aperture scopes, which were simply too small to see the American satellites. It is thus not surprising that this site was hardly used. Very few observations were made during the period it was active (late 1957 till March 1958).

Early in 1958, about 25 five-inch aperture Apogee telescopes were sent to Cape Town and 25 to Bloemfontein. Roy and Jan Hers complained to the CSIR, and around middle Feb 1958 approval was given that some Apogee scopes at Bloemfontein (not yet installed), were to be transferred to Johannesburg & Pretoria Moonwatch. Five Apogees were supplied to each location.

*Fig 2. (left) Station 8575CSIR. Note the covered telescopes on the roof.*

*Fig3. (below) Detail of the CSIR rooftop telescopes.*

At the end of the International Geophysical Year (IGY), the CSIR asked Roy to set up a permanent station to ensure that optical tracking would carry on. This was done and the station was set up on top of a building in the CSIR grounds in 1959. Roy designed a new mounting for the five Apogee telescopes available.

**Station 8575: (Pretoria 1)**

Station code = 8575 Pretoria I
National Research Institute for Mathematical Sciences (NRMS)
Longitude 28d 16m 39.27s East
Latitude 25d 44m 46.56s South
altitude 1374.6m
with Roy as the Team Leader.

The CSIR had promised the Smithsonian Astrophysical Observatory a South African observer for the Baker Nunn camera (SC2) at Olifantsfontein during the IGY. Roy was seconded there by the CSIR in March 1958. Here he worked with Dr RC Cameron (station manager) and Claude Knuckles who were the American staff during IGY. Roy usually did the evening pass(es) and Claude, who lived near SC-2, did the early morning ones. This continued until December 1958, after which Roy returned to work at the CSIR. Roy also mounted one of his Apogee telescopes on the SC-2 camera in place of the useless small M17 telescope, which, at the time were fitted to all the SC cameras. This enabled the observers to (hopefully) see what they were photographing.

Roy resigned from the CSIR in June 1961 to work at the SC2 station. Here he was employed until May 1964. Louw N Martins, a colleague in the NPRL, took over as Team leader of PRETORIA 1 when Roy left in July 1961.

From July 1961 until 1964, PRETORIA 1 was run by Louw. He did reasonably well by getting two first Moonwatch sightings (OSO on 9 March 1962 and 61 Omicron on 25 April 1962).

In early 1964 Roy received a request/invitation from the CSIR/NPRL, to return to work at the NRMS laboratory (which he did in June 1964). Here he found that Martins had been transferred to the Cape, so Pretoria 1 was closed down. It is not known how many observers Louw had managed to get when he was running it, but at least when the official photo was taken, Roy had all the telescopes manned!

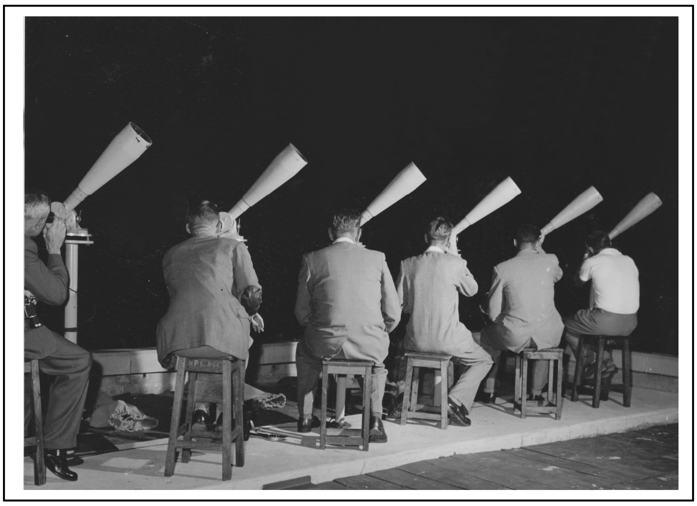


*Fig 4. CSIR Station 8575. L-R Jack Bennett, Walter Meadway, Roy Smith, Louw Martins, ?, Jennings.*

**Pretoria**

Mention of a station called PRETORIA II was found in the literature. Investigation revealed that this was the home of Louw N Martins, who apparently was planning to observe from home. It would appear that it was never really active.

Pretoria II (no site number)
National Research Institute for Mathematical Sciences
Longitude 28d 18m39.156s East
Latitude 25d 44m 30.223s South
altitude 1333.195m

**Station 0405 Riviera**

Roy also installed four Apogees in Jack Bennett's (JB) backyard in 1958. This was where Pretoria Moonwatch operated from and where they did very well, making the world's first observation of 1958 Epsilon! They logged a total of 195 observing sessions during the IGY, which ended 1958.

Station code = 0405 Riviera
90 Malan Street, Riviera, Pretoria
Longitude 28d 12m 42.58s East,
Latitude 25d 43m 43s South
altitude 1310 metres.

During the IGY there were four regular observers for the four Apogee scopes, namely: Jack Bennett, Roy Smith, N. van der Vlist and either W. D. Meadway (Smith's uncle) or Jannie Jooste (see *MNASSA* Oct 2002).

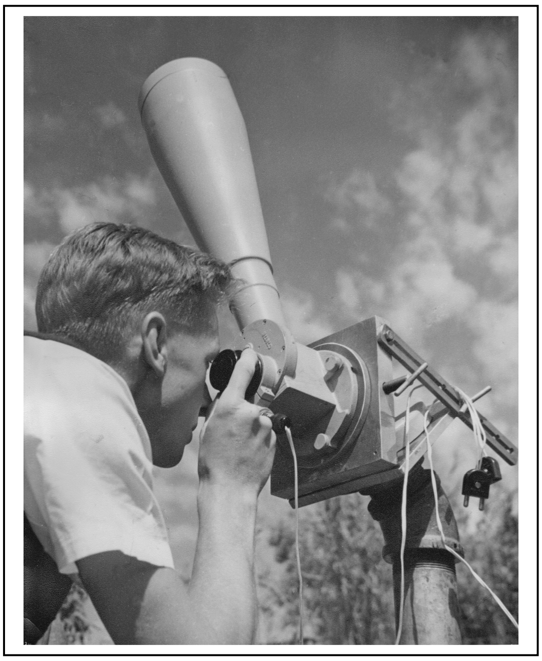
 

*Fig 5 (left) Roy Smith at Station 0405 with one of the original Apogee mountings. Fig 6 (right) Jack Bennett with one of the new mountings.*

During 1959, until June 1961, the observers were Jack Bennett and Roy Smith. During the period July 1961 – 1975, this decreased to Jack Bennett alone. By 1971 Jack had essentially stopped observing satellites, logging only two observations that year. He instead was concentrating on comets and supernovae with his special Apogee which Roy had been able to organize for him from SC2 in 1958. This scope had its own tripod, specially made for the Apogees, which SAO had sent to (some of?) the Baker-Nunns in 1958.

**Station 0410 Murrayfield**

Station Code = 0410 Murrayfield
Longitude 28d 18m 35.23s East
Latitude 25d 44m57.47s South
alt 1359 metres

This was set up at the home of Roy where he operated as a single observer from 1964 to 1975. He always observed for Moonwatch SAO, but on occasions for Farnborough (Satellite Orbits Group) and for Dr McLaughlin at Jet Propulsion Laboratory in the USA. Activity continued till about June 1975, after which the Moonwatch program was officially closed down.

In 1969 Roy used a 12-inch reflector, set up on the old Moonwatch site at Radcliffe Observatory by the Pretoria branch of the ASSA, to track Apollo 11 on its way to the Moon, until 160 000 km out.

It appears that no further satellite observations were made by Roy after Moonwatch closed down.

**Other stations**

Two other stations were established in Southern Africa, namely #0406 which was the Moonwatch station of the Bancroft Astronomical Society in Bancroft, Northern Rhodesia. It is listed in the "COSPAR World List of Satellite Tracking Stations" as follows:
Longitude 27d 50' 09.58" E
Latitude 12d 22' 32.75" S
altitude 1379 metres
Telescopes M17, meridian scope recovery fences.

Apparently a Moonwatch station was also set up in Lusaka. It was assigned number #0409 but no other information is available. It would appear that the Bancroft and Lusaka stations were never really active.

**Thanks**

My special thanks to the late Roy Smith who sorted out the mystery of the numerous stations in Pretoria. He also provided photographs and two large press cutting books, started by Jack Bennett. These detail much of the early years of the Space Age and South Africa's involvement.

The next article will deal with the various tracking stations in the Durban area, namely stations #0407, #0408 and #0411.

# Sky Delights: Crater, a cup full of Stars

Magda Streicher

The constellation Crater is one with a very strange name, but when one thinks more about the name it could have several meanings. The one, and perhaps the most familiar, is that ancient Apollo sent the crow Corvus with a goblet to fetch him some water, but wasted time on his way eating figs from a fig tree. Corvus then used Hydra the water snake as an excuse. In his rage, Apollo sent the crow, cup and water snake into the sky. But the cup would have been one of the first household articles humans would have used early on, and is therefore probably deserving of a place of honour in the starry skies. Although this U-shaped pattern of stars no brighter than magnitude 3.5 suggests a wine goblet named by the early Greeks, it surely lives up to its name.

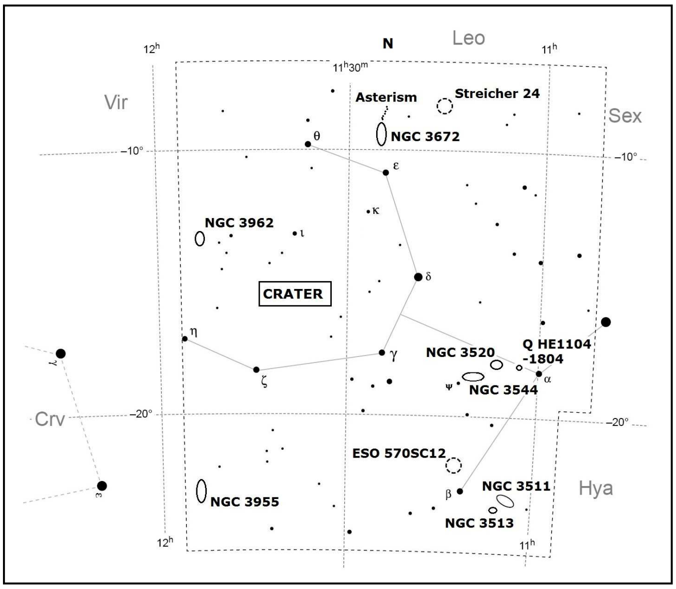
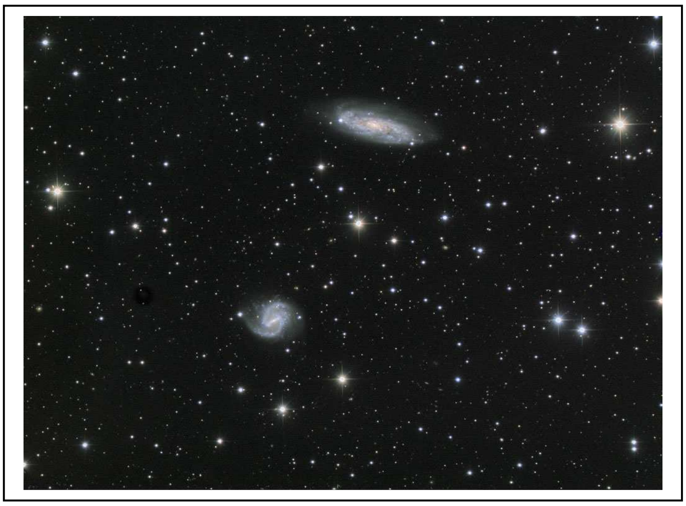



*Fig 1. The constellation Crater.*

Crater does not offer many different types of objects, but holds a good number of galaxies. Discover a drop of moisture next to the base of the glass with a galaxy two degrees west of beta Crateris in the far southern part of the constellation. **NGC 3511** is a special galaxy that displays a fat hazy oval in a north-east to south-west direction. It brightens slowly towards the middle with an oblong nucleus slightly north of centre. Closer investigation and high power reveals a hazy edge with magnitude 13 and 14 stars respectively on its tapered ends. Averted vision appears to let the galaxy grow in size. Only 10 arc-minutes south the circular glow of a companion barred galaxy, **NGC 3513**, can be seen. In truly dark skies this



galaxy shows its real colours. It displays a surprisingly bright central bar with some structure covered in a hazy envelope. Two faint stars can be glimpsed on the eastern edge. It's a pleasant surprise to find an object with modest catalogue statistics that shows such clear detail.

*Fig 2. NGC3511 and NGC3513*

**ESO 570-SC12** is a lovely grouping of half a dozen magnitude 8 stars only one and a half degrees north of beta Crateris. The stars, mostly dressed up in yellow and orange, flow from north to south. Two fainter stars draw the focus to the middle area forming a block with two other stars.

The cup holds in its midst historical wine with the magnitude 5.8 psi Crateris star showing the way to a companion galaxy **NGC 3571** (also documented as NGC 3544) only 18 arc-minutes north-west. The galaxy displays only a faint streak of light in an east to west direction, with a faint stellar nucleus. NGC 3571 = NGC 3544 was found 8 January 1886 UT by Ormond Stone with the Leander McCormick 66-cm refractor. The NGC position for NGC 3571 comes from William Herschel's single discovery observation on 8 March 1789, but is good enough to identify the galaxy unambiguously (the position was later verified by Bigourdan at Paris in 1888 and 1900, Kobold at Strassburg in 1901, Porter at Cincinnati in 1906 and 1908, though curiously, first by Leavenworth at Leander McCormick in 1887). The galaxy is just bright enough for Shapley-Ames, and it has been listed there and in the subsequent literature under NGC 3571 as the NGC position for that number is more nearly correct than the NGC position for NGC 3544. So, in spite of Paturel's use of the number NGC 3544 in RC3 (he perhaps followed ESO-B which has the listing as "NGC 3544 = NGC 3571"), we should retain NGC 3571 for consistency (Credit: DOCdp – Auke Slotegraaf).

Then there is also the **Quasar HE 1104-1804** to be found between the stars of Crater. Barely a degree east of alpha Crateris this extremely distant quasar found a home. To study these faint objects scientists use a technique called gravitational lensing. They use a galaxy as a lens to focus on a quasar billions of light years away. It highlights the accretion disc's descent into a black hole. It is believed that HE 1104-1804 is between 4 and 11 light years across. The team led by Jose Munoz of the University of Valencia in Spain studies this quasar. The galaxies NGC 3520 and NGC 3514 form a triangle with the quasar to the west. (*Astronomy*, April 2012)

*Fig 3. QSO 1104-1804 (NASA, ESO & JA Muñoz)*

**NGC 3520** has been listed as a cluster discovered by Brian Skiff, who refers to this group only as an asterism of four stars between magnitude 12 and 15. Research however shows that it is possible an extremely faint galaxy. NGC 3520 is another of the Leander McCormick discoveries, this one by Leavenworth. His nominal position is close to an asterism of 4 or 5 stars spread over an area of 0.8 by 0.6 arc-minutes, but his description (m = 15.3, D = 0.4, iR, gpmbM, sev vF sts inv) does not match the appearance of the stars. In addition, they are too bright, being 13 to 15th magnitude. A more likely match is to ESO 570- G004, an interacting triple or quadruple system 1 min 35 sec east and 5 arc-minutes south of the nominal position. It matches Leavenworth's description pretty well. Other possible matches include the double star at 11 01 55.6, -17 40 23; and NGC 3514 = ESO 570-G001 at 11 01 32, -18 30.7. These don't match the description as well as the interacting system, however, so I view them as less likely to be Leavenworth's object. (Credit: DOCdp – Auke Slotegraaf)

At the other end of the constellation in the far south-eastern part of the constellation another galaxy, **NGC 3955**, can be found. It is a very thin elongated galaxy in a north to south direction. Although outstanding against the background star field, it displays only a slight brightening towards the centre and slightly brighter southern part. NGC 3955 is covered in a hazy blanket with just a glimpse of a faint star on the northern edge. Three stars in a line accompanied by other fainter stars occupy the southern field of view.

The brightest star in the constellation is delta Crateris with a spectral type K and obvious in a very light yellow colour. Further north is magnitude 4.8 epsilon Crateris and luck would have it that I stumbled on a star group, **Streicher 24**, resembling a more modern tin cup in formation. The cup of stars opening towards the west with a magnitude 8.9 star towards south resembles the end of the handle.

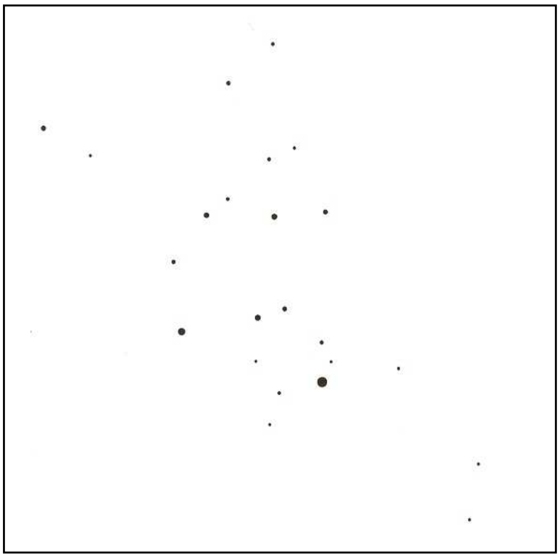
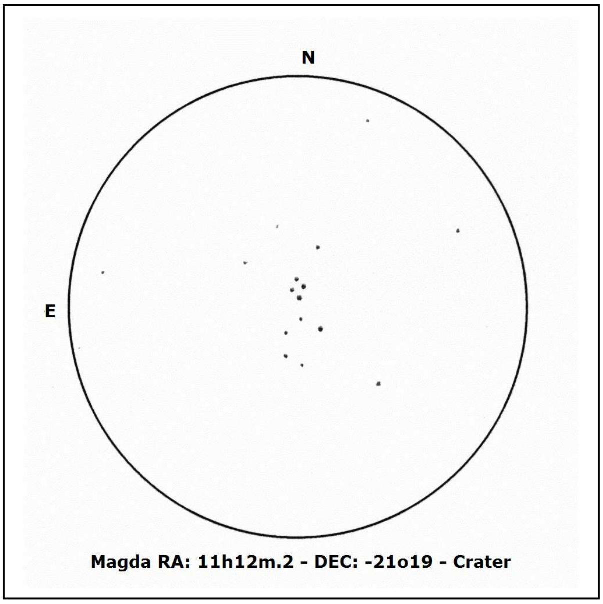


*Fig 4. Streicher 24*

Asterisms are scattered all over the starry skies and virtually every constellation should have a few outstanding ones. There is a nice curved string ending off with the fainter stars just a few arc-minutes north of the galaxy **NGC 3672**, which was a surprise. The galaxy forms a triangle with magnitude 4.6 theta Crateris and was not aware of the galaxy at the time. NGC 3672 is a quite easy target shining with a magnitude of 12 in a north to south direction. The very faint small galaxy IC 688 is only 20 arc-minutes to the west. The pair of elliptical galaxies NGC 3636 and NGC 3637 only 3 arc-minutes apart is situated a degree south-west with a lovely orange magnitude 6.5 between them.

*Fig 5. Asterism in Crater*

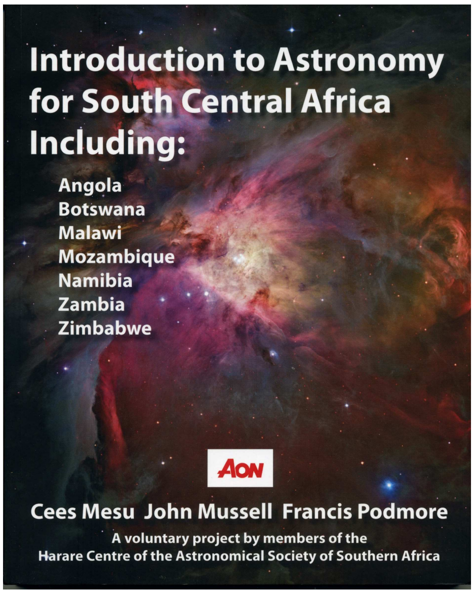



Take the last sip out of the heavenly cup and taste the galaxy **NGC 3962** with a difference! According to studies the various wave lengths show that the stars in this galaxy rotate at a right angle to the rotation of the gas. However, through a medium amateur telescope this elliptical star city shows only a slight bright central nucleus. But it forms a nice triangle with two magnitude 10 dark orange-coloured stars to the south.

*Fig 6. NGC3962*

Don't let a Crow or a Snake keep you away from a cup full of stars that has more to offer than one glass of wine!

| Object | Type | RA | DEC | MAG | Size |
|---|---|---|---|---|---|
| | | | | | |
| NGC 3511 | Galaxy | 11h00'.8 | -22o50' | 11 | 5.5'x10' |
| NGC 3513 | Galaxy | 11h03'.8 | -23o15' | 11.5 | 2.9'x2.3' |
| Quasar HE 1104-1804 | Galaxy | 11h04'.0 | -18o04' | | |
| NGC 3520 | Galaxy | 11h07'.8 | -18o01'.3 | 14 | 1.3'x1' |
| NGC 3571 NGC 3544 | Galaxy | 11h11'.5 | -18o17' | 12.1 | 2.9'x1' |
| Streicher 24 | Asterism | 11h11'.6 | -08o36'.5 | 8 | 8.5' |
| ESO 570-SC12 | Open Cluster | 11h12'.2 | -21o19' | 8.3 | 13' |
| Asterism | Star Group | 11h24'.4 | -09o30' | 10 | 18' |
| NGC 3672 | Galaxy | 11h25'.0 | -09o48' | 11.4 | 3.9'x1.8' |
| NGC 3955 | Galaxy | 11h54'.0 | -23o10' | 11.3 | 3.7'x1.1' |




# Book Review: Introduction to Astronomy for South Central Africa

L Labuschagne

*Authors: Cees Mesu, John Mussell, Francis Podmore*
*CBC Publishing, distributed by Pagoda Tree Press*
*First edition, 2013 (soft cover). ISBN 0 9572979-1-3*

This book was a labour of love – a voluntary project published last year by members of the then battling Harare Centre of ASSA. Joint authors/editors John Mussell and Francis Podmore write that it is offered as a tribute and memorial 'to a colleague and fellow lover of astronomy, Cees Mesu,' who first felt the need for the book. Much beloved for his involvement with Harare Centre, Mesu started on the manuscript for this book before his death in 1999. Additions to his work later came from other members of the Harare Centre.

General astronomy guides aimed at Southern African readers – and specifically also suitable for beginners as well as general enthusiasts - are still rare, and although this introduction to astronomy for South Central Africa is specifically aimed at Angola, Botswana, Malawi, Mozambique, Namibia, Zambia and Zimbabwe, we here in South Africa share the same southern skies with them. It is therefore worth looking at the way this book has been compiled and presented by fellow enthusiasts. Starting of with a brief overview that looks among others at viewing conditions in South Central Africa and at the issue of light pollution, the second chapter briefly looks at the relationship between astrology and astronomy, and then offers practical advice on finding your way around the night sky, the celestial grid, the constellation and finding interesting objects. There are also brief notes on sky-watching parties.  Chapters on the Solar System, stars and galaxies are then followed by one on traditions and myths (with references to African folklore and starlore of other cultures) and one on cosmology.

After that follow useful, practical chapters on skywatching (from notes on climate and viewing location, through night vision, levels of knowledge, pointing at objects, memory aids, looking at satellites, meteor showers, to resources and equipment, and graphic aids) and an entire chapter on optical aids.

I particularly liked the penultimate chapter with brief, but very useful notes on measures, laws and methods (from large numbers through an explanation of an astronomical unit to summaries of Kepler's Laws and ways in which astronomical distances are measured), as well as the last chapter titled 'The Wow! Factor', which lists some 'interesting details and amazing facts about the universe'.  These two chapters include exactly the kind of thing you may find useful when preparing for public or sidewalk astronomy activity. All the chapters are illustrated with relevant and beautiful images from NASA, ESA and other sources.

Almost half of the 256-page book is devoted to appendices, starting with a southern constellation reference list consisting of brief notes on naming and mythology, and notable objects.  The notes are not aimed at the seasoned observer (who will probably want to add many additional favourite objects), but the short lists of objects may also have the advantage of not overwhelming  beginners. Other appendices look at pronunciation and the Greek alphabet, the 25 brightest stars visible from the region, astronomy organisations and websites of the region (including ASSA) , further reading, a useful glossary of common astronomy terms, diagrams, star charts for each month and an index.

This would be a worthy addition for the libraries of ASSA centres, beginners and those who are often engaged in astronomy outreach activities. Copies may be sourced via i.murphy@mac.com.

Note: Although absent from the review copy, an A2 star chart printed in luminous ink is included with the book .

# ASTRONOMICAL SOCIETY OF SOUTHERN AFRICA

The **Astronomical Society of Southern Africa** (ASSA) was formed in 1922 by the amalgamation of the Cape Astronomical Association (founded 1912) and the Johannesburg Astronomical Association (founded 1918). It is a body consisting of both amateur and professional astronomers.

**Publications**: The Society publishes its electronic journal, the *Monthly Notes of the Astronomical Society of Southern Africa (MNASSA)* bi-monthly as well as the annual *Sky Guide Africa South.*

**Membership**: Membership of the Society is open to all. Potential members should consult the Society's web page assa.saao.org.za for details. Joining is possible via one of the local Centres or as a Country Member.

**Local Centres:** Local Centres of the Society exist at Bloemfontein, Cape Town, Durban, Harare, Hermanus, Johannesburg, Pretoria and Sedgefield district (Garden Route Centre). Membership of any of these Centres automatically confers membership of the Society.

**Sky & Telescope:** Members may subscribe to Sky & Telescope at a significant discount (proof of membership is required). Please contact the Membership Secretary for details.

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