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Cover picture: *The Veil Nebula in Cygnus, NGC6960 – a supernova remnant from about 5000 years ago and nearly 1500 light years away. See Sky Delights inside (APOD Image Credit: Joaquin Ferreiros).*

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Southern African Large Telescope reveals too large a black hole

The Southern African Large Telescope (SALT), Africa's most powerful eye on the sky, has been used to discover a supermassive black hole in the centre of a modest galaxy, SAGE0536AGN. All but the smallest galaxies are thought to harbour black holes, but in this case the black hole was found to be thirty times more massive than what one would have expected for this size galaxy. It leaves scientists scratching their heads in pursuit of an explanation.

The presence of a black hole was suspected when the infrared emission from its dusty environs was discovered in 2009 using NASA's Spitzer Space Telescope. Now, scientists from the United Kingdom SALT Consortium, Jacco van Loon from Keele University and Anne Sansom from the University of Central Lancashire used the SALT to take a spectrum of the galaxy. The spectrum showed emission at particular wavelengths related to hydrogen gas, but shifted to redder wavelengths than on Earth due to the large recession velocity of the galaxy, placing it at a distance from which light took 1.86 billion years to reach us. This already indicated that the central engine of the galaxy must be very luminous. The spread in wavelength of the hydrogen emission betrayed gas moving very rapidly in the strong gravitational field of the black hole, and from this the mass of the black hole was determined to be 350 million times that of the Sun. For comparison, this is a hundred times more massive than the black hole that lives in the centre of our own Milky Way. However, when they also measured the mass of the galaxy itself, from the absorption of light by heavier atoms, they were surprised to find the galaxy's mass to be a mere 25 billion times that of the Sun, less than that of the Milky Way

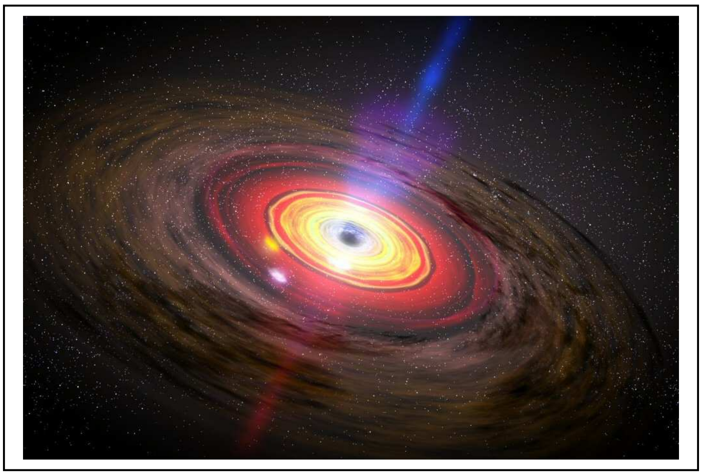


Fig.1 *An artist's impression of an active galactic nucleus, with jets of material flowing from a central black hole. (Credit: NASA / Dana Berry / SkyWorks Digital*)

According to van Loon, for a long time scientists have been trying to explain the good observed relationship between the mass of the black hole and the mass of the galaxy host. Now they will need to start explaining how some systems can deviate so much from this relationship."

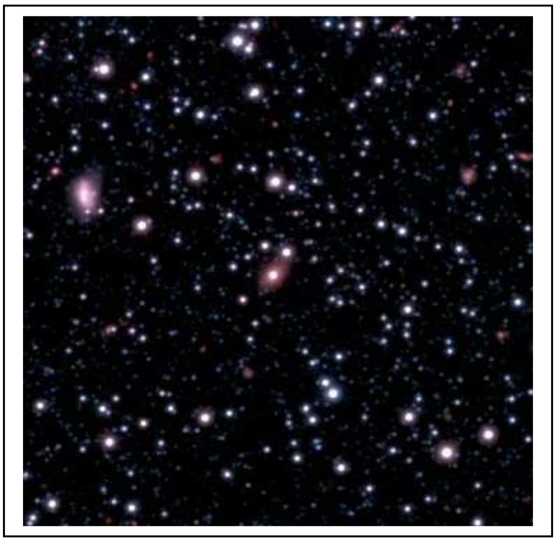


Fig. 2 *An image of the galaxy SAGE0536AGN, from the Vista Magellanic Clouds survey. The galaxy is the elliptical object in the centre of the image. (Credit: Vista Magellanic Clouds survey)*

Because the galaxy was only found by accident in the distant background of a survey meant to study a very nearby dwarf galaxy, surveys aimed at finding extragalactic supermassive black holes may have missed more systems like SAGE0536AGN. SALT may thus have opened a new window and a new view of how galaxies and their central engines have grown over time.

The van Loon and Sansom paper is available at:
http://arxiv.org/abs/1508.00698

Obituary: ESO Astronomer, Alphonse Florsch (Zeekoegat 1962)

On Wednesday 8 October 2015 the pioneer European Southern Observatory (ESO) site testing astronomer, Alphonse Florsch, died in his home town of Farschviller, France.

In June 1962 Alphonse Florsch, his wife Marguerïte and their two sons Bruno (7) and Nicolas (5), came from France to work at the European Southern Observatory (ESO) at Zeekoegat (Florsch 2005-2006). This was during the time of site testing to find the best location for the ESO.

He worked at the Zeekoegat observatory where the "Grand Prism Objectif" telescope was installed. Alphonse and his family returned to France after the decision was reached to establish ESO at La Silla in Chile and not in South Africa.

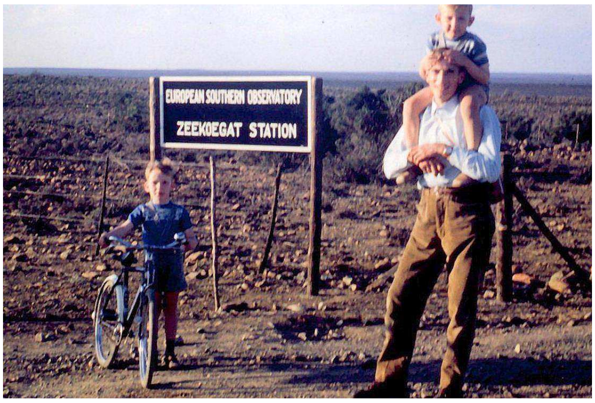


Fig. 1 – Alphonse Florsch with his sons, Nicolas on his shoulders and Bruno on the bicycle.

Fig. 2 – Zeekoegat station (January 1962).

Source: Florsch, B, 2005-2006, "Memoirs of Bruno Florsch", Fransie Pienaar Museum, Prince Albert, South Africa,1

- Errol Swanepoel

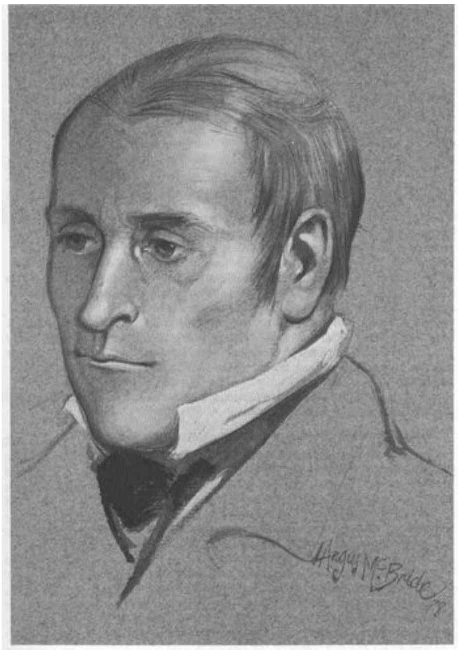
A Stellar Highway

Case Rijsdijk, Astronomical Society of Southern Africa

Abstract: Thomas Henderson, at the Royal Observatory of the Cape, was the first person to measure the distance to a star in 1834. Robert Innes, at the Union Observatory in Johannesburg, discovered that Proxima Centauri was the nearest star to the Sun in 1915. The idea of marking the 100th anniversary of the discovery of Proxima Centauri in 2015 led to the development of a Stellar Highway, similar to the well-known scale models of the Solar System or Planetary Highways, but showing the scaled distance between stars.

1 The First Stellar Parallax Measurement

The early Greek geometers knew about parallax and today it is used regularly on Earth by surveyors. But the Greek, Babylonian and Egyptian astronomers knew that the stars were far away because they were unable to detect any parallax. But Henderson, at the then Royal Observatory at the Cape, now SAAO, knew of α-Centauri's large proper motion, and so suspected that it was close to the Sun. He observed α-Centauri from the Cape in the years 1830 to 1833. Ill health caused him to return to England, where he was appointed to be the first Astronomer Royal in Scotland.



Right: *Reconstructed portrait of Thomas Henderson.*

In 1834, using his data from the Cape, he calculated that α-Centauri was 3.25 light years away. He wasn't confident of this distance and as a result didn't publish his results. He was justified in a way, as the distance later turned out to be 25.6% too small. [1]

However in the race to be the first to measure the distance to a star, the German astronomer Friedrich Wilhelm Bessel, measured and published the distance to 61 Cygni as 10.3 light years in 1838, 9.6% too small! [2]

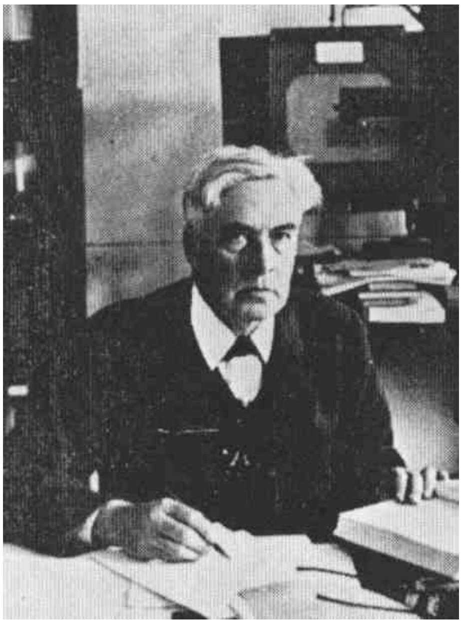
Right: F.W. Bessel

Henderson then published his results in 1839, but his lack of confidence put him into second place in the measurement race!

But the fact remains that the first measurement of the distance to a star was made from the Observatory in the Cape – a South African first!

2 Discovery of Proxima Centauri

Robert Thorburn Ayton Innes took up the position of Director of the Transvaal Meteorological Observatory in 1903 which became the Transvaal Observatory in 1906, and was later appointed the first Union Astronomer of the now Union Observatory in 1912. He had acquired a 9" Grubb refractor in 1909, and in the same year, British amateur John Franklin-Adams donated his 10" astrographic camera to the Union Observatory.



Right: R.T.A. Innes

Innes was aware of the large proper motion of α-Centauri and was interested in finding others stars with similar high proper motions, in the belief that often stars were accompanied by one or several more stars nearby. [3]

Using the Franklin-Adams camera [4] Innes found another star with a similar proper motion to α-Centauri in 1915 and reasoned that this group of stars was the closest to the Sun. With not too much evidence he felt that his newly discovered star was closer than α-Centauri, and in 1917 he named it Proxima Centauri – the closest star to the Sun.

This was later confirmed in 1928 by Harold Lee Alden at the Yale observatory station in Johannesburg using a long focus camera, ideally suited for stellar parallax work. No closer star has been found to date, so Proxima Centauri remains the closest star to the Sun – another South African first.

3 A Stellar Highway

The South African Agency for Science and Technology Advancement, SAASTA, a business unit of the National Research Foundation, NRF, decided to commemorate this significant South African astronomical discovery by supporting several different functions and activities throughout the country leading up to the main event on 8 October 2015.

In order to get ideas on how best to celebrate this centenary, SAASTA set-up a meeting for a range of stakeholders to put forward proposals.

As Henderson worked at the Observatory in Cape Town and Innes at the Observatory in Johannesburg it seemed to be an ideal opportunity use the two Observatories to create a Stellar Highway, and the ASSA put forward the following proposal.

It is possible to construct a scale model of Proxima Cen and the Sun using the distance between Johannesburg and Cape Town as a baseline. In

Johannesburg a stone plinth could be constructed, with sloping sides containing a plaque with a 6 cm hemisphere to represent the Sun and a 0.9 cm hemisphere for Proxima placed side by side with some appropriate wording cut underneath. Another plaque on the rear could briefly say what Henderson and Innes had done, whilst a side plaque could give details of the ASSA project.

In Cape Town, the original calibration pillar of the former Transit telescope was employed to mount a duplicate set of plaques. This pillar also carries a small plaque to commemorate Prof R.H. Stoy, the final HM Astronomer at the Cape.

The pillar at the SAAO in Cape Town and the stone plinth at the Observatory in Johannesburg would indicate the relevant sizes and distances of the Sun and Proxima, to scale from each site. The Johannesburg plinth could have a sundial mounted on top. These could then each mark the Proxima Centenary in a lasting manner.

4 Calculation

Let P be the ratio for the Sun size to Sun-Proxima distance, and let S be the ratio of the scale model Sun to Cape Town-Johannesburg distance. Please note these data are not precise, but will suffice for the purpose of this project.

Data

Sun's diameter = 1.5×10^6 km
Sun-Proxima distance = 4.23 light years
1 light year = 9.47×10^{12} km ($365.25 \times 24 \times 3\,600 \times 3 \times 10^5$ km)
Cape Town- Johannesburg distance = 1 600 km
Size of model Sun = d

Since $P = \frac{\text{Sun's diameter}}{\text{Sun-Proxima distance}} = \frac{1.5\times10^{6}\text{km}}{4.23\times9.46\times10^{12}\text{km}} = 3.75\times10^{-8}$

and $S = \frac{d}{\text{CT-JHB distance}} = \frac{d\ \text{km}}{1.6\times10^{3}\ \text{km}}$

and since $P = S$

so $3.75\times10^{-8} = \frac{d}{1.6\times10^{3}}$ therefore $d = 1.6\times10^{3} \times 3.75\times10^{-8} = 6\times10^{-5}\text{km}$

But 1 km = 10^5 cm so d = $10^5 \times 6 \times 10^{-5}$ = 6 cm

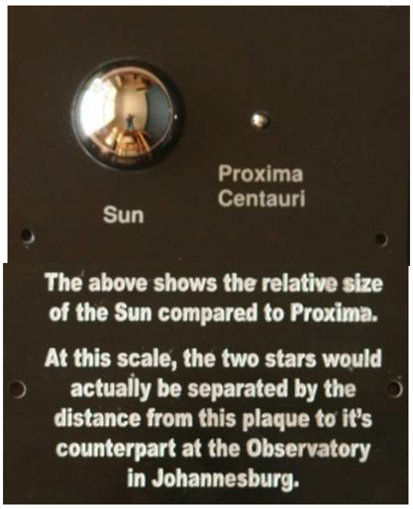
It is also known that Proxima is about 1/7th the diameter of the Sun, so Proxima's scaled size would be

$\frac{6}{7} = 0.857\,\text{cm} \approx 9\,\text{mm}$

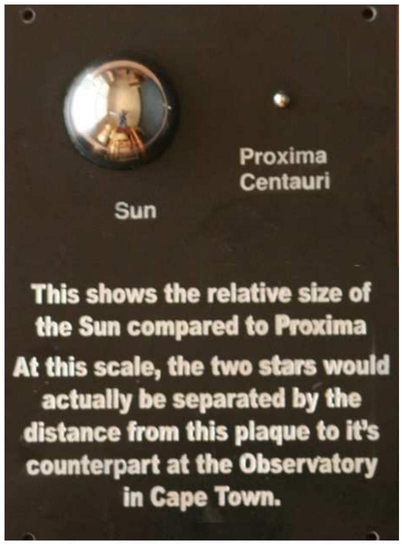
Notes:

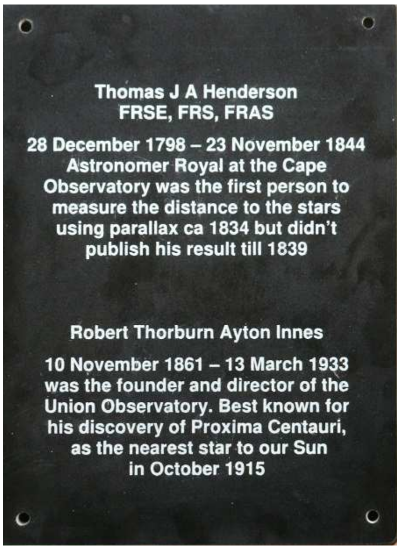
The data used are approximate. For example the author took the Cape Town - Johannesburg distance as 1 000 miles (~1 600 km). Google gives the distance as 1 403 km. Using these gives a scaled Sun size of 5 cm diameter and Proxima 7 mm – a little too small! So it was decided to stick with the first set. But one feels that this does not significantly impact on the general idea.

5 The Plaques in Cape Town and Johannesburg

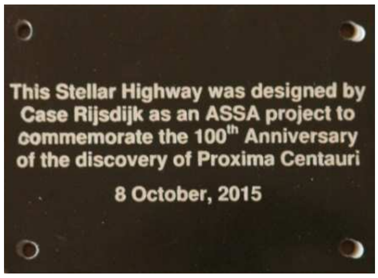


Plaque 1 in Cape Town . (left) . . and in Johannesburg (right)





Each plinth in Cape Town and Johannesburg also carries one of these



6 Construction details

The beautiful stainless steel (SS) hemispheres representing the scale size of the Sun and Proxima were made by Martin Visser of the SAAO workshop in Cape Town, facilitated by Dr Lisa Crause, SAAO. The granite plaques were made by Exclusive Granite in George, and they managed a challenging task well. The plaques are roughly A4 in size and 20 mm thick, except for the last plaque which is A5. All are bolted onto their respective mounts using 6 mm SS coach bolts.

The plaques mounted on the Meridian Pillar at the SAAO in Cape Town. The Johannesburg counterpart was not yet complete at time of writing.

7 Educational and Outreach potential

An extension of the project could be that assorted school groups or university students could use some simple parallax techniques to measure the distance to the Moon or some Solar System planets like Mars, Venus, Jupiter or Saturn using relatively small telescopes and digital cameras. [5, 6]

In addition, the commemorative plaques could be used to explain what parallax is and how it is actually used by astronomers using both Earth based telescopes [7] and spaces based telescopes such as HIPPARCOS [8] and GAIA [9]

There are also a wide variety of related exercises, available from the SAAO, in which the distance to the Moon and Sun can be calculated, [10] finding the size of the Earth using a modern interpretation of Eratosthenes' method and calculating the distance to alpha Centauri using the Inverse Square law. There is also has a module on how to model the Solar System or creating a Planetary Highway using a simple print-out on A4 sheets.

8 Acknowledgements

The author wishes to thank Shadrack Mkansi, Hubert Mathebula and Vanessa Naidoo of the South African Agency for Science and Technology Advancement, SAASTA, a business unit of the National Research Foundation, NRF, who were instrumental in initiating the Centenary celebrations. At the SAAO Prof Ted Williams, Lisa Crause, Martin Visser and Noël Miller, the ASSA Council for giving their whole-hearted support to the project, and approving the funding, and finally, the Cape and Johannesburg ASSA Centres for their support.

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The Magnetic Observatory Buildings at the Royal Observatory, Cape

I.S. Glass (South African Astronomical Observatory)

Introduction

During the 1830s there arose a strong international movement, promoted by Carl Friedrich Gauss and Alexander von Humboldt, to characterise the earth's magnetic field. By 1839 the Royal Society in London, driven by Edward Sabine, had organised a "Magnetic Crusade" - the establishment of a series of magnetic and meteorological observatories around the British Empire, including New Zealand, Australia, St Helena and the Cape. Members of the Royal Artillery were assigned to man them.

Each observatory was to have the following equipment (Anon, 1838)

1 Declination Magnetometer by Grubb of Dublin
1 Horizontal Force Magnetometer by Grubb of Dublin £73 10 (together)
1 Vertical Force Magnetometer by Robinson £21
1 Dipping Needle by Robinson £24
1 Azimuthal Transit by Simms £50
2 Reading Telescopes by Simms £6 6
2 Chronometers, £50

1 Barometer by Newman
1 Mountain ditto by Newman
1 Standard Thermometer by Newman
1 Osler's Anemometer
Wet and Dry Bulb Thermometers by Adie of Liverpool
Maximum and Minimum Thermometers by Adie of Liverpool
Daniells's Hygrometer
An Apparatus for Atmospherical Electricity

The declination and horizontal force magnetometers were similar to those designed by Gauss. Since spatio-temporal variations were part of the aim of the study, measurements were to be taken at the same time as at Göttingen.

Note: The magnetic declination (or variation) is the angle between the direction in which a compass points and the true meridian. The dip (or inclination) is the angle between the horizontal and the direction of the earth's magnetic field lines.

The Magnetic Observatory at the Cape

The Royal Observatory was chosen as the site for the Cape magnetic observatory. In charge there was Thomas Maclear who had been Her Majesty's Astronomer at the Cape since 1833.

The military contingent sent to operate the Magnetic Observatory consisted of Lieut Frederick Marow Eardley-Wilmot (1812-1877), three non-commissioned officers, two gunners and drivers. They arrived on site in March 1840. Eardley-Wilmot was then 27 years old and not yet married. From his published letters (Eardley-Wilmot, F.S., 1879), it is clear that he came from an upper-crust military family. He went to school at Rugby and studied at the Royal Military Academy, Woolwich. In character, he appears to have been very religious. For example, in some of his letters home he complains about the relatively disorganized state of the Anglican Church at the Cape and expresses his worries about the increasing influence in England of the Oxford (Anglo-Catholic) movement. In another letter he reveals that he held prayers and a Bible reading daily with his men. He seems to have regarded his actual work at the Magnetic Observatory as a chore to be borne stoically. At one point during his stay he was obviously happy to have escaped magnetic observing to take part in military operations along the Eastern Frontier. He was to leave the Cape around 1846 and the running of the Observatory then devolved onto Maclear, as the latter had from the start feared that it might. On his return to England Eardley-Wilmot became director of the Military Academy at Woolwich and eventually attained the rank of Major-General. He became a Fellow of the Royal Society in 1863.

Some of the equipment had suffered breakages in transit but with Maclear's aid he was able to get it repaired. His magnetic Observatory was established in the SE part of the Royal Observatory's grounds and was finished in February 1841. A few more months elapsed in preparing the equipment for use.

A map of the Royal Observatory grounds dating from 1850 still exists and shows clearly the buildings of the Magnetic Observatory. This was made accurately, to scale, and can be overlaid on later maps to show precisely where the buildings were or still are relative to others that still exist (see Fig 1).

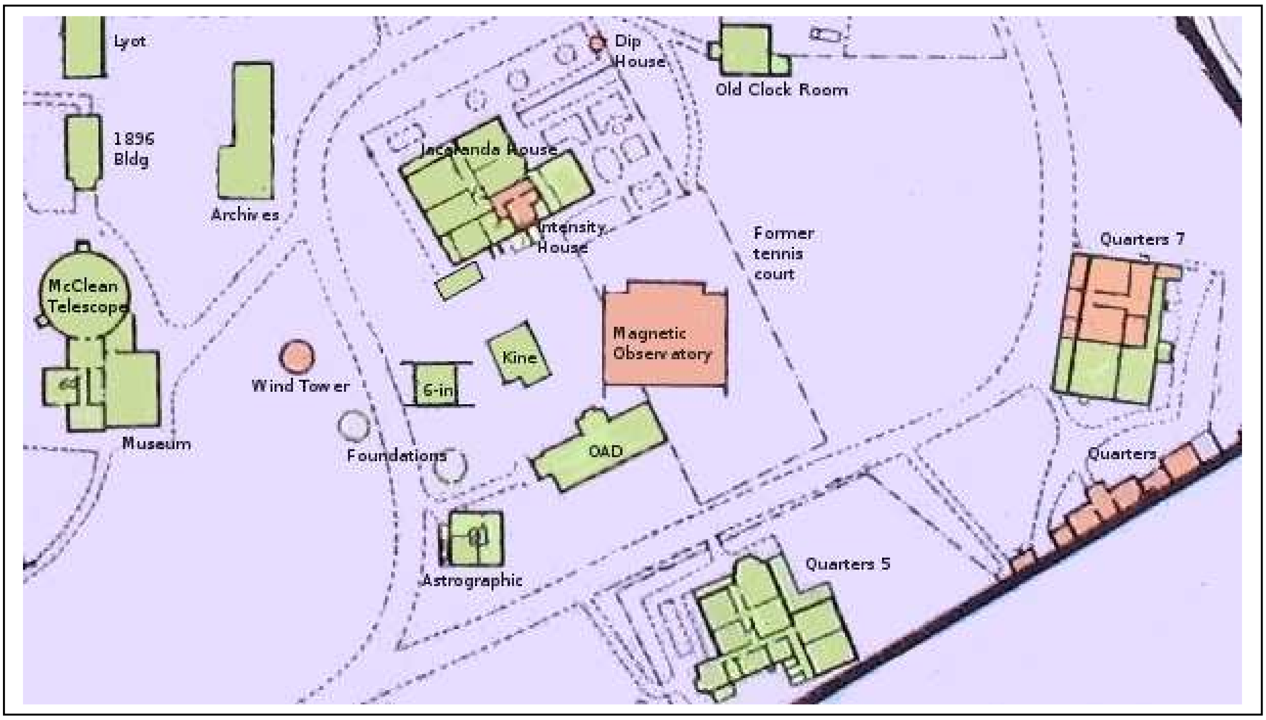

Fig 1*. The positions of the buildings of the Magnetic Observatory (red),* overlaid *on a more recent map. The Observatory itself, the Wind Tower, the Dip House and the row of small buildings labelled "Quarters" have completely disappeared. North is up*.

Among the earliest photographs taken at the Cape (by CP Smyth, the First Assistant at the Observatory) are a few of the Magnetic Observatory around the start of 1843. Two of these have been reproduced by Warner

(1978 and 1983). Several nineteenth-century drawings of the Observatory show the magnetic buildings (see, for example, Figs 2 and 3).

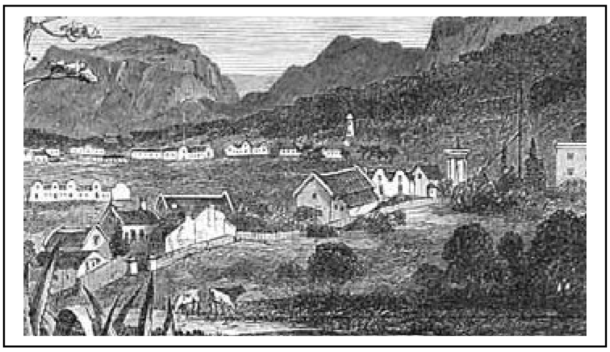

Fig 2 *(left) Part of a view, looking SW, by CF Angas, that must have been drawn around 1847 when he visited the Cape.* Fig. 3 *(right) is from the Illustrated London News, 17 June, 1865. Clearly seen in both are the Wind Tower, Intensity House and Magnetic Observatory. In the 1865 view, the Dip House (very small) also appears (between the Intensity House and the Wind Tower). A Corner of the main Royal Observatory building appears on the right in each image.*

The Main (Magnetic) Observatory Building

The interior of the main Observatory building was 48 x 28 feet (14.6 x 8.5m) and built of 12-inch (30cm) logs (Sabine, 1851). Inside was a lath and plaster lining separated from the outer walls by 1 foot (30cm). The roof was of felt. Non-magnetic construction materials such as copper and zinc were used instead of iron nails. In general, freedom from drafts and extreme temperature changes were essential for the functioning of the somewhat delicate instruments inside.

The main laboratory ran the whole length of the south side of the building and was 17’ wide by 12 high (5.1 x 3.7m). Isolated solid sandstone pillars supported the instruments and the floor was of Purbeck paving stone.

This building was destroyed by fire on 12 March 1852. The papers it contained were lost but the instruments were saved. Vast numbers of copper nails and other metal bits were collected from the ruin.

According to Warner (1978), a new, smaller Observatory with dimensions 18 x 18 feet (9.2 x 9.2m) was budgeted for in 1859, using some of the materials, including the paving stones, from the ruined one. It is not clear where this building was. Fig 3, which dates from 1865, shows a possible candidate, though it looks the same as the building in the 1847 one (Fig 2). The similarity of these two pictures suggests that the artist of the second one was strongly influenced by the first one and may have been lazy about updating the details. Another picture was published on 21 March 1857 in the Illustrated London News (see Glass, 2015) but does not show this building (which may however have been just outside the edge of the scene).

The Cottage

A two-room cottage had been constructed for Eardley-Wilmot to occupy but he ceded it to Captain Clerk, an additional assistant, who had a family to take care of. He himself then lived in the Wind Tower (see below). "I need hardly say that this, though apparently a small evil, is, when continued for four years, a very disagreeable sort of habitation" (Eardley-Wilmot, F.S., 1879).

The Cottage still exists as Quarters 7 but has been considerably extended, probably during the 19th Century, and possibly before 1865, if the detail in the picture from that date (Fig 3) can be believed.

The Wind Tower

The Wind Tower (Fig 4), a circular building having an internal (?) diameter of 9 feet (2.74m), originally supported an Osler Anemometer, invented in 1835 by A.F. Osler (1808-1903). This consisted of a large wind vane and a "pressure plate" that was deflected according to the wind strength. Both the strength and the direction of the wind were recorded automatically by pencils on a clock-driven paper chart. An automatically recording rain gauge was included. Osler instruments were also in use at the Royal Greenwich and other observatories.

Figure 4. The Wind Tower, photographed around 1889, when it was in use for the sky survey known as the Cape Photographic Durchmusterung. The CPD telescope with its Dallmeyer lens can be seen within the open dome.

The flat lead roof of the Wind Tower was removed in 1882 when a building was needed to house a new 6-inch (15cm) telescope, bought with the Transit of Venus in mind. A dome of 15 feet (4.6m) diameter was purchased from Grubb of Dublin by the then HM Astronomer, David Gill. This dome was somewhat unusual in that it was partly cylindrical in shape. Its steel frame was covered by canvas over a wire and felt underlayer. It ran on a cast iron rail and gutter, finished with lion-head spouts. Inside was a tapered concrete pillar was built to support the telescope. The modifications were completed around June 1882 (see Gill, 1881).

In September 1882, the new telescope was put to good use. William Finlay used it to make the first observations of the Great Comet of that year and with it he also discovered Comet 1886e (Finlay). Later the same month it supported and acted as a guider for the Ross camera with which Gill took the photographs of the 1882 Comet that eventually led to photographic charting of the stars (Glass, 1985).

The 6-inch mount was used to bear the square wooden camera fitted with the Dallmeyer lens for the definitive exposures of the Cape Photographic

Durchmusterung from -19° to -58°. This was in the period April 1888 to November 1889. The remainder of the sky, from -58° to the pole, had been observed earlier, in a dome on the site of the present 18-inch/Heliometer building. The camera had then been mounted on another stand owned by Gill, which nowadays carries the 9-inch Grubb at the former Republic Observatory in Johannesburg.

The 6-inch telescope was back in the Wind Tower in 1898-99 at the time of Willem de Sitter's visit. To it was attached a Zollner photometer. In 1935 it was moved to its present building with a roll-off roof. A Cooke 6-inch telescope was subsequently mounted in the Wind Tower and was used by amateurs until 1954, when it fell into disuse.

The Wind Tower building was demolished in 1966, having decayed to the point where it was not worth repairing. In 1970 its dome was used to cover the Ron Atkins Telescope of the Cape Centre of ASSA (Anon 1970), though it seems to have been altered considerably for this purpose. When the Cape Centre building was demolished ca 1985 the dome was acquired by Mr Rainer Noack, a Cape Town amateur.

The Intensity House

In the 1847 figure (Fig 2) the building next to the Wind Tower was the Intensity House. However, the 1865 (Fig 3) picture shows that it had in the meantime been extended, with two extra gable ends. The three-gable structure probably forms the core of the present "Jacaranda House". In a recent survey of the house, the Cape Town heritage architect John Rennie found that the part coincident with the site of the Intensity House (see Fig 1) has thicker walls than the rest, which more-or-less confirms the identification.

Dip House

The Dip House was a comparatively small structure that stood where the fence around Jacaranda House was later placed. It survived into the 20th Century.

Mens' Quarters

Fig 6. This shows some of the small buildings labelled "Quarters" on the map (Fig 1).

This group of buildings along the boundary fence (see Fig 6) included two dwelling rooms and a pantry. Also in this row were probably the wash house, toilets, stables and a shed. They were demolished at some point during the 20th Century.

None of the magnetic instruments supplied to the Cape observatory still exist. However, a barometer by Newman can be seen in the room of the SAAO where the Airy transit circle once stood and may have been that of the Magnetic Observatory.

The end of the Magnetic Observatory

According to Warner (1979), interest in the magnetic observatory gradually waned and after Maclear's retirement in 1869 no further work was carried out. The only remaining parts of the original buildings have been greatly modified.

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Moonwatch Part 9

G Roberts

Abstract: This part deals with the various MOONWATCH stations set up in the Pretoria and Johannesburg area. Valhalla was at Pretoria as was Colbyn. At Johannesburg were Moonwatch stations 0415 (Republic Observatory) and Johannesburg II. The latter was the last Moonwatch station to be set up in South Africa.

Station Valhalla 8689

Karel J Sterling was a very keen and active member of the Pretoria branch of the Astronomical Society of South Africa. As a result of discussions with Roy Smith and Bill Hirst during his official Moonwatch tour in 1966, on 26 October 1966 Karel applied to join the Moonwatch network.

Bill Hirst, Moonwatch chief replied on 3 November, 1966 as follows: "*I was very pleased to get your letter of 26 October and to hear that you propose to join us. As Roy may have told you, we are particularly anxious to get more observers in the Southern hemisphere*".

On 5 December Karel replied, advising that the information sent had been received and that he had made some observations but had not reported them as he was still busy acquiring experience in observing satellites.

His observing station was located at 5 Hekla Road, Valhalla, Pretoria with geographical coordinates

Longitude 331d 50' 43" (28d 09' 17"E),
Latitude -25d 48' 08"
Altitude 1438 metres (4720 feet)

On 20 February 1967 he was allocated the site number 8689. Roy supplied him with a 5-inch Apogee scope that originally came from the site that had been operated by L. Martins (site number 8575) and had ceased operating June 1964 when Martins had moved to the Cape.

On 29 March 1967 Moonwatch headquarters advised him that he would be supplied with one of the special Moonwatch mounts in a few months' time. The special mount was supplied on 22 September 1967 and installed as instructed. Apparently Karel experienced some problems with it which resulted in a fair amount of correspondence. Apparently he also had observing problems in that he did not have suitable star charts, so it appears observations were rather far and few between.

In 1969 Moonwatch expanded its observing program by adding some high altitude satellites which meant using relatively large amateur telescopes. On 5 March 1969 Karel volunteered the 12.5-inch reflector belonging to the Pretoria branch and located at the Radcliffie Observatory. It was later used by Roy Smith to observe one of the Apollo missions.

During the period July - Dec 1967 Karel made 24 observations of which 13 were rejected. In the period Jan - June 1968, 9 observations were made and 4 rejected.

Fig 1. Wallar, Harry Kanowitz, unknown, Barnard, Karel Stirling (white shirt), J C Bennett at eyepiece, Roy Smith, unknown)

Whilst there was a fair amount of correspondence with SAO, he does not appear to have been particularly active. The last communication from SAO to Karel appears to have taken place on 15 May 1969 after which the trail dies. It thus seems that he lost interest.

Station 0412 Colbyn:

Harry Kanowitz became interested in Astronomy at a very early age and was an active member of the Pretoria branch of ASSA. He recalls seeing the first Sputnik rocket and calling his wife and friends to observe it but they were not interested.

Fig 2. J W Wolterbeek (in shorts), Barnard?, Roy Smith, J C Bennett, Karel J Stirling

Harry, being a Radio Amateur (call-sign ZS6AMP), was able to monitor Mission control and followed the flight of Project Mercury astronaut Alan Shepard making his one orbit of the Earth.

Since South Africa did not have television at that time, the University of Pretoria used to screen daily TV films that came from United States, showing the latest happenings.

Harry had this to say:

Karel Stirling actually got me involved with Moonwatch. I went one evening to Jack Bennet's home where he gave me a lowdown on what is required. Jack was using his 5-inch and at the same time he lent me, what I think was called an M7, which was the eyepiece section of the 5" but with a small objective lens of about 2" diameter.

When Karel informed me that he was registered as a Moonwatch station as Mount Valhalla, I was most amused. The only mountain in the area was a small pimple of sand some 2 km from him!

Roy Smith gave Harry a 5-inch Apogee and a set of BD & CoD star charts. After a bit of setting up and fitting the mounting, he was "up and away" at his home located at 28 Florence Street, Colbyn, Pretoria with the following details:

Station Identification Code: 0412
Longitude 28d 14m 45.47s
Latitude -25d 44m 26.19s
Altitude 1352 metres

On 24 January 1968 Harry advised SAO that he was ready to start tracking. He became somewhat unpopular with his wife when they had visitors and he had to go outside to observe a satellite pass. Sometimes the visitors were curious and asked to have a look but usually commented: "so what is happening, I only see spots". What does one say under such circumstances?

Harry further reports: *I remember building a shelter in which my 5-inch was mounted. Friends used to laugh because it looked like an outside toilet. When you opened the front door you could roll it out of the way as it was on wheels. The 5-inch was permanently mounted on a large water pipe of about 4-inch diameter and this was set into a concrete base. The Alt/Az fitting was a thick steel right angle piece that had the degrees on it for both adjustments. The counterweight was a heavy plate that was cut out to fit onto the underside of the scope, to which a steel rod and counter-weight was attached. It all worked beautifully. I had mounted a small finder scope onto the side of the 5-inch with a large circlip (one that you tightened with a screwdriver).*

During the period Jan to June 1968, 23 observations were made, decreasing to 13 observations during the next six months and during 1969 a total of 10 observations were made.

Harry had this to say: *I don't know if I told you but I was the 2nd last observer of Echo II, but the box-up I made that day is both a joke and a tragedy. I was not aware that this was going to be the final orbit, so the day before I decided to do it photographically. I did 1 second exposures, 1 second off, on for a second, etc. Then went off to develop the negative, which I used to do myself. By the time I phoned in the 6 results, they told me it was too late as Echo II had decayed somewhere over the southern Indian Ocean.*

I remember being phoned by the Baker Nunn camera observer, sometimes at 11 at night, and told that a re-entry was expected. Midnight in the middle of winter! I was on the garage roof and waiting only to find that the object had decayed before reaching my viewing area. I have one viewing residual here, but nothing else really. I don't think that my residuals were that great, but I was involved, and that is important.

I do not know when I stopped doing observations, I do remember that we had a terrible storm one day and it blew my scope hut off and the 5-inch was full of water. I took it apart to dry it out. Someone from Moonwatch said they would fix it for me, and took it away and I never saw it again. I missed it very much. This, combined with the fact that I was busy every evening for many months giving extra maths lessons to Matric and 1st year University students contributed to my lack of activity. We were going through a very tight financial time at the time, having just opened a second hand furniture shop.

Some time later Moonwatch headquarters sent out a message to say that as a reward for the work we had done, we could keep the telescope as a gift. I received nothing. Is it too late to complain?"

0415 Johannesburg

Greg Roberts arrived in Johannesburg 1 April 1969 to take up appointment at the Republic Observatory to undertake the International Planetary Patrol Program for the Lowell Observatory under contract to NASA. He soon acquired a flat in Yeoville north of the Observatory which was at the corner of Mons and Del La Ray Street. He planned to do satellite tracking from a large balcony outside the flat.

The site was assigned Moonwatch site no 0415 with the following coordinates:

Longitude 28d 04m 30s east
Latitude 26d 01m 21s South
Height 5560 feet (1695 metres)

However a few years ago when checking on Google Earth, the author discovered that the latitude was definitely wrong. Referring to the correspondence of the time, it was discovered that the minutes in the latitude position had been transposed at Moonwatch Headquarters and should instead have read; latitude 26^{o} 10' 21" (instead of 26^{o} 01' 21") – quite a difference!

On 18 May 1969, 3 observations were made of the Pageos 1 (66056A) balloon satellite using 7x50 binoculars. He reported that the 5-inch Apogee telescope was expected to soon be operational and a suitable mount for it was being constructed in the observatory workshop.

It subsequently turned out that these were the only optical observations made from this site so the error in latitude did not affect many observations!

In 1969 a house became available in the Observatory grounds and Roberts relocated. Station 0415 thus ceased to exist after only making a few observations. This also appears to have been the last optical observations carried out by Roberts as part of the regular Moonwatch programme.

The Western Satellite Research Network (WSRN) assigned the number WSRN 107 to Roberts at the observatory. WSRN, BELLCOMM.INC, and the Smithsonian Astrophysical Observatory asked Roberts to try and observe various Apollo lunar missions.

Predictions for Apollo 11 were received too late so no observations were possible. Apollo 12 was more successful and four objects in trans-lunar trajectory were sighted using the 26.5-inch refractor and the 20-inch reflector telescope. During the 3 hour observing session on 15 November 1969 the distance of the objects from Earth increased from 118 240 to 130 460 miles (189 200 to 208 700 km). On the 16 November the objects were again observed during which time the distance increased from 178 875 to 186 794 miles (286 200 to 298 900 km). Attempts were made to observe it again on the 17th but conditions were very hazy and the Moon's glare was a severe problem. so nothing was seen. It was estimated that it should be possible to see an Apollo object at the distance of the Moon at about magnitude +17 if the Moon's glare was minimal.

The final Apollo mission tracked was the ill-fated Apollo 13 mission. On 12 April 1970 it was tracked using the 26.5-inch refractor and the 20-inch reflector. Three objects were sighted but this time the Saturn IVB rocket appeared to be a little off predictions. An attempt to photograph the objects failed as the glass plates used were too old and full of defects. Attempts were made to observe the mission again on the 13 April but nothing was seen, possibly because of the mid-flight explosion that put the mission in jeopardy (resulting in the famous "Houston, we have a problem!" phrase). No tracking was possible on subsequent nights due to bad weather.

Although no further observations were made for Moonwatch, some tracking was done for the Kettering Group as regards Soviet and Chinese satellites. Several transfer burns of Intelsat satellites to the final geostationary orbit were also observed.

With the heavy night observing program Roberts was not too enthusiastic about doing extra optical tracking. The emphasis shifted to radio tracking which could be done 24 hours a day.

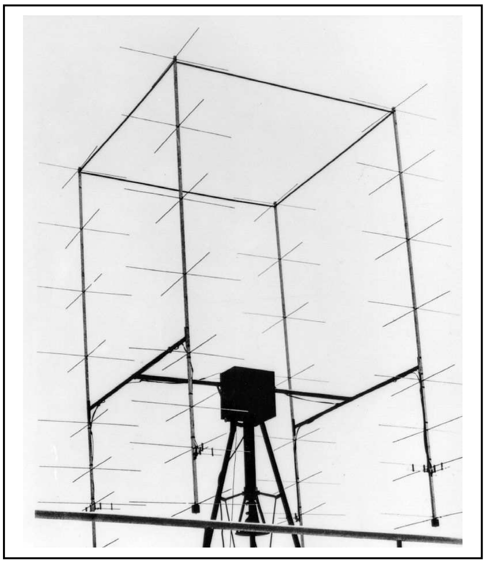


Fig 3. Antenna at Republic Observatory.

A large antenna array was constructed in the observatory workshop to Roberts' design and installed on the roof of the new office block in the Observatory grounds. It was used for the reception of weather satellite images (the first amateur station in South Africa) for which Roberts had to acquire a special "Satellite Experimenters Licence" from the then Department of Posts and Telegraphs. The intention of this experiment was to try and locate the best observing site in South Africa which the Republic Observatory was looking for. Site testing was carried out at several different locations, e.g. Faure and Graaf Reinet. All this came to nothing when the CSIR accepted the Sutherland site, recommended by the then Royal Observatory as the site of South Africa's new observatory. Although not officially part of Roberts's "job-description", the support of the observatory's Acting Director Jan Hers and other staff members for the private activities of Roberts was greatly appreciated - what better atmosphere in which to "work"!

This antenna was also used to monitor the first experimental test using the geostationary satellite ATS-1 launched in 1966 and stationed above Ecuador. It provided communication between the Goldstone Deep Space Communications station at Mojave, California and an aircraft on its way to New Amsterdam in Guyana, South America. In addition the first transmissions of time signals via geostationary satellite were also monitored as well as transmissions of weather satellite images.

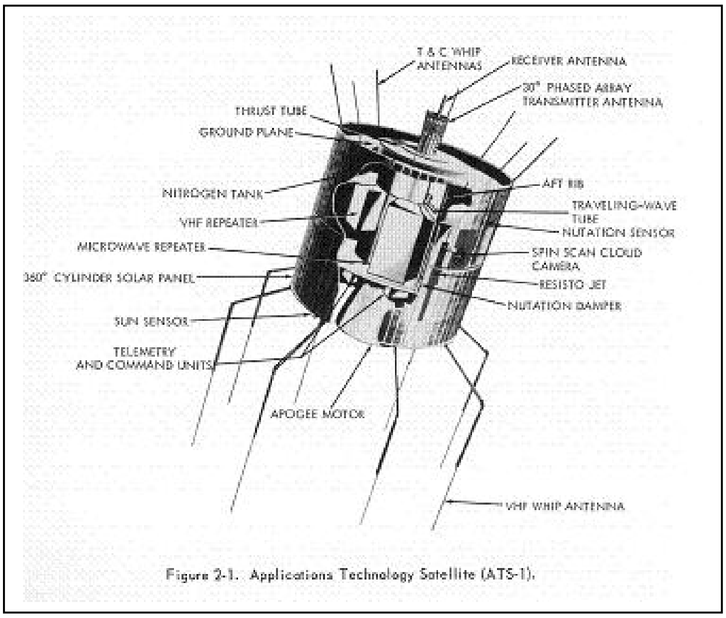


Fig 4. The ATS Satellite.

With the conclusion of the Planetary Patrol, the Republic Observatory closed down and Roberts was re-located to the South African Astronomical Observatory in Cape Town in February 1974. It appears he made no serious effort in getting optically operational again, only resuming optical tracking around 1988.

8700 JOHANNESBURG II

Ron Lake began his professional career in Astronomy when he joined the then Royal Observatory, Cape. He was employed in the Electronics Department, starting in the late 1950s. He assisted Roberts in making observations of a variable star during Roberts's one month University vacation training at the Cape Observatory in January 1961. As appeared to be the custom then, suitable observatory staff members were expected to also observe. Ron therefore did a fair amount of observing in photoelectric photometry and apparently also at the Radcliffe Observatory, Pretoria. Although an electronics technician, he was also an experienced astronomical observer.

He then moved to the Time Service Department of the Republic Observatory in Johannesburg where he was employed for a period of six years. Here he again encountered Roberts who joined the Republic Observatory later in 1969 and again assisted him, but this time teaching

Roberts electronics (which was not part of Ron's or Greg's professional duties). With the closure of the Republic Observatory (and the formation of the South African Astronomical Observatory), the Time Service and related staff were transferred to the Time Standards Section of the National Physics Research Laboratory of the CSIR in Pretoria. Here he worked with Roy Smith who was the "leading light" in amateur satellite tracking in the Pretoria area.

On 30 June 1973 Ron wrote to Moonwatch Headquarters in the US:
After conversations with Mr R F Smith of Murrayfield Moonwatch station, with whom I work, I have become interested in the possibility of setting up a Moonwatch station at my home. I live in Johannesburg, about 5 miles east of the Republic Observatory where I was previously employed for six years. I have also worked at the Cape Observatory and I have most of the equipment needed to set up such a station. Mr Smith has said I would need a set of SAO Star Charts - I have the BD and CoD charts - and alt/az to RA and Dec conversion tables for my site if these are available. In view of the above I would appreciate your decision on my joining the Moonwatch organization.

Moonwatch headquarters replied on 23 July 1973 and stated they would be pleased to have him as part of their network and would send him the required star charts and conversion tables in the near future. In addition they would send him all the relevant documentation and report forms by surface mail and advised that Roy Smith would educate him in the necessary procedures. EHEMERIS VI predictions were airmailed to enable him to observe the satellites of interest. They also requested his geographical coordinates and on receipt of his first observations he would be assigned an SAO tracking number. He sent the following in reply:

Longitude	28d 08m 44s east
Latitude	26d 07m 31s south

and apparently also sent some observations and a letter in which he stated that he had not yet received the information sent by surface mail. In late October 1973 Moonwatch headquarters replied with the comment that apparently surface mail between Pretoria and the United States takes even longer than anticipated and sent him the most important documents under same cover. They acknowledged receipt of his observations and coordinates and said that and since Greg Roberts already had a station in Johannesburg, Ron would be assigned the identity JOHANNESBURG II.

Ron made at least one more observation on the 11 November 1973 with station identification 8700 of the satellite Pageous. In a phone conversation in 2013 Ron, who now lives in Silvermine Village, Noordhoek, Western Cape, advised Greg that he had installed a borrowed 5-inch apogee from Roy Smith in his yard and made a few observations but then decided "that standing in the cold weather was not for him". He returned the scope to Roy and thus station JOHANNESBURG II 8700 ceased to exist.

This was the last Moonwatch station to be set up in Southern Africa and Moonwatch closed down in 1975.

Acknowledgments: Harry Kanowitz, Ron Lake and the late Roy Smith - for email correspondence, and especially Ellen Alers, reference archivist at the Smithsonian Archives, Washington DC for all her invaluable aid, without which it would have been far more difficult to produce this series.

Colloquia and Seminars

These form an important part of a research facility, often as a sort of pre-publication discussion or a discussion of an individual’s current research, and as such it is virtually impossible to “publish” this material. However by recording the topics discussed in the form below does indicate to those, who are unable to attend, what current trends are and who has visited to do research: it keeps everyone ‘in the loop’ so to speak

Also included in this section are the colloquia/seminars at the SAAO, UWC and the Astrophysics, Cosmology and Gravity Centre at UCT, ACGC. Also included are the SAAO Astro-coffees which are 15-20min informal discussions on just about any topic including but not limited to: recent astro-ph papers, seminal/classic publications, education/outreach ideas and initiatives, preliminary results, student progress reports, conference/workshop feedback and skills-transfer.

SAAO

Title: The Solar Corona at Recent Total Solar Eclipses
Speaker: Jay M. Pasachoff (Williams College (Williamstown, Mass) and Caltech (Pasadena, CA)
Date 14 September
Time 15h00
Venue SAAO Auditorium

Abstract: We have been studying the solar corona, its dynamics, and its configuration over the solar-activity cycle, using imaging and spectroscopic techniques. I will discuss a variety of results from the most recent total solar eclipses, those of 2012 in Australia, 2013 in Gabon, and 2014 in Svalbard. I will include information about other recent eclipses in Africa, including 1992 from an airplane in the ocean south of Cape Town and 2001 from Zambia, as well as the partial eclipse of 2004 observed from Cape Town and any recent images from Cape Agulhas the day before this talk.

Title: Femtosecond Electron Diffraction: Making an Atomic Movie!
Speaker: Nicolas Erasmus (SAAO)
Date: 15 October
Time: 11h00
Venue: SAAO Auditorium

Abstract: Trying to explain macroscopic properties of materials from a microscopic perspective has been the challenge for many physicists, past and present. In the past two decades several technological advancements have resulted in new techniques being developed that now enable the atomic dynamics within materials to be studied on the sub-picosecond time scale. Femtosecond Electron Diffraction (FED) is one of these techniques. By instantaneously disrupting the material with a femtosecond optical pulse, and following the evolution of the sample's response via electron diffraction patterns in real time, valuable insight can be gained behind the principles and interesting physical properties that occur in several exotic materials.
In this talk I will introduce the principle behind the method, known as a "pump-probe" measurement, that is employed in FED to temporally resolve atomic motion on the sub-picosecond time-scale. I will also show results from our most recent experiments demonstrating the investigating power of FED.

Astro-Coffee

Title: Mapping Diffuse HI around Galaxies
Speaker: Assoc Prof D.J. Pisano, West Virginia University
Date: 27 August
Time: 13h00
Venue: SKA Office, 2nd Floor Auditorium
Abstract: In order to better understand how galaxies accrete gas from their surroundings, it is necessary to map neutral hydrogen emission down to the log N(HI)~17-18 level. While MeerKAT and SKA should be able to detect such gas, this sensitivity is currently achievable with the Green Bank Telescope

Title: Magnetic Fields and Cosmic Rays in Halos of Disk Galaxies
Speaker: Prof Ralf-Jūrgen Dettmar (Univ Bochum)
Date: 1 October
Time: 13h00

Venue: SKA Office – 2nd Floor Auditorium

Abstract: The disk-halo interface provides a diagnostics for the global state of the dynamical ISM in star-forming disk galaxies. In this talk emphasis is given to the role of cosmic rays and magnetic fields since these components contribute significantly to the pressure of the ISM. Results for the cosmic ray transport in the galaxies NGC 7090 and NGC 7642 are presented showing that convection and diffusion will result in different total power and spectral index distributions. An outlook on results from the "Continuum HAlos in Nearby Galaxies - an EVLA Survey (CHANGES)" of 35 edge-on galaxies will be given.

Title: Bayesian Inference for Radio Observations
Speaker: Dr Michelle Lochner
Date: 8 October
Time: 13h00
Venue: SKA office – 2nd Floor Auditorium

Abstract: New telescopes like the Square Kilometre Array (SKA) will push into a new sensitivity regime and expose systematics, such as direction-dependent effects, that could previously be ignored. In order to maximise the science output of these next generation instruments, careful treatment of these instrumental effects is needed. Current methods for handling such systematics rely on alternating best estimates of instrumental calibration and models of the underlying sky, which can lead to inaccurate uncertainty estimates and biased scientific results because such methods ignore any correlations between parameters. These deconvolution algorithms produce a single image that is assumed to be a true representation of the sky, when in fact it is just one realisation of an infinite ensemble of images compatible with the noise in the data. In contrast, here we report a Bayesian formalism that simultaneously infers both systematics and science. Our technique, Bayesian Inference for Radio Observations (BIRO), determines all parameters directly from the raw data, bypassing image-making entirely, by sampling from the joint

posterior probability distribution. Using simulated data, we show that systematics such as time-varying pointing errors can cause severe biases and effectively lower the sensitivity of the telescope (by dominating faint sources) if not properly treated. We demonstrate that BIRO is able to fully recover both the scientific parameters, such as a catalogue of sources, and the instrumental parameters, such as pointing errors, as well as the uncertainties and correlations between all parameters.

Title: The Unveiling of a newly discovered supercluster in Vela
Speakers: Renée C. Kraan-Korteweg & Ed Elson (UCT)
Date: 15 October
Time: 13h00
Venue: SKA office - 2nd Floor Auditorium (CT)

Abstract: Recent multi-object spectroscopic observations of a few thousand galaxies in the Zone of Avoidance in Vela (l ~ 265 ± 15 deg) revealed strong evidence for the existence of a previously completely unknown supercluster. At similar redshift as Shapley (f = 1.2 more distant), the Vela SCL appears a twin to the well-studied Shapley SCL with regard to extent, number of clusters, as well as dynamic mass. Given its location in the sky, the Vela SCL may well constitute an important missing piece of the puzzle in the quest to understand the various, partly contradictory bulk flow results.
This discovery demonstrates that we still do not know our cosmological neighborhood very well despite the numerous redshift surveys that have been ongoing in the last decades. Even this newly discovered nearby supercluster can only be partly mapped because spectroscopic techniques fail to identify the galaxies at the highest dust and star density levels close to the Galactic Plane. Only HI surveys will prevail. We have hence assessed and will present HI-survey scenarios across the most obscured part of the Vela Supercluster area that could be pursued as Early Science projects with MeerKAT (M16 or M32) - could be useful for commissioning aspects as well.

UWC

Title: Gravitational Back-Reaction in Cosmology
Speaker: Prof. Nikolaos Tsamis (University of Crete
Date**:** 21 August
Time**:** 14h00
Venue: Room 1.35, Physics Department

Abstract: We present some results from classical and quantum gravity in the presence of a positive cosmological constant that have interesting implications for early cosmology. (This was a joint colloquium with AIMS – ed.)

Title: WTF? Discovering the Unexpected in next-generation radio continuum surveys.
Speaker: Prof Ray Norris (CSIRO/CASS/ATNF)
Date**:** 2 October
Time**:** 14h00
Venue: Room 1.35, Physics Department

Abstract: The majority of discoveries in astronomy have come from unplanned discoveries made by surveying the Universe in a new way, rather than by testing a hypothesis or conducting an investigation with planned outcomes. For example, of the 10 greatest discoveries by HST, only one was listed in its key science goals. Next generation radio continuum surveys such as MIGHTEE on Meerkat and EMU on ASKAP will significantly expand the volume of observational phase space, so we can be reasonably confident that we will stumble across unexpected new phenomena or new types of object. However, the complexity of the instruments and the large data volumes mean that it may be non-trivial to identify them. On the other hand, if we don't, then we may be missing out on the most exciting science results from Meerkat and ASKAP. We have therefore started a project called "WTF", which explicitly aims to mine EMU data to discover unexpected science that is not part of our primary science goals, using a variety of machine-learning techniques and algorithms. Although targeted specifically at EMU, we expect this approach will have broad applicability to astronomical survey data.

Title: Dusty Star-Forming Galaxies at High Redshift
Speaker: Prof Andrew Baker is a co-PI of LADUMA
Date: 9 October
Time: 14h00
Venue: Room 1.35, Physics Department

Abstract: Since the discovery of sub-millimetre galaxies in the late 1990s, we have come to appreciate that a complete picture of galaxy evolution must include the overlapping populationsof obscured, dusty star-forming galaxies (DSFGs) that are much more prevalent at high redshift than in the local universe. Gains in our understanding of DSFGs have followed the deployment of new instruments that probe expanded ranges in wavelength, redshift, and/or observational efficiency, a trend that is continuing as the Atacama Large Millimetre /sub-millimetre Array (ALMA) comes into its own. I will discuss recent results on the redshift distributions, evolutionary states, and detailed internal properties of DSFGs and comment on what we can learn from lensed DSFGs about mass distributions along the line of sight.

Title: How supermassive black holes produce jets: recent insights from radio polarimetry
Speaker: Dr Shane O'Sullivan (UNAM)
Date: **7 October**
Time: 14h00
Venue: Room 1.35, Physics Department

Abstract: Substantial progress in our understanding of AGN jets has been made in recent times, particularly in relation to the conditions required for efficient jet formation, as well as our knowledge of the three-dimensional magnetic field structure of the jet. I will present new radio polarization and Faraday rotation observations of radio-loud AGN from parsec to kiloparsec scales. I will show the importance of full-Stokes, broadband radio observations in providing important constraints on fundamental jet parameters such as the jet magnetic field strength, it's 3D structure, and the amount of magnetic flux at the jet launching site. I will also briefly describe some work on using radio-loud AGN as tools to study the origin and evolution of cosmic magnetism.

NASSP

Title: Do not do what your mother taught you: How to advance in physics
Speaker: Prof Jarita C. Holbrook from UWC
Date: 26 August
Time: 16h00
Venue: RW James, Lecture theatre D (James D)

Abstract: The caveat is if your mother was a scientist then it is probably OK to listen to her. I will touch on taking on extra service, doing outreach, and other unacknowledged and low reward work which impacts on productivity. Negotiating job offers, time management, and other things that may impact negatively the science careers of women.

Title: Space Science – the Polar Perspective
Speaker: Dr Pierre Cilliers from SANSA
Date: 9 September
Time: 16h00
Venue: RW James, Lecture theatre D (James D)

Abstract: SANSA Space Science is a key participant in the South African National Antarctic Programme (SANAP) through its maintenance of a number of scientific instruments in Antarctica which contribute data to the understanding of phenomena in the ionosphere and magnetosphere and of changes in the Earth's magnetic field. Since many phenomena in geospace map down to the ionosphere along magnetic field lines which converge at the poles they provide a unique vantage point for Space Observation at a fraction of the cost of putting satellites in Space.

ACGC

Title: Galactic Center, Observations, Mysteries, And Questions Of Interpretation.
Speaker: Jeandrew Brink of Stellenbosch University
Date**:** 18 August
Time**:** 12h00
Venue**:** M111 Maths Building, UCT

Abstract: I explore the Galactic Centre as a playground for probing strong field gravity observationally within the next 20 years. I summarize some of the existing observational data, highlighting mysteries that need to be resolved to gain a full understanding of gravitation and matter in this region. Recent observations of the gamma-ray excess around the Galactic Center by the FERMI Gamma-Ray Space is consistent with emission from some forms of dark matter annihilation. An equally plausible explanation is emission by pulsars. To d ate however very few pulsars have been directly detected around Sgr A*. I discuss how this situation may change with the advent of MeerKAT and HIRAX and the implication these observations will have for our understanding of the region.

Title: GR: 100 years old and still full of surprises
Speaker: Jeff Murugan
Date: 8 September
Time: 12h00
Venue: M111 Maths Building, UCT

Abstract: In the spirit of celebration of the centennial of Einstein's landmark 1915 theory of GR, I will review some of its development in the light of the other idea who's centennial it is this year, Noether's theorem.

The talk will be broadly accessible and very suited for undergraduates as well.

Title: Theory of stochastic lensing
Speaker: Prof Jean-Philippe Uzan
Date: 22 September
Time: 12h00
Venue: M111 Maths Building, UCT

Abstract: I will describe a new formalism, introduced recently with Pierre Fleury and Juline Larena, that aims to describe small-scale lensing as a diffusion process: the Sachs and Jacobi equations governing the propagation of narrow light beams are treated as Langevin equations. I will derive the associated Fokker-Planck-Kolmogorov equations, and use them to deduce general analytical results on the mean and dispersion of the angular distance. It will be applied to some concrete examples.

Title: Cosmology from EMU
Speaker: Prof Ray Norris (CSIRO/CASS/ATNF).
Date: 6 October
Time: 12h00
Venue: M111 Maths Building, UCT
Abstract: The Evolutionary Map of the Universe (EMU) survey is one of the two key projects primarily driving the design and construction of the new $165m Australian SKA Pathfinder telescope. EMU will increase the number of known radio sources from about 2 million to about 70 million, with a median redshift of about 1.4. The sheer volume of radio sources enables a number of tests of cosmology and fundamental physics that provide an independent measurement to complement those of other cosmological surveys such as BOSS and DES. Here I will describe the EMU survey and the limits that we expect to be able to place on the measured parameters, and will discuss the sources of uncertainty that need to be pinned down before we can make definitive measurements. Particularly interesting are the likely complementarities between MIGHTEE (the Meerkat continuum

survey) and EMU (the ASKAP continuum survey), and potential projects which capitalise on the strengths of both Meerkat and ASKAP to deliver results which would be unachievable by either on its own.

AIMS

Title: Photometric supernova classification in the era of LSST
Speaker: Dr Michelle Lochner (UCL):
Date: 5 October
Time: 12h00
Venue: Upstairs Hall, AIMS

Abstract: The Large Synoptic Survey Telescope (LSST) will produce an unprecedent ed amount of supernova data during its ten-year survey. However, traditional supernovae cosmology analysis requires spectroscopic follow-up to ensure a pure sample of Type Ia supernovae, which will not be possible for the full LSST sample. Several methods have been proposed in the last few years to classify supernovae from photometric data alone, but it is not yet clear which method is most appropriate for LSST data. In this work, we create a multi-faceted pipeline, combining three different feature extraction paradigms with several machine learning algorithms. The pipeline is developed to be flexible to easily add and compare new methods proposed in the future. We test the pipeline on data from the supernova photometric classification challenge, and explore each method's dependence on representative training sets and redshift information. I will also briefly talk about my work applying the pipeline to LSST simulations, to investigate the effect of observing strategy (which has not yet been fixed) on supernova classification.

On the Bookshelf

This is a new part of MNASSA which will try to get readers to share their experience of “good reads” of popular science writing by some of the world’s leading scientists. These are not reviews, just comments and pointers to enjoyable and informative writing.

1 An Astronaut's Guide to Life on Earth by Chris Hadfield

I enjoyed this book by Chris Hadfield who became famous for his YouTube videos demonstrating aspects of life aboard the ISS, the International Space Station. In 2001 he became the first Canadian to walk in space and in 2012 the first to command the ISS where he was stationed for five months. His achievements were numerous and astonishing and he did much important work on the ground at the Kennedy Space Centre and at the Yuri Gagarin Cosmonauts Training Centre in Russia. He comments on the paradoxical mix of personality traits required for today's astronauts who need to be as driven and obsessively focused as ever but also able to live and work in harmony with others aboard the Space Station, in trying conditions and for many months at a time.

Wendy Vermeulen

2 Copernicus Complex – Caleb Scharf

Caleb Scharf is the director of astrobiology at Columbia University, New York. He takes a very different view on extra-terrestrial life. And rather like Copernicus, who replaced our old, self-important, geocentric view of the universe with one that makes our planet a fairly insignificant occurrence. Scharf then looks to the existence humanity’s place in the universe and how it evolved, making us neither central nor special. Well written, understandable and thoroughly enjoyable, Scharf takes a rational middle course between life’s rarity and abundance in the universe. Highly recommended.

Case Rijsdijk

3 Time Reborn by Lee Smollin

The book offers an alternative to the current fashionable multiverse interpretation of the laws of physics, string theory, general relativity and quantum theory.

Smollin is a theoretical physicist at the Perimeter Institute in Canada having contributed primarily to loop quantum gravity. In the book he explains the concept of an "effective" theory, one that can not only explain the *what* of reality but also the *why*. For example why the laws of the universe are what they are and why the constants of nature are what they are. Importantly an effective theory is one that can also be falsifiable unlike many of the multiverse approaches criticised by South African physicist George Ellis. Smollin proposes an effective theory of evolutionary cosmology with the concept of a preferred (non-relative) global time from the interesting field of shape dynamics. He also supplies do-able experiments that could falsify his hypothesis. An enjoyable and thought provoking read.

Pablo Casada

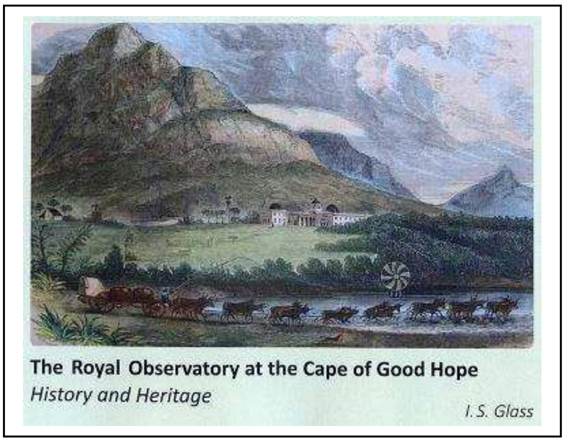
4 From Quantum to Cosmos – Neil Turok

Turok is the Founder of the African Institute of Mathematical Sciences, AIMS, in Muizenberg, Cape Town and currently Director of the Perimeter Institute for Theoretical Physics in Canada. In this book, Turok, one of the world’s leading theoretical physicists, celebrates science with rationality and eloquence, which reminds one of Sagan and Bronowski. He takes one from the classical science of Hypatia and Newton, to the cutting edge of modern science. In doing so he conveys, not only the passion and excitement of modern research, but also the humanitarian aspects of our role in the cosmos. Essential reading and highly recommended by Brian Cox and Sir Roger Penrose by many other leading scientists.

Case Rijsdijk

Book Reviews

The Royal Observatory at the Cape of Good Hope: History and Heritage



by I.S. Glass
Published by: Mons Mensa Publishing, Cape Town
Publication date: 2015
ISBN: 978-0-9814126-2-7
Paperback 287 x 209 mm; 80 pages with 138 illustrations (73 in colour)
Price R150. Available from the author: glass.ian@gmail.com and from SAAO (Thembela Matungwa tm@saao.ac.za).

The Royal Observatory at the Cape of Good Hope was founded in 1820, and 150 years later became the South African Astronomical Observatory (SAAO). The author, Ian Glass, professional astronomer and science historian, has been intimately involved with the SAAO for the past 40 years and has now written a delightful and accessible book about this venerable institution. Delightful because it is generously illustrated with many photographs and drawings of the buildings, equipment and people involved. Accessible because the history is presented in a straightforward way, and the science is well explained and easy to grasp.

The Royal Observatory has been part of the Cape Town scene for nearly two hundred years. It is the oldest scientific institution in South Africa, if not in all of Africa. It is treasured for its science as well as for its special architecture. Now the headquarters of the SAAO, it is situated on a 9 hectare site occupying a small hill about 5 km east of central Cape Town at the confluence of the Black and Liesbeek Rivers. The observatory's location was chosen to be within view of Table Bay, to permit the visual signalling of time by the Observatory to visiting ships.

The book draws on the extensive SAAO collections of instruments and historical images to present a vivid account from its foundation to the present day. Outlined are the Observatory's history, its buildings and astronomical achievements, conservation and heritage issues and its natural setting.

Presented in a coffee table format, the book lends itself to browsing and is easy to read in detail. A good balance has been struck between presenting the personalities involved, the instruments and buildings, and the many scientific accomplishments. The photographic record assembled in this book makes it a valuable contribution to the history of science.

We are told that there were many famous names associated in one way or another with the Observatory. Among these are John Herschel, Eddington, de Sitter, Maclear, Thomas Bowler and Nobel laureate Allan Cormack of CAT scan fame.

Here we find out that the imposing pillars of the main building are not made of stone and that the 'Noonday gun' on the slopes of Signal Hill has been fired electrically from the Observatory every day since 1864. The first astronomical long exposure photograph ever was taken here in 1882, done by strapping a camera borrowed from a local photographic portrait studio to the 6-inch telescope (which telescope many will be familiar with from their visit to the Observatory on 'Open' nights). Keen-eye readers will spot a photograph of how the present Auditorium looked before it was converted to its present use. For a full list of the topics covered, see the table of contents below.

Of course a reviewer must be critical, and the following were not as they should be. The very important image credits are hidden at the back of the book, and in my first passes through the book I was frustrated not to find any descriptions of the cover, the sketch on page 2 or the photograph on page 46. The section on the 'Twentieth century' ends somewhat abruptly in the second or third decade of that century, which puzzled me, until I found that it continues some 40 pages farther on under title ‘Latter days of the Royal Observatory’. The ‘Further reading’ section omits a couple of useful references such as Brian Warner’s Royal Observatory Cape of Good Hope, 1820-1831, Dave Laney’s History of the South African Astronomical Observatory available on the SAAO website, and Ian Glass’s own article on the UNESCO/IAU Portal to the Heritage of Astronomy website. The cover of my copy curled upwards whenever I left it flat and unopened on my coffee table.

But these are minor criticisms indeed, and I strongly recommend this book to anyone with even a passing interest in astronomy, and also to those with an interest in scientific history or the history of South Africa. And its low price makes it a bargain indeed.

-- Maciej Soltynski

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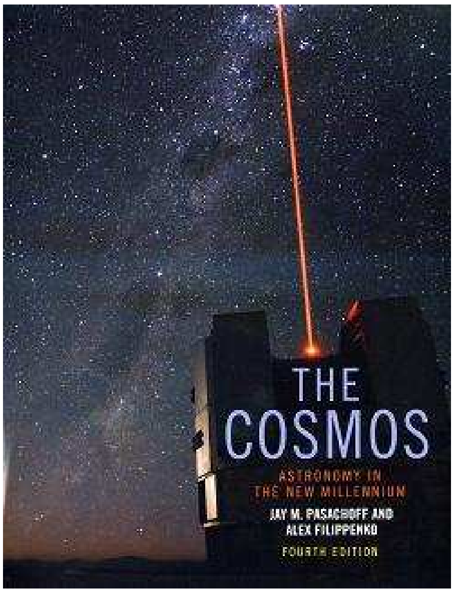

The Cosmos: Astronomy in the New Millennium

By: Jay M Pasachoff and Alex Filippenko.

Publisher: Cambridge University Press Fourth edition, 2014 (soft cover, 600 pages) ISBN 978-1-107-68756-1

When looking for a textbook that provides a good introduction to modern astronomy - one that is written by two acclaimed teachers of astronomy and visually presented in a way that is accessible, with clear, descriptive text, yet also comprehensive enough to cover all the main topics in astronomy - this surely has to rank high on the list. The subject matter is presented in an user-friendly style and illustrated throughout with numerous photographs, clear figures, graphs and star charts. This fourth and updated edition includes many of the latest developments in astronomy: '… we describe the current state of astronomy, both the fundamentals of astronomical knowledge that has been built up over decades and the incredible advances that are now taking place. We want simply to share with you the excitement and magnificence of the Universe.'

The credentials of the authors speak for themselves. Jay M Pasachoff, who visited South Africa very recently to observe the partial eclipse of the Sun on 13 September 2015 and present talks on observing eclipses, is Field Memorial Professor of Astronomy at Williams College and Director of the Hopkins Observatory. He pioneered the emphasis in textbooks on contemporary astronomy alongside the traditional bases, and received the American Astronomical Society's 2003 Education Prize - among others for his 'eloquent and informative writing of text books… his devotion to teaching… for sharing with the world the joys of observing eclipses.'

In addition to observing almost 60 eclipses, he has also been carrying out research on transits of Venus and of Mercury, and collaborates in observations of occultations of stars by Pluto and its largest moon, Charon. He chairs the working group on eclipses of the solar division of the International Astronomical Union, and also the American Astronomical Society's historical astronomy division. Pasachoff is the author of a number of other books, and has had an asteroid (5100 Pasachoff) named after him.

Alex Filippenko's record as teacher is also exceptional. He is Professor of Astronomy at the University of California, Berkley, and has nine times been voted the best professor on campus. In 2004 he won the Carl Sagan Prize for Science Popularisation; in 2006 he was named the US National Professor of the Year, and in 2010 he received the Emmons Award of the Astronomical Society of the Pacific for excellence in college (university) astronomy teaching. He became particularly well known internationally through his college level astronomy video courses through '*The Great Courses*', as well as television documentaries ('*The Universe*').

Filippenko's primary areas of observational research are supernovae, gamma-ray bursts, active galaxies, black holes and observational cosmology. Together with collaborators, he discovered some of the best evidence for the existence of stellar-mass black holes in the Milky Way. Importantly, he also made major contributions to the work of both teams that discovered the acceleration of the expansion of the universe.

These two authors start their book with a 'grand tour of the heavens' to discuss some general concepts to show why astronomy is important, and to stress in a short discussion of the scientific method its importance in the verification of observations. They then systematically work through specific topics: the basics of light, matter and energy; light and telescopes; observing the stars and planets; gravitation and motion; the sun and the solar system (four chapters); the sun and other stars, how they shine and die (three chapters); black holes; galaxies, quasars and active galaxies; cosmology, and finally life in the universe.

In addition to the basic twenty chapters of text, special features are included under five themes: *'Star Parties'* (basic observing guidelines); *'Figure it Out'* (mathematical exercises); *'Lives in Science'* (biographies of important historical figures); *'A Closer Look'* (more details and explorations of interesting topics such as how stars are weighed or the shape of the universe); and '*People in Astronomy'* (interviews with notable contemporary astronomers).

Every chapter outlines its aims, and ends with questions for revision and topics for discussion. Additional information is contained in appendices on measurement systems, basic constants, planets and dwarf planets, the brightest stars, the nearest stars, the Messier Catalogue, and the constellations. There are also a glossary, a recommended reading list and an index.

Although the text is written in an easy-to-follow, conversational style, the book provides an excellent basis for the understanding of modern astronomy.

The book is linked to a website (www.cambridge.org/cosmos) with additional information, including podcasts, chapter updates, astronomy news, and a large number of documents in .pdf format that cover topics from common misconceptions in astronomy, to a telescope list. The website also makes a large number of figures and flashcards available for download. These should be particularly useful to teachers and others presenting courses on astronomy.

-- Lia Labuschagne

Sky Delights: Another Cross

Magda Streicher

It cannot be otherwise: if the southern starry skies have a cross (the constellation Southern Cross) then of course one also has to be found in the northern skies. Isn't that the way our human minds work?

Well, a cross can indeed be found in the north – in the star combination of the constellation Cygnus. And the Northern Cross can definitely boast with some exceptional objects within the constellation, which is found in the lower reaches of the Milky Way. What I always find interesting is the way nicknames are given to deep-sky objects, and particularly by northern amateurs. Cygnus, therefore, has no shortage of objects that boast an array of nicknames in abundance. Cygnus is better known as the Swan, and appears to represent some flying bird or other.

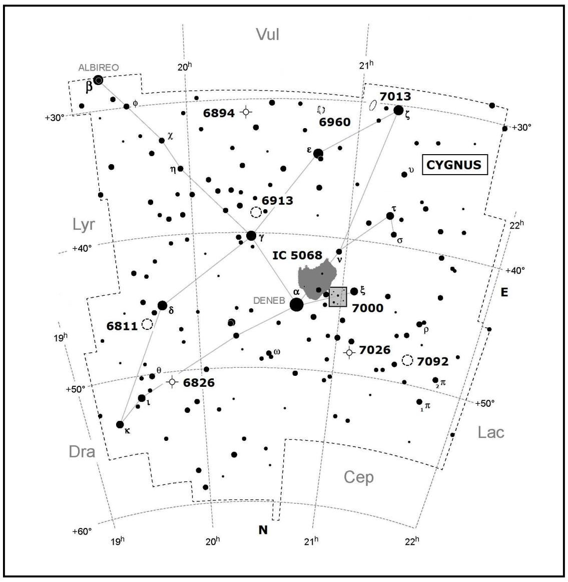

Fig 1. The constellation Cygnus

The stars in the formation that represents the cross are alpha, gamma, epsilon, delta and beta Cygni. The starting point of Cygnus is indicated by the beautiful magnitude 1.3 bright white star Deneb towards the north. Seen from the southern skies, alpha and the image as a whole are fairly close to the northern horizon, which makes observation somewhat difficult. Cygnus's long neck is represented by beta and eta Cygni.

From our southern vantage point we look first at the western part, where the star kappa (magnitude 3.7), the double star iota and theta (magnitude 4.4) are located. The planetary nebula **NGC 6826**, better known as "the blinking nebula", can be found only one degree north-east of theta Cygni.

NGC 6826 is a fine, bright green-bluish planetary slightly elongated from north-west to south-east. My fortunate position in South Africa has enabled me to easily locate this object. The planetary conveys a non-stellar impression with a magnitude 10.6 central star. The star is prominent within this roundish green-blue nebulosity. This beautiful nebula certainly blinks, as its name states. It works like this: stare directly at the centre of the star-like core of the planetary until the brightness overwhelms the eye and the nebula disappears. However, with the use of averted vision the nebula grows again fully and reappears. Overall, with high magnification it is a fine object that exhibits a soft disc with a hint of an outer envelope (see sketch). There are several other planetary nebulae that have the right central star to the nebula brightness to show of this effect. William Herschel discovered this planetary in 1793.

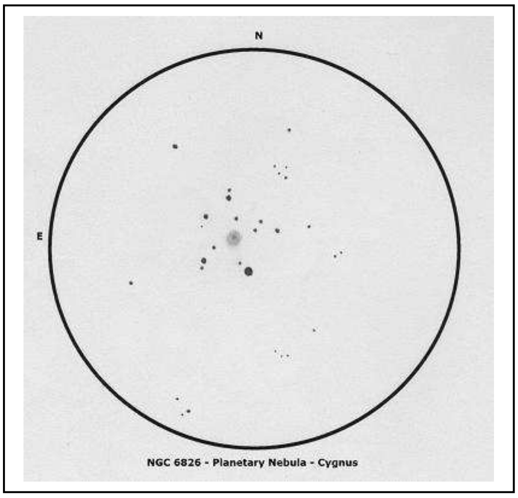

Fig 2. NGC 6826, a planetary nebula, also known as the Blinking Nebula.

Move along up on the sleeve of the feathery bird wing to the bright star delta (magnitude 2.9). Just north of delta the small open cluster **NGC 6811** can be found. It is a very faint spacious grouping of stars with some open areas and more so towards the middle part. With imagination it sort of displays an old bicycle shape with faint strings of stars stretching out into the field of view. Brighter stars take up space alongside the cluster towards the west which is immediately seen.

Way up towards the middle of the constellation is the beautiful magnitude 2 star gamma Cygni. Situated in this far end of the Milky Way is another cluster, **NGC 6913**, better known as Messier 29. This cluster, 1.7 degrees south of gamma, comprises only a few bright stars quite outstanding against the busy star field. The group is arranged in the form of a reverse-shaped “K”. This lovely handful of stars displays a boxy impression with

Fig 3. The open cluster M29.

the southern part more defined and busy. It is a beautiful part of the constellation which is worth taking one's time over discovering. Just 23' north of gamma another fine cluster, NGC 6910, is also worth a glance with both your eye and your mind. Slightly more southwards, nestling against the star eta Cygni, is the dark nebula Barnard 144.

Look the bird in its eye with beta Cygni or refer to the star Albireo, which is one of the most exceptional and attractive double star combinations. The primary magnitude 3.1 has an unusual golden yellow colour, which contrasts beautifully with the blue to green reflected by the fainter magnitude 5 with a separation of 34.4 in a position angle of 54°. The system was previously identified as multiple in the Hipparcos Input Catalogue.

A few degrees south another planetary nebula, **NGC 6894**, is situated close to the constellation Vulpecula. Although it's indicated magnitude is not at all favourable, it is relatively easily seen. And here come the nicknames: known as the Miniature Ring Nebula, this baby nebula however displays a thin smoky ring effect. A magnitude 14 star close to the nebula's north-western edge gives it another nickname: the Diamond Ring Nebula. William Campbell discovered this unusual star-like object at Lick Observatory in 1893. Campbell's star PK 64+5.1 completely overpowers the tiny disc.

Further east, a complex area of diffuse nebulae can be found with **NGC 6960** and **NGC 6992** the brighter parts of the complex. It is famously known as the Veil nebula, but also by the names Cirrus and the Bridal nebula. Quite surprisingly, this flimsy elongated loop of light was visible when Tim Cooper and I observed it a few years ago.

Fig 4. The Veil Nebula, a supernova remnant.

The star 52 Cygni can be seen on the western edge of the curved nebula. The central segment of the Veil is known as Pickering's Triangular Wisp, which is visible through an O-III filter. This supernova remnant exploded about 30 to 40 thousand years ago. William Herschel discovered the complex with his 18-inch reflector telescope in 1784.

Another surprise was to find a galaxy in this part of the Milky Way awash with nebulosity. **NGC 7013** displays an oval streak of light in a north-western to south-eastern direction – quite outstanding, although faint at first, with a few field stars to the east and west. A star of magnitude 12 can be glimpsed on its north-western tip. This galaxy requires long and intensive observation to bring the long silver streak out well.

The guys in the north, not satisfied with their cross alone, also found a dark northern Coal Sack indicated by the name **IC 5068**. The large, dark, very faint area is situated just eastwards and between gamma and alpha Cygni. Two faint stars are embedded.

More famous and just to the north of the northern Coal Sack is the North American Nebula known as **NGC 7000**, situated just east of alpha (magnitude 3) and close to xi Cygni further east. The nebula was seen but just as a faint glow from my northern site with my 12-inch telescope. Wolfgang Steinicke indicates the following: with a 4 1/4" f/4 with a 20 mm

Erfle and a UHC filter, the nebula is very bright and very large, filling the 1.5^{o} field with nebulosity. The brightest section is Mexico and the Pelican Nebula (IC 5067) nearby. Many stars are involved in the nebula. The Pelican Nebula also plays home to God's Finger, IC 6057, a dark trunk-like pillar (Herbig-Haro 555).

Yes, and there is a burger to eat in this birdy constellation in the impression of the Cheeseburger Nebula indicated as **NGC 7026**. This tasty object is situated halfway between alpha and the double star pi Cygni. NGC 7026 is pretty small, shining in a soft blue-green colour in a north-east to south-west direction. It is a bipolar nebula and has two gaseous lobes that expand away from a common centre. A very faint star is superimposed on the nebula, but is not the central star.

In the far north of the constellation is **NGC 7092**, better known as Messier 39, situated two degrees south of pi Cygni – a lovely outstanding grouping of approximately two dozen stars to be enjoyed with low power through a telescope. The cluster was discovered by Le Gentil in 1750 and Messier added it to his catalogue in 1764.

What did I say about nicknames? This is the constellation with perhaps the most nicknames in the whole of the starry heavens. Add the following to your list next time around.

1. Baseball asterism at RA: 20h03m – DEC: +35^{o}20'.
2. A Fairy Ring asterism at RA: 20h04m – DEC: +38^{o}10' named by the Utah amateur Kim.
3. The backward Eklund's "J" star group at RA: 20h23m.5s – DEC: +38^{o}54'.7",lying on a line between Messier 29 and Gamma Cygni.
   Three of these stars are members of Cygnus OB 1 (including the star HD 194280).
4. Matthew Cluster is a zig-zag trapezium, unique at RA: 19h43m.7s – DEC: +38^{o}21'.3".

5. The little Leaping Dolphin, named by Mr Patchick at RA: 20h24m.9 – DEC: +41o37’.
6. The Crescent Nebula, Cygnus Star cloud, the Cocoon Nebula and Cygnus X-1, one of the first X-ray binaries studied, one can go on and on.

Even if we here down south cannot glimpse the constellation Cygnus in its full splendour there is surely enough to talk about.

OBJECT	**TYPE**	**RA**	**DEC**	**MAG**	**SIZE**
NGC 6811	Open Cluster	19h36m.9	+46°23’.2	6.8	13’
NGC 6826	Planetary Nebula	19h44m.8	+50°31’.0	9.8	25”
NGC 6894	Planetary Nebula	20h16m.4	+30°24’.0	12.3	42”
NGC 6913 Messier 29	Open Cluster	20h23m.9	+38°32’.0	6.6	7’
NGC 6960 NGC 6992	Emission Nebulae Nebula	20h45m.7 20h56m.4	+30°43’.2 +31°43’.0	2-5 2-5	70” 60”
IC 5068	Diffuse Nebula	20h50m.8	+42°31’.0	2-5	40’x30’
NGC 7000	Nebula	20h58m.8	+44°20’.0	1-5	120’x100’
NGC 7013	Galaxy	21h03m.6	+29°53’.7	11.3	4.8’x1.5’
NGC 7026	Planetary Nebula	21h06m.3	+47°51’.4	10.9	21”
NGC 7092 Messier 39	Open Cluster	21h32m.2	+48°26’.0	4.6	32’

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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