ISSN 0024-8266

mnassa

monthly notes of the astronomical society of southern africa

Volume 73 Nos 5 & 6 June 2014

In this issue:

TRIPLE MASSIVE BLACK HOLE – WARP IN MILKY WAY - TOM LLOYD EVANS (1940-2014) – FIREBALL OBSERVATIONS 2013 – MEASUREMENTS OF DOUBLE STARS - AMATEUR OPTICAL SATELLITE TRACKING – COLLOQUIA AND SEMINARS - SKY DELIGHTS: LIBRA

Cover: Tom Lloyd Evans, former ASSA President, who died 12 June 2014, seen here earlier this year during a holiday in the Scottish Highlands.

mnassa

Vol 73 Nos 5 & 6 June 2014

News Notes

Close binary black hole in a triple system

In a letter to *Nature* published on-line on 25 June 2014, a team headed by Roger Deane (UCT) with participants from UWC, Rhodes and a number of overseas institutions have announced the discovery of a rare triple massive black hole system at a redshift of z = 0.37. They carried out infrared imaging and VLBI observations of an object from the Sloan Digital Sky Survey, namely J15023.09 + 111557.3, that showed evidence for duplicity. The VLBI imaging revealed that one of the two sources was, in fact, a close (on galaxy scales) pair of black holes separated by about 414 light-years. The other member is about 22 000 light years away from these. A deep examination of old survey images suggests a spirally distorted radio jet originates from the binary black holes.

Evidence for warping in outer disc of Milky Way galaxy

The precise shape of our galaxy is difficult to determine because we are inside it and a lot is hidden from us by dust. Using the Japanese/South African Infrared Survey Facility at Sutherland, M.W Feast, J.W. Menzies, N. Matsunaga and P.A. Whitelock have found a number of Cepheid variables in a direction about opposite to the Galactic Centre (*Nature on-line* 14 May 2014). Since the luminosities of these stars are well known, the newly discovered ones could be shown to lie at a distance appropriate to an outer spiral arm. However, they lie somewhat above the Galactic Plane, leading to the conclusion that the arm must be a warped one.

Obituary: Thomas Harry Hope (Tom) Lloyd Evans 1940-2014

On 12 June 2014 the well-known astronomer Tom Lloyd Evans died in Scotland. For most of his career he had worked in South Africa but for the last thirteen years of his life he lived in Scotland, not far from where he grew up.

Tom was born during the Second World War on 2 December 1940 at an RAF base in Wimslow, England, where his father, Wing Commander Dudley Lloyd Evans DFC, a flying ace during the First World War, was involved in investigating aeroplane accidents. However, at the age of a few months he moved with his mother to her family's castle in the Scottish countryside. His father joined them when the war ended.

Tom attended the well-known school Fettes College in Edinburgh and it was there that one of the masters awakened his interest in astronomy. While still at school he joined the Dundee Astronomical Society and was already contributing observations to the AAVSO and the BAA. He was elected an Honorary Member of the BAA in 1956 and later on an Honorary Member of the Dundee Astronomical Society.

Career

He attended university at St Andrews, a place of which he was already very fond, graduating with first-class honours in astronomy in 1963. He stayed on at St Andrews and began a PhD there on the photometry of star clusters. This was completed in 1968, while he was at the Radcliffe Observatory.

In 1966 he joined the Radcliffe Observatory in Pretoria, then directed by David Thackeray. He remained there until it closed in 1974 except for a short period that he spent at the Royal Observatory, Edinburgh. Following

this, he moved to the South African Astronomical Observatory in Cape Town where he worked, except for a sabbatical of four months at the Anglo-Australian Observatory in 1980, until his retirement in 2001. On his return to Scotland he became a Special Lecturer in the School of Chemistry at Nottingham University until 2007 and also an Honorary Lecturer at St Andrews from 2004 onwards.

Science

Unsurprisingly, in such a long career, Tom's research interests were many and varied. An early interest in the radial velocities of classical Cepheids showed that a significant number are in binary systems. This allows the possibility of determining their masses (see e.g. Lloyd Evans, 1968).

At Radcliffe, Tom took a long series of Newtonian plates of fields in the Magellanic Clouds, the Baade Clear Windows near the Galactic Centre and globular clusters. These were examined for variable stars and their light curves were extracted (e.g., Lloyd Evans, 1976). Later he used the "Unit Spectrograph" to obtain further information about the variables, finding correlations between their periods, metal content and ages. He identified the first Miras in the Magellanic Clouds, leading to the discovery that these variables obey a tight period-luminosity relation (Glass & Evans, 1981).

He continued with spectroscopy of Magellanic Cloud clusters at Sutherland and confirmed the evolutionary transition from M via S to C stars as due to material being processed by thermonuclear reactions, especially the s-process elements and carbon.

Most globular clusters show a certain degree of uniformity in the evolutionary paths followed by their late-type stars. However, the cluster Omega Cen is anomalous and Tom showed the scatter in its colour-magnitude diagram and the presence of strong s-process lines resulted from increasing quantities of processed material from different stellar generations (see e.g. Lloyd Evans, 1977).

Using results from the early infrared satellites, Tom found that certain carbon stars invisible at ordinary wavelengths and having anomalous quantities of silicon-rich dust emitting at 9.7μm (expected from oxygen-rich rather than carbon-rich giants) have relatively high abundances of the heavier carbon isotope ^{13}CO. The dust was hypothesized to have been accumulated during their earlier oxygen-rich phase in a disc associated with a binary companion (see e.g. Lloyd Evans, 1990).

Another interest of Tom's was in RV Tauri stars. These were found to have characteristic mid-infrared colours, possibly arising from dusty discs. This property was used to identify new examples of RV Tauri stars including a new class with small amplitudes in binary systems (see e.g. de Ruyter et al, 2006). A spectroscopic study of RV Tauri stars in the Large Magellanic Cloud showed that they have the same range of spectra as their galactic counterparts but that at least one is a carbon star with s-process elements as might be expected if they are post-AGB objects.

A study of V Hydrae and R Lep showed that the characteristic fading exhibited by such stars is restricted to the reddest C types, which are enveloped in dust clouds (see Lloyd Evans, 1997). During dust episodes, C_2 appears in emission instead of absorption, as may the resonance lines of Na, K and Rb. V Hya shows high-velocity gas ejection.

Since his return to Europe, Tom has collaborated with Peter Sarre (Nottingham) and Hans van Winckel (Leuven) and was particularly glad to have had the opportunity to work with students.

With Peter Sarre he carried out the first complete study of the silicon dicarbide molecule in stellar spectra, following his discovery of a carbon star (IRAS 12311-3509) with C_2 and SiC_2 emission bands, surrounded by a dusty disc (see e.g., Sarre et al, 1996).

Other professional activities

For about ten years Tom ran the Summer School for undergraduates, a precursor of the present-day NASSP programme. In addition he ran a number of South African Astronomical meetings and was the organizer of the SAAO's weekly seminars for 17 years. He was responsible for the allocation of observing time on the SAAO telescopes for several years. He occasionally served as Acting Director of SAAO for short periods and was a member for three years of the SA National Committee for the IAU. He was also Chairman for some time of the SAAO Staff Association. He was President of Commission 45 (Stellar Classification) of the IAU in 2000-03.

In 1991-92 he served as President of the Astronomical Society of Southern Africa, in which he always took a strong interest.

Tom commenced his observing career with photographic photometry and later undertook spectroscopy, infrared photometry and infrared imaging. In addition to his administrative duties, Tom was in charge of the Cassegrain "Unit" spectrograph for many years, including supervising its many transformations from Carnegie image tube to Boksenberg IPCS, to Reticon PCS, to CCD detector, with the associated optical changes. He personally took care of its optical alignment.

Personal Life

Tom, though very conservative in his political views, was very conscious of the need to keep an open outlook. He was a strong swimmer and enjoyed snorkeling and underwater photography in such places as the Comores, Mauritius, the Great Barrier Reef and Egypt. He was an enthusiastic member of the local Archaeological Society and among other things conducted a dig on the Sutherland Observatory site.

Tom was very fond of hiking and enjoyed the varied Cape flora. He belonged to the Botanical Society and became one of its walk leaders.

After he returned to Scotland with his family he became a member of the Fife Mountaineering club.

He had many other interests, including aviation, and he was able to recognize most types of warplanes! He was widely read, with a large collection of books. He also liked to attend concerts and operas.

An interest in Scottish Country Dancing led Tom to meet his future wife, Marlene, who he married in December 1985. They have two children, Robert and Anne, who are now adults. Marlene, a science teacher, continues to work at a school in St Andrews.

Published Output

Tom was the author or co-author of at least 116 papers in refereed international journals, principally *Monthly Notices of the Royal Astronomical Society, The Observatory* and *Astronomy and Astrophysics.* He published 57 papers in conference proceedings, many of them of IAU Symposia. In addition he had about 38 papers in *The Astronomer* and the *SAAO Circulars* as well as many items in the *International Bulletin of Variables Stars*, the *IAU Circular s*and the *Journal of the British Astronomical Association* including 18 in *MNASSA*. He had numerous collaborators, some of the more frequent being R.M. Catchpole, M.W. Feast, I.S. Glass, D.M. Kilkenny, M.C.J. Koen, J.W. Menzies, K. Pollard, P.J. Sarre and H. van Winckel.

References

de Ruyter, S., van Winckel, H., Maas, T., Lloyd Evans, T., Waters, L. B. F. M., Dejonghe, H., 2006. Keplerian discs around post-AGB stars: a common phenomenon?
Astronomy and Astrophysics, **448**, 641-653.

Glass, I.S, Evans, T.L. 1981. A period-luminosity relation for Mira variables in the Large Magellanic Cloud, *Nature*, **291**, 303- 304.

Lloyd Evans, T., 1968. The frequency of Cepheid binaries, *Monthly Notices of the Royal Astronomical Society*, **141**, 109-142.

Lloyd Evans, T., 1976. Red variables in the central bulge of the Galaxy. I. The period distribution of Mira variables*. Monthly Notices of the Royal Astronomical Society*, **174**, 169-184.

Lloyd Evans, T., 1977. Near infrared photometry of globular clusters. VIII - The anomalous giant branch of Omega Centauri *Monthly Notices of the Royal Astronomical Society*, **181**, 591-598.

Lloyd Evans, T., 1990. Carbon stars with silicate dust shells. I - Carbon stars with enhanced C-13 (J stars) *Monthly Notices of the Royal Astronomical Society*, **243**, 336-348.

Lloyd Evans, T., 1997. Spectroscopic changes and the variable mean light of carbon stars *Monthly Notices of the Royal Astronomical Society*, **286**, 839-847.

Pollard, K. R., Lloyd Evans, T., 2000. A Spectroscopic Study of RV Tauri Stars in the LMC, in *The Impact of Large-Scale Surveys on Pulsating Star Research*, ASP Conference Series, Vol. 203; also IAU Colloquium No 176. Eds L. Szabados and D. Kurtz., p.116.

Sarre, P. J., Hurst, M. E., Lloyd Evans, T., 1996.Optical Absorption and Emission Bands of SiC_2 in Carbon Stars. *Astrophysical Journal Letters***, 471**, L107-L109.

[Ian Glass with thanks to Marlene Lloyd Evans and Dave Kilkenny]

Southern African Fireball Observations 2013

T P Cooper, Bredell Observatory

Catalogue of Recent Sightings

This article continues the sequential numbering of reported fireball sightings from southern Africa, and covers fireballs observed during 2013. By definition, a fireball is any meteor event with brightness equal to or greater than visual magnitude (m_v) -3. The following events were reported to the author and details are reproduced as given by the observer. All times were converted to UT unless stated, and all coordinates are for epoch J2000.0.

Event 244 – 2013 January 7 – nr Waterpoort and Modimolle, Limpopo

Observed by Brink Schlesinger and Chad Wright. Brink Schlesinger, together with Nonna Fick, observed the event from Brink's house, high up on the northern side of the Soutpansberg, close to Waterpoort, which commands a spectacular view of the whole Limpopo Valley into Zimbabwe and Botswana. The fireball was described as 'comet-like in rainbow colours, with a head and colourful rainbow tail', moving in direction of Mussina to Lephalale [that is azimuth 360° to 250°, or from right to left]. Very bright and lit almost the whole of the Limpopo valley from their perspective. It left a persistent train or smoke cloud, visible for 15 minutes after the fireball. Chad Wright observed the event while on holiday in the Waterberg, near Modimolle. He recorded the time as 8pm local time, and described the fireball as 'looked like a shooting star at first, then it exploded lighting up the entire sky for half a second and shot across for a short distance. During its passage it changed colour a few times (blue, green, yellow). After it died down, we noticed it had left a white trail behind it, which took a while to disappear, about 3-6 minutes'.

Event 245 – 2013 January 8 – Plumstead and Durbanville, Cape; Worcester, Cape

Maritza van den Heuvel and her husband observed at 20h10, while driving up Herschel Walk, halfway between Monmouth Avenue and Torquay Avenue, (Wynberg/Plumstead) Cape Town. Seen facing south, crossing their path travelling westwards, starting about 60° above the horizon and then disappearing below the tree line. Colour was bright yellow/white, with tail fluorescent green and blue, duration 2-3 seconds. Amy Brunette was in Durbanville, and caught a glimpse of something shooting across the sky at around 20h04. Duration a few seconds, green/blue colour with a tail and was very bright. It moved towards south-west, left to right and downwards (towards the city from her viewpoint). Roelie du Toit was at Worcester, and gave the time as around 20h00. Looking in direction of Villiersdorp towards Kwaggaskloofdam, just above the mountains, about 25° above the ground (roughly south-west). Roelie said it had a green tail, was large and moved fast. Duration 2 seconds.

Event 246 – 2013 February 19 – Pretoria, Gauteng and Modimolle, Limpopo

Observed by Percy Jacobs and Jaco Engelbrecht. Percy gave the time as between 18h30 and 19h00, duration 2-3 seconds, slow-moving, very bright, and greenish coloured. He observed from Pierre van Ryneveld looking south-east, moving from east to south descending from 45° and burning out 20° above the horizon. Jaco observed from about 20km west of Modimolle, time 18h13, with the appearance of a small comet, with a head and short tail, very bright. Duration 2-3 seconds, fast moving, and colours noted were white and turquoise. Travelling north to south, and disappeared on the southern horizon.

Event 247 – 2013 March 4 – Mountain View, Pretoria, Gauteng

Observed by Schalk Nell between 03h40 and 03h45 (dawn twilight already advanced, last quarter moon almost overhead). Duration about 5 seconds. Observed while travelling in a northerly direction from Mountain

View, Pretoria North towards Onderstepoort, the path was from left to right, and descending, then just disappeared.

Event 248 – 2013 March 6 – Hout Bay, Bantry Bay, Camps Bay, Milnerton Ridge, Cape Town

Reports of this object were received from Sibusisiwe Lwandle, a reporter from the Cape Argus newspaper. He received several reports from the public (no observers names given) including from Hout Bay, Bantry Bay and Milnerton Ridge. The latter reported fire in the sky and the sound of a sonic boom. The Hout Bay observer also claimed to hear a sound like crashing. However, I also received an independent report from James Measures who witnessed the event while sitting outside his house in Camps Bay, seeing a 'large bright light streaking across the western night sky on a southerly trajectory'.

Event 249 – 2013 March 12 – Various, Western Cape

This event was widely seen in the Western Cape just after noon local time on March 12. A full report was given in *MNASSA* Vol 72, pp 47-52 (April 2013). The object was visible in broad daylight, probably brighter than m_v = -10, and lasted a few seconds before exploding, leaving a smoke cloud visible for up to one hour after the explosion.

Event 250 and 251 – 2013 May 5 and May 6 – Bredell, Gauteng

Observed by Tim Cooper, during observations of the eta Aquariid meteor shower. Event 250 was seen on May 5 at 02h50, m_v = -3, speed fast, colour white with orange terminal burst, duration 0.5 seconds leaving a 2 second persistent train. Event 251 was seen on May 7 at 03h10, m_v = -3, speed fast, colour yellow, with a persistent train. Both fireballs were eta Aquariids.

Event 252 – 2013 May 10 – various, western Cape

At first glance, this event appeared rather curious, with many reports of a flash, like lightning, seen over a wide area (including Bloemfontein!), and I was in some doubt as to whether it was a fireball at all. Initially there

were no reports of the passage of a bright meteor. Finally, two reports came to hand of persons who actually saw the passage of a meteor coincident with the flashes of light. The most complete report came from Peter Stoffberg who observed from Berg En Dal Farm, Cederberg. He gave the time as 21h48, direction west to east, 'extremely bright, valley looked like daylight, brighter than a flash from a camera'. Duration several seconds, and colours were white and red. Peter commented 'it was daylight on the farm, many people saw the event . We were convinced the meteor hit the mountains heading out to the Karoo. It was huge and we intend looking for the impact site'. The object fragmented into three pieces and was followed by sound like a loud thunder roll, and a tremor lasting about 4 seconds. With so many reports of what was apparently a very bright event, it remains unexplained why the passage of this meteor was only reported by two persons, despite the late hour.

Event 253 – 2013 May 18 – Wilderness, Cape

Observed by Case and Sue Rijsdijk and Elizabeth Boje, from Wilderness. Case said 'I was showing some craters on the Moon, when we suddenly saw a fairly bright fireball at 16h10. Duration was about 2 seconds, start 40° altitude towards north-east, that is just above the tail of Leo, gradually brightening to a sudden burst at 10° altitude towards north, in Ursa Major, m_v = -5 to –6. Case gave the colour as white, and Sue says she observed a greenish colour.

Event 254 – 2013 May 28 – Bankies, nr Dordrecht, Eastern Cape

Observed by Andrea Myburg at 15h40, who described it as 'very bright with a tail'. Duration 2 seconds, colour silver/red, left a persistent train visible for a few seconds after the fireball, but no disintegration noted. The path was from altitude 45°, azimuth 135°, descending vertically and ending at altitude 10° in the same direction. From this I calculate the path roughly from RA 13h40, Dec -53° to 16h40, -43°.

255 – 2013 June 3 – Edgemead, Cape Town

Observed by Leonard Klass and his wife at about 04h10 while they were walking towards the BP shop in Edgemead. They were about to cross Louis Tibault Drive when they saw a white point, with a long tail, moving low and very fast. The duration was 4-5 seconds, was first seen to their left (east) and was headed south-east, or more or less towards Table Mountain/Lions Head. Mrs Klass noted red colouration. Leonard gave the brightness as 'much brighter than the moon', (which was a 25% illuminated waning crescent at the time). The tail was long and narrow and glowed with the same intensity as the head.

Event 256 – 2013 July 1 – Belville, Cape Town

Observed by Derik Greeff from his place of work at 05h15. As he got out of his car, he saw a sudden blue flash like a lightning bolt. Looking up he noticed a blue/white burning mass moving from above in the direction of south-west. The duration said to be ten seconds, and left a grey/white smoke trail after it burned out.

Event 257 – 2013 September 22 – Goodwood, Cape Town

Observed by Juergen Buchelt at 17h15 from his house in Goodwood. He was looking at Venus and Saturn at the time, trying to spot Mercury and Spica, when the fireball travelled from just north of and at the same altitude as Venus, downwards at an angle of about 10° from vertical towards the left, before being obscured by trees and a neighbour's roof. From this description the path was very roughly from RA 15h00, Dec –11° to 13h30, 0°. The fireball fluctuated in brightness during its passage, but peaked about twice the brightness of Venus, so m_v about -5. It left a glowing train which disappeared in less than a second after the passage.

Measurements of nine southern double stars

Dave Blane

Introduction

Nine bright southern double stars were measured and compared with observations made by Bob Argyle (from Cambridge University) using the 26” refractor in Johannesburg and the values listed in the Washington Double Star Catalog (WDS). The exercise was done to see whether a small telescope with a Meade Astrometric eyepiece could give results that are of sufficient accuracy to be of scientific value. The main reason for measuring double stars is to determine the total mass of a double-star system. Why? This information is of crucial importance to theorists working on stellar evolution. Indeed, our understanding has benefited greatly from thousands of measurements made by double-star observers since the time of Wilhelm Struve in the early 19th century.

Equipment

The telescope used was a 150mm refractor with a 2.5x barlow lens giving a focal length of 3 000 mm, mounted on Skywatcher HEQ5 GOTO equatorial mount and a Meade Astrometric eyepiece.

Fig 1. Meade astrometric eyepiece.

The Meade Astrometric is a Modified Achromat eyepiece of 12mm focal length incorporating a laser etched reticle and a battery powered variable illumination system.

The illuminated reticule has a 360° protractor scale at the edge of the field and a linear scale across the centre. The linear scale, which is used to measured separation, is a ruler graduated from 0 to 50 at 100 micron intervals. The position angles may be determined by using the drift method.

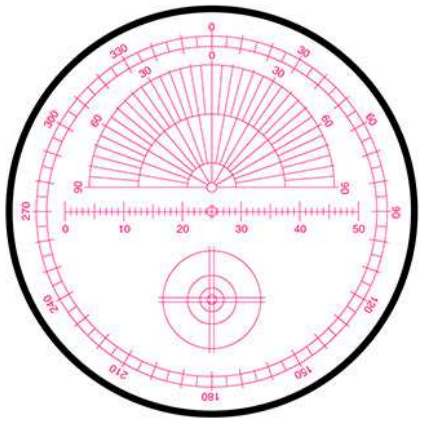


Fig 2. (right) Astrometric reticle.

Fig 3. (left) Meade 150mm Skywatcher.

Calibration of the linear scale

The linear scale on the Meade Astrometric eyepiece must be accurately calibrated in order to determine the scale constant (Z) i.e. the number of arc-seconds per division. The scale constant is given by:

$$Z = \frac{(15.0411)\, T_{AVE} \cos\delta}{D}$$

Where Z is the linear scale value in arc-seconds per division.
T_{AVE} is the average of the drift times.
δ is the declination of star.
D is the number of divisions (D=50 for this eyepiece)

The scale constant of the linear scale constant was determined for two different stars using the drift method (Argyle 2004). The eyepiece was rotated until the stars drifted from east to west exactly along the linear scale. The times to drift from the “50” division to “0” were then timed to one hundredth of a second. Twenty drift times were recorded and

averaged for each star. The average of these two values (Z=7.407) was used to determine the separations.

Table 1. Scale constant determination

Star	**Declination**	**Drift (sec)**	**Std dev**	**SEM**	**scale const**
Canopus	-52° 42’	40.57	0.167	0.037	7.397
Avior	-59° 51’	48.58	0.112	0.025	7.416

Procedure

To determine the separation, the double stars were aligned along the bottom of the 180° “fan” scale. They were then positioned on the central calibrated linear scale and the separation was then estimated to the nearest 0.1 division. This process was repeated five times for each pair and he values were then averaged and multiplied by the scale constant to give the separation of the double star in arc-seconds.

Position angles were determined using the drift method, taking the position angle directly from the protractor scale (Argyle 2004). First, the primary and secondary were aligned on the linear scale by rotating the Astrometric eyepiece. Then, using the hand controller, the primary star was taken past the centre of the linear scale. The tracking was then stopped and the star allowed to drift through the centre. If the star drifted off to either side of the centre, the process was repeated until the crosshairs in the centre cleanly bisected the drifting star. Once the star properly passed through the centre, it was allowed to drift to the 360° protractor scale. The position of the primary star as it crossed the protractor was then noted and recorded. The tracking feature was then re-enabled and the process was repeated five times for each double star and the resulting position angles were averaged.

Table 2 (next page). Observations

		Comparison of RWA - DLB - WDS				
	Designation	**M1**	**M2**	**Sep**	**PA**	**Epoch**
DUN126AB	12546-5711	3,9	5			
RWA				34,75	16,3	2010
DLB				34,4	17	2011
WDS				34,6	17	2001
DUN141	13417-5434	5,2	6,5			
RWA				5,58	162,2	2010
DLB				5,4	164	2011
WDS				5,4	163	2010
CPO61	13515-4818	7,4	7,4			
RWA				30,36	130,1	2010
DLB				30,0	131	2011
WDS				30,4	130	2010
DUN159AB	14226-5828	5	7,6			
RWA				9,05	156,8	2010
DLB				9,1	155	2011
WDS				9.1	157	2010
HJ4690AB	14373-4608	5,6	7,7			
RWA				19,21	23,8	2010
DLB				18,8	24	2011
WDS				19,2	24	2010
CPO415	15107-4344	7,1	7,7			
RWA				49,87	19,8	2010
DLB				50,6	19	2011
WDS				49,9	20	2010
DUN178AC	15116-4517	6,5	7,3			
RWA				30,41	256,9	2010
DLB				29,8	257	2011
WDS				30,7	257	2010
DUN177	15119-4844	3,8	5,5			
RWA				26,53	143,2	2010
DLB				26,9	143	2011
WDS				26,5	143	2010
DUN192AB-C	15471-3531	6,9	7,3			
RWA				34,73	143	2008
DLB				35,0	143	2011
WDS				34,6	143	2010
RWA	Bob Argyle	26.5" refractor JHB		Repsold micrometer		
DLB	Dave Blane	6" refractor		Meade Astrometric eyepiece		
WDS	Washington Double Star catalogue					

Conclusion

Ronald Tanguay, who has had many years of experience working with reticle micrometers, states that, "*Measurements within 5% of catalog values can be considered good and measurements within 1% or less can be looked upon as excellent work. With a well calibrated reticle micrometer, we may expect measurements to average about ± 1 degree in the position angle and ± 2% in separation from the data listed in the WDS Catalog. The reticle micrometer, if carefully calibrated, can be a reasonably accurate tool for use in measuring double stars.*"

The tabled separation measures made with the Astrometric eyepiece differ from the WDS values by an average of 1.2% while the position angles differ by an average of 0.6^{o} which indicates that it is possible to obtain acceptable results for wide double stars. The main limitation of the eyepiece is the relatively course linear scale. In this case Z=7.407 which means that separations less than this do not span even one division on the linear scale. If we are able to estimate to 0.1 division this translates to 0.74 arc-seconds or about 10% error. Not only is the distance measurement prone to a larger percentage error than for a wider pair, but also the position angle (PA) is much more difficult to determine, as there is such a short baseline available for aligning the central scale for the PA measurement.

Also, the large number of scales etched on the reticle results in a markedly brighter field when it is illuminated. With the equipment described above, this limits the measuring of double stars to systems where the secondary is brighter than about 8.5 magnitude.

With several thousand visual double stars within range of 75 to 200mm telescopes, and with the availability of inexpensive reticle micrometers, today's amateurs are in a unique position to make contributions to double-star astronomy that they previously may not have thought possible.

References

Mason, Brian. *The Washington Double Star Catalog.*

Webb Deepsky Society- DSSC 19

Argyle, R. Observing and Measuring Visual Double Stars, Springer, London 2004.

Frey, Thomas G. Journal of Double Star Observations, Spring 2008, , 3(2),p.59-65.

Tanguay, Ronald C., Sky and Telescope. February, 1999 p. 116-120.

Grisham, D. et al. Journal of Double Star Observations, 4, 10. "Double Star Measurements with a Three Inch Tasco Telescope." (2008).

Amateur Optical Tracking in South Africa during 1957-2014. Part 3

Greg Roberts

Abstract: This is the third article of what is planned to be several, covering the history of amateur satellite tracking in South Africa during the period 1957 to the present. It will concentrate almost exclusively on optical tracking rather than being a complete record of optical and radio tracking and will only handle observers who reported scientific data to the various tracking networks.

First stations

Initially four Moonwatch stations were set up in South Africa and were all that was required in SA. It should be no surprise that the stations were setup at four professional observatories since the technical and astronomical expertise was available from astronomers. In addition the observatories possessed the necessary infra-structure such as time signals and communications. Each station was given a site number, starting at 0401 and increasing incrementally. (The series starting 0400 was reserved for Africa). These numbers were used to identify a particular station as the geographical co-ordinates were registered in a central database so it was a unique identification. No two sites could have the same number and for an observation to be processed by the various processing centres the observation had to have been made at one of these numbers.

The SA stations were not arranged in a network, but their considerable north-south separation provided a wide observation fan for coverage of all predicted satellite orbits. These stations were so located that for four months of the South African summer satellites were sunlit all night over some parts of the fan.

The station numbers were allocated alphabetically as follows:
0401 Bloemfontein – Team Leader G N Walker, Longitude 26d 13m 35.50s E, Latitude 29d 06m 19.56s S, altitude 1494 metres.
0402 Cape Town 120 Woodgate Road – Team Leader W P Hirst, Longitude 18^{o} 28’ 37.984” E, Latitude 33^{o} 56’ 00.440” S, altitude 7 metres.
0403 Johannesburg – Team Leader Dr C N Williams, Longitude 28^{o} 04’ 30” E, Latitude 26^{o} 10’ 55.3” S, altitude 1806 metres
0404 Radcliffe Observatory ,Pretoria – Team Leader R F Smith
Longitude 28^{o} 13’ 43.5” E, Latitude 25^{o} 47’ 18” S, altitude 1542 metres.

Station 0401 Bloemfontein

Bloemfontein in the 1950-1960's could have been regarded as the astronomical centre of South Africa. It was home to two professional observatories - the University of Michigan's Lamont-Hussey Observatory on top of Naval Hill in central Bloemfontein and used for double star observations, and the multi- ational Boyden Observatory situated some 24 km outside of Bloemfontein at Mazelspoort. In addition Bloemfontein enjoyed the best all year round observing conditions.

Fig 1 (left). Bloemfontein - Naval Hill

Initially plans were to set up a MINITRACK MARK 1 radio tracking station south of Bloemfontein with Dr FJ Hewitt, Director of the National Telecommunications Research Laboratory in charge of the project. It was further proposed to set up at the MINITRACK site a teleprinter that would be linked to the Moonwatch teams, the Precision optical-tracking station at Olifantsfontein (also known as the Baker-Nunn station or SC2) and the Marconi Cable and Wireless Station in Cape Town.

Unfortunately for Bloemfontein the MINITRACK station was eventually sited at Harteebeesthoek , near Krugersdorp.

Dr Jurgen Stock was sent to Boyden in Dec 1956 as caretaker/director. He first set in motion the possibility of a Moonwatch station at Boyden when the first recruitment of people for Moonwatch was launched, using articles in two local newspapers – *Die Volksblad* and *The Friend*.

According to a detailed reported to Moonwatch headquarters in the United States, the Bloemfontein Moonwatch Group was officially formed on the 12 July 1957 at a meeting held at Boyden Observatory.

Stock left soon after the first meeting and returned to Hamburg at the end of July 1957. He was replaced by Professor H. Haffner (from Hamburg, Germany) who took over as Boyden's Director, giving his full support and enthusiasm to the venture to ensure its success.

It was initially planned to host the Moonwatch site at Boyden and practice sessions were held in the Boyden Library. One of the Moonwatchers – Eric Burton – son of Ernest Burton who was the resident engineer at Boyden – provided his 35 mm slide projector. They put in a slide with a totally black piece of film, which had a pin hole in it so that a ray of light could be projected. By moving the slide across the projection slot, they could simulate a satellite passing across the projection screen. Eric was an amateur enthusiast, whose full-time job was with *The Friend* newspaper in Bloemfontein, now no more.

Fig 2 (left). Mr and Mrs Burton with their son Eric in the middle.

Under the guise of the International Geophysical year programme and financed by a grant in aid from the South African Council for Scientific and Industrial Research (CSIR), Boyden received a case of optical lenses from the United States with instructions on how to make simple telescopes which could be used to accurately observe satellites passing overhead. A simple drawing of how to make the telescope (fixed focus) was enclosed in the package. The tube

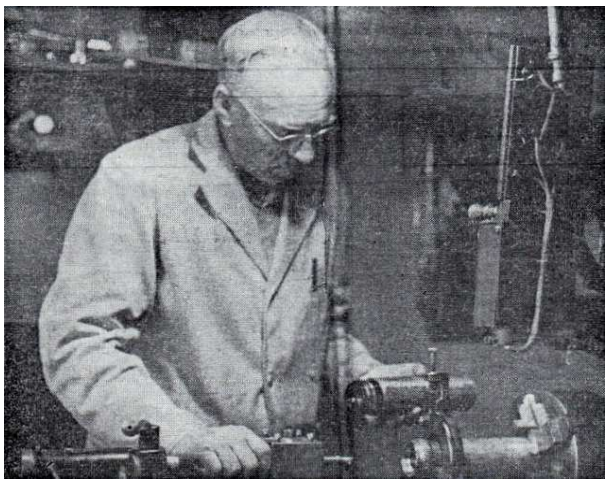


Fig 3 (left). Ernest Burton machining a 50mm telescope.

housing the optics was two inch (50mm) galvanised piping with brass turned lens holders. These were machined by Ernest Burton in the Boyden workshop with the help of some volunteers who worked in the Railway workshops in Bloemfontein. The cross-wires in the telescope was a piece of Free State spiders web! Ernest also constructed the mountings which used to support the telescopes. These 50mm aperture scopes were popularly known as Elbow Telescopes.

While the telescopes were being made, Dr Haffner enlisted a team of people to be a Satellite Watch Team using these telescopes. Ernest was one of the team. Observations through the telescopes had to be conducted within two hours after sunset, or within two hours before sunrise, as that was the only time the satellites were generally observable. At other times, during the rest of the night, they passed through the earth's shadow and gave off no reflected sunlight, so were not observable. The programme thus called for several very early morning wake-up calls (3 am).

It appears that originally the Moonwatch station was to be set up at Boyden but this did not last long. However some early observations were made of Sputnik 1 – for example an observation made on 31 October 1957 of Satellite 1957 Alpha 1 (Sputnik 1) with station identification "Boyden Observatory Station number 2400", observation no 00614 made at 01h54m42s UT. Station 2400 had geographical co-ordinates 26^{o} 24’ 21” east longitude, 29 ^{o} 02’ 18” south latitude and height 1387 metres.

On the 29 November 1957 the site, situated in the game reserve on top of Naval Hill, near the centre of Bloemfontein, was used for the first time. Due to the requirement for observers to be present shortly after sunset, or before dawn, this had imposed quite a burden on most of the volunteer observers who were resident in Bloemfontein. This meant that the Boyden folk now had to travel 24 km to reach the new site.

The observation site on Naval Hill was in the old SA Broadcasting Reserve where two buildings were available for use. The one nearest the actual observing site was used to house equipment and materials whilst the further one was used for meetings and the dispensing of refreshments – an essential item in the cold morning hours!

The whole arrangement was very satisfactory, and since the move to the site had taken place there was a distinct increase in enthusiasm as its close proximity to all parts of town made it easily accessible at all times.

The team leader was Graham Walker, a civil engineer who worked with Shand's construction company designing and overseeing the construction of dams (among other projects). Prior to that time, the company's engineers had modelled what was believed to be a then-unique hydrodynamic design for passing silt downstream and oversaw the construction of Mockes dam upriver from Mazelspoort.

The meridian pole stood in front of the "operations building", with the line of telescope pedestals running north and south diagonally to the front face of the building with the ground falling from south to north, the pedestals being set at a slope of 1 in 20 to follow very closely the fall of the land and the site was surveyed by Walker to determine the meridional line and the latitude and longitude of the meridian pole was determined as:

Latitude 29^{o} 06’ 19.56” South
Longitude 26^{o} 13’ 35.50” East

whilst the height of the ground level above sea level was 4901 feet or 1633.7 metres.

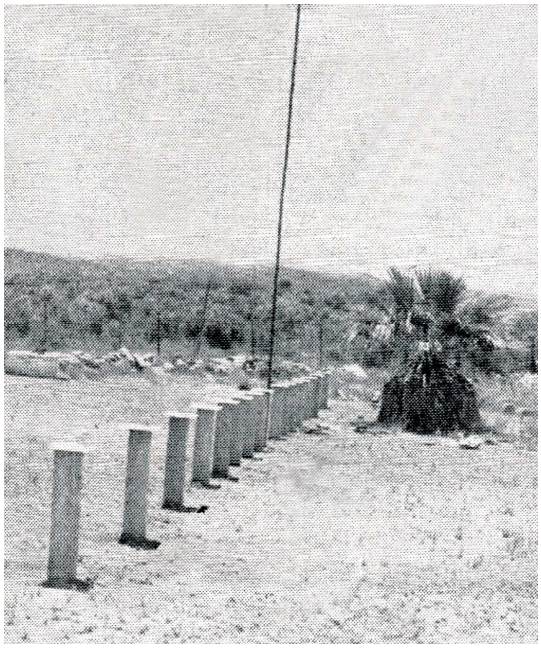
Walker recruited and organized the team and leaders were appointed, and taught to coordinate the setting up of the small telescopes on a preset north/south plain, so that each telescope looked at a different part of the sky with overlapping views. This had to be done at least 30 minutes before the scheduled crossing of the satellite. The telescopes were set up, each on a separate pedestal, fanned out facing skyward – like an open hand of fingers facing upwards. This resulted in only two or three out of a six-person team being lucky enough to see the passing satellite each time, as its precise path was not known. In the very early stages, satellite ephemerides did not exist, so a lot of time was spent/wasted hoping for a sighting. Only later when orbits were better known was it possible to expect a sighting and the observational data was then used to improve the satellite orbit.

When the satellite passed over and one of the observers spotted it passing through the telescope image, he would shout "Satellite!" As the moving image passed through the view and crossed the crosshair wire, he would shout "STOP". One of the team members had a stopwatch and started the watch at the exact moment of the "STOP" command. The stopwatch time was then used to accurately determine the exact time of the crossing when measured against the standard 24-hour chronometer clock, and recorded. The telescope that had viewed the occurrence was then accurately measured for its declination and the resulting information was telexed back to America.

A detailed report made by the Bloemfontein Moonwatch Group to Moonwatch Headquarters at its founding, makes interesting reading. It is referred to in some detail The Bloemfontein Moonwatch Group was officially formed on the 12 July, 1957 at a meeting held at Boyden Observatory. The group was organised on lines which made it possible to decentralise the control and execution of the multitudinous duties involved.

Control was vested in a Central Committee whose membership of the Group at the time of formation was forty, with office bearers as follows:

Director of Boyden Observatory	Dr W Haffner
Leader of Group	G N Walker
Deputy Leader of group	(photocopy not readable)
Secretary	Miss J.Stark
Treasurer	G P N Coetsee
Timing Committee-Convenor	R van Allemen
Star Charts –Convenor	R Reynolds
Radio and Communications – Convenor	H W Clarkson
Traffic and Police - Convenor	W Watson
Transport - Convenor	C A E Swanepoel
Telescopes - Convenor	G E Burton
Entertainment – Convenor	T R Cooper



A Construction Committee was appointed and was responsible for the preparation of the site for use, and was able to have most of the materials supplied free of charge by local firms.

Fig 4. (left). Telescopes, pedestals and meridian mast.

The pedestals consisted of 6-inch Everite pipes, concreted into the ground to a suitable height. These were then partially filled with soil and the upper 12 inches (30 cm) filled with concrete. A plate with three anchor bolts was then set into the top of each pedestal to correct level, line and distance.

The meridian pole, 41 ft. (12.5 m) in height, had a cross member at the top, extending 11 ft. (3.4 m) on each side and was supported by steel wires.

Fifteen telescopes were constructed by the Telescope Committee and stated to be an “excellent job". These were set up using the meridian mast and provided a meridian arc of 115^{o} with a 1.5^{o} overlap with their 12^{o} field of view. The telescopes thus covered from a zenith distance of 61^{o} south (declination 90^{o} south) to a zenith distance of 54^{o} north (declination $+25^{o}$).

Star charts were used to locate the satellite in its path across the field of view and were provided by the Boyden Observatory as photographic reproductions of the Skalnate Charts, with white stars and a black background.

Finance of course was always important. The Boyden Council made a donation of 30 pounds and the firm G A Fichardt Ltd made one of 5

pounds 5 shillings. An offer of 15 pounds by Dr Evans from the Cape Team funds was not taken up as it was felt that the Bloemfontein group see to its own finances and not look to other groups – however the gesture was appreciated. A grant of 50 pounds had been approved by the City Council of Bloemfontein and apparently paid to the team. It was subsequently turned down by the Administrator as not being within the authority of the Council.

(The report contained a full list of all members of the team for those interested.)

New telescopes

It soon became obvious that the original 50mm aperture telescopes supplied were completely inadequate for the task of observing the US Vanguard and Explorer satellites so larger aperture telescopes were soon supplied to teams.

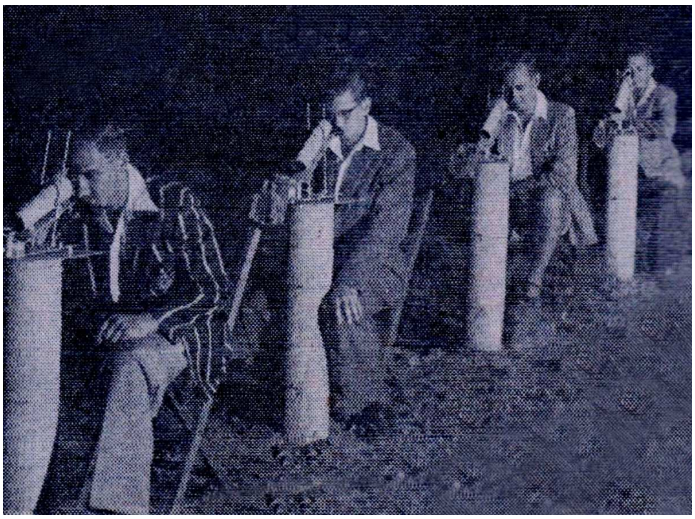
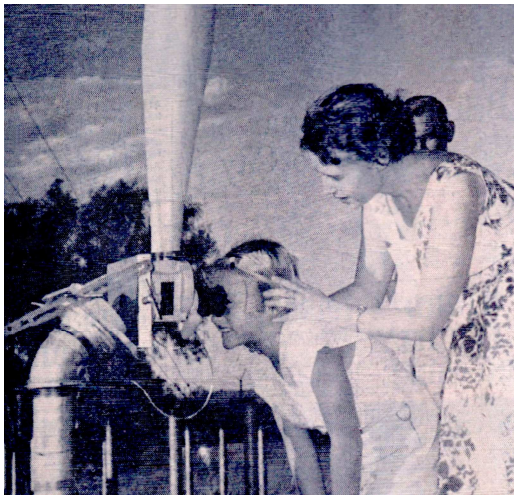


Fig 5 (right). Bloemfontein observers with the original 50mm telescopes.

Towards the end of 1957 Dr Evans (who was the Moonwatch visual coordinator for South Africa) was approached by Moonwatch HQ and asked whether he could use 20 so called "APOGEE telescopes" at each of the four South African stations. This was subsequently changed by the US Naval Research Labs (who constructed the telescopes) to 50 each for Cape Town and Bloemfontein with none being supplied to Johannesburg and Pretoria with the explanation that they were "too far north to observe the Vanguard satellite" – rather a remarkably incorrect statement! (source Jan

Hers Moonwatch in South Africa 1958-1959). Roy Smith of the Pretoria group thought it more likely that Cape Town and Bloemfontein were considered the safest addresses.

50 APOGEE telescopes were installed at Cape Town in Jan 1958. However, at Bloemfontein there was some difficulty as they were unable to field enough observers (it would appear that most of their original 75 observers had rapidly lost interest with the strenuous observing times!).



There is some uncertainty about the exact number of APOGEE telescopes supplied. In *MNASSA* 1958 Vol 17 Page 4 where David S Evans wrote "Two consignments of additional instruments were delivered to teams at Cape Town and Bloemfontein. Each consisted of 49 5-inch APOGEE telescopes and 18 2-inch telescopes... etc..."

Fig 6 (above). Miss J. Stark, Secretary of the Bloemfontein Moonwatch group demonstrating the 5-inch Apogee telescope in operation.

The decision to only supply to Cape Town and Bloemfontein naturally dismayed the Johannesburg and Pretoria teams and there was a vigorous protest. Around middle Feb 1958 approval was given for some of the APOGEE scopes at Bloemfontein, but not yet installed, to be transferred to Johannesburg and Pretoria Moonwatch. Five APOGEE telescopes were sent to each location with the five Pretoria Apogee telescopes being installed at the CSIR Site.

Following the first United States satellite launch (EXPLORER 1 launched on 31 January 1958) Bloemfontein obtained its first observations of it on 21 February, made by P J Visagie of First Avenue and Eric Burton. Further

observations were made on 23 and 25 February and on 23 February at an almost incredibly low altitude of 17.9 ^{o} to the north.

Fig 7 (right). PJ Visagie and Ernest Burton – first Bloemfontein observations of US satellite Explorer 1.

During the period 1957-1958 Bloemfontein reported a total of 52 observations of various satellites to the Moonwatch program. In addition Dr Haffner often used to send messages to Russia with observations of Soviet satellites made by the team.

Peter Usher was one of the Moonwatch team while in his final study years at the University of the Free State. This was before he went and completed his astronomical studies in the USA, where he now lives. Peter used to help with exacting measurements and the transmitting (by Telex) of the information the Moonwatchers got.

Peter recounts an amusing story how, late one evening, he decided to walk up to the telex building from Union Avenue to see if there were any new predictions etc. It was pitch black and he could barely make out the macadamized (tarred, paved) road by the light of the stars. All of a sudden all hell broke out around him with bodies flying through the air. He had walked into the middle of a herd of impala!

At the end of the IGY (International Geophysical Year) program, the team members were each awarded with a lapel pin badge with the IGY insignia on it.

The end of Bloemfontein Moonwatch

It would appear that the Moonwatch team in Bloemfontein was only originally set up for the duration of the International Geophysical Year – about one year. By the end of 1958 it had virtually ceased to operate. The last observation appears to have been made on 19 December 1958. It was of the large PROJECT SCORE (1958 Zeta) satellite which was an Atlas rocket some 80 feet (24 m) long and diameter 9 foot (2.7 m). It was launched on 18 December 1958 into an orbit inclined at 32.4^{o} to the equator and with an orbital period of 101.5 minutes. The orbit ranged from 118 to 911 miles (190 to 1 460 km) above the earth.

According to a *Sky and Telescope* magazine article, visual observations of the tumbling of the Atlas satellite were made by G N Walker and his associates. On 21 December they observed a recurring brightness cycle of 63 seconds, each maximum of light intensity being double, with peaks about five seconds apart.

However, the flashing behaviour was quite different on 3 January when the Atlas was seen from Cambridge, Massachusetts, by Moonwatch observers. Although the rocket was some 2 000 km away, it periodically attained an apparent magnitude of +1 during its short life-time.

On 28 December 1961 Moonwatch headquarters wrote to a Mr P J Kruger of the University of the Free State with the comment: "Our records show that the last observations received from Bloemfontein were in December 1958. We cannot but feel that interest is low and unless there is a possibility that observations will again be made on a regular basis, we must give consideration to withdrawing the team from the program."

On 30 March 1962, Moonwatch HQ again wrote and requested that the equipment be sent to the Baker-Nunn Smithsonian Satellite Tracking Station. It detailed 10 APOGEE telescopes, 3 stopwatches, a pair of binoculars and three tape recorders. On 6 April 1962, Bloemfontein

Moonwatch was given formal notice by Moonwatch HQ of the withdrawal of the Bloemfontein Team from SAO's Moonwatch network.

However it would appear that the correspondence did not reach P J Kruger (it's not clear what his actual role was with Bloemfontein Moonwatch) as he was no longer at the University of the Free State. On the 3 April 1963 he replied from the South African Wool Textile Research Institute in Grahamstown to the Moonwatch correspondence as follows:

"In 1959 we re-organised the Moonwatch team in Bloemfontein. In 1960 we had it in operation but during that time I left Bloemfontein for Europe and informed your office accordingly. A new team leader was appointed in the person of Mr J Booeyens and his name and address was also forwarded. Unfortunately he left a few months later. In the meantime correspondence did not reach him but was still sent to my old address. Some of these letters came to my attention recently after my return to this country. I refer to your letters of 16 January 1962; 5 March 1962, 6 April 1962 and that of 30 March 1962. The equipment was called back by you but the correspondence did not reach the people concerned. I hope to get in contact with the people in Bloemfontein and trust that you succeeded eventually in getting the equipment. However the equipment as listed is not correct. We had only one tape recorder and not 3 as mentioned"

And so Bloemfontein Moonwatch ceased to exist.

However Bloemfontein was not keen to disappear from the tracking scene just yet!

In 1962 a team was sent out from the USA to Bloemfontein to try and observe the geodetic research satellite ANNA 1B which had a flashing light source on it that was operated under command. The writer recalls reading a short article in a local newspaper at the time but that is about the sum total of the info available on Bloemfontein's involvement.

On 13 February 1963, SYNCOM 1, a small hatbox sized satellite (71 cm diameter and 38 cm high, weighing 35 kg) was launched into a 32^{o} inclination high altitude orbit by a Thor-Delta booster to mark the beginning of the synchronous communications satellite era.

Initial communications tests conducted from the USNS Kingsport, a tracking ship located off the African coast near Nigeria, were successful but 20 seconds after a ground command was given to fire the spacecraft's apogee motor, all communication with the spacecraft was lost. The cause of the failure was eventually determined to be the rupturing of a tank of nitrogen that was part of the on-orbit control system.

Using search data based on data obtained from the Kingsport, the Boyden Observatory photographed Syncom 1 as a 17^{th} magnitude object some two weeks later. However all attempts to re-establish communication contact with the spacecraft failed.

Thanks

A special thanks to Dawid van Jaarsvelt (UFS) who spend many hours going through old newspapers in the State Archives and scanning any satellite related articles and pictures – some of which are included in this article.

In compiling this report I would also like to sincerely thank the following people for their input and support: Ellen Alers-reference archivist at the Smithsonian Institute, Washington, USA Eric Burton (New Zealand) Willie Koorts (SAAO), Keith Snedegar (USA), Peter Usher (USA) and the late Roy Smith (Pretoria).

Note. The poor quality of some of the images is due to the fact that the originals could not be located and as a result images were scanned from Newspaper archives.

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. - *Editor*

SAAO

Title: Sonification for the exploration of 1D Astrophysics data
Speaker: Wanda Diaz Merced
Date: 17 April
Time: 11h00 – 12h00
Venue: SAAO Auditorium

Abstract: The current analysis techniques of astrophysical data are mainly based on visually scrutinizing the data. However data sets acquired from the natural lab of the interstellar medium can contain events that may be masked by noise, fleeting, non-persistent etc, making it difficult to identify them. In this talk, we will explore another way of analysing data, using sonification techniques: sonification of data conveys information using mainly non-speech sound. This research presents the use of sonification

techniques as an adjunct to visualization in order to enrich current data analysis techniques. The results from a focus group are also presented

Title: Development of Astronomy in Nigeria and West African Countries
Speaker: Romanus Eze (University of Nigeria, Nsukka)
Date: 30 April
Time: 15h00 – 16h00
Venue: SAAO Auditorium

Abstract: Development of Astronomy in Nigeria and West African countries which started as early as 1960 had been very slow but steady as a result of the following factors: Government lack of interest and poor funding, lack of manpower as a result only the University of Nigeria runs both graduate and undergraduate programs in Astronomy, which is complemented by International collaboration, lack of working equipment, ground and space based telescopes and poor motivation on part of the students. In this talk I will briefly discuss the efforts made recently by the Nigerian government to boost the study of Astronomy in Nigeria and the efforts made by some other West African countries to get the study of Astronomy on board.

Title: Faltering Steps into the Galaxy
Speaker: Gary Zank
Date: 05 May
Time: 11h00 – 12h00
Venue: SAAO Auditorium

Abstract: Voyager 1 has now entered the interstellar medium, a moment of great historical import. We describe the Voyager 1 magnetic field and energetic particle observations, the initial uncertainty surrounding a possible crossing of the heliopause, and the eventual clarification by the Plasma Waves Analyzer. The interaction of the solar wind and the interstellar medium is complicated by the presence of neutral hydrogen that is coupled via charge exchange to the plasma. We present the current

status of theory, models, and simulations, describing the highly non-equilibrated interaction and the underlying physics. We conclude by discussing briefly related interactions of stellar winds with their local environments.

Title: EXO-COMETS: Now you see them, now you don't
Speaker: Barry Welsh
Date: 05 May
Time: 15h00 – 16h00
Venue: SAAO Auditorium

Abstract: It is thought that planets form out of cosmic dust grains that collide and stick to form larger and larger bodies. Once at the 1km size these icy rocky bodies are termed "planetesimals", and are the building blocks of all planetary systems. In the case of our own Solar System, these small bodies have evolved to become comets or asteroids that mostly reside in either the Kuiper Belt or Oort cloud. Recent observations of young (< 50 Myr old) nearby A-type stars have revealed the spectral signatures of these "exo-comets" as they become gravitationally dragged towards the central star and release large amounts of evaporating gas. To date, exo-comet activity has been detected towards about a dozen of these young stars, all of which probably harbor (as yet undetected) orbiting exo-planets. In this talk we present an overview of exo-comets and the observing techniques required to detect them.

Title: Science Outreach and Education through Film – Storytelling in a Digital World
Speaker: Kai Staats
Date: 15 May
Time: 11h00 – 12h00
Venue: SAAO Auditorium

Abstract: The on-line, digital video medium has become as commonplace as was television for the prior generation. One in every 7 humans on the

planet visits YouTube each month and more than 100 hours of new video are uploaded each minute.
How can we use digital video and film as a means of encouraging learners to embrace a science education?
The key may lie less in computer-generated special effects and editing for a short attention span and more in old-fashioned story telling.
Amateur astronomer, MSc student at AIMS, and film-maker Kai Staats will share “LIGO, A Passion for Understanding” which premiered at Space.com mid April, ”Chasing Asteroid 1998 QE2” with SAAO astronomer Nicola Loaring in May 2013, and a short from a 2014 Mars Analog. Kai will engage the audience in discussion about film-making as it relates to science outreach and education.

Title: Pulsational properties of the B-type supergiants
Speaker: Jakub Ostrowski
Date: 29 May
Time: 11h00 – 12h00
Venue: SAAO Auditorium

Abstract The unexpected discovery of pulsational frequencies in the light variations of the blue supergiant HD 163899 (B2 Ib/II) has prompted a few groups to re-analysis of pulsational stability in models after Terminal Age Main Sequence (TAMS). The star has become a prototype of a new class of pulsating variables coined Slowly Pulsating B-type supergiants (SPBsg). Previously, it was believed that pulsations (especially g-modes) cannot be present beyond Main Sequence (MS) due to a very strong radiative damping in the helium core. The presence of g-mode pulsations in B-type post main sequence stars has been explained by a partial reflection of some modes at an intermediate convective zone related to the hydrogen shell burning or at chemical gradient zone surrounding the radiative core. However, these two interpretations are based on the assumption that HD 163899 is before helium core ignition, i.e., in the phase of hydrogen shell burning. This assumption does not have to be necessarily adequate because the blue loop can reach temperatures of early B spectral types.

Using MESA evolution code and a non-adiabatic pulsation code, I investigate and compare SPBsg models before and after He core ignition. The new instability areas and comparison of pulsational properties of models on both evolution phases will be presented. I will also discuss prospects for mode identification in such stars. Analysis of SPBsg stars can be of great value for understanding poorly known details of physics of massive stars on the later stages of evolution, such as parameters of convective zones or influence of various parameters on the emergence and shape of the blue loops**.**

Title: The structure of the Galactic Disc
Speaker: Michael Feast
Date: 05 June
Time: 11h00 – 12h00
Venue: SAAO Auditorium

Abstract After a short general introduction to our understanding of the Galactic disc the talk will focus on its outer regions. Five classical Cepheids have been found beyond the Galactic bulge at heliocentric distances of ~25 kpc and 1-2 kpc above the plane. Their significance in establishing a stellar component to the flared disc and its structure will be discussed with particular reference to HI work.

Title: Teaching History of Astronomy to the Public: The ABC Experience
Speaker: Dr. Julio Saucedo Morales (University of Sonora)
Date: 19 June
Time: 15h00 – 16h00
Venue: SAAO Auditorium

Abstract: Astronomy has played an important role in the history of civilization; unfortunately this is not properly appreciated, for the public knows little about astronomy and its history. But people from all walks of

life find our science attractive, which represents an opportunity to fill the gap through outreach and education. Here I present our efforts in this direction, through teaching the Astronomy Basic Course (ABC). I will present the structure of the ABC, a 3-month theory-practice course we have taught for the public for the last 25 years. I will then concentrate on a survey carried out to study the impact of the ABC. I will also briefly discuss some other astronomical activities we do at Universidad de Sonora, concentrating mainly on outreach and education, as well as about the possibilities for collaborations

ACGC

Title: Measuring the transition to homogeneity with photometric redshift surveys
Speaker: Roy Maartens (UWC)
Venue: M111 Maths Building, UCT
Date: 13 May
Time: 12h00

Abstract: If the B-mode signal in the CMB polarization seen by the BICEP2 experiment is confirmed, it will be the first detection of the imprint of primordial gravitatio nal wave s generated during inflation. This result will have dramatic implications for inflationary models - and is also in tension with Planck limits on standard inflationary models. It is therefore important to investigate whether this signal can arise from alternative sources. We investigate whether vector and tensor modes from primordial magnetic fields can explain the signal. We find that in principle, magnetic fields generated during inflation can indeed produce the required B-mode. In this case, the primordial gravitational wave amplitude is negligible, so that there is no tension with Planck and no problems posed for current inflationary models. However, the simplest magnetic model is in tension with Planck limits on non-Gaussianity in the trispectrum. Alternatively, a weaker magnetic field can pass the non-Gaussianity constraints and allow

the primordial tensor mode to be reduced, thus removing the tension with Planck data and alleviating the problems with simple inflationary models .

Title: The Dark Energy Survey – Year 1 Observations and Results
Speaker: Roy Maartens (UWC)
Venue: M111 Maths Building, UCT
Date: 27 May
Time: 12h00

Abstract: The Dark Energy Survey (DES) has just completed it's first full year of science operations. This third generation experiment, operating on the 4m Blanco telescope in Chile, has been specifically designed to constrain the nature of "Dark Energy", the most significant problem in cosmology today. Over a 5 year period, DES will map out the large scale structure of the Universe and discover up to 4000 SNe Ia to z=1.2, allowing us to determine the nature of Dark Energy to 1%. The inferred constraints on the contents of the Universe will be an order of magnitude better than current datasets and will not be superseded until the LSST & the SKA.
In this talk, I will review the first year of DES observations, highlight early science results and emphasise the key role being p layed by the SALT telescope in South Africa to harness the full potential of this survey. This talk will give the first glimpse of the DES SNe first year data and initial results as we begin our five year survey in search of the nature of dark energy.

Title: Correlation function on very large scales
Speaker: Daniele Bertacca - UWC
Venue: M111 Maths Building, UCT
Date: 24 June
Time: 12h00

Abstract: We extend previous analyses of wide-angle correlations in the galaxy power spectrum in redshift space to include all general relativistic effects. These general relativistic corrections to the standard approach

become important on large scales and at high redshifts, and they lead to new terms in the wide-angle correlations. We show that in principle the new terms can produce corrections of nearly 10% on Gpc scales over the usual Newtonian approximation. General relativistic corrections will be important for future large-volume surveys such as SKA and Euclid**.**

UWC

Title: Modelling cosmological reionization and IGM temperature evolution
Speaker: Sourav Mitra (UWC)
Venue: Room 1.35 of the Physics Department, UWC
Date: 27 June
Time: 14h00

Abstract : Reionization is a complex process whereby hydrogen (and helium) in the Universe is ionized by the radiation from first luminous sources. Theoretically, the importance of the reionization lies in its close coupling with the formation of first cosmic structures and hence there is considerable effort in modelling the process. In this talk, I will present our recent works on some aspects of this subject. In particular, I will give an overview of a semi-analytic approach to study the observational constraints on reionization. We implement a method to do a detailed statistical analysis using Principal Component Analysis (PCA) technique. I will also discuss different observational aspects on this area of research and show how reionization can affect the IGM temperature evolution. In the latter half of the talk, I will also discuss about one of my ongoing works on constraining the equilibrium model for galaxy growth by Markov Chain Monte-Carlo (MCMC) technique using various recent observations.

NASSP

Title: Multiple supermassive black hole systems
Speaker: Roger Deane from UCT
Date: 16 April
Time: 14h00
Venue: MCB LT1

Abstract: Multiple supermassive black hole (SMBH) systems have long been predicted to play an important role in galaxy evolution and determine the stochastic gravitational wave background spectrum in the nHz-microHz frequency range. I will provide an overview of the above, as well as the current observational status of multiple SMBHs, highlighting our recent discovery of the highest redshift, sub-kiloparsec binary SMBH known to date. I will discuss the multi-wavelength techniques used to find these systems and argue that the radio-jet morphology may be a very efficient way to do so with radio facilities like MeerKAT and the SKA.

Title: Rise of the Machines
Speaker: Bruce Bassett from AIMS, SAAO and UCT
Date: 08 May
Time: 16h00
Venue: MCB LT2

Abstract: Will machines be able to do research? In this talk we will examine the massive recent progress in artificial intelligence and deep learning and investigate how machine learning will impact science research with a focus on astronomy.

Title: Corridor Talk: Learning How to be an Astrophysicist
Speaker: Jarita Holbrook from UWC
Date: 14 May
Time: 16h00
Venue: MCB LT1

Abstract: In the classroom, at the telescope, working in offices students learn the ins and outs of the scientific content of astrophysics and space sciences; however, it is in the informal discussions that often take place in the corridors that students learn how to be an astrophysicist or space scientist. This discussion with activities tries to bring such useful discussions to a more formal setting. Come and be prepared to examine what you have learned about the scientific culture in which you live.

Title: Space Weather - what you can't see can hurt you!
Speaker: Dr Pierre Cilliers, Pr.Eng Research Physicist in the Space Science Directorate of SANSA
Date: 21 May
Time: 16h00
Venue: MCB LT1

Abstract: SANSA was appointed in June 2007 as the African Regional Space Weather Warning Centre for Space Weather of the International Space Environment Service (ISES). The vulnerability of modern communications and electrical power distribution technology to space weather events is one of the reasons for SANSA's research on Space Weather and for South Africa's cooperation with various institutions on the design and development of a space weather payloads for satellites.
Dr Pierre Cilliers participated in an Antarctic expedition in December 2007 and an expedition to Marion Island in April 2010 to promote international research on Space Weather.
Dr. Cilliers will present challenges and opportunities for research in Physics and Engineering which relates to the following areas
- space weather observations inter alia in Antarctica, on Marion Island, on Gough Island
- the development of space weather sensors for CubeSats
- the prediction and mitigation of space weather impacts on technology.

AIMS

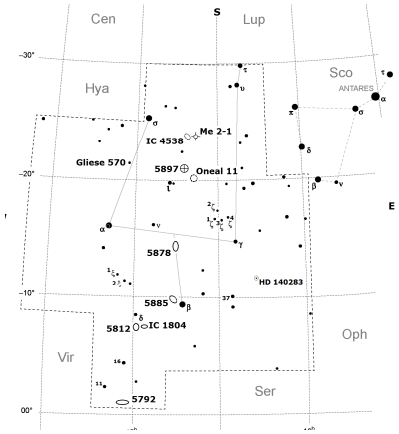
Title: Modelling cosmological reionization and IGM temperature evolution

Speaker: Sourav Mitra (University of Western cape, Postdoctoral fellow).
Venue: AIMS research centre
Date: 14 April
Time: 12h00.

Abstract: Reionization is a complex process whereby hydrogen (and helium) in the Universe is ionized by the radiation from first luminous sources. Theoretically, the importance of the reionization lies in its close coupling with the formation of first cosmic structures and hence there is considerable effort in modelling the process. In this talk, I will present our recent works on some aspects of this subject. In particular, I will give an overview of a semi-analytic approach to study the observational constraints on reionization. We implement a method to do a detailed statistical analysis using Principal Component Analysis (PCA) technique. I will also discuss different observational aspects on this area of research and show how reionization can affect the IGM temperature evolution.

Sky Delights: Balance your view through Libra

Magda Streicher



When the constellation Libra pops its head up above the eastern horizon it also brings the importance of balance to the fore. Balance has relevance to many things, not only for us as people, but also, and especially, to astronomy. Is our inclination not frequently to seek out only the bright deep-sky objects, whether with a telescope, binoculars or the naked eye, while so many of the fainter objects are pushed aside? And this is where, when a balance is maintained, we can be surprised by the results. Libra is located just north of the better known constellation Scorpius. The stars currently making up the constellation were first characterised by Eratosthenes as the pinchers or claws of the Scorpius shape.

About 4 000 years ago the Sun resided in Libra at the northern autumn equinox, when day and night have equal lengths and are in balance. Over time (due to the wobble of Earth's axis under the influence of the Sun's and Moon's gravity) the Sun in its autumn equinox reside now in the constellation of Virgo.

Virgo was a goddess known as Astraea who held the scales of Justice, which explains the association with the Scale indicated by the constellation Libra. Quite coincidentally, and aptly, on 22 May 2000 a message was received announcing that the shadow track of an occultation of the magnitude 9.4 star Hipparcos 75185 by the minor planet 5 Astraea in the constellation of Libra was expected to cover Polokwane, the province in which I live, after crossing the Australian mainland and the Indian Ocean. The star is situated only one degree east of beta Librae. Albert Brakel and I were advised by the RASNZ Occultation Section that we

had been successful in our observation of the occultation in defining the major dimension at 162 km x 96 km in size. The late Danie Overbeek (then the occultation director) was very exited and send Brakel and the author a note of appreciation.

The two famous stars alpha and beta Librae, known in ancient times as the two claw stars belonging to Scorpius, probably have the strangest nicknames of all the stars in the sky: Zubenelgenubi, alpha (the southern claw) and (even worse!) Zebeneschamali, beta (the northern claw). Don't feel guilty if you have not heard these strange names before – you're not alone!

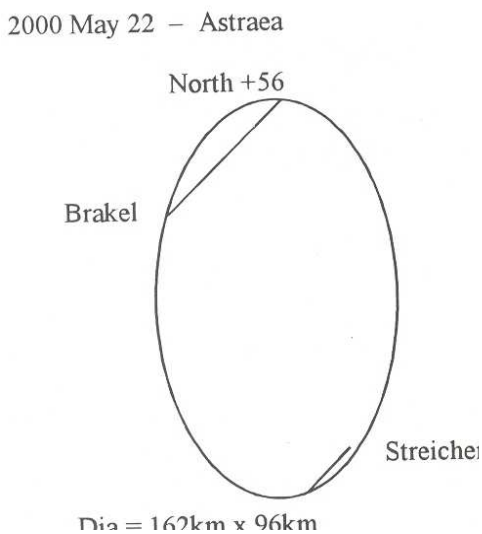


Fig 2. (left) Occultation sketch of asteroid Astraea.

The southern magnitude 2.7 alpha is also a double star, shining with a pale yellow primary and a light grey companion, with a separation of 60" and visible with the naked eye in very dark starry skies. The brighter beta Librae, with a magnitude of 2.5, is sometimes referred to as the pale emerald star

Fig 3. PLN 342+27.5 (Dale Liebenberg).

Looking at the constellations Scorpius and Hydra, we find the magnitude 3.2 sigma Librae, just a few minutes from the north-eastern boundary of Hydra. To find the planetary nebula **PNG 342.1+27.5** (more popularly known as Me 2-1) it is easiest first to search out the galaxy **IC 4538**. No

easy task, this galaxy is extremely faint, but averted vision will bring to the fore at least a soft oval haze. But when success is achieved, PK 342.1+27.5 will be found, situated only 15' towards the east of the galaxy. The planetary, which is about 15 000 light years away, is also the close neighbour of the magnitude 9.8 star SAO 183407, only an arc minute towards the east. The planetary nebula appears as a faint dot, barely seen, which disappears with direct vision, but averted vision shows an out-of-focus star with a soft edge. With higher magnification there seems to be a faint star on the western periphery. Perhaps a nebular filter would help one spot it and make the task slightly easier. If it had not been for the blinking effect I would not easily have seen it. Higher magnification reveals a really soft, round planet Uranus impression with a light blue colour and smooth disc. The hot central magnitude 16 star could not be seen. Sometimes it requires careful observation and a lot of time and patience to spot special objects like this one.

The planetary was discovered by Paul Willard Merrill (15 August 1887 – 19 July 1961) in 1942. Merrill was an American astronomer whose speciality was spectroscopy. He was the first to define S-type stars (in 1922). He spent the bulk of his career at Mount Wilson Observatory, from which he retired in 1952.

Fig 4. Paul Merrill

Approximately 2.3 degrees north and 1.6 degrees south of the double star 4.5 and magnitude 6 iota Librae, one of the giant clusters found its home. The globular cluster **NGC 5897** displays a soft, round, perhaps slightly oval glow with a fringy edge. It is not very condensed, gradually getting brighter towards the middle. Careful observation reveals a sandpapery texture. It could also be seen as a loose heap of very faint stars mingling in haziness. With higher power, however, the very faint stars just seem to multiply, revealing a milky, blazing core blending together. The north-western edge

comprises a few brighter stars, together with faint stars spreading out, which most probably gives it the slightly elongated impression. In the wider north-eastern field of view brighter stars run out in zig-zag formation with a look-alike double star accompanying them. Try to spot this globular cluster with binoculars when you next experience favourable dark skies. "In April 1784, William Herschel was sweeping with his 18' speculum telescope and recorded this globular cluster as a compressed cluster of stars, 8' in size, extremely rich, of an irregular round figure a little extended. Further he add that the stars are so small as hardly to be visible and so accumulated in the middle as to look nebulous."

Fig 5. NGC5897 (Dale Liebenberg).

Gliese 570 is a multiple system approximately 19 light years from the Sun towards the south-western part of the constellation. It consists of a 5.8 magnitude primary orange dwarf star (A) with a close binary secondary (8.2 magnitude) component (B, C) of two red dwarf stars orbiting A at a distance of 190 AU with a period of about 2130 years. The angular separation is 25.6" at a position angle of 305 deg. In 2000 a brown dwarf was found to orbiting the system at a distance of more than 1500 AU and at the time it was the coolest brown dwarf yet discovered with a surface temperature of only 500 degree C. The WDS lists three other distant components E, F and G, which may be part of the multiple star-system (credit to Dave Blane).

Asterisms are the beauties of the starry skies, just search them out. Not only is it fun but it will be more than rewarding; and on top credited by the

Deep Sky Hunters forum if satisfied with the indicated criteria. Michael O'Neal, is one the most active amateurs in America and one that contribute the most to DSH (Deep Sky Hunters) catalogue. Search 2.7 degrees east of NGC 5897 for **Oneal 11.** It is one of the faintest star strings, but daintily situated in an east-west direction. Seven varied-magnitude stars between 11 and 13 with a pair of magnitude 11.8 stars ended of the string towards the east end, one a pure white and the other a yellow colour.

Fig 6. Mike O'Neal with his 16-inch Newtonian.

NGC 5878 is an edge-on galaxy in the true sense, three times as long as it is wide and situated more or less halfway in line with alpha and the magnitude 3.9 gamma Librae. The galaxy is just south of two relatively bright stars and elongated in a north to south direction. The one thing outstanding is the small bright stellar nucleus. A nice V-shaped asterism is situated 30' towards the east of the galaxy.

A special galaxy, **NGC 5885**, is situated 2.6 degrees south-west of beta Librae. The galaxy is not very bright, but shines with a uniformly oval glow in a north-west to south-east direction. With really high power, very dark skies and patience a vague spiral structure can be glimpsed slightly towards the southern part. There is a slight brightening towards the inside north-eastern part of the galaxy which deep pictures show as a distorted arm. A magnitude 10 star plus a few faint companion stars pair together on the north eastern rim of the galaxy. Large observatory telescopes show a soft inner ring.

Just an interesting note: one of the most distant stars known in our Milky Way is the lovely buttery color magnitude 7.2 (HD 140283) only 190 light

years away from us. Found the star south east of Beta and halfway to the star 37 Librae. According to a study it is low in heavy elements sugesting it to be one of the oldest stars known so far.

Another lovely star in the constellation is Delta librae, forming a long triang north-west with alpha and beta Librae. This magnitude 4.9 eclipsing binary system consists of two stars orbiting each other every 2.3 days dims a full magnitude. The cooler, fainter one passes in front of the brighter companion, which experiences a 60 percent drop in brightness. It takes only an equal six hours to fall and rise in brightness and it is possible to trace this in one night of observation.

Move your attention only a degree south from Delta to a pair of galaxies quite different from each other. The brighter of the two, **NGC 5812**, is a typical elliptical galaxy, a fairly bright circular halo, well defined, with a stellar nuclues. The companion, **IC 1084**, is definitely a hide-away that is not easily seen. Real deep sky pictures, however, show a very small east to west spiral a quarter the size of NGC 5812.

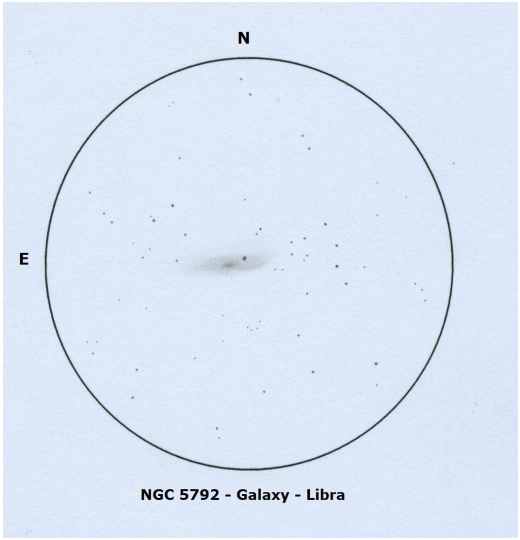


Fig 7. NGC5792.

To end this article, an introduction to another galaxy: **NGC 5792**, a typical barred spiral galaxy slightly elongated in an east-west direction and situated on the northern border with Virgo. It is just south of a magnitude 9.5 red-orange star embedded towards the north-western part to greated a double nucleus. Although with averted vision the galaxy is clearly separated from the star. On closer investigation the stellar nucleus appears to have a soft envelope around it. Higher magnification and very dark skies will show small dark knots on the surface, with the norther edge slightly more defined. Try to avoid the star by ignoring it and concentrating

on the galaxy for faint detail. The star 11 Librae is only 2 degrees south-west and shines with a nice yellow colour and a magnitude of 4.5.

Balancing your life is not always easy, but do try weighing the objects of the less well-known constellations against those of the better known ones and find a balance that will make observation worthwhile again and again.

NAME	OBJECT	RA	DEC	MAG	SIZE
Gliese 570 AB C – E F G	Double Star	14h57m.5	-21°25’.0	5.8 8.2	Sep 25.6” PA 305 deg
NGC 5792	Galaxy	14h58m.4	-01°05’.0	11.2	7.3’x1.9’
NGC 5812	Galaxy	15h01m.0	-07°27’.1	11.2	2.3’x1.9’
IC 1084	Galaxy	15h01m.3	-07°28’.6	14.7	0.6’x0.4’
NGC 5878	Galaxy	15h13m.7	-14°16’.7	12	3.5’x1.4’
NGC 5885	Galaxy	15h15m.1	-10°05’.1	11.8	3.2’x2.6’
NGC 5897	Globular Cluster	15h17m.4	-21°00’.6	8.6	12.6’
IC 4538	Galaxy	15h21m.4	-23°39’.5	12.7	2.6’x2.0’
Me 2-1 PK 342.1+27.5	Planetary Nebula	15h22m.3	-23°37’.5	11.6	6”
Oneal 11	Open Cluster barred	15h28m.9	-20°21’.6	10	5’
HD 140283	Star	15h43m.3	-10°55’.8	7.2	*

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 own electronic journal, the *Monthly Notes of the Astronomical Society of Southern Africa (MNASSA)* bi-monthly as well as its 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.

Internet contact details: email: assa@saao.ac.za Home Page: http://assa.saao.ac.za

Council (2013-2014)		
President	Prof MJH Hoffman	hoffmamj@ufs.ac.za
Vice-President	P De Villiers	pierredev@hermanus.co.za
Vice-President	Dr I S Glass	isg@saao.ac.za
Membership Secretary	Pat Booth	membership@assa.saao.ac.za
Hon. Treasurer	Adv AJ Nel	ajnel@ajnel.co.za
Hon. Secretary	L Cross	secretary@assa.saao.ac.za
Scholarships	M G Soltynski	Maciej@telkomsa.net
Members	C Stewart	Mwgringa@mweb.co.za
	G Els	gels@randwater.co.za
	Bosman Olivier	bosman@compendia.co.za
	L. Labuscagne	Grinz50@gmail.com
	Peter Dormehl	peterd@astronomydurban.co.za
	J Saunders	shearwater@hermanus.co.za
	C Rijsdijk	Particles@mweb.co.za
Hon Auditor	R G Glass (Horwath Zeller Karro)	RonnieGlass@horwath.co.za
Directors of Sections		
Shallow Sky	D Blane	theblanes@telkomsa.net
Deep Sky	A Slotegraaf	auke@psychohistorian.org
Photometry, Spectroscopy	Vacant	
Cosmology Astrophysics	JFW de Bruyn	Debruyn1@telkomsa.net
History	C de Coning	Siriusa@absamail.co.za
Dark Sky	J Smit	Johans@pretoria-astronomy.co.za
Astrophotography	Allen Versveld	Allen.versveld@gmail.com
Instrumentation	Chris Stewart	Chris.stewart@alcatel-lucent.com
Observing Director	Kos Coronaios	elephantcastle@lantic.net

ISSN 0024-8266

mnassa

monthly notes of the astronomical society of southern africa

Contents: Volume 73 Nos 5-6 **June 2014**

CONTENTS