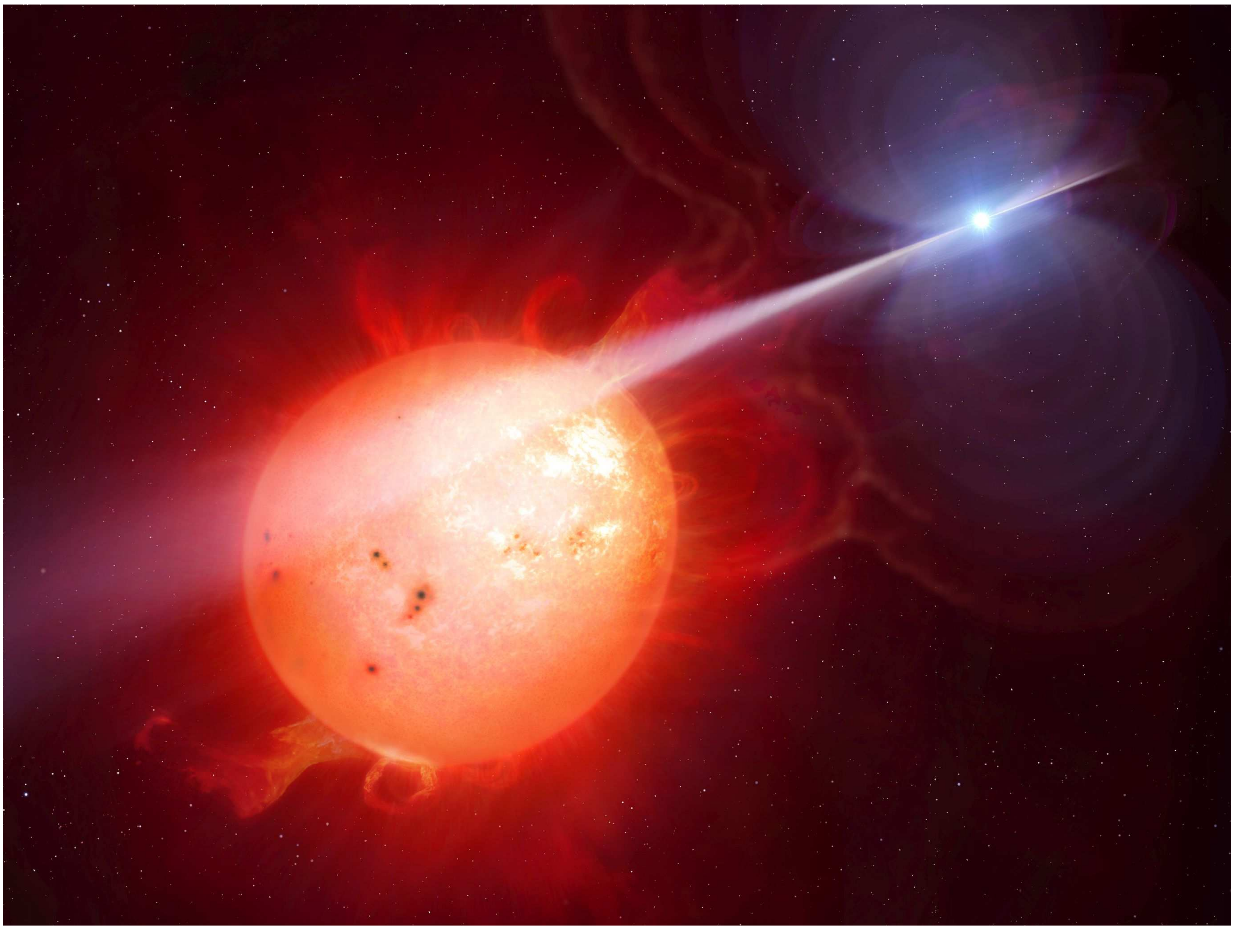
ISSN 0024-8266

mnassa

monthly notes of the astronomical society of southern africa

Volume 76 Nos 1 & 2 February 2017



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Cover: A bizarre binary star system has been discovered where a degenerate white dwarf pulsar is "lashing" its red dwarf companion with its strong magnetic field and beamed radiation every minute as it spins on its axis (See News Note :Dwarf-Star wars".
Picture credit: University of Warwick and Mark A. Garlick.

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Editorial

The last issue of MNASSA focussed on Amateur observatories in SA. As a continuation of this topic, this issue will focus on some of the highlights and work done at these Observatories. This is not an exhaustive description, but rather an overview of the type of work they do.

Having to a large extent completed this; the Editor is now looking for the many amateurs who do great work without an observatory. So submissions with a brief description of the instrument (s) used, its location, ie. from where observations are usually made, (GPS coords) and what observations are done and any other activities, would be gratefully received.

News Note: Dwarf-Star Wars: the revenge of the degenerates

A bizarre binary star system (se cover picture) has been discovered where a degenerate white dwarf pulsar is “lashing” its red dwarf companion with its strong magnetic field and beamed radiation every minute as it spins on its axis. This is the conclusion reached by a small team of three South African and two UK astronomers who have just published a paper in the new journal Nature Astronomy, announcing their discovery of strongly polarized pulsed optical emission from a white dwarf, a so-called degenerate star, in the binary system known as AR Scorpii, establishing it to be a white dwarf pulsar.

Last July, the UK co-authors of the current paper, Professors Tom Marsh and Boris Gänsicke from the University of Warwick, together with their collaborators, announced in Nature the discovery of strongly pulsed emission, across wavelengths from the radio to ultraviolet, from the fast spinning white dwarf, which rotates once every 2 minutes. Their conclusions were that the system was dominated by non-thermal emission, characteristic of pulsars. The current paper firmly establishes the pulsar link with the discovery of pulsed polarization at extremely high levels, reaching 40%, which is amongst the highest polarization levels detected in astronomical objects.

The discovery was made in March 2016 with the venerable and modest sized 1.9-m diameter telescope at the South African Astronomical Observatory (SAAO) in Sutherland, known as the Radcliffe reflector when it began operating about 70 years ago in Pretoria. The observations used the HIPPO photopolarimeter, an instrument which is one of only a few in the world capable of making such observations of fast varying polarization. "This is a demonstration that forefront science can still be done with modest sized telescopes and niche instruments", said Dr David Buckley, lead author of the paper and an astronomer at the SAAO. "HIPPO was really the ideal instrument for this study", confirmed Dr Stephen Potter, also at the SAAO, who, together with Dr Buckley, had conceived of this instrument over 15 years ago and managed its design, construction and commissioning, which was completed in 2007. He went on to say, "Polarimetry is an often overlooked discipline in astronomy, with perceptions of it being difficult to do, but the results can sometimes be revolutionary", as in the case of the results presented in their Nature Astronomy paper.

One of Dr Buckley's UK collaborators, Professor Tom Marsh of the University of Warwick, had alerted him to their discovery of the fast pulsations discovered in AR Scorpii during their 2015 observations, and plans were put in place for a more detailed follow-up campaign in 2016, utilizing telescopes across the globe, including in South Africa. “It occurred to me from the outset that this object was ripe for polarization observations”, said Dr Buckley, “so we successfully applied for observing time to do this in May”. However, after having a spell of good weather during an earlier observing week in March and having observed all of his main targets for the week, Dr Buckley decided to observe AR Scorpii for an hour or so on his penultimate night, “Just to take a quick peek since it was too tempting to wait”, he said. He was astounded to see, in only a matter of a few minutes of observing, huge values of linear polarization, changing over the 2 minute rotation period of the white dwarf. “It was extremely exciting to see this in real time and was more than my wildest expectations”, he said. Further observations were done on the following night and it is these two nights of observations which feature in their Nature Astronomy paper.

The detection of the strongly pulsed optical polarization, which varies periodically at the spin period of the white dwarf and its beat period with the 3.6 orbital period, has been explained in terms two mechanisms. One of them is beamed radiation and the other due to magnetic interactions between the two stars. Professor Pieter Meintjes, from the Physics Department of the University of the Free State, who took the lead on the theoretical modelling and interpretation, commented: “AR Sco shows all of the hallmarks of a pulsar (dense stellar objects about 20 km in size consisting of a spinning neutron star), including being dominated by synchrotron emission from relativistic particles, both from the white dwarf and in the stellar wind produced by its interactions with its red dwarf companion”.

But the big difference in the case of the AR Scorpii white dwarf pulsar is that at a diameter of ~6000 km, it is about 300 times larger than any neutron star pulsar. “This is why it is able to provide the huge energy generation seen over all wavelengths”, says Dr Buckley, “because its moment of inertia is 100,000 times higher than for a neutron star”. The conclusions in the paper, based on the slowing down of the white dwarf’s spin period, have led to the suggestion that the magnetic field of the white dwarf is very high, up to 500 million Gauss (the Earth’s and Sun’s field strengths are 0.5 and 1 Gauss, respectively, and a fridge magnetic is about 50 Gauss). “This will produce radiation due to the white dwarf’s strong magnetic field”, says Professor Meintjes, “and is also strong enough to pump the weaker field of the red dwarf companion, producing periodic emission from the coronal loops, producing radio emission”. It was the radio pulsations, first discovered from observations with the Australia Telescope and presented in the original Nature discovery paper, that were particularly intriguing. “The radio data was what really started to make us believe that this object had some unique properties, not unlike pulsars”, said Professor Marsh. Although there is one other similar binary star, also with a fast spinning white dwarf, called AE Aquarii, “That object is quite different and, importantly, not polarized, so with weaker pulsar credentials”, says Professor Gänsicke.

Professor Meintjes calculations imply that so-called magneto-hydrodynamic (MHD) instabilities occur in the surface layers of the red dwarf, due to the magnetic field of the white dwarf sweeping by every minute. This results in energy loss which can account for some of the observed optical properties and explain why the white dwarf is slowing down so fast, on the relatively short timescale of 10 million years. “In a very real sense, this is a tug of war between two dwarf stars”, says Dr Buckley, “where right now the red dwarf is being “slapped in the face” once a minute by its rapidly rotating degenerate white dwarf companion.” Eventually these strong interactions will slow down the white dwarf until it is synchronously locked to the 3.6 hour orbital period of the pair. Perhaps the biggest puzzle, however, is why the white dwarf is spinning so fast in the first place. This is most likely a result of mass transfer from the red dwarf during a previous evolutionary phase, but as Professor Marsh says, “The evolutionary path that AR Scorpii took to its current configuration is still an open question.”

This month's cover shows an artist's impression of the binary star AR Scorpii, with the spinning white dwarf pulsar in the upper right emitting a beam of energetic particles and radiation from its two magnetic poles. This beam and the strong magnetic field of the white dwarf lashes the larger red dwarf companion star as the white dwarf rotates, once every 2 minutes. The magnetic interactions between the two stars produces strongly polarized and pulsed radiation and also causes strong electrical field generation, powering the ejection of charged particles at close to the speed of light. The drag by the red dwarf on the magnetic field of the spinning white dwarf is slowing its rotation, which will eventually synchronize with the 3.6 h orbital period in about 10 million years.

News Note: British Astronomical Association Visits 2016

Clyde Foster, Director of Shallow Sky Section, ASSA

Introduction

Despite a lifelong interest in Astronomy, my serious interest in high resolution planetary and lunar imaging really took off in early 2014. With this came the steady growth of an international network, with contacts being made in various international organisations and forums. One of these was the British Astronomical Association, in particular its planetary and lunar sections.

Key Contacts in the BAA

My initial, and ongoing primary interest, when I started imaging, was Mars, which was particularly well placed for observation from Southern Africa at the time. Soon after this, I started submitting my images to various international forums, including the BAA. I also commenced Jupiter and Saturn imaging as well as submitting images to the BAA Lunar section. My Mars images have appeared in various editions of the Journal of the

BAA and my lunar images regularly feature in the monthly BAA Lunar Section Circular (LSC). My primary contacts have been:

Dr Richard McKim- Director of Mars Section
Dr John Rogers- Director of Jupiter Section
Dr Michael Foulkes- Director of Saturn Section
Dr William (Bill) Leatherbarrow- Director of Lunar Section

Over and above this, I have developed relationships with a number of other notable BAA members with whom I have interacted to a greater or lesser extent on astronomical, planetary and imaging related issues:
Dr David Arditti- Author and astro-imager
Martin Lewis- Author and astro-imager.
Bob Marriot-Director of Instruments and Imaging section
Dr Jeremy Shears- President
Damian Peach- Astro-imager

Ordinary Meeting of the BAA- 23 January 2016

It was at fairly short notice that I decided to attend the Ordinary meeting of the BAA at Burlington House on Saturday the 23 January, joined on the trip by my partner Marina. This had been on my "bucket list" for quite a while. We flew out of OR Tambo International airport on the Thursday evening, landing on the Friday morning and had arranged to meet up with David Arditti at his Stag Lane Observatory in North London that same afternoon. We had a great "work session" working through, and sharing, our image processing techniques. On the Saturday, we met up with John Rogers (Jupiter section director) and Mike Foulkes (Saturn section director) for an enlightening and thoroughly enjoyable lunch at a restaurant close to Burlington House. Burlington House is the home of the Royal Astronomical Society (amongst other esteemed societies), but shares its facilities with the BAA. Once at Burlington House, Bill Leatherbarrow (Lunar section director) treated me to a personal showing of some historic lunar observational records, which were fascinating.

Whilst Marina did some further sightseeing, I was warmly welcomed at the meeting by the President, Jeremy Shears. Being my first meeting, it was a special and memorable occasion for me. After the meeting we went for drinks with a number of members and further interesting discussion on various astronomical and imaging related matters ensued. We flew out of London the following day after having squeezed in a quick visit to Greenwich observatory.

Burlington House visit - 22 November 2016

In November I had a trip to the UK with my son, and whilst in London, arranged to meet up with a number of my BAA contacts. I was privileged to have Dr Richard McKim (Director of Mars Section) sign a copy of his "Telescopic Martian Dust storm: A Narrative and Catalogue" (BAA Memoirs Vol 44 June 1999), which he left at Burlington House with Madeleine Davey for me to collect. In doing so I was able to have an informal meeting with Jeremy Shears, President of the BAA, where we were able to build on the interaction that we had during the previous meeting.

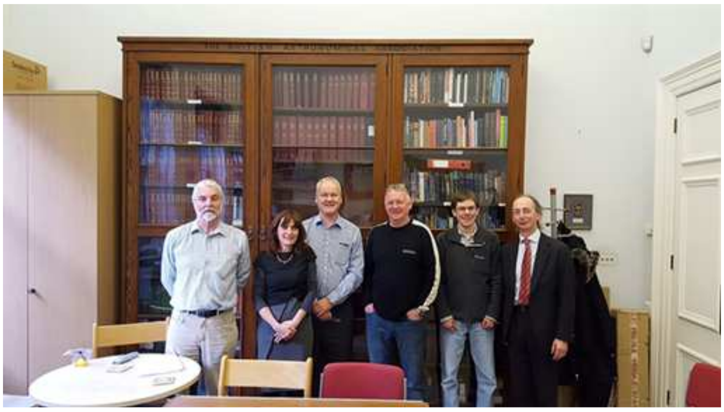


Fig. 1 Nov 22 2016 at Burlington House, whilst collecting a signed copy of Dr Richard McKim's BAA memoir on "Telescopic Martian Dust storms": L-R Bill Tarver, Madelaine, Jeremy Shears, Clyde Foster, Dominic Ford and "Q"(!)

In the evening we met up with Dr John Rogers, Dr David Arditti and Martin Lewis for dinner at the Imperial China restaurant near Piccadilly. I hadn't personally met Martin previously, but we had extensive previous interaction on various planetary and imaging related issues. Again a very enjoyable, instructive and enlightening evening was held. It is often during these types of discussions and interactions that the finer details of processing techniques are discovered.

Fig. 2 Nov 22 2016 C Foster, Jeremy Shears (BAA President), Dr John Rogers (Jupiter section), David Arditti (Astro-imager and author) in the Library of the Royal Astronomical Society, Burlington House, Piccadilly, London prior to meeting up with Martin Lewis (astro-imager and author) for dinner

Conclusion

It has been a pleasure and a privilege for me to have built strong relationships with various key role players in the British Astronomical Association and I hope and trust that this also builds on and reinforces the relationship between the ASSA and the BAA in the specific astronomical fields where I am active. In terms of my current observing and imaging programmes, it is fully expected that this interaction will continue and grow.

Obituary – Anthony (Tony) Barry Jones

(26 July 1942 - 23 November 2016)

Tony was born in Springs on the East Rand. Early in his childhood the family moved to Nyasaland (now Malawi). He went to primary school in Fort Jameson and Lilongwe and then attended boarding school at Gilbert Rennie High School in Lusaka, Northern Rhodesia (now Zambia). It was with nostalgia that he described a childhood where he and his brothers were free to roam in the bush on their bicycles during school holidays. He often spoke of helping his father grind a mirror and build a telescope.

After getting his A levels he went to the UK and enrolled in pilot training with British European Airways, being employed by that organization for a few years. The next decade was spent working at Harwell (Atomic Energy Research Institution) while at the same time studying for his qualifying certificates to enable him to take a B.Sc. Degree at Oxford University. He found his work at Harwell both challenging and very fulfilling. In his spare time he helped run a gymnasium, played cricket and rugby and assisted behind the scenes organizing concerts. It was while working at Harwell that Tony met and married his wife, Vivien. Their daughter, Anna was born in 1971 and the family came to South Africa in 1972.

Tony worked for Plessey for a year and then obtained employment with Sperry Univac (later called Unisys). In the course of his career his work as an electronics engineer took him all over South Africa and as far afield as Yugoslavia, Russia, Australia, Norway and the USA.

When Tony joined the Cape Centre of ASSA he became a very dedicated member, involving himself in the many activities of the Centre. He was a regular contributor to the *Cape Observer* and edited the magazine for many years. He was also editor of the 2007 to 2010 editions of *Sky Guide Africa South.* He recorded and reported on special events such as occultation timing, meteor shower observations, as well as double star work. In June 2005 he was awarded a Certificate in Astronomy from the University of Central Lancashire. He trained as an official guide to take the public around the facilities at Sutherland, including SALT. He also showed visitors the night sky through the 20 and 30 inch telescopes. He was a reliable and informed participant over many years at SAAO open nights, Kirstenbosch “Star Walks”, numerous sidewalk outreach events and the Cape Centre’s dark sky outings.

His further contributions included giving many talks at the Centre, organising field trips, presenting a beginners' astronomy programme, participating in astrophotography and organizing successful ScopeX shows at Kirstenbosch and the Cape Town Science Centre. He also served at different times on the committee as honorary treasurer, secretary and auditor. In March 2013 Tony was awarded Honorary Life Membership of the Cape Centre of the Astronomical Society of Southern Africa. With Karen, his companion of later years, Tony also enjoyed sharing interests such as birding, photography and observing the natural world in general.

In essence, it gave Tony great pleasure, in his patient and unassuming manner, to share his vast knowledge of astronomy by providing reliable information, giving instructive and enjoyable tours of the night sky and assisting less experienced observers. In all, surely, a life well spent!

(Karen Koch)

SN searching in the Western Cape at the Kleinkaroo Observatory

Berto Monard

After nine successful years of discoveries at the Bronberg Observatory, we moved to Calitzdorp, Klein Karoo at the end of 2010. A new observatory was erected early in 2011 and SN searches were resumed from the new environment, one as it would turn out, with unpredictable weather and often bad seeing.

Observing conditions at the Bronberg Observatory in Gauteng had been predictable with >90% of open nights in the period April-September and <10% for October-March. The seeing was rarely excellent but usually good enough. Light pollution however had gotten increasingly worse due to excessive and often ineffective lighting in the Gauteng province.

At the Klein Karoo Observatory in Calitzdorp light pollution is minimal but open skies are less frequent with an average of less than 25% of open skies during the year.

Clearings often appear in the pre-dawn sky, usually only noticed by crispy sunrises. Seeing is variable and can remain bad over extended periods. Such conditions under otherwise clear skies are suitable for photometric observations of variable stars in not too dense star fields. This has always been the main activity for the CBA projects.

Once in a while, when the air moves steadily, the seeing is excellent, providing superb conditions for SN searching as pinpoint stars contrast against the galaxy background. That's when the opportunity must be taken.

Competition for SN discoveries has grown immensely since the early years of the millennium. Many new observers have appeared in the last decade, and also many surveys that now start to reach similar observing depths as small observatory telescopes do. They observe large parts of the sky continuously.

As time has gone by, those survey efforts have gotten more, more powerful, more stars surveyed, real-time processing etc. It's very hard now for small scale observers to still make a contribution. Still, many enthusiastic observers continue their efforts in the SN hunt, some with good success, most of them with very little.

I have adapted to the situation by observing less galaxies, more deeply in order to find nearby supernovae in the early stage of development. Since the discoveries of the NGC 300 transients in 2008 and 2010, dedicated efforts to find more such explosions in galaxies of the Local Group and the Sculptor group were intensified. Those galaxies all reside within 10 million light years, close by in astronomical terms.

Below is the table of SN discoveries made from the Klein Karoo Observatory over the period 2011-2016

SN name/ Other name (PSN)	Galaxy	Type SN	Date of discovery	M discovery	M peak
2011I	anon.	Ia	11-01-06.91	15.8	15.8
2011di	IC 4754	Ia	11-05-13.01	17.5	15.0
2011dp	MCG-1-5-31	Ia	11-06-02.18	16.1	16.0
2011dq	NGC 337	II	11-05-15.17	16.3	16.2
2011dx	NGC 1376	Ia	11-06-27.18	16.5	16.5
2011eb	NGC 782	Ia	11-07-09.13	15.2	15.2
2011ec	ESO 147-5	Ia	11-05-14.12	17.0	16.5
2011fh	NGC 4806	IIn	11-08-24.75	14.5	14.5
2011hp	NGC 4219	Ic	11-11-03.10	15.7	15.7
2011ja	NGC 4945	IIP	11-12-18.09	14.0	13.2
2011jz	ESO 85-1	II-P	11-11-25.02	18.3	18.2
2011ka	ESO 119-46	Ia	11-12-29.89	16.1	15.7
2011kb	anon.	II-P	11-12-16.03	16.8	16.1
2012J	ESO 386-39	Ic	12-01-02.08	16.8	16.8
-	IC 5202	-	12-01-28.80	17.8	17.5
		PSN J22225848-6548431			
-	ESO 472-20	-	12-04-24.16	17.6	17.6
		PSN J00130473-2413068			
2012ec	NGC 1084	II-P	12-08-11.04	14.5	14.3
2012es	NGC 5597	IIb	12-08-12.81	16.2	15.4
2012fx	ESO 417-3	Ia	12-08-22.13	17.2	16.8
-	anon.	Ia	12-10-05.00	18.4	
		PSN J22522345-2036537			
2012hy	NGC 4903	Ia	12-11-11.10	16.5	16.5
2013L	ESO 216-39	IIn	13-01-22.02	15.6	15.4
-	ESO 298-19	-	13-05-12.18	16.7	16.5
		PSN J02115555-3912158			

2013cy	ESO 532-25	II	13-05-31.17	16.8	16.6
-	NGC 309	IIb	13-06-10.14	17.2	17.1
		PSN J00564446-0954595			
2014df	NGC 1448	Ib	14-06-03.18	14.0	13.9
		PSN J03442399-4440081			
2014bu	NGC 694	IIP	14-06-17.19	15.5	15.2
2014co	NGC 418	II	14-06-21.18	16.8	16.7
		PSN J01103622-3013376			
2014cr	NGC 6806	Ia-02cx	14-06-27.86	17.8	17.7
		PSN J19370613-4217505			
-	UGC 1120	Ia	14-08-06.10	17.2	16.6
		PSN J01340299-0104458			
2014di	ESO 244-31	II	14-09-21.01	18.1	
		PSN J01300340-4241487			
-	NGC 6899	-	14-11-21.80	17.7	
		PSN J20242491-5026054			
-	anon.	Ib	15-02-22.13	16.3	16.2
		PSN 20580766-5147074			
2015F	NGC 2442	Ia	15-03-19.79	16.8	12.8
		PSN J07361576-6930230			
2015an	IC 2367	II	15-09-13.15	15.2	15.0
		PSN J08241502-1846281			
-	NGC 6156	?	15-10-11.76	15.5	15.5
		PSN J16345090-6037063			
-	ESO 61-8	?	15-11-23.06	16.2	15.9
		PSN J09195286-6854419			

There has been a problem with the coding of SNe in recent years by IAU mainly due to the excessive number of reported SN discoveries in far-away galaxies, a result of deep searches by large telescopes over the globe and from satellites. Insufficient staffing at IAUC and no discretional measures to distinguish nearby discoveries have contributed to this situation.

A new discovery reporting mechanism and naming convention was initiated end of 2015. That my name is still not on it, is a sign of no success lately.

Some interesting facts on the above list:

* SN discoveries in nearby galaxies (<50Mpc): NGC 337, 4945, 1084, 1448, 2442. As expected they reached bright magnitudes although some were reported to be somewhat sub-luminous for the type.

* Previous SN discoveries in the same galaxies had already been made at the Bronberg Observatory in galaxies NGC 309, 1448 and ESO 244-31 (2x)

* Early detections (several days before peak brightness) were made in IC 4754 (17d), ESO 147-5 (4d), NGC 4945 (30d?), ESO 119-46 (8d), NGC 1084 (13d), NGC 5597 (10d), ESO 417-3 (5d),
ESO 216-39 (10d), UGC 1120 (10d), ESO 244-31 (10d), NGC 2442 (16d), IC 2367 (12d).

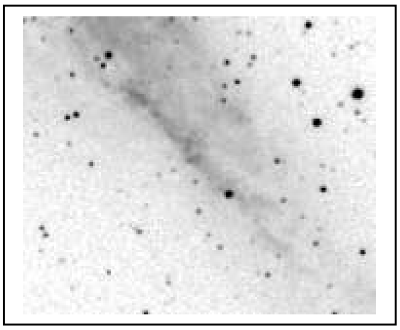
These days, unless SNe are discovered in the early phase, well before peak, it's unlikely for an observer to have a chance to report and claim discovery, as discoveries will likely be made by one of the surveys. Exceptions are for discoveries made at low positions above the horizon during dawn in the East or dusk towards the West. The latter discoveries however will have no chance to be spectrally confirmed by large telescopes, which has been one of the requirements for post 2010 coding. See the table above where report generated PSN names are the only reference for such discoveries.

* The discovery of SN 2015F in NGC 2442 must have been within a couple of days after the actual explosion and two weeks before the SN reached its brightness peak. This SN has been well observed from other southern observing stations and through diverse optical filters.

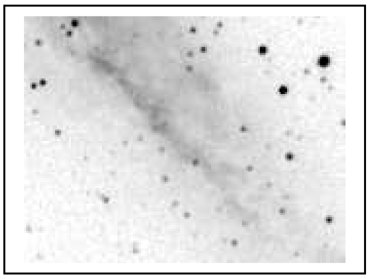
The development (rise and fall) of SN 2015F in NGC 2442 was also shown as astronomical picture of the day on the NASA website on 9 Feb 2016. See http://apod.nasa.gov/apod/ap160209.html

Note that most types of SNe reach the peak about two to three weeks after explosion. As the observed magnitudes here refer to unfiltered CCD magnitudes, peak brightness may occur at later times than would be the case when observed in visible light. Peculiar SNe as the nearby SN 2011ja in NGC 4945 and SN 2012ec in NGC 1084 may appear to have evolved far more slowly because of this.

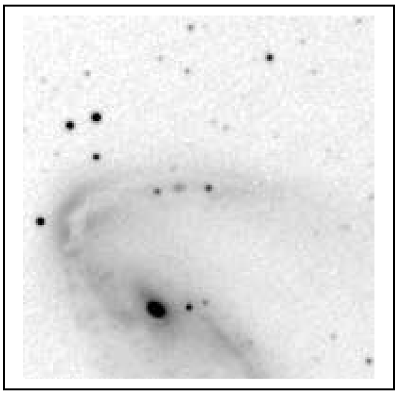
Peculiar developments took place in the type IIn SNe in NGC 4806 and ESO 216-39. Despite its large distance away the latter remained visible over a period of nearly 1 year.



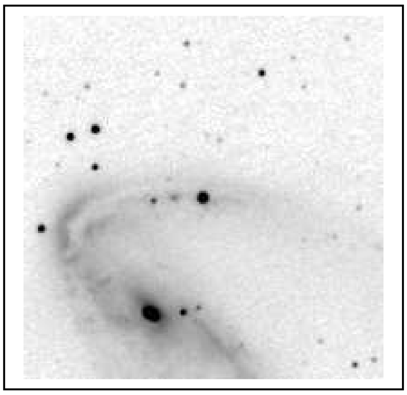
Figs 1 & 2: SN 2011ja in NGC 4945 at two different stages of development, taken on 2 Jan and 12 May 2012 respectively.



The SNe concerned are near the centre of the images and show distinct differences in brightness at the two epochs. All the other stars on the images are foreground stars. They are stars from the Milky Way and therefore much closer to us, roughly a factor of 100 000 x.



SN 2015F in NGC 2442 at two different stages of development, taken on 22 March and 15 June 2015 respectively.



Rating professional astronomers in South Africa: A comparison of the H-index and NRF Ratings

I.S. Glass (SAAO)

Two methods for rating astronomers are compared – the scheme of the National Research Foundation (NRF) and the H-index. The two methods do not yield closely similar results.

Introduction: the NRF system

Nearly all active South African scientists today are rated by the National Research Foundation and placed into a number of classes as follows:

- A – Leading international researchers
- B – Internationally acclaimed researchers
- C – Established researchers
- P – Prestigious Awards
- Y – Promising young researchers

These classifications are available at www.nrf.ac.za/rating but their sub-classes A1, A2, B1, B2, B3 and C1, C2, C3 are not given and are therefore not considered here. NRF ratings are important to the individuals concerned as they strongly affect the research funding available to them. The various local academic institutions also like to be able to boast of the number of “Rated Researchers” they have on their staffs and at least some have special offices to help their staff members complete the application process. An application takes about a year to process and the result remains valid for 5 years.

The procedure is that an applicant fills in a detailed form mainly concerning his (or her) research outputs. This form goes to a subject committee that selects around six anonymous referees in the applicant’s field, some of whom may be colleagues suggested by the applicant. The referees are given copies of the applicant’s forms. Their reports in turn are

evaluated by each of the members of the subject committee before they meet, both as to what they say about the applicant and how carefully his (or her) work has been considered. At the rating meeting, each committee member's recommendation is presented and, especially when there is disagreement, a discussion ensues until a unanimous conclusion is reached. Certain indecisive or marginal cases, as well as recommendations for A ratings, are looked at again by a higher committee.
The candidate is given some feedback about the conclusion reached and it is possible for her/him to appeal the decision.

In this note I make a comparison between the NRF ratings of members of the SA professional astronomical community and an alternative form of rating called the H-index, which has the merit of being much simpler to evaluate.

The H-index

The H-index is the number H of publications of a particular author that have been cited H or more times. It was devised in 2005 by J.E Hirsch of the University of California for evaluating the relative quality of theoretical physicists. H is easily evaluated for an astronomer by looking at his or her publication list on the NASA-ADS database
http://adsabs.harvard.edu/abstract_service.html. One enters the name of the person concerned and ticks the "sorting" choice at the bottom of the page to "Sort by citation count". The papers are then automatically listed and numbered (from 1 to *n*) in order of the number of times each one has been cited (*nc*). The person's H-index is then the number *n* of the last paper in the list whose *nc* is greater than or equal to *n*.

Some people's data are accessible on Google Scholar, including their H-indices. In the few cases that I have looked at, the straightforward citation indices obtained as I have described agree fairly closely with the Google values. Google Scholar does not give the "normalized citation indices" referred to below.

There are many caveats associated with using the H index. One of them is that all papers are weighted equally, even if there are dozens of co-authors. For this reason, I use a “normalized citation index”. Here, the total number of citations for each paper is first divided by the number of co-authors, which should be fairer. Then the papers are sorted by “normalized citation count” instead of “citation count”. This is an option offered by the NASA-ADS service.

Of course, the longer the time since a paper was published, the greater the number of citations it is likely to have attracted. Also, an author is likely to have published more papers if his career has been long. It has been suggested that H-indices would be more realistic if divided by some age-related factor.

In comparing a person’s H-index with his NRF rating, it should be born in mind that the latter is largely subjective, depending as it does on reputation and popular recognition, both of which are also likely to increase with time.

Discussion

Table 1 (below) gives the NRF ratings and H indices for as many members of the South African professional astronomical community as I could find data for. The NRF ratings were taken from the NRF web site and the H-indices were evaluated, in the manner described above, in early December 2016.

In some cases, the H indices were somewhat trickier to evaluate because the person’s name was similar to that of another. It is also possible that some authors have published in journals not forming part of the NASA-ADS database.

The results of the comparison are given in Fig. 1.

Table 1: Names, institutions, NRF ratings and normalized H-indices for members of the SA astronomical community, as of December 2016. These data are public and can easily be checked.

Balona, L.	SAAO	B	25
Barway, S.	SAAO		4
Bassett, B.	UCT	B	20
Beesham, A.	UZ/RBay	C	12
Bernardi, G.	Rhodes	B	8
Bietenholz, M.	HartRAO		12
Block, D.	Wits	B	11
Blyth, S.	UCT	C	6
Boettcher, M.	Potch	B	20
Brink, J.	Stel		9
Buckley, D.	SAAO	B	10
Burger, A.	Potch	B	12
Carignan, C.	UCT	B	23
Clarkson, C.	UCT	B	18
Cluver, M.	UWC	C	4
Colafrancesco, S.	Wits	B	15
Crause, L.	SAAO		7
Crawford, S.	SAAO	C	4
Cunow, B	Indep	C	6
Dave, R.	UWC	B	26
Depagne, E.	SAAO		8
Dunsby, P.	UCT	B	15
Ellis, G.	UCT	A	36
Englebrecht, C.	UJ		8
Faltenbacher, A.	Wits	B	10
Feast, M.	UCT	A	36
Ferreira, S.	Potch	C	10
Flanagan, C.	Indep	C	6
Gilbank, D.	SAAO	C	9
Glass. I.	SAAO	B	29

Goswami, R	UKZN	C	10
Govender, M.	DUT	C	:
Hellaby, C.	UCT	B	16
Heywood, I	Rhodes		5
Hilton, M.	UKZN	P	5
Jarrett, T.	UCT	B	15
Jarvis, M.	UWC		19
Jejjala, V	Wits	B	8
Jonas, J.	Rhodes		8
Jozsa, G.	Rhodes		4
Kilkenny, D.	UWC	B	18
Kniazef, A.	SAAO	B	10
Koen, C.	UWC	B	18
Komin, N.	Wits	C	4
Kraan-Korteweg, R	UCT	B	14
Leeuw, L	Wits	C	4
Ma, Y-Z	UKZN		8
Maartens, R.	UWC	A	36
Maharaj, S.	UKZN	B	15
Martinez, P.	UCT		10
McBride, V.	UCT	P	5
Medupe, T.	UNW		4
Menzies, J.	SAAO	C	19
Mizalski, B	SAAO		7
Mohammed, S.	SAAO	P	6
Moodley, K.	UKZN	C	6
Murugan, J.	UCT	P	7
Nicolson, G.	HartRAO		10
Potgieter, M.	Potch	A	20
Potter, S.	SAAO	B	7
Ray, S.	UKZN	C	5
Razzaque, S.	UJ	C	15
Romero C., E.,	SAAO	C	:
Schroder, A.	SAAO	C	9

Sefako, R.	SAAO		2
Sickafoose, A.	SAAO	C	7
Sievers, J.	UKZN	B	12
Sirothia, S.	Rhodes		5
Skelton, R.	SAAO		6
Smirnov, O.	Rhodes		6
Taylor, A.R.	UCT	A	19
Vaisanan, P.	SAAO	C	5
vd Heyden, K.	UCT	C	7
Venter, C.	Potch	P	6
Warner, B.	UCT	A	38
Weltman, A.	UCT	P	7
Whitelock, P.	SAAO/UCT	A	23
Williams, (T)	SAAO		15
Winkler, H.	UJ	B	12
Worters, H.	SAAO		2
Woudt, P.	UCT	B	13
Zunckel, C.	UKZN	P	4

Note: my own NRF rating is not a recent one as I am now retired and have not been re-rated.

Quite clearly, there are huge overlaps between the H-indices for the different NRF classes. There is an A-rating at H = 19 and a C-rating at the same value! Can this be fair? - and, if so, why? The averages and standard deviations are given in Table 2 for convenience.

Whether the very large overlaps arise from the subjective nature of the NRF process or from some other cause is worth dwelling upon.

Table 2. Statistics for the A, B and C ratings

	A	B	C
Number	6	26	17
Average	31.3	15.5	8.2
SD	8.1	5.8	4.1

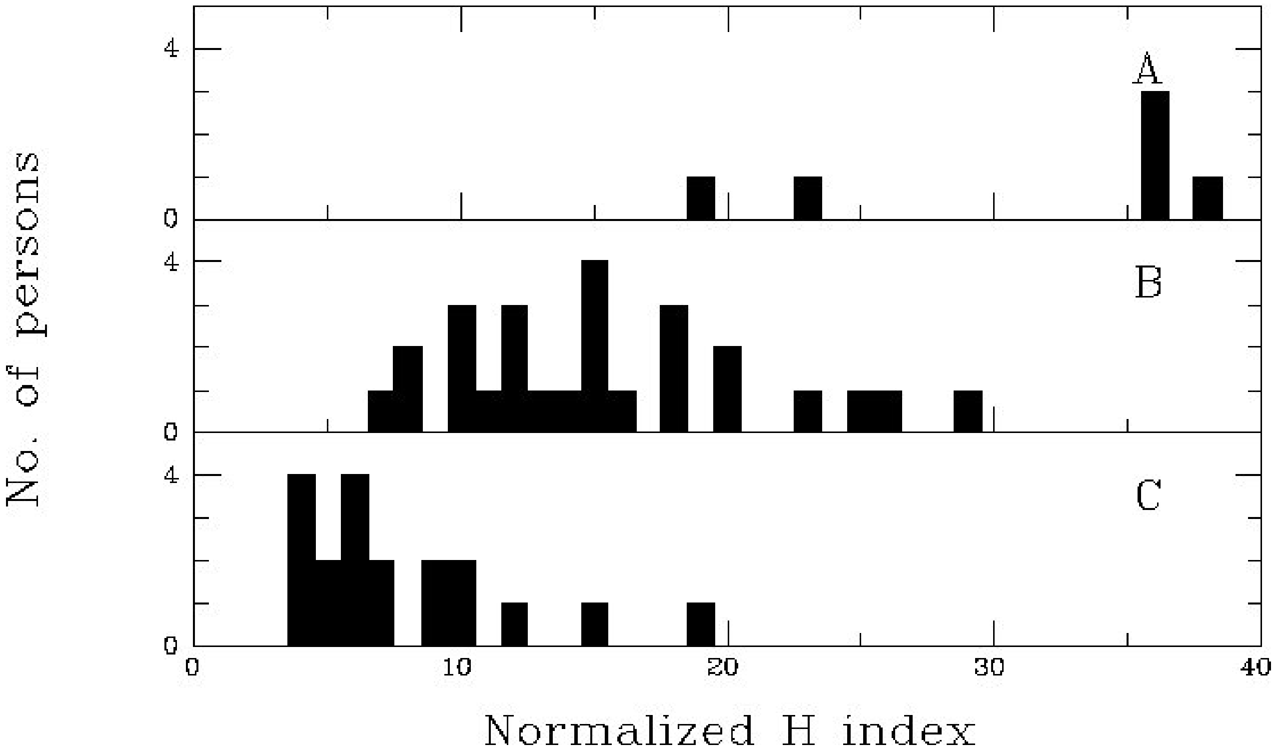


Fig 1: The normalized H indices for astronomers in the three main NRF rating categories. Note the considerable overlap. Only four A-rated researchers stand out strongly.

Having served on the NRF rating committee for physics, I believe that it is fairly immune to the personal prejudices of individual committee members though the initial choice of referees is usually up to one committee member only. The most difficult people to evaluate in my experience are those who work in such narrow fields that most of their citations are from a very few other scientists, who may often be their colleagues.

There are, of course, many ways in which each of these evaluation methods can be criticized. Readers can probably think of some for themselves.

Some group leaders list large numbers of group members as co-authors and, as a consequence, their probably considerable influence is not adequately taken into account by the citation indices, especially the normalized one.

Wikipedia has an article about the H-index that discusses a number of important issues and is worth accessing by the interested reader (https://en.wikipedia.org/wiki/H_index).

Some brilliant researchers may publish only occasionally but receive a great many citations and would thus be prejudiced by the H-index because it also depends on the number of papers. Yet others are producers of catalogues that are often referred to but are not particularly original.

On the other hand, it can be said against a referee system that a person who works in a narrowly-defined field may well have become the leader of that field and will have greatly impressed any likely referees. In contrast, the totality of the work of another who covers many disciplines is unlikely to be known to any particular referee.

I often wonder what exactly makes a "Great Scientist" and do not think either of these indices is a sure-fire way of forecasting a long-term reputation. The number of papers produced and the number of times that they are cited are not necessarily indications of scientific originality.

I hope I have not made too many mistakes in this hasty compilation and that not too many people will suffer bruised egos. I would like to thank M. G. Soltynski and C. Rijsdijk for comments on a draft of this paper.

Magda’s nebulosity

A letter from Magda Streicher

Observing the Large Magellanic Cloud led me to find a small round patch of nebulosity just 2.7' south-east of NGC 2035. All the nebulae in this area were brilliantly enhanced with an UHC Filter through the 12" telescope, 218x. I could not find any data about this nebular patch, so I forwarded my query to Brian Skiff, a professional astronomer at Lowell Observatory.

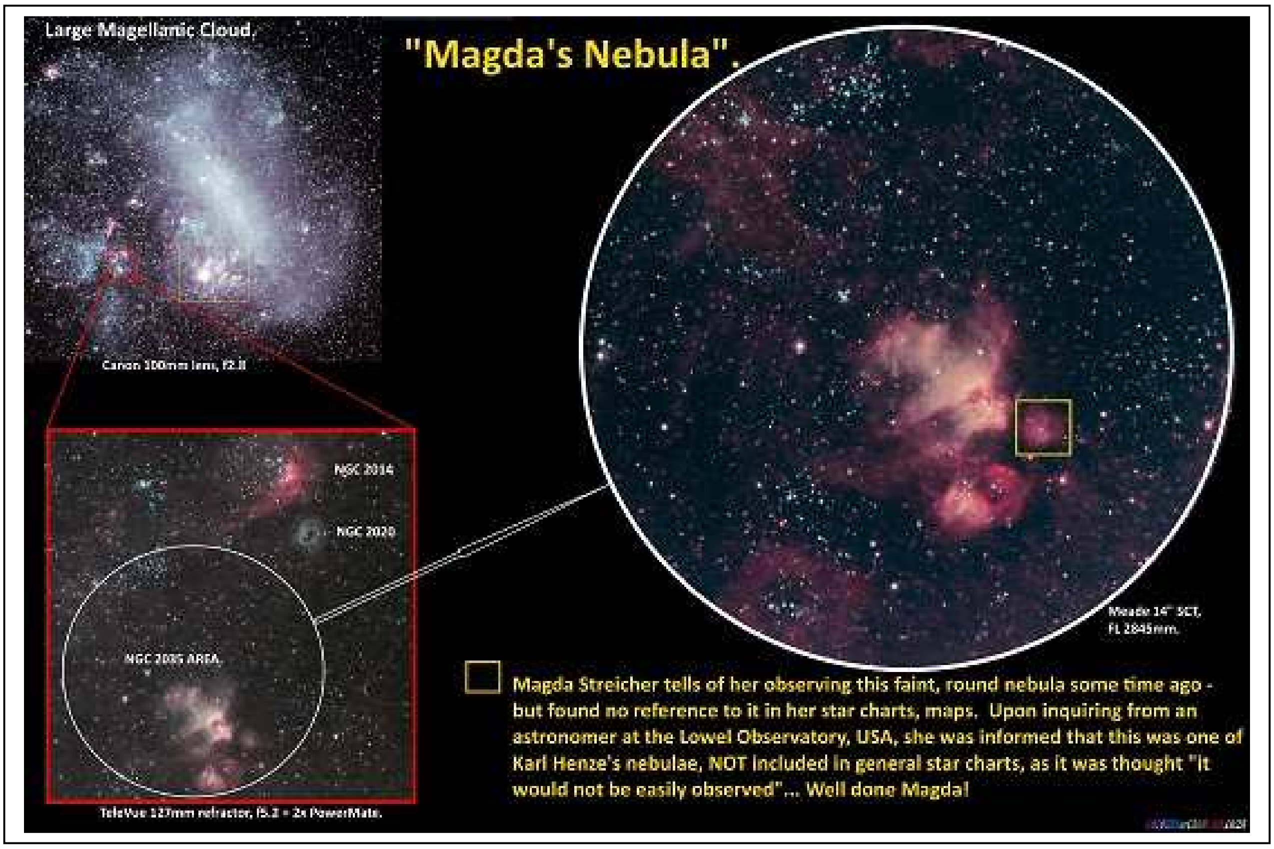


Fig: “Magda’s Nebulosity”

His reply was: "The object you have found was catalogued by Karl Henize in 1956 as his 'N59c', or more fully 'LHA 120-N59c'. It is centre around on a 14.5-magnitude star that is obviously the star that causes the circular nebula to fluoresce. The position of the star is:

RA: 05h35.39.7 and DEC: -67°37'04".8 (J2000).

In the MC catalogue by Phil Massey (who is also at Lowell Observatory), it is called [M2002] 163282. His photometric data are: V = 14.55, B-V = -0.05, U-B = -1.01. The strong negative value for the U-B colour is indicative of a very hot star.

LHA 120-N59c - (M2002) 163282 - DORADO

Interestingly, the nebula is not drawn-in (sic) on Mati Morel's usually very complete large-scale maps of the Clouds". So I asked Mati Morel directly, and he replied to me as follows:

Hi Magda. - Thanks for your interesting note. The region is shown on my chart 23 of "LMC Selected Areas" but the photo-chart I used as a basis Fig. 2.
probably did not show Henize N59c (or not very well), so it was ignored. I have looked at a print from UK Schmidt plate and, not surprisingly, N59c shows up very nicely. At least your observation proves that even this small nebula is within reach (visually) under good conditions. If you want to send along more stuff I would be happy to receive it and add to my files. Regards, Mati."

Remarkable Work at Private Observatories in South Africa

<u>Archer Observatory</u>

Barry Dumas

Transit of Mercury 2016: Determining the angular diameter of Mercury

Fig 1

Time:	16:11:52
Telescope:	Meade LX90GPS 12”
F.L.:	3048 mm
Filter:	Baader solar filter (AstroZap)
Camera:	Canon 60 Da
Exposure:	1/500 sec
ISO:	400
Image res.:	3456 × 5184 (pixels)

Fig. 2:

Time:	16:10:30
Lens:	Sigma 150-500 + 1.4 × converter
F.L.:	700 mm
Filter:	Orion glass solar filter
Guiding:	AstroView 120 + EQ-6 mount
Camera:	Canon 550 D
Exposure:	1/800 sec
ISO:	400
Image res.:	3456 × 5184 (pixels)

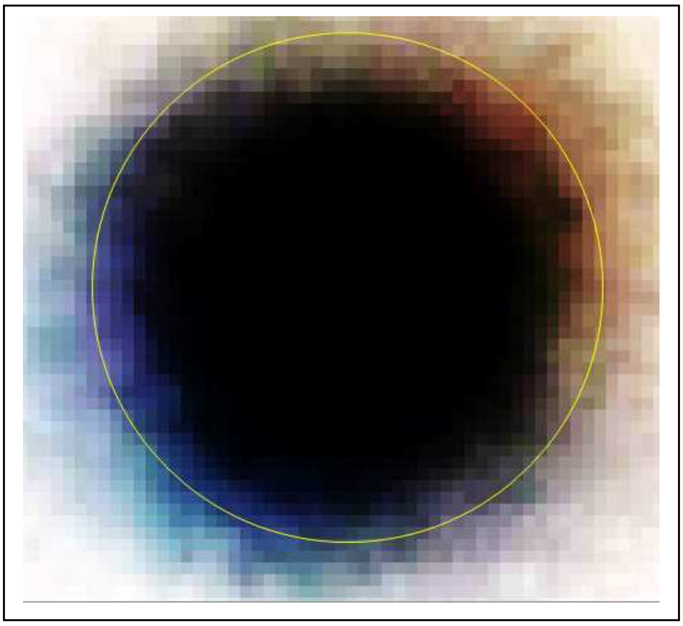


Fig. 3. Extract from Image 3 containing only the image of Mercury, 16x magnification of the original image.

Image res.: 0.291128786"/ pixel
@ F.L.: 3048 mm (LX90GPS)
Scale: 30 pixels per 10 cm ⇒
1 pixel ~ 0.336 cm

Mercury: Diam. 12" ⇒
12/0.291 = 41.219 pix ⇒

Circle diam. 41.219 × 0.336 = 13.9 cm

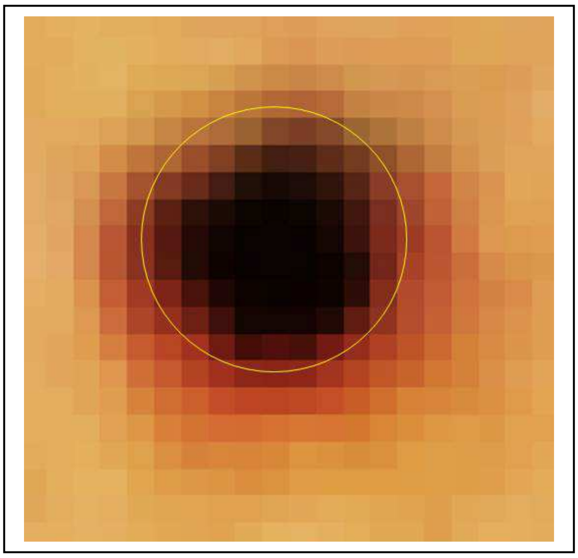


Fig 4. Extract from Picture 4 containing only the image of Mercury, 16x magnification of original image.

Camera: type	Canon 550-D DX
Lens:	Sigma 150-500 plus
1.4 x converter	
F.L.	700 mm
Filter:	Orion solar filter
Image res.	1.838828"/ pix @ F.L. = 500 mm
	⇒ 1.838828 × 500/700
	⇒ 1.313449"/pix @ F.L. 700 mm
Scale:	20 pixels per 10 cm
	⇒ 1 pixel ~ 0.5 cm
Mercury:	Diam.: 12"
	⇒ 12 ÷ 1,313449 = 9.136251 pixels

$\Rightarrow$ Circle diam.: $9.136251 \times 0.5 = 4.57$ cm

$\Rightarrow$

In both cases the calculated circle (yellow) represents the diameter of Mercury during the transit, which was 12” (Fred Espenak).

(The fuzziness of area outside the circle is caused by the degree of focusing, the sky condition (it was cloudy & misty) as well as the quality of tracking during exposure (wind).)

Comments

It is very important to establish the limitations of observing equipment before a field observation. The transit of Mercury is an ideal situation for such an exercise. For this reason the telephoto lens (Sigma 150-500 plus 1.4x converter) was put to the test; the results were most satisfactory.
In the case where the Meade LX90GPS 12” telescope was used the main interest was in the uncertainty (blurriness) of the boundary of Mercury’s image. It was very difficult to establish the weight of contribution of the optical system towards the total uncertainty, because the other factors involved were

- The precision of focusing,
- Due to the bright environment, it was somewhat difficult to find the best focusing of the image as observed through the eyepiece of the camera.
- Although the exposure time was very short the quality of telescope tracking can have a significant effect on the uncertainty of the image boundary.
- In all the cases the sky was not clear during exposures. There was always some sort of mistiness present even when the Sun shone bright.

Nevertheless, the results were most satisfactory considering the circumstances during which the photos were taken.

Centurion Planetary and Lunar Observatory

Clyde Foster

Introduction

Despite having had a lifelong interest in Astronomy and a number of increasingly larger telescopes over the years, career and family commitments had limited my involvement in serious observation. However, with the purchase and installation of a 14” Celestron Edge HD SCT in my backyard observatory in the first quarter of 2014, a serious interest in high resolution lunar and planetary imaging quickly developed.

Mars

With the installation of the new telescope in the first quarter of 2014, Mars, being in the southern sky, was well positioned from Southern Africa, albeit already past opposition. I started imaging on a regular basis, and was rewarded with the “discovery” of a localised dust storm in the Isidi/Libya region of Mars at the end of June. With this being in the southern winter season on Mars, which is not the season when storms are normally expected, this created widespread interest and a global alert was issued by the BAA as a result. I was able to follow the development and dissipation of the storm over a number of days. I was credited with a number of further dust storm “discoveries” over the next few months, whilst comprehensively covering the end of the apparition.

For the current 2015-2016 Mars apparition, imaging commenced towards the end of 2015 with Mars barely at 4 arc-seconds in diameter and I am still covering the last few days of the apparition at this point in time(Jan 2017). Images have been submitted on over 200 days on the apparition. A few dust storms were observed, but significantly less than the 2013-2014. An image captured close to opposition, with a similar view to that obtained from Hubble a few days later, caused some interest.

My images have been used on the ALPO Mars Highlights page, the ALPO journal and the Journal of the BAA. A number of my images were also used in my SABC TV news Mars interview in October 2016.

Mars images are submitted to the following forums:
BAA Mars section
ASSA Astrophotography section
Association of Lunar and Planetary Observers (ALPO), USA, Mars Yahoo group
ALPO-Japan, Mars section
Communication in Mars Observations (CMO)/The International Society of the Mars Observers (ISMO), Japan
PACA (Professional-Amateur collaboration in Astronomy) Mars group- by invitation only.
Des Etoiles plein les Yeaux- France
Planetary Virtual Observatory and Laboratory (PVOL), Europe
Images:

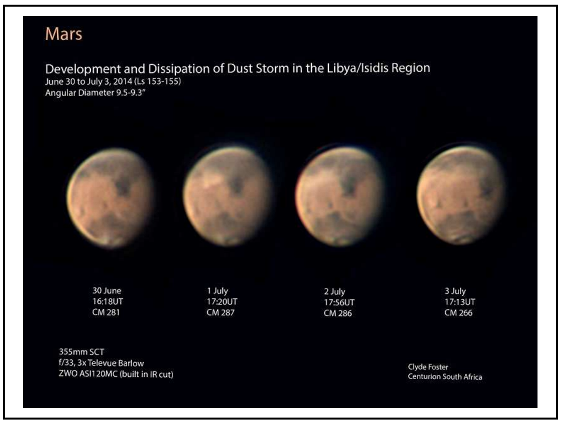
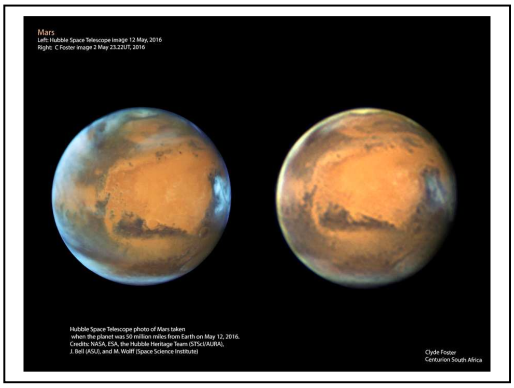


Fig 1. First dust storm: Composite image of development and dissipation.

Fig 2. (right) Hubble comparison images



Jupiter

Imaging of Jupiter over the last two years has been done, although I was not particularly happy with the quality.

However, initial results at the start of the latest apparition (Jan 2017) have been significantly improved.

My current imaging project involves submitting images to the NASA Juno team in support of their pro-am Junocam project, where hi-res amateur images are used to create global maps of Jupiter. These maps are used to identify, select and target features on Jupiter for imaging by the Juno spacecraft during its closest orbital approach (Perijove), which, in its current orbital configuration, occurs every 53 days. Initial feedback from the NASA Juno team has been positive. Images are also submitted to the European Jupos team who create an ongoing record of conditions on Jupiter by generating global Jupiter maps on a regular basis.

Jupiter images are submitted to the following forums:
BAA Jupiter section
ASSA Astrophotography section
ALPO-Japan, Jupiter section
PACA (Professional-Amateur collaboration in Astronomy) Jupiter group- by invitation only.
Des Etoiles plein les Yeaux- France
NASA- Junocam mission
Jupos
Planetary Virtual Observatory and Laboratory (PVOL), Europe

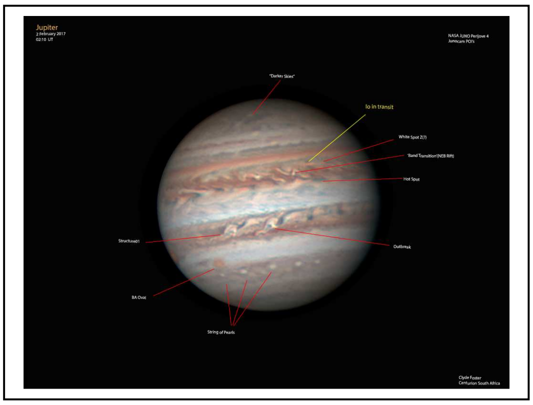


Fig 3. Image: Jupiter 24 Jan 2017

Other Planets

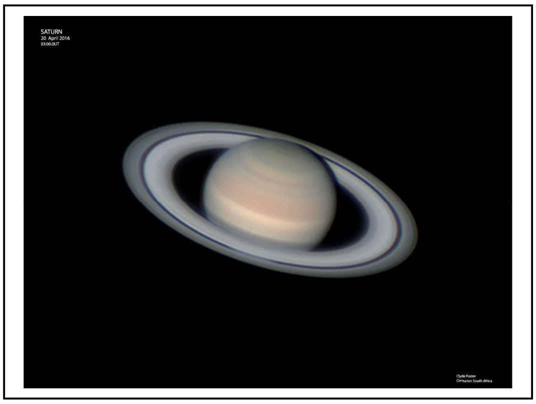


Fig 4. Saturn

Mercury, Venus, Saturn, Uranus and Neptune have all been imaged, although no serious programme has been initiated. It is however the author's intent to incorporate these targets in his future imaging programmes. The Mercury transit of the sun was captured in both full globe imaging as well as high resolution.

Lunar

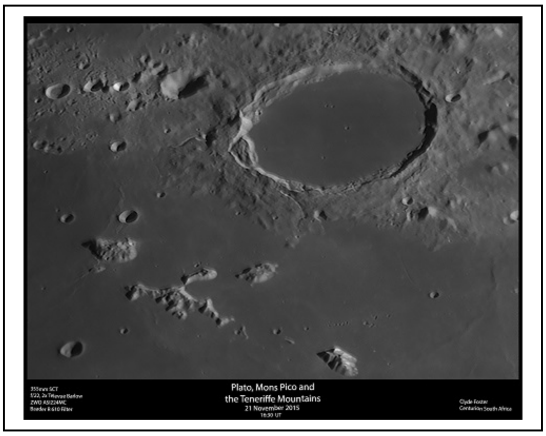


Fig 5. (right) Plato, Mons Pico and the Tenerife mountains.

Extensive high resolution imaging of various lunar features has been undertaken. The author has worked with the Lunar Geological Research Group(LGRG) in Italy, which has now been incorporated into the BAA lunar section. Images are regularly submitted to the BAA lunar section and published in the BAA Monthly Lunar Circular. Images are also submitted to the ASSA Astrophotography section. Full globe lunar eclipse and partial solar eclipse imaging has been done using the authors 110mm Refractor in conjunction with a Canon 60Da DSLR.

Henley on Klip observatory

Brian Fraser

This observatory has existed for more than 30 years, in various guises and locations. It started out on the roof of some outbuildings of my home in Kensington. It then moved to Sunninghill into a custom-designed and built observatory on top of a garage.

But for the past 15 years it has been in Henley on Klip (HOK) , in a specially built home consisting of two rooms each 4m square. One is the observatory with a roll-off roof and the second room serves as an office/study.

In 2001 it housed an 8 inch Celestron C8 with motor drives and electronic setting circles, which served as a workhorse for many years. It was used mainly to observe one star, Delta Sco, photometrically, in a project that started when thee star suddenly brightened in 2000. Other Be stars were also observed together with a sprinkling of variables and novas.

Another observing activity was timing of lunar occultations and minor planet occultations. There were even a few grazing occultations that were observed.

About 4 years ago the telescope was replaced with a 12-inch Meade LX200 in order to catch occultations of fainter stars. This was necessary since macular degeneration affected my eyes. The observing activities can be listed as:

Variable stars, mainly Be stars.
Novas
Other variable stars in the AAVSO program
Lunar occultation
Minor planet occultations
Grazing occultations
In addition, other events of interest observed
Transit of Mercury
Transit of Venus
Various lunar eclipses and partial solar eclipses.

The observatory has hosted many school groups, church groups and adult special interest groups.

A time signal is obtained from a special short-wave radio receiver tuned to the WWV time service.
The observatory also houses a solar flare monitoring receiver which runs 24/7. This station has detected many solar flares and at least one GRB.

Current observing is restricted to timing of lunar occultations through a webcam attached to the eyepiece of the telescope. The image is recorded on a computer together with the time signal and played back later at leisure.

Numerous papers have been printed regarding observations made at this observatory. These cover mainly minor planet observations and photometric observations of Delta Sco. An article on the observed GRB was printed in MNASSA.

Kleinkaroo Observatory

Berto Monard / KKO

The Kleinkaroo Observatory (KKO) is an amateur observatory, owned and run by Berto Monard. It is the successor to the Bronberg Observatory, which was located east of Pretoria and operated over the period 2001-10.
It's a working observatory and engaged every clear night. The observatory houses two telescopes Meade RCX400 of 30 and 35cm apertures respectively, both with CCD cameras SBIG ST8-XME and dedicated computers. Observations are overseen from a computer in the main-house via cable connection to the observatory.
The observing programs are a continuation of those from the Bronberg period with some priority shifts and consist of:

Timeseries photometry of cataclysmic variables (CV):

Timeseries are continuous observations by tracking a single star field, containing the object of interest, over several hours.
Timeseries photometry is specifically of interest in the study of cataclysmic variables (CV). The photometrically derived light curve reveals particular behaviour of the target star, which helps to characterise its nature. Orbital periods of the observed binaries are mostly between 1 and 8 hour.

Observations of the same star are repeated night after night over periods up to a couple of months. The observations are done in the same way every night using the same settings.
Because of the limited size of the observing instrumentation and the faintness of those objects (>mag 14) they are observed in unfiltered mode in order to catch every photon.
Most of these observations are done in cooperation with the CBA and VSNET networks and in many cases triggered by sudden transients, often erupting CVs, reported in alert notes by one of the large survey groups.
Besides participation projects, observations include prospection of possible CVs, observing flares on Proxima Centauri or other nearby red dwarf stars, variable quasar behaviour and others as described in earlier reports. Specially mentioned must be the observations of bright microlensing events over peak in collaboration with the uFUN network from the Ohio State University.
See also the news note in *MNASSA* **75**, 192, 2016 (NOS 7&8, October).

Snapshot observations of magnetic CVs and symbiotic stars:

Snapshots observations of objects and star fields (faint stars, deep sky objects) show the objects as they are on that moment. To get detailed and 'deep' views on those targets, many consecutive exposures are acquired, which are stacked to produce a deep resulting image. Snapshots at regular epochs will show gradual change in variable stars and other objects.
Magnetic cataclysmic variable stars (CV) are subdivided on the basis of magnetic strengths into two classes: polars and DQ Her stars.
They are monitored once or twice monthly, unfiltered. The intention of the observations is to derive long term light curves and study possible periodicities of low and high activity behaviour.
Symbiotic stars are large cataclysmic systems with orbital periods longer than 1 year. The complex interaction between a dense WD and a red giant star, lots of dust and gravitationally flowing hydrogen, gives rise to a number of light changes for the system which is observed. Usually more than one periodicity is derived from long term light curves. In addition to

hints of an orbital period for the whole binary there are periodic pulsations of the red giant, orbital variations of both donor and WD, and phases of obscuration due to local dense dust areas in the system. Some symbiotic stars show eclipses, which are the best indicators of the duration of an orbital period.
This project started in 2004 with filtered observations in V only. I band observations were added in 2013. Observing cadence is weekly or monthly based on variability and perceived importance of the object.
The symbiotic star monitoring project has now turned into one of the main priority observing programs at KKO.

Discovery observations

More than 100 supernovae were discovered from the Bronberg Observatory. Those were pioneering years for such discoveries and gave international recognition to that observatory.
After 2010 and the start of the KKO, many more observers and observing groups also got involved in SN searching using larger and automated telescopes. Sky surveys organised by Universities and professional groups and in later stages the prompt automatic data processing via subtraction photometry shifted the discovery success nearly fully away from dedicated amateurs.
Despite this competition 35 more SNe were discovered from the KKO up to 2016, 20 of those in the first two years, 2011 and 2012. As surveys started their auto-productive searches, discovery tellies at KKO dropped and efforts gradually diminished and shifted.
Some of the more interesting discoveries at KKO were supernovae in nearby galaxies NGC 4945, NGC 1448 and NGC 2442. Those SNe reached brightness levels beyond visual magnitude 14 and were visible through small telescopes over their peak periods lasting more than a month.
More information and comments on those SNe appear as an article in this issue; see SN searching in the Western Cape at the Kleinkaroo Observatory, page 10 of this issue.

STATION 0433

Greg Roberts

COSPAR (International Committee on Space Research) satellite tracking station 0433 was established at 4 Willow Way, Pinelands (Cape Town) in 1977 and has since been used almost exclusively for artificial satellite tracking of classified (secret) launches.

Purpose

The prime objectives of the tracking station are as follows:

1 Acquire and track newly launched classified satellites as soon as possible after launch, in many cases before the first orbit has been completed and often during the actual insertion of the satellite into its initial orbit with the aim of obtaining accurate positions of the satellite/rocket against the celestial background to enable orbit determination to aid in later acquisition.

2 Track newly launched classified objects as they change their orbit to reach the final destination. This can sometimes take many days and in at least several cases, several months. Search for bright objects that do not appear in the official Spacetrack public catalogue of orbital elements, determine the orbital elements of such objects and, if possible identify the object.

3 Monitor certain classified satellites for orbit behaviour - many change their orbits on an irregular basis and it is often necessary to perform orbit plane scans or searches that can last an hour or more, to reacquire and determine the new orbit.

4 Provide regular positional observations on suitably placed classified satellites that appear in the orbital databases used by the amateur

satellite tracking network. There are more than 500 such objects in orbits ranging from low Earth orbits to orbits reaching far out into space.

5. Requests are frequently received from various organisations for optical observations of certain satellites. One request was from the BBC for video footage of the British PROSERO satellite for a feature to celebrate its 50 years in orbit. Another request from a well-known US TV network was for footage of the classified secret satellites known as NOSS (Navy Ocean Satellite System) – it is not known if the footage was actually ever used as the network was warned several days before the planned TV transmission by a U.S federal agency not to broadcast the video. When the European Space Agency flagship satellite ENVISAT suddenly failed in orbit a request for optical observations was received in case it might shed light on the failure. Another incident was the failure of a high altitude US research satellite that failed to respond to radio commands and a request for optical observations was received to try and determine if the satellite had lost its attitude stabilization. Another interesting request was for observations of an Egyptian imaging satellite that had failed and the request was for the station to determine if the satellite was still in orbit where it was supposed to be as there was a suspicion that it had been interfered with by another unidentified space power. The satellite turned out to be where it was supposed to be.

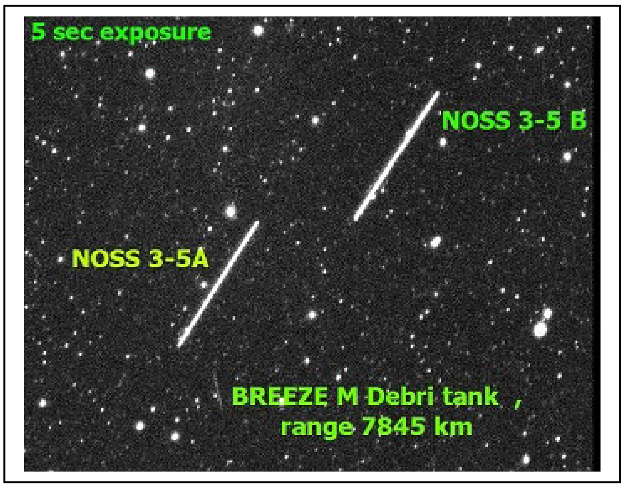


Fig 1. NOSS 35a and b + BREEZE debris.

6 Optical ground support for certain missions, mostly deep-space orientated. One example was that station 0433 was the only station worldwide to secure optical observations of the STEREO launch and the observations indicated that the spacecraft was slightly off course. Several

missions attempted were not successful - one being a lunar probe and another to the planet Venus - in the first case the sky was too bright and the second one the pass was not ideally placed and bad weather. Several close earth slingshots were observed where the spacecraft is placed in a highly elliptical orbit around the Earth and as the satellite passed through its closest point to Earth (perigee) the gravitational field of the Earth is used to slingshot the satellite to a higher velocity and shoot it out into space towards its distant target - some examples observed being the famous ROSETTA mission, the JUNO mission to Jupiter and the MESSENGER mission to Mercury.

7 In two instances video footage was taken of the venting of propellants related to classified launches and requests were received from the launch agency for the video footage, which was supplied, but a "thank you" or reply or any indication of what went on was ever received!

8 When a classified satellite in geostationary orbit suddenly failed numerous observations were made by station 0433, and two classified "inspection" satellites were moved to the vicinity of the doomed satellite to try and determine what had taken place. Observations from station 0433 showed that the official story provided was incorrect as to the dates of inspection and analysis of the video footage was done by a US organization to determine just how close the doomed satellite had subsequently passed close to a tightly knit group of commercial geostationary satellites - relying on memory I think it was about 12-15 kilometres. In addition requests for orbital data for the doomed satellite were received from commercial operators of some geostationary satellites who wished to take avoidance measures should the satellite pass too close to their satellites as it drifted along the geostationary belt out of control.

9 Suitably placed passages of NEO (near Earth objects) have been observed and positional observations secured to further refine the objects orbit. Some NEO's pass very close to the Earth in terms of astronomical

distance and the Earth could experience a disastrous collision with an object that passes a little too close!

10 "Hostile" countries such as North Korea and Iran launch satellites and these are tracked, either optically or by radio. There is a great deal of overseas interest in North Korean satellite activities and a considerable amount of effort was put into observing such and reporting results in an attempt to answer whether it was an active or inert payload that had been orbited.

11 From time to time other interesting launches have been observed, purely for the "fun of it". One such effort produced a great deal of interest from the European Space Agency when the EXOMARS mission was observed shortly after it appeared above the horizon just after EXOMARS had separated from its Russian BRIZ-M rocket stage. Images showed the Briz rocket surrounded by a "haze", brighter than expected and in images obtained by an observatory in South America several hours later it was shown that there were a large number of objects in orbit; so a natural question was "did the Briz rocket explode" around the time it was observed or was the rocket venting propellant etc. No convincing answer was ever received other than the Briz rocket was subjected to "non-gravitational forces" at that time. ESA was supplied with the images obtained, along with the relevant astrometry and they in turn measured the images. There was considerable discussion about the accuracy of 0433's GPS geographical position, which turned out to be in error by a few metres in longitude. These observations, along with other observations, were used in determining the trajectory of EXOMARS and the Briz rocket to Mars.

Fig 2. Tracking ExoMars and Briz.

Equipment

The main mode of operation is optical observations where the position of the satellite is determined using the celestial star background as a reference foundation and determined at an accurately known time. This is the classical technique used for celestial bodies and is known as Astrometry.

Time is determined to better than 50 milliseconds using satellite GPS signals and positional accuracy is typically sub-arc second. Since there is a need for a large number of reference stars in the determination of the satellite position a reasonable field of view is desired - usually around 1 degree or even more. This then implies relatively short focus telescopes with as large an aperture as possible since aperture really determines the magnitude limit.

From experience it was determined what was best suited for the bright sky conditions of 0433's location. The requirements for imaging low Earth orbit satellites where magnitudes can go as faint as mag +8 or +9 (or even fainter) is different from that required for imaging classified high altitude satellites where the satellites are generally a lot fainter. There are of course fainter satellites but these are very small and because of the bright sky background exposures are limited to seconds, rather than the hours that are typically used by deep sky observers to get deep magnitude penetration. As stated earlier exposures are only long enough to capture the satellite and the brighter stars around it - the latter brighter than magnitude +12. Using too long an exposure can produce long satellite trails which makes it a little bit more difficult to derive an accurate position, especially in crowded fields where trails overlap or can even obscure the satellite.

Consequently the optical equipment is that typically found in use by amateur astronomers with a modest budget. A high quality CCD camera is used and this allows astrometry down to sub-pixel level. Since some satellites are in unstable orbits one is forced to use a reasonable sized field of view otherwise the satellite may pass outside the field. Thus large aperture telescopes are not suitable as the field of view is too small, so small aperture short focal length telescopes are used with a resultant astrometric accuracy of around 1 to 5 arc seconds which in fact is better than the average "astronomical seeing" experienced which can be as bad as 12-16 arc seconds normally.

The optical equipment available includes numerous camera lenses and telescopes up to 10-inch aperture. For low altitude satellites a Nikkon telephoto lens with a focal length of 80 to 200mm and working at a focal ratio of f/2.8 allows coverage down to about satellite magnitude +9. For higher, fainter satellites a 102mm f/3.17 refractor is used whilst for the more difficult ones a 200mm f/3.65 reflector is required. The telescopes are common place telescopes, fitted with home-made focal reducers. The 10-inch originally saw life with a Bird-Jones optical configuration which is well known for poor quality images, so the mirror was reground and polished by well-known amateur telescope maker Chris Forder.

Fig 3. (left) 4-inch refractor on GOTO mounting.

Fig 4. (right) 8-inch reflector on CoSaTrack mounting.

In order to track certain classified satellites when in Earth shadow or doing daylight passes and hence not observable optically, use was made of the radio transmissions from such satellites. However many do not transmit on a continuous basis as there are no radio tracking stations in this part of the world to command classified satellite transmitters "on" and "off" so only a few satellites classified satellites in low Earth orbits transmit continuously. Many of the older geostationary classified satellites still put out radio signals which aid in identification and tracking if moved. Use is made of frequencies up to around 4 GHz using satellite dishes as large as two metres. However due to the high level of radio interference in Cape Town reception of weak signals can be a problem and most of the radio tracking on a regular basis has now ceased but can be resurrected if required.

Hardware/Software

The heart of the tracking station is the CoSaTrak system which (Computer Controlled Satellite Tracking). Originally constructed in 1999 so was in the very early days of amateur computer controlled GOTO telescopes. The system is entirely home-made using all sorts of pieces meant for other purposes - Meccano gears, belt drives out of teletype machines, stepper motors out of computer printers etc and is controlled by a computer running DOS and situated in a comfortable observing room some 20 metres or so from the mount which is in the open air. The original software used to control the telescope was written by Willie Koorts of the Electronics Department of the South African Astronomical Observatory using Pascal code and tailored to meet needs. Mike McCants in Texas rewrote some of the package and added a few extra facilities. Both Willie's and Mike's versions are still used, depending on the task.

Fig 5. The Observing Room

Accurate time signals used to be a problem. Relying on overseas time signals was often a problem, especially during solar minima when radio propagation conditions were very poor and sometimes made tracking impossible with no time signals. The situation improved considerably when Willie obtained one of the old crystal controlled time systems that had been used by the observatory prior to switching over to GPS signals. The unit was repaired, got operational and it was a big improvement but still required frequent checking against radio time signals due to the drift of the temperature controlled quartz crystal oscillator. A Motorola GPS module was donated and this, with a suitable interface connected to a computer, provided accurate time as well as supplying the geographical location. The old observatory crystal clock was slaved to the GPS unit and this served to provide a reasonably accurate time signal.

Up to this stage video cameras of various sensitivities had been used, recording the video to a DVD recorder for later analysis. This was a rather laborious task and sometimes the video quality left something to be desired. A MEADE DSI Pro Model II monochrome CCD camera from Hong Kong was obtained and this more or less was the death of using video for any serious work. However there was still a problem in that it was quite difficult to try and determine the precise time that the Meade DSI camera did an exposure - accurate enough for high altitude satellites where a minimum timing accuracy of around 1 second was adequate, but not good enough for low altitude satellite work where an accuracy of 0.1 seconds, or better, was desirable.

The astrometry carried out was done in various ways and of moderate accuracy but was very time consuming. As a result of collaborations with various organizations and providing observations, the International Scientific Optical Network (ISON), managed by the Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences, offered the use of the software used in their network, known as APEX, and written by Vladimir Kouprianov of the Pulkova Observatory Astrometric Department. Since the author was not officially a member of the ISON network but a private observer whose observations they used, it was provided with the reservation that there would be no official support. Fortunately there was a very active observer in the United States - Scott Campbell - and he and the author tackled the project of getting APEX operational on their respective (different) systems.

It took a fair amount of effort but, eventually, with a lot of help from the Vladimir Kouprianov, it all worked. The program was written in Python and tailored for the equipment used in the ISON network which was somewhat different to what amateurs were using as it was intended for CCD systems on equatorial mounts.
Shortly after Scott and the author got the APEX systems operational Ian Roberts (Station 0434) got interested and he was provided with a copy of the software – with permission to do so, but Ian had a different system. He wanted to use a common DSLR camera. Initially APEX refused to recognize his images but through a lot of experimenting, Ian managed to get APEX to work in his situation. Although APEX was distributed to several other members in the western amateur tracking network, it was tried and found too complicated so the other members chose not to persevere with it and used their own methods. Scott no longer observes satellites so Stations 0433 and 0434 are the only amateur observers outside of ISON using APEX.

During the IAF (International Astronautical Federation) in Cape Town in 2011 the author was visited by Vladimir Kouprianov and Igor Molotov. Igor, who is the Coordinator of the ISON network and a former radio astronomer, spent some time observing how tracking at 0433 was done, and referred to the stepper motor system as a "wonderful device!". A few weeks later a large package arrived containing a very expensive large format CCD camera and a matching GPS system which controlled the camera shutter to an accuracy of 50 milliseconds or better. This was provided as a "free gift - no strings attached" by the ISON network and is the ideal set-up for any astronomical or satellite imaging - naturally any observing done is biased in favour of obtaining data that might be of use to ISON.

This camera now forms the nucleus of the optical observing and is used on all the telescopes, and lenses, fitted with suitable home-made adaptors. Video is only used as a "finder" with the image displayed on a monitor in real time, typically showing stars down to magnitude +12 and ensures that the main optical system, with normally a smaller field of view, is accurately positioned.

Software, again written by Vladimir Kouprianov controls the GPS and CCD camera and obtaining the CCD image which is subsequently measured with APEX. For displaying satellite positions in real time, whilst observing, use is made of the freeware program HEAVENSAT, written by Alexander Lapshin, who is employed by ISON. Software, provided by Mike McCants (and in the public domain – QUICKSAT and HIGHFLY), are used to generate predictions at the start of an observing session. Finally use is also made of the program GUIDE by Bill Gray, of which the latest version (V9) is now in the public domain.

Orbital data for classified satellites is obtained from the website operated by Mike McCants who maintains the amateur satellite orbital databases. Use is also made of orbital data obtained from ISON. For satellites in the public domain use is made of the orbital data supplied by SPACETRACK, which is the worldwide (SSN), Space Surveillance Network operated by the United States.

For more sensitive material extensive use is made of facilities available on the Internet for communication between the more active/experienced members of the world- wide amateur satellite tracking network.

A typical observing session is controlled by the local cloud conditions. On a good night it is possible to observe about 50 classified satellites in a 4 to 5 hour period. Seeing conditions are seldom good due to the proximity to Table Mountain and the wind streams up the Cape Flats from the south, and from the northwest, meeting above 0433's location. Light pollution is a serious problem so exposures are never more than a minute at maximum, and typically long enough to record stars as a trail, so ten to fifteen seconds is adequate. The faintest satellite ever recorded was about magnitude +16.2, but observations are typically confined to about magnitude +15.

Fig 6. SL8 – 82037B rocket near the Pleiades Mag 4.2 with 3 secs exposure.

All observations made are reported to the SeeSat page on the Internet which is the homepage of the amateur satellite network. Since the homepage is open to all, this data is available to anyone who wishes to use such, which unfortunately does mean it could be misused.

An accurate count of how many satellites/objects observed has not been maintained, but Ted Molczan, (Canada) has kept records since Station 0433 started observing classified satellites with the first recorded observation made on 8 September 1989 and the total observations made now is in excess of about 90 000 observations on a large number of satellites. The actual number is considerably more than this since observations of non-classified satellites are seldom reported.

Finally to try to promote interest in satellites, a Facebook was created (***So You Want To Track Artificial Satellites***) which currently has about 120 members, many of them leading lights in the tracking of satellites.

Tracking Asteroids & Satellites from stations L24 & 0434

Ian Roberts (itrmail2003@yahoo.com)

The beginning

An article in a magazine detailed then satellite guru Steve Birkill's reception in 1976 in the UK of the experimental ATS-6 direct broadcast TV satellite as used in India on 860 MHz. This was the top end of the commercial UHF TV broadcast band. This triggered the author's interest in electronics, and later astronomy.

As things turned out, the Soviet Union orbited a similar satellite (EKRAN, or Stationar-T series) located at 99E longitude geostationary position and semi-direct broadcasting on 714 MHz UHF to its northern horizon (Siberia) where there was previously no direct TV coverage due to lack of infrastructure.

If the satellite produced sufficient power on its rear lobes it was hoped that a high gain, low noise array could be home built and would provide reasonable TV pictures despite the elevation being only about 9 degrees from Station 0434 in Pretoria. This proved to be the case in 1979. Later equipment progressed to 4 GHz satellite TV and amateur satellite working, each time using home-made equipment.

Fig 1. Stationar-T174 received in Pretoria 1979.

Testing the Equipment

Sensitivity was tested by measuring solar activity as detected at all frequencies and the noise signature of the Moon at 10.4 GHz in the amateur band, where the average temperature of the Moon is around 220 Kelvin, somewhat above the microwave background temperature of about 10 Kelvin as seen from a parabolic antenna at ground level. In this sense, the Moon is a "hot body" and could be located by panning the antenna across the invisible new Moon for example, where Moon noise as high as 2-2.5 dB could be readily obtained. Various noise sources such as Cygnus A, Cassiopeia and similar were also used. This technology is familiar to, and widely used, by radio astronomers.

Fig 2. Parabolic antenna at ground level.

Satellite Tracking Using Radio and Telescope

These activities were closely associated with radio tracking a variety of satellites. In the early 1980's contact was made with Greg Roberts, who was located in Cape Town. He ran a weekly SA-AMSAT (South African Amateur Satellite) net on amateur radio frequencies. The net concerned itself with all aspects of satellite tracking, not only amateur satellites.

To aid these activities Greg had written satellite tracking software running on the TRS80 computer, and the BASIC interpreter built into the Sinclair ZX Spectrum home computer. See Article on PXX in this issue.

These programs were noteworthy for their dual purpose functionality, both radio tracking where the satellite positions in azimuth and elevation degrees for antenna pointing, and optical tracking where satellite positions in RA and Dec suitable for telescope pointing, were computed.

As there were no telescopes at Station 0434 at the time there was no use for the optical tracking information.

Greg also compiled newsletters such as "The Journal of the Satellite Interest Group" which he sent out at his cost - there was no Internet in those days. Contributors had to be careful as receiving satellite TV and such activities constituted a criminal offence at the time and the South African Post Office was likely to pitch up and impound the equipment, at the very least.

Greg had a row with the SA-AMSAT hierarchy and distanced himself from matters concerning amateur radio, electing instead to concern himself with the optical tracking of satellites. The amateur satellite fraternity in South Africa has to this day not recovered from the lack of Greg's enthusiasm and technical expertise.

Optical Tracking of Satellites

Optical satellite tracking was started and the author’s location was registered as COSPAR (Committee on Space Research): site 0434. The last 10 years has seen the use of an 8" Meade SCT for satellite tracking, but it was found to be quite unsuitable due to its long focal length of f10 and resultant small field of view even when using DSLR cameras such as Canon's 650D. A short focal length 4" refractor such as the Celestron 102SLT operating at f6.5 improved the field of view greatly and a modified focal reducer intended for the Meade works satisfactorily providing a focal length of f4.4 and a field of view of 2.8 x 1.9 degrees which is even better. [1] This setup is now used each time, and Station 0434 in Randburg has a clear view of the geostationary satellite belt on the eastern horizon (in the blazing light pollution of the greater Johannesburg area) to the north western flank at some elevation. Until recently Station 0434 was the most eastern station doing optical satellite tracking with reports to Seesat-l. LEO (low Earth orbit) satellites are not tracked due to obstructed horizons.

Satellite tracking data is available in 2- or 3-line Keplerian element format to public access at Space-track.org which has tracking elements for just on 16 000 objects of which the majority is debris resulting from satellite collisions and anti-satellite tests. Elements for secret military satellites from the USA, Israel, some British and some French satellites are suppressed and not available. It goes without saying that these are the interesting birds for satellite trackers as all other satellite data including Chinese and Russian satellites, is freely disbursed. But we in the satellite tracking community are not biased against any one country - ALL satellites we come across are reported.

Previously it was found that optical satellite tracking was a labour of love - each image had to be reduced using software such as Pinpoint, then the RA and Dec for satellites visible on the image obtained, then those values used against satellite predictions to ID the satellite, then that data converted into universal reporting format IOD (Interactive Orbit Determination) for uploading to the interest group at Seesat-l. A lot of rather tedious work. Then Greg Roberts said that he had come across software, APEX 2, available from the Pulkovo Observatory, Observational astrometry lab, St Petersburg, Russia, author Vladimir Kouprianov.

APEX 2

This remarkable software is intended to largely automate the image post-processing associated with the tracking of satellites and asteroids. It is used by the Russian-based ISON observatories scattered around the globe and the author made the point we were welcome to use it, but there would be no user support for our activities due to work load.

APEX has no user interface as it is launched from a batch file, runs in a Windows command box and uses a configuration file for control. It is multi-processing and utilizes all computing power available on a quad core PC for example, with up to 24 concurrent instances running.

Greg Roberts and Scott Campbell (USA) were starting up with APEX for satellite tracking and the author joined them. There were difficulties and initially the image rejection rate was very high, especially with the author's noisy Canon 1000D DSLR that was used at the time. By mutual mentorship results were fine-tuned and currently up to 100% success rate is obtained using a much better Canon 650D. A typical hour or two of scanning the geostationary satellite belt might capture 30 images with up to 80 or so satellites complete with IOD formatting for submission to the Seesat-l group.

APEX has two modes, apex_geo which only reduces satellite information, and apex_mpc which reduces asteroid data ready formatted to pass the parsing robot's syntax requirements at the MPC (Minor Planet Centre, part of the Smithsonian Institute in the USA) which is tasked with maintenance of the world's asteroid objects (currently 706 483) and comet (891 objects) databases.

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Processing summary

-- General --

Total objects:        90
Unidentified objects: 8

Seeing: 10.4"
Limiting magnitude at SNR=3: 12.92 +/- 0.30


-- Astrometric reduction --

Reference catalog:      Tycho2
Reduction model:        Cubic 20-constant linear plate reduction model
Reference stars:        64 (+ 3 unused/discarded)

Projection: Tangential (TAN)

WCS parameters:             Reduced            Original
  Equinox                      ICRS                ICRS
  Image center RA        16 14 28.299       16 13 48.334
  Image center HA        20 26 24.118       20 27 04.191
  Image center Dec       +01 52 26.03       +02 11 59.23
  X scale ["/px]               7.7506             7.7500
  Y scale ["/px]               7.7430             7.7500
  Focal length [mm]         449444.63          449258.06
  Field of view [']    168.19 x 112.14    168.17 x 112.25
  Rotation [deg]             194.3124           249.0000
  Shear [deg]                  0.0029             0.0000
  Flip                            Yes                Yes
```

Fig 3. Part of the APEX process log.

39237	0434 E 20160608173441000 16 15 1525047+041703 18 +119 02
41103	0434 E 20160608174718000 16 15 1649588+040557 28 +117 02
41103	0434 E 20160608174808000 16 15 1650486+040557 18 +117 02
41121	0434 E 20160608174718000 16 15 1644344+040600 28 +107 01
41121	0434 E 20160608174808000 16 15 1645242+040559 18 +106 01
41434	0434 E 20160608180048000 16 15 1749439-012726 28 +110 02
41434	0434 E 20160608180147000 16 15 1750165-014055 28 +101 00
40208	0434 E 20160608174718000 16 15 1647360+040054 28 +101 01
40208	0434 E 20160608174808000 16 15 1648257+040052 18 +101 00

Table 1 Satellite tracking data output in IOD format

APEX allows both processes to run on the same image "plate" so satellites and asteroids can be handled simultaneously with sub-arc/second accuracy.

Asteroid Tracking

Astrometric and photometric results for asteroids are in exact agreement with catalogue data. APEX will not handle images in a format other than monochrome FIT, so colour photometry is not possible. Star catalogues used locally now are Tycho 2 for satellites, and UCAC4, USNO-A and USNO-B1 for both asteroids and satellites as necessary. Asteroid and comet data may be verified in Sky Charts (Cartes du Ciel) after loading the latest databases available from the MPC together with a comprehensive star catalogue such as NOMAD (around 350 GB) which Greg Roberts kindly Torrent downloaded over a period of several days. Any item detected in this process and remaining UNID could be a new discovery (or even a hot pixel!), deserving a second imaging attempt for confirmation before submission to the MPC.

MPC Observatory status

Using the apex_mpc functionality observatory status was obtained with the MPC as L24 Gauteng when using the 4" Celestron refractor. The MPC side-steps the issue of accuracy to meet the acceptance requirement but it is surely better than 1 arc-sec astrometrically. Catalogue data for asteroid Doris (48) magnitude 10.8 used, indicated results were within 0.3 arc-secs RMS with an acceptable photometric (magnitude) tolerance.

In correspondence with the supervisor at the MPC, the question was asked whether it was necessary to also qualify the "better" 8" Meade LX200R as part of L24 Gauteng. This question was not answered. Point made. Does the MPC qualify the equipment or the astronomer at these observatories (or any observatory) as the astronomer, knowing what he or she is doing, can obtain stellar results with such equipment?

There are only three other "private" observatories listed by the MPC in South Africa, two run by the late Jan Hers from Linden, Johannesburg and later, Sedgefield near George. In recent correspondence with Peter Hers, son of Jan, Peter mentioned he had taken over the property in Sedgefield, and that the observatory building was very run-down, he had recovered the instrument, and believed the conditions in Sedgefield were not suitable for astronomy. The third is Andre van Staden in the Overberg, station 641. See MNASSA Vol. 75 Nos 11 & 12.

Since the magnitude range of telescope and camera combinations under Johannesburg's severe light pollution is only 14 and 17 respectively, asteroid observations are not done; the MPC is already fully stretched processing the daily tens of thousands of observations automatically processed and sent to the parsing robot by the world's giant telescopes. But it's nice to periodically keep one's eye in by processing a few asteroids.

Readers looking for suitable asteroids to log might be interested wanting to try EPOS7. Ask the author for a copy if you can't find it on the web.

In his article **Hunting Asteroids From Your Backyard** Dennis Di Cicco contributing editor to Sky & Telescope magazine states: "From October '95 through January '96 I have never failed finding a new object when

observing this way for two hours on a given night — there's a lot of stuff out there waiting to be discovered, and it doesn't take long to find it!" [2]
But things have changed dramatically since 1996 as far as amateur observers competing with the world's great automated scan telescopes are concerned, but you never know!

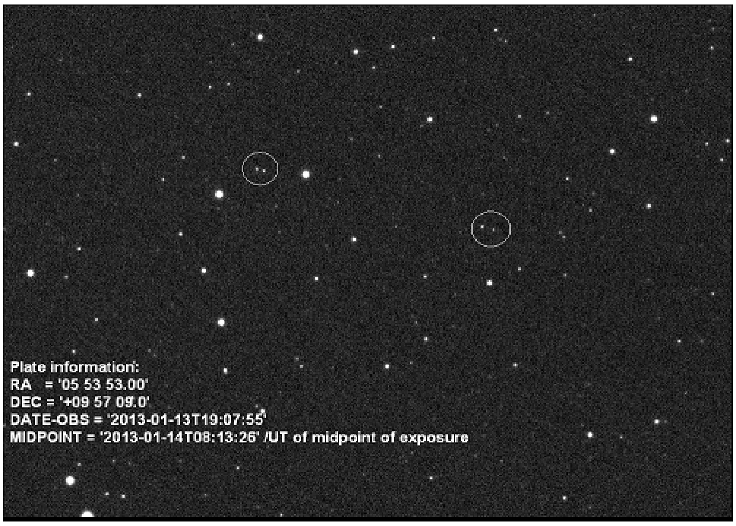


Fig 4. Example Plate: Astroid Camiilla mag 13 on time-separated exposures 13-14 January 2013.

References

[1]http://www.cloudynights.com/page/articles/cat/user-reviews/celestron-nexstar-102slt-test-review-r2453)
[2]http://www.skyandtelescope.com/observing/celestial-objects-to-watch/hunting-asteroids-from-your-backyard/

Sterkastaaing Observatory

Magda Streicher – a personal reflection

My interest in the stars goes right back to childhood and I can clearly recall the fascination those twinkling, silvery lights in the dark skies above held for me as a youngster. It was clear in my mind then that I will dedicate my life to astronomy. Since then I have become an active amateur astronomer, and over the past twenty two years I have become steadily more involved in advanced participation in South Africa. Been an active member of the ASSA, served on its council and was the President in 2008/2009.

Staying in a town called Polokwane, in the far northern part of South Africa. Using 12” and 16” Schmidt-Cassegrain telescopes enables me to do useful Deep Sky observing on our farm close to the Zimbabwe border with excellent dark skies. In the town of Polokwane were we stayed an observatory was constructed in 2007 on our home roof which slides down by the means of an electric motor made it user friendly. The setup has been done with a 16-inch telescope on a permanent pier, it also houses star catalogues and books, a working table which can be wheeled around the telescope to make observing night-work easy, which lasts most of the time a few hours if weather permits. I have done that with great passion and satisfaction over the past years, completed several astronomy deep sky projects. Searching out deep sky objects, sketch them to add to a wonderful, interesting world with certain exceptional and unique characteristics. The name of my observatory is been dedicated to a bush field tree, seeing that trees and stars are truly nature. I strive to share my interest with others through regular radio talks, articles for the local newspaper and talks abroad. Further contributions include my Deep Sky Delights a regular deep sky column in MNASSA; essays for various deep sky sections in SA include meteor, comets, occultations and double star observation feedbacks. An ongoing observation of 164 double stars enables me to pick up any changes of which 4 were notably different over years. Various eyepieces enable me to do measurements like the use of a metric eyepiece which been calibrated to my telescope scale.

The main-belt asteroid 5 Astraea was discovered by Karl Henze accidentally in December 1845 while searching for the asteroid Vesta. 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.

I hope that my humble contribution can help reveal some of the wonders of the universe, and that these results on some of my favourite objects will motivate others to try observing and recording deep sky objects and develop their own dedication to astronomy.

Editor: Magda Streicher’s monthly columns, and other articles, have been a regular feature of MNASSA for many years, and much of her work is unique – who today still draws and sketches deep sky objects and Asterisms?

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: INTEGRAL multiwavelength observations of X-ray binaries
Speaker: Dr. Julia Alfonso-Garzón
Date: 24 January
Time: 11h00 – 12h00
Venue: SAAO Auditorium
Abstract: The extreme variability of X-ray binaries requires simultaneous observations across the spectrum, therefore multiwavelength long-term studies of these high-energy sources are crucial for their understanding. Since INTEGRAL has been observing the high-energy sky for more than twelve years, good time-coverage light curves have been acquired for many of these sources. INTEGRAL has two main instruments, the imager IBIS and the spectrometer SPI, working in hard X-rays/soft gamma rays. JEM-X and OMC monitor the high-energy sources in soft X-rays and in the V-Johnson band respectively. OMC and JEM-X have the same field of view and this is co-aligned with the central part of the larger FoVs of the main

instruments. I will show long-term INTEGRAL observations of a sample of X-ray binaries and present first results on the correlation between the optical and X-ray variability of the microquasar V 404 Cygni during its outburst in June 2015.

Title: Dust-obscured galaxies under the cosmic zoom lens in the Herschel Astrophysical Terahertz Large Area Survey
Speaker: Dr Mattia Negrello
Date: 26 January
Time: 11h00 – 12h00
Venue: SAAO Auditorium

Abstract: The Herschel Astrophysical Terahertz Large Area Survey (H-ATLAS) is the widest-area extragalactic survey undertaken with the Herschel space observatory, covering around 600 square degrees of the sky from far-infrared to sub-millimetre wavelengths. One of its scientific goals is the systematic search of gravitationally lensed dust-obscured galaxies using a simple and efficient method that was first proposed in the 90s, which exploits the steep number counts of sub-mm selected galaxies.
After discussing the importance of gravitational lensing in the study of distant galaxies and the key role played by dust-obscured galaxies in our understanding of galaxy formation and evolution, I will review the status of the search of lensed galaxies in H-ATLAS and of the associated campaign of follow-up multiwavelength observations. I will then show and discuss some examples of dust-obscured lensed galaxies discovered so far. In particular I will focus on SDP.81, the first gravitational lensing event we identified in H-ATLAS, in which the spatial resolution offered by follow-up observations with the Atacama Large Millimetre Array (~30 milliarcsec) and the extra "zoom-in" provided by gravitational lensing allow us to probe scales of just few tens of parsecs in a z=3 galaxy!
The talk is meant for a wide audience so please come along even if you are not very familiar with far-infrared/sub-mm astronomy and/or gravitational lensing

Title: Double degenerate binaries in spectroscopic surveys
Speaker: Dr Elmé Breedt (University of Warwick)
Date: 13 February
Time: 11h00 – 12h00
Venue: SAAO Auditorium

Abstract: The use of type Ia supernovae (SNIa) in cosmology over the past decade has led to a huge amount of research on SNIa, but the exact nature of their progenitors is still unclear. Here we consider the double degenerate population in the Galaxy, and whether there are enough of them to account for the observed SNIa rate. To answer this question we need multiple radial velocity measurements of ideally thousands of white dwarfs, as only a small fraction of the double degenerate population is massive enough, with orbital periods short enough, to be considered viable Type Ia progenitors. We show how the radial velocity information available from public surveys such as the Sloan Digital Sky Survey can be used to pre-select targets for variability, leading to a ten-fold reduction in observing time required compared to an unranked or random survey.

Title: Robotic Spectroscopy and STGs
Speaker: Dr Rick Hessman (University of Goettingen)
Date: 13 February
Time: 14h00 – 14h30
Venue: 1896 Building

Abstract: This project aims to install a fibre-fed spectrograph on the MONET-South telescope during 2017 which utilizes the "STGs" design of Darragh O'Donoghue & Chris Clemens.

Astro-Coffee

Title: The fundamentals of nuclear physics
Speaker: Dr Rob Adam, SKA SA Project Director
Date: 26 January
Time: 13h00
Venue: 2nd floor auditorium SKA office, Pinelands

Abstract: In 2007 and 2008 I gave a 20 lecture Honours course in Nuclear Physics at the University of Pretoria. The first one hour lecture in this course provided an overview presenting the basics of the subject and its applications. I have adapted this material into a talk for an audience of astronomers, assuming knowledge of standard undergraduate physics. The talk begins with a discussion of the four fundamental forces of nature and shows how nuclear phenomenology can be understood from this vantage. I explain the relationship between the underlying strong force and the meson exchange theory of nuclear forces, and how nuclear structure and dynamics are built from here. Computational limitations provide the imperative for the development of models of any physical system, and I use the Liquid Drop Model of the Nucleus and its quantitative expression, namely the Semi-Empirical Mass Formula, as the departure point for an understanding of a wide range of nuclear phenomena. As interesting areas of application of the theory, I explain different types of radioactivity, why neutron stars blow up when they get too small, how to calculate critical mass for a nuclear weapon and how South Africa has excelled in the production of medical radioisotopes. My emphasis is to be quantitative without being complicated.

Title: The fundamentals of nuclear physics Part II
Speaker: Dr Rob Adam, SKA SA Project Director
Date: 2 February
Time: 13h00
Venue: 2nd floor auditorium SKA office, Pinelands

Abstract: As above

UWC

Title: Spots on the Sky: cosmic superstructures and their ISW effect
Speaker: Dr. Sesh Nadathur (ICG, University of Portsmouth)
Date**:** 24 February
Time**:** 14h00
Venue: Rm 1.35 New Physics Building, UWC

Abstract: In the presence of decaying potentials at late times, large rare superstructures in the universe imprint secondary temperature anisotropies on the CMB via the integrated Sachs-Wolfe effect. Measurement of this effect in stacking analyses has been controversial, due to a long-standing discrepancy between the measured value and LCDM theoretical expectations. I will present a new method for detection of the stacked ISW signal based on the construction of an optimal matched-filter for the CMB. Applying this method to our new catalogue of superstructures from SDSS DR12 data allows a very precise measurement of the ISW amplitude, at high statistical significance. I will show how the new measurement resolves the tension with LCDM, compare the result to other recent measurements including by the Dark Energy Survey, and discuss the implications for explanations of the CMB Cold Spot anomaly.

AIMS

Title: B modes: component separation using Gibbs sampling in the context of the SPIDER experiment
Speaker: Benjamin Racine from the University of Oslo
Date**:** 8 February
Time**:** 12h00
Venue: Upstairs Hall

Abstract: Detecting B-modes due to primordial gravitational waves in the polarization of the Cosmic Microwave Background is one of the greatest goals of modern observational cosmology. Many experiments have been designed to detect this weak signal, and upper limits are improving year by year. In fact, while B-modes have now been clearly observed, these are not of primordial origin, but rather induced by late time effects. At large scales, the signal is most probably dominated by the galactic dust, whereas at small scale, it is due to gravitational lensing.
In this talk I will give a general introduction to CMB polarization and B modes, and show some recent observational highlights. I will then review the problem of component separation, and present a recently developed method for joint estimation of cosmological parameters and astrophysical foregrounds. Finally, I will discuss how this may be applied to observations from the SPIDER balloon borne experiment.
Note this talk was repeated at UWC on 10 February.

Sky Delights: The Lesser Lion and Two Similar Dogs

Magda Streicher

The Lesser Lion

Studying and appreciating the northern night skies can sometimes be difficult for those of us living in the southern hemisphere. Nevertheless, it is important to describe a few of the northern constellations, since they are home to some of the most interesting objects known.

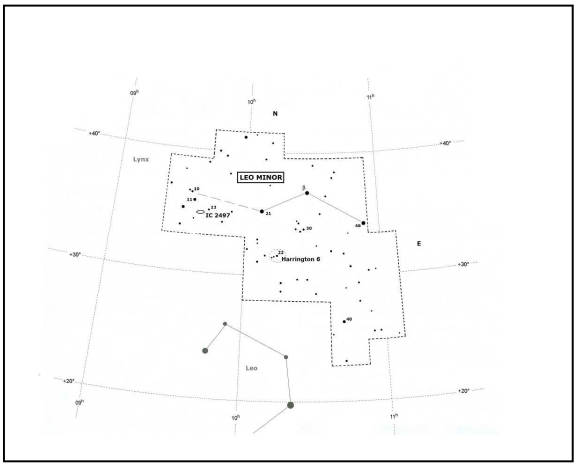


Fig 1. Leo Minor

So, for example, we have Leo Minor almost piggybacking on the famous old greater Leo. In French the smaller constellation is known by the charming-sounding name Petit Lion. The Germans call it der Kleine Löwe, and for the Italians it's Lencino. The Polish astronomer Johannes Hevelius used only 20 stars in 1687 to define the shape which nestles between Ursa Major and Leo.

This relatively small, but substantial constellation contains a special object discovered by Dutch school teacher Hanny van Arkel in 2007 while she was participating as an amateur volunteer in the Galaxy Zoo project. She found, photographically, a greenish flimsy haze close to the spiral galaxy **IC 2497**, now popularly known as Hanny's Voorwerp (Hanny's Object). The extremely faint magnitude 14.9 galaxy is situated only 2 degrees south of the lovely yellow-coloured 10 Leonis Minoris with a magnitude of 4.5 in the western part of the constellation. Brian Skiff notes that this object appears to be a giant patch of [OIII] emission, centred at about RA: 09h41m04 – DEC: +34°43'.6 (J2000), only 24" south of IC 2497.

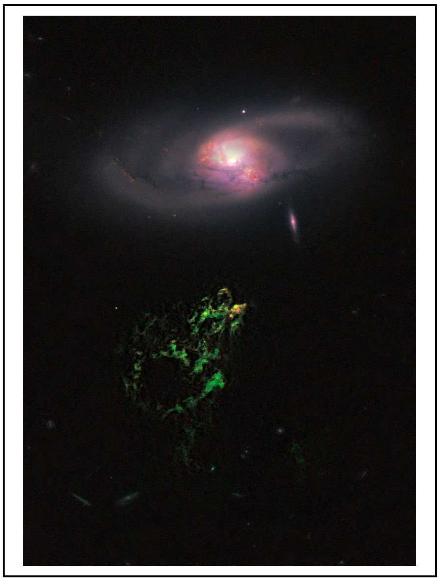


Fig 2. Hanny's Voorwerp (Object)

The SDSS catalogue shows Hanny's Voorwerp only as a single-point source type of entry, with a Sloan magnitude of 18.8. Since it covers a fair stretch of sky, this must be a lower limit on the brightness, so perhaps something between 17 or 18 might closer to correct. Skiff also noticed that SDSS images of IC 2497 show that the galaxy is absorbing a companion object whose nucleus lies a few arc-seconds south-west of the main galaxy's centre. Hanny's Voorwerp glows green from high-energy radiation that once emanated from an active quasar at the centre of IC 2497. Researchers have found about 20 of these objects all within 1 billion light-years of Earth.

In the southern corner of the constellation is a bunch of bright stars known as **Harrington 6**, a beautiful grouping of a dozen yellow-coloured stars which includes the star 22 Leonis Minoris. The grouping is named after Phil Harrington, author of many books on astronomical equipment, observing selected sky targets, solar and lunar eclipses and many more.

Two similar dogs

Climb over the feet to the two so-called hunting dogs, in other words the constellation Canes Venatici. The constellation was first recorded in the 16th century, and Hevelius brought it more into context during the 17th century. The magnitude 2.9 alpha Venaticorum was named Cor Caroli (Heart of Charles) by Halley in honour of King Charles I of England. The star alpha Venaticorum is 120 light-years distant, and is a binary pair with a separation of 19.4” and position angle of 230°.

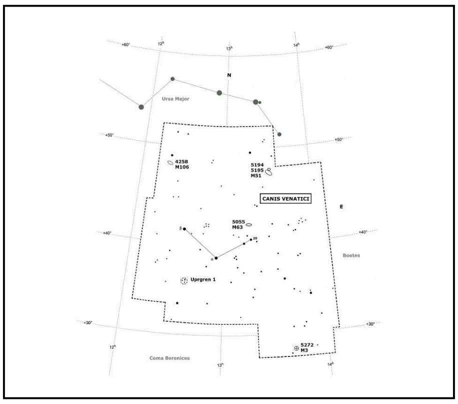


Fig 3. Canes Venatici).

The constellation is also the proud proprietor of a stream of galaxies belonging to the Local Supercluster of galaxies more than 50 million light-years away.

This constellation probably has the largest spectrum of galaxies in terms of shapes and character. Consider that the galaxy NGC 4449 is rectangular in shape with distorted arms. The large, thin spindly galaxy NGC 4244 has knots of gas on its surface. The galaxy holds a secret in that if deep-sky photos are studied, one can see a break on both sides of the nucleus – faint irregular hazy knots on the tapered tips. And then the galaxy NGC 4490 has a teardrop shape. A pair of galaxies, NGC 5395 and NGC 5394, appears to be in a spiral dance with each other.

A bunch of galaxies near the border with Ursa Major has within its mists surely one of the most delicate galaxies one will ever see: **NGC 4258**, better known as Messier 106. This galaxy is a whole 35 000 million light-years distant, with a radioactive source. The bright nucleus is well concentrated with a slight halo around it. Large telescopes reveal two tight spiral arms north and south, which give it an elegant, smooth look.

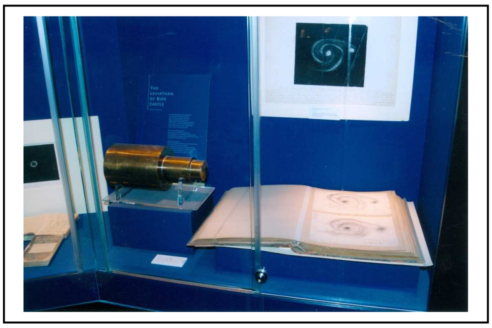
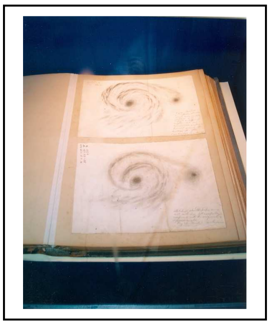


Fig 4. (left) Lord Rosse's book in display case.

Fig 5. (right) Whirlpool sketch by Lord Rosse.



But the best-known galaxy pair situated in the far north-east of the constellation is certainly **NGC 5194** and **NGC 5195**, well known as Messier 51. Charles Messier discovered this beautiful object in 1773. Its spiral structure was discovered by Lord Rosse only much later, in 1845, when he observed it using his 6-foot reflector at Parsonstown in Ireland. In the 1920s they were recognised as spiral galaxies comparable to our own galaxy. The large open spiral with its companion galaxy, appear as two misty magnitude 8 clouds clearly displaying two close, bright nuclei. A closer look at the large spiral brings to view the two misty arms standing out against the dark dust sections between them. With some care, one can spot a few bright hazy patches and faint stars on the surface. This is one of the finest examples of a face-on galaxy and is popularly referred to as the Whirlpool Galaxy. NGC 5195 the companion, displays a bright oval, quite outstanding just north. However, NGC 5194 rated brighter, appears slightly fainter than the smaller satellite companion. Three much fainter companion galaxies is situated further east; see Fig. 3.

Another striking galaxy is **NGC 5055**, better known as Messier 63, which forms a triangle north-east with alpha and beta Venaticorum. M63 is also a large open spiral, slightly tilted towards our view. Reminding the viewer of a beautiful open flower, it is aptly named the Sunflower Galaxy. M63 has a large, bright nucleus surrounded by tightly wound spiral arms that appear as a misty envelope around the nucleus.

Take a break and enjoy the open cluster named **Upgren I**, which seems to be trying to hold its own in galaxy world. Upgren I is an outstanding group of a few bright yellow stars. Data suggests a much larger extension of stars for up to 37 arc-minutes in size. The brightest star in this grouping is HD 109530, which is situated on the extreme northern side. Arthur Upgren and Rubin have suggested that a small group of bright F stars, moving in the direction of the galactic North Pole, may be the remnant of an old cluster. Utilising the multichannel astrometric photometer (MAP) the authors have determined the parallaxes of six of the candidate stars with an average precision of 1.1 thousandths of an arc-second (1.1 mas). The derived distances are, as suggested, similar, and an unusual space density of F stars seems indicated. However, the derived space velocities indicate that the proposed cluster is composed of members of two dynamically different groups (*SAO/NASA Astrophysics*).

One of the brightest globular clusters in the northern starry skies is **NGC 5272**, or Messier 3, discovered by Charles Messier in 1764. It is a splendid object, large, bright and outstanding against the star field. M3 displays a compact, bright, unresolved core with starlight that blazes off from the core with outliers and pinpoint stars scattered around the flimsy edges of the cluster. The south-western side of the globular is busier, with star strings spreading out into the field of view. A triple star south-east, along with a magnitude 8 yellow star keeps coming back with observation to claim its place.

This part of the northern hemisphere star field houses many animal named constellations, not to be afraid of, but to befriend and to take you into a rare celestial wonder star park.

Table of objects referred to

OBJECT	TYPE	RA	DEC	MAG	SIZE
IC 2497	Galaxy	09h41m.4	+34°43′.8	14.9	0.6′x0.3′
Harrington 6	Open Cluster	10h13m.5	+31°27′.0	8.5	42′
NGC 4258 Messier 106	Galaxy	12h19m.1	+47°18′.0	8.4	20′x8.4′
Upgren 1	Open Cluster	12h35m.0	+36°22′.6	6.3	15′
NGC 5055 Messier 63	Galaxy	13h15m.8	+42°02′.0	8.6	13.5′x8.3′
NGC 5194 NGC 5195 Messier 51	Galaxies	13h29m.9 13h30m.0	+47°12′.0 +47°16′.0	8.4 9.6	8.2′x6.9′ 6.4′x4.6′
NGC 5272 Messier 3	Globular Cluster	13h42m.2	+28°23′.1	5.9	16.2′

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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ISSN 0024-8266

mnassa

monthly notes of the astronomical society of southern africa

Volume 76 Nos 1 & 2 **February 2017**

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