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monthly notes of the astronomical society of southern africa
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Hubble turns 21

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Hubble turns 21

The newly released Hubble image shows a large spiral galaxy, known as UGC 1810, with a disk that is distorted into a rose-like shape by the gravitational tidal pull of the companion galaxy below it, known as UGC 1813. For more information, see the article on p.104.

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news notes

History of the African Astronomical Society (AfAS)

The call for a Pan-African professional society of astronomers goes back several years. In 2008 both Peter Martinez (South Africa) and Pius Okeke (Nigeria) published articles on ways to develop astronomy in Africa, the latter specifically calling for the formation of a Pan-African African Astronomical Society.

The launch of the African Astronomical Society. (from right to left) Pius Okeke (Nigeria), AfAS President; Hakeem Oluseyi (USA), AfAS Immediate Past President; Jacob Ashong, (Ghana) – Treasurer; Susan Murabona (Kenya), Education and Public Outreach Spokesperson.
Image credit – Charles McGruder, Past President of the National Society of Black Physicists.

Regional professional astronomical societies had been formed in both West Africa and East Africa. Colleagues in North Africa also have organized professional astronomy organizations, and the history of astronomy in South Africa is well documented.

At the 2010 launch of the African Physical Society in Dakar a number of astronomers from throughout the continent and the African diaspora resolved to form the African Astronomical Society in much the same manner as the African Physical Society was being formed. Following this meeting Pius Okeke wrote a whitepaper on the formation and the structure of the African Astronomical Society that was widely disseminated amongst African astronomers.

At the same time Claude Carignan of Burkina Faso, who was also at the Dakar meeting, was actively organizing an IAU Symposium on galaxy formation in Ouagadougou for December 2010. This was the first IAU Symposium ever in Africa outside of South Africa. The Dakar meeting participants decided to form the African Astronomical Society at this IAU symposium.

In a visit to Cape Town, Carignan and Kevin Govender, then the manager of the Collateral Benefits Division of SAAO, agreed to organize a Skype teleconference to gain support for the African Astronomical Society. After this teleconference an "Interim Working Group" was formed that was to carry out the formation of the African Astronomical Society at the Ouagadougou meeting.

In Ouagadougou the Interim Working Group agreed upon a structure and constitution for the African Astronomical Society (AfAS). Jacob Ashong of Ghana was charged with officially registering the society under the laws of the Republic of Ghana, a task he completed in January 2011.

The Ouagadougou meeting is historic in that it marks the official formation of the AfAS in addition to being the first IAU Symposium ever in West Africa. It was in part made possible through the generous support of UNESCO, Sweden's International Science Progamme and the National Society of Black Physicists.

The AfAS was ceremoniously launched at the 2nd Mideast Africa Regional IAU Meeting, MEARIM 2, in Cape Town, South Africa in April 2011.

For further details, see: http://www.africanastronomicalsociety.org ☆

Dame Jocelyn Bell congratulates Pius Okeke on becoming the President of the AfAS.

IAU President Bob Williams presents AfAS President Pius Okeke with a gift of congratulation at the launch.

SAAO Report: 2004-2009

Compiled by Prof. Phil Charles and Dr. Ian Glass

Director's Overview:

The last decade has seen perhaps the most dramatic developments and advances in the astronomical facilities of SAAO since it was formed almost 40 years ago. Construction was beginning on SALT, the Southern African Large Telescope, and anticipation was running high as to the science potential of what would be the largest single optical telescope in the southern hemisphere. SALT was driven as a South African project by my predecessor, Bob Stobie, whose untimely passing in 2002 meant that he was sadly not to see the completion of what was then the largest scientific research project in South Africa. But even before its completion, the perceived success of SALT as a high-level scientific collaboration on a global scale had contributed to South Africa proposing to host the SKA and beginning the construction of a technology demonstrator and SKA-precursor, MeerKAT.

Consequently, there has been much interest in the activities and output of South African astronomy in recent years. And while SAAO contributes to the (published) annual report of the NRF, under whose auspices SAAO is administered, there has been no separate annual report of the Observatory since 2003/4. However, the NRF and its research facilities are independently reviewed every five years, and part of this process requires SAAO to generate a "Self-Assessment Report" covering that five-year period. This happened most recently in mid-2010 when the NRF's Astro-Geosciences facilities (including SAAO) were reviewed for the interval 2004-2009, and SAAO produced its self-assessment report (SAR). I decided that this SAR, whilst containing a large amount of management information, also included scientific material which would be of wider interest to the astronomical community, both locally and internationally. Consequently, the SAR has been edited into an astronomical report of that period, for which I am very grateful to our Librarian (Shireen Davis) and Ian Glass for their efforts in compiling this document.

SAAO has evolved significantly during this interval, as it prepares to host a truly world-class facility (SALT), and offer it as part of a full suite of research telescopes and instruments at Sutherland to the South African astronomical community. In parallel with these activities, which form the core of SAAO, it was recognised that South Africa had to generate the home-grown human capital capable of exploiting this new facility. This meant an expansion of the number of South African research astronomers, and required a re-think of the system to produce them. SAAO has played a leading role in the creation of

NASSP, the National Astrophysics and Space Science Program, hosted at UCT, but utilising the resources of SAAO in both Cape Town and Sutherland. NASSP brings together scientists from all SA universities and national research facilities which have involvement in astronomy to provide international-standard courses that take students to Honours and Masters level in Astronomy, thereby preparing them to undertake PhDs. The number of PhD students in Astronomy in SA has expanded considerably over the last 5 years, and while there is a concomitant demand for increased supervisory capacity, to which SAAO has been contributing, it has the added benefit of increasing the overall breadth and scope of research undertaken at the SAAO. NASSP continues to grow and is held up by DST as an example of how such fields should be developed given the limited national resources available.

Furthermore, the SALT Collateral Benefits Programme, which was established at the start of the SALT construction project, has expanded considerably the SAAO's efforts in education and outreach. Special attention has focused on the needs and aspirations of young people in the Northern Cape, particularly in and around Sutherland. The success of this division was demonstrated recently with the decision by the IAU to host its global office of astronomy for development at SAAO in Cape Town.

In spite of all these efforts, which have occupied a significant fraction of the time of SAAO's research-active staff, the scientific output of SAAO and its research collaborations during this interval has been considerable. These play to its world-class strengths in time-domain astronomy and the late stages of stellar evolution, now enhanced by new researchers in planetary and extragalactic astronomy. Since 2005, SAAO has held the contract to operate SALT on behalf of the SALT consortium, which has led to a substantial increase in its staffing level and annual budget. And with SA as the majority shareholder (⅓) in SALT, SAAO is the steward of this share on behalf of the South African community. While SALT's entry into normal operations has been delayed by the problems described here, some significant science has nevertheless been undertaken as part of the commissioning and performance verification process. These provide a hint of the scientific potential of this outstanding, African facility.

Phil Charles, March 2011

Outline of Activities and Responsibilities: The SAAO provides observational facilities for optical and near-infrared astronomy and the necessary engineering and technical support. Its research facilities are made available to South African and international astronomers. SAAO also operates the Southern African Large Telescope (SALT) under contract to the international SALT consortium in which South Africa has a major share (⅓). SAAO staff also contribute to the teaching and training of the next generation of South African research astronomers.

Scientific output: In the period under review, 696 scientific papers were published using SAAO facilities, of which 494 were written or co-authored by SAAO staff.

Human Capital Development: SAAO is contributing to the training and development of the next generation of astronomers through the National Astrophysics & Space Science Programme (NASSP), which began only in 2003, and has grown and evolved substantially during the period under review. This is one of the biggest challenges facing SAAO. Only a tiny fraction of those students who enter university as undergraduates, end up graduating with a PhD: almost ten times less than in developed countries. Yet it is essential that SALT (and other SA facilities) be utilized fully by the South African astronomical community in future.

Since the required numbers of postgraduate students do not currently exist, the astronomical community decided to "grow its own timber." NASSP was established in 2003 as a collaborative venture by the astronomical community to produce the next generation of astronomers. SAAO is one of the founding members and a committed supporter of this programme, both financially and academically through the provision of lecture courses on observational astronomy, spectroscopy and computational methods at Honours level and on stellar structure and evolution, observational cosmology and space technology at Masters level.

SAAO staff members supervise Honours and Masters students' projects, and also organise the summer and winter schools associated with NASSP (more details below). NASSP takes advantage of the combined skills and expertise of the wider South African astronomical community to present a powerful and broad-based postgraduate training programme at a single university. The NASSP consortium as of 2009 is comprised of ten SA universities and three national facilities.

In most respects NASSP has been highly successful (DST holds NASSP as an example to be emulated in other fields) and the demand for places growing so that by 2010 there were over two applicants for each Honours place and four applicants for each Masters' place. The fraction of women was around 30% which although less than ideal is better than for most mathematical or physical science programmes in South Africa. However, the number of black South African graduates has remained a major challenge.

To meet this challenge, in 2008 an Extended Honours Programme (EHP) was created. This is only open to students from previously disadvantaged backgrounds and it is aimed at preparing those students so that once they enter NASSP they don't just scrape through, they do well. Recruitment is via a Winter School held at SAAO and run for the first time in 2007. Staff members with HBU experience visit these institutions and invite students to come to Cape Town for the 2-week school. The Winter School is run by staff from SAAO, UCT and UWC, with a growing contribution from "graduates" of the EHP itself. It gives students from HBUs a flavour of astronomy and Cape Town as well as giving us an opportunity to see where their learning gaps are. The Winter School is financed from SAAO, SKA and NASSP – as it was not part of the programme originally envisaged when DST funding began.

Perhaps the single largest change in the scientific practices of SAAO during the period under review was that, by 2009, SAAO staff were supervising or co-supervising 23 MSc and PhD students.

SAAO also provides training to students in various other supporting disciplines, such as mechanical and electronic engineering, optics and IT.

Conservation: The SAAO is at the forefront of South Africa's efforts to preserve its dark sites for astronomy. SAAO is the primary institute responsible for maintaining Sutherland as an "Astronomy Advantage Area" within the AGA Act, passed in 2007 and now signed into law. This act aims to preserve and protect the geographical advantages of South Africa's best astronomical sites. The protection of the Act has already been invoked in order to influence proposed mining and wind-farm developments in the Northern Cape. (This also includes of course the radio astronomy development of MeerKAT, which is underway near Carnarvon, and under the control of SA's SKA Project Team.)

Space: The SAAO hosts the Space Secretariat, which has played a leading role in the development of the space arena in South Africa, and in particular its National Space Policy, which was adopted by the Minister of Trade and Industry in March 2009. This led to the establishment of the new South African Space Agency in 2011. SAAO is the chief local organiser of the International Astronautical Congress 2011, which is being held in Cape Town, the first time it has ever been in Africa.

Awareness and Outreach: The SAAO plays a leading role in the promotion of science awareness and community development through a variety of science outreach programmes delivered by the SALT Collateral Benefits Division (SCBD) of SAAO. These activities are regarded as part of the core functions of the SAAO.

The overarching goal of SCBD is to ensure that the maximum collateral benefits are

derived from the SALT project to advance the economy, technology, and society of Africa. In January 2006 the SCBD came under new leadership (Kevin Govender) at about the same time that SALT moved from the construction to operational phase. Although the main focus of activities has been in the immediate vicinity of the SAAO sites (Sutherland and Cape Town areas), the programme has made an impact across the continent.

The SCBD has focussed on three areas:

- education in mathematics, science, engineering and technology in order to supply the country and the continent with well-trained and motivated professionals in substantially increased numbers;

- science communication and awareness to effectively engage with the public in order to disseminate relevant information in the fields of astronomy and space science;
- and socio-economic development in order to contribute to a better quality of life for all people, especially the disadvantaged.

The biggest impact that SALT and astronomy has had on the people in South Africa has probably been in education. SALT is now an icon that is known by virtually every school learner in the country – it is even a part of the school curriculum at various levels. What it means to a young South African is that there are great opportunities in their own country in the fields of science, engineering and technology. The SCBD uses this icon to inspire learners towards careers in these fields. Astronomy and SALT are also used as a tool for teaching concepts in mathematics, science and technology at school level.

The IYA 2009 allowed these activities to be taken to an even higher level, achieving record visitor numbers in both Cape Town and Sutherland, combined with the SCBD reaching into the African continent as a result of international funding support. This led directly to SAAO winning the competition to host the IAU's Global Office of Astronomy for Development (GOAD), which opened in 2011 and is based at SAAO.

Hosting international telescope projects: SAAO hosts a number of specialised telescopes on behalf of international organisations. Some are manned, most are robotic:

- *BiSON:* Birmingham Solar Oscillation Network of stations, University of Birmingham, UK (198X). Part of an international network to monitor the spectrum of vibration frequencies observed on the surface of the Sun.
- *IRSF:* Infrared Survey Facility. 1.3m survey telescope. Developed and constructed by Nagoya University, Japan in collaboration with SAAO (2000). Equipped with a simultaneous 3-channel infrared camera which has mapped the Galactic Bulge region and both Magellanic Clouds, providing the most sensitive surveys yet undertaken.
- *YSTAR:* 0.5-m telescope. Yonsei University, Korea (2000?). To monitor large areas of the sky for variability and moving objects.
- *SuperWASP:* The Wide-Area Search for Planets. UK University Consortium (2005). Daily surveys of transient and variable phenomena, especially planetary transits. In just 5 years SuperWASP has become the principal source of bright, transiting exoplanet systems in the southern hemisphere.
- *KELT-South:* The Kilodegree Extremely Little Telescope. Vanderbilt University, USA (2009). The KELT project is a survey of planetary transits of very bright stars using a wide-field small-aperture telescope.
- *MONET:* Network of two remotely-operable, fast-slewing 1.2m telescopes, the other being at the University of Texas. Goettingen Univ, Germany (2009). Associated with SALT.
- *GFZ:* Field measurement instrumentation for GeoForschungsZentrum, Potsdam, Germany (199X). Geo-dynamic observation of the Earth.

Public and School Visitors: Typically ten thousand each of visitors and school pupils pass through the facilities each year. This number was greatly exceeded during 2009, as a result of activities associated with the International Year of Astronomy, but the momentum of this increase has been maintained.

Staff numbers and Affirmative Action: In the period 2004 (pre-SALT) to 2009 the number of staff increased from 73 to 113. The Observatory is striving to achieve the following targets by 2015:

- To have a workforce of over 70% black employees. As at 30 March 2009, our black staff accounted for 63% of our total workforce.
- Females to reach a representation level of 45%. As at 30 March 2009 the figure was 35%.
- People with disabilities to account for at least 2% of the total staff complement.

Budget: The core annual budget of SAAO increased from R21M to R24M over the period under review. However, separate contracts, principally for the operation of SALT, increased the total from R28M to R52M over this time.

Telescope usage: About half of the available time on the 1m and 1.9m telescopes was suitable for observing; the remainder was downtime due to adverse weather. Demand typically exceeds the available time on these two telescopes by about 20%, although this has increased very recently, as a result of the increased demand for student research projects. The 0.5m and 0.75m telescopes are about ⅔ subscribed. A few percent of the time is lost to routine or unscheduled maintenance.

The SALT Telescope: SALT Science productivity has not yet reached its anticipated level due to various incomplete subsystems, plus the discovery of serious problems during the initial commissioning year (2006), which are detailed below. Nonetheless some astronomical projects have been undertaken since August 2005 using the two First Generation instruments, SALTICAM (a CCD camera for high-speed photometry plus general field acquisition) and RSS, the Robert Stobie Spectrograph (a multi-mode imaging and low/medium resolution general-purpose spectrograph).

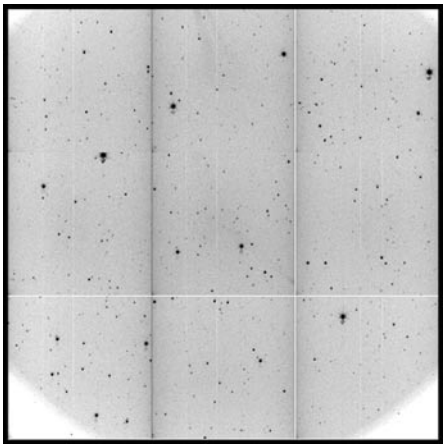
Data has been obtained for astronomers within the SALT consortium, both as part of commissioning and the initial Performance Verification (PV) phase. While in many cases these observations were severely compromised by poor image quality and other telescope/instrument issues, some have resulted in science publications. Somewhat more than half the available observing time has been devoted to engineering work during most of the review period.

More recently, considerable engineering work was devoted to diagnosis of the image quality and other problems. On-sky image quality testing took precedence over scientific observations. The scientific programs during this time were on an *ad hoc* basis, with feasible proposals accepted at any time from users. They mostly exploited the high-time resolution capability of SALTICAM, and included rapidly varying astronomical phenomena (CVs and X-ray binaries, flare stars, asteroids, planetary transits and occultations). In addition, some full-field imaging programs were attempted (e.g. stellar population and extinction law studies in nearby galaxies).

SALT Image Quality problems: It was only in late 2005 that imaging over the full 8 arcmin field of view became possible, leading to the realization that there was an image quality (IQ) problem. This manifested itself as a focus gradient with time-dependent effects that appeared to be associated with the instrument rotator angle and temperature. A detailed IQ study through much of 2006 and 2007 revealed that the source of this problem lay not with the auxiliary instruments or the primary mirror array, but with the Spherical Aberration Corrector (SAC). This unit is of a design unique to SALT, and allows for a much wider field-of-view and larger back-focal distance than that of the HET original.

From this study it was concluded that:

- the last pair of mirrors in the SAC are mis-aligned with respect to the optical axis of the telescope, and
- there are significant mechanical stresses transmitted into the SAC via the Tracker interface due to thermal effects and instrument rotation.



The SALT SAC is substantially different from that of HET (the Hobby-Eberly Telescope in Texas, which acted as a prototype for SALT) and most importantly has a much higher optical specification. It therefore requires a much more sophisticated mechanical support system, which was missing from the original design.

Since high quality (0.85 arcsec) images were obtained early on with SALT, there was no reason to doubt the optical quality of the individual SAC mirrors, or the overall SAC optical design. A redesign of the SAC-Tracker mechanical interface took place in 2008/09 and the process of installing the new interface and realigning the SAC mirrors began in April 2009. It was successfully completed in mid-2010.

SALT Spectrograph blue-throughput problem: The RSS spectrograph was installed on SALT in late 2005, and most of its observing modes were exercised during its initial commissioning year. The poor image quality of the telescope itself precluded comprehensive testing of its wide field capabilities, but a significant and completely separate problem was found: poor UV/blue throughput. This was traced to the fact that some lens-coupling fluid within the collimator and camera lens multiplets was degraded as a result of a previously unrecognised chemical reaction between the fluid and its surrounding

polyurethane bladder. The spectrograph was removed from the telescope in 2006, and the key optical components returned to the US for repair. It has since been fully reassembled, and tests show that the blue-throughput problem is solved. During the SALT IQ repair, RSS has been undergoing exhaustive additional improvements and testing of all its electronic, mechanical and software components, building on the experience gained during initial commissioning.

These are the two main problem areas that have been the principal focus of SALT activities during the period of this review. With the SALT construction team having left in mid-2006, the operations team, together with key personnel from SAAO, has had to undertake the task of resolving these problems. This is without doubt the most radical surgery and intervention that SALT has undergone since its completion. That it took place entirely in SAAO's facilities in Sutherland is a dramatic event worthy of note in its own right, as it takes SALT technical operations to a potentially new level. Ten years ago the SAC repair project would only have been possible in high-tech facilities in either Europe or the US. However, advances in modern optics (such as the computer generated hologram) and the acquisition of some specialised, though affordable, equipment (such as an alignment telescope, wavefront camera and portable coordinate measuring machine) meant that all this work could be undertaken at Sutherland by SAAO staff. Thus the adjustment, maintenance and repair of SALT's opto-mechanics are now within the capability of the SALT team. This is a far better situation than that envisaged at the beginning of the SALT project, and bodes well for future developments and new instrumentation projects.

Virtual Observatory: The Virtual Observatory initiative at SAAO will be a major effort to utilize the most recent advances in computer hardware and software technology to develop a new generation of data analysis, visualization and mining tools. These tools will be able to address multi-terabyte data sets generated by SALT and SKA. It will be possible to apply the developments to a variety of disciplines within astronomy, from the optical to the radio regime as well as outside astronomy, e.g. in remote sensing, biological and social sciences.

Research Highlights: Selected items of research worthy of note:
Extragalactic Astronomy: Understanding how the elemental abundances of galaxies have changed over time is an essential issue for understanding galaxy evolution. Abundance measurements constrain theoretical models, providing important clues on modes and rates of star formation in galaxies and on the importance of infall and outflows. HII regions indicate the present-day gas-phase element abundances, while planetary nebulae (PNe) reveal the chemical composition of a galaxy at 'intermediate' ages of a few 100 Myr to a few Gyr. Spectrophotometric

results were obtained with SALT during its performance-verification phase on two PNe in the Sagittarius dwarf, the closest known dwarf spheroidal galaxy that is strongly disrupted by its interaction with the Milky Way. One of these is the most metal-rich PN known in any dwarf spheroidal galaxy. This result supports the idea that the Sagittarius dwarf contains a younger stellar population, in good agreement with spectroscopic abundance measurements in these stars.

The 1.4m infrared survey facility (IRSF) at Sutherland is a jointly run Japanese - South African telescope that has proved very productive for both partners. The first papers were published in 2002, since when there have been about 70 publications and two South African (UCT) PhDs awarded.

A study of asymptotic giant branch (AGB) stars in Local Group galaxies has involved scientists from SAAO, UCT and various institutes in Japan. Observations of the Leo I, Fornax and Phoenix dwarf galaxies have been published to date. For each of these galaxies extreme mass-losing AGB stars have been identified and characterized. They provide an independent method of estimating the distances to these galaxies that, together with other work by the same South African scientists, provides the foundation of a distance calibration method that will be useful with the next generation of extremely large telescopes. This is based on the period- luminosity relation for large amplitude AGB variables. Several of these newly discovered AGB stars have been studied with the Spitzer Space Telescope in a collaboration involving astronomers from the UK, Australia, USA, Japan and South Africa. Their spectra show strong C_2H_2 bands and relatively high mass-loss rates have been deduced. Mass-loss from AGB stars remains a poorly understood aspect of stellar astrophysics, despite its importance to the enrichment of the interstellar medium and thus for star and planet formation.

High-speed photometry of polars: The first extensive SALT science observations, which were subsequently published as the first SALT scientific paper (O'Donoghue et al. 2006), were eclipse light curves of the polar, SDSS J015543.40+002807.20, observed in August and September 2005

with SALTICAM. These high-speed "slot mode" photometric data were taken with time resolutions of between 112 and 285 milliseconds, and with minimal dead-time losses (<9 msec). The eclipse light-curves were of unprecedented quality and completely resolved the eclipses of the two accretion spots on the white dwarf surface. Model-fitting to the data enabled determinations of the likely masses of the component stars, the orbital inclination of the system and co-latitudes of the accretion spots.

Extrasolar Planets: The PLANET collaboration has used the 1.0-m telescope at Sutherland to monitor micro-lensing events in the Galactic Bulge, being allocated typically 10 contiguous weeks per year. The aim has been to detect deviations from "ideal" micro-lensing light curves that might reveal the presence of an additional object of planetary mass that is associated with the lensing star. For this it is important to have full (24 hour) coverage of the complete micro-lensing event, since a planetary deviation would last typically only 1 day compared with a lensing timescale of 40 days. SAAO is advantageously positioned between Australia and South America where the other PLANET telescopes operate.

Instrumentation : The Instrumentation Division comprises 14 staff responsible for the conception, design and construction of new instrumentation for the SAAO/SALT telescopes. During the review period the Electronics Dept completed extensive work on constructing and optimising the instrumentation for SALT. This included extensive work on modifying the SALTICAM camera, participating in the testing and commissioning of the RSS detectors, and a CCD test facility to allow for the testing of any CCD chip.

This has meant that SAAO telescope instrumentation work has largely been restricted to repair and maintenance, with staff limitations meaning that significantly less new development has been possible than in the past. One pleasing exception to this has been the development of a new polarimeter (HIPPO) that was completed and commissioned in 2008/9, and is now fully operational. Other projects that have started include the upgrading of the Unit Spectrograph on the 1.9m, the 1.0-m and 1.9-m telescope control systems were changed to PLC based, the ACT (Alan Cousins Telescope) was upgraded to PLC control, 1.0-m and 1.9-m X-Y slides were built and installed, and the 0.75-m was upgraded for remote control (encoders, software). This last upgrade formed the basis of a PhD project for a UCT student.

The Mechanical Department has been involved in various projects: manufacture of RSS cryostat and various additional components, manufacture of many parts for SALTICAM, manufacture of the new SAAO polarimeter and many parts for the extensive SALT Image Quality investigations described above.

Analysis of Publications: As already mentioned, a total of 696 publications were reported for the period, April 2004 to March 2009. A study using NASA-ADS reveals that 450 of the papers produced were cited 6722 times. 92 papers (13%) were written by SAAO staff, 402 papers (58%) were co-authored with researchers from elsewhere and 202 papers (29%) were written by visiting researchers using SAAO facilities. SAAO staff members were first authors of 95 collaborative papers. Further analysis indicates that 398 papers (57%) were published in ISI-rated journals, 178 were published in conference proceedings, 56 were published in other international journals and 39 were published in local journals. The cumulative figure also includes 17 papers authored by SAAO staff, published as individual chapters in various books and 8 books authored or edited by SAAO staff.

Challenges facing SAAO: it is important to be aware of some of the challenges to be addressed over the next five years:

- Full commissioning of SALT and its first generation instrumentation, with the aim of reaching normal operations as soon as possible (goal: mid 2011).
- Establishing a development program for SALT that identifies future scientific goals and the instrumentation to address them.
- The funding of SALT future instrumentation development.
- Replacement of ageing SAAO laboratory infrastructure (ongoing) with the aim of participating in future SALT and other Sutherland instrumentation projects (very recently, late 2010, substantial additional funding has been made available for this purpose by DST).
- Addressing the increasing demand from other African countries for participation in, and support in terms of astronomy/ education development.
- Educationally and socio-economically, the town of Sutherland relies heavily on astro-tourism and related activities for its development.
- Liaison, collaboration and cooperation with MeerKAT operations and scientists in the CT area.
- Continuing to grow NASSP with the aim of achieving, a) demographic representation of
- participants and b) wider SA institutional involvement.
- Maintaining and enhancing the small telescopes so as to support SALT, and thus improve
- the overall efficiency of operation as well as extending its scientific capabilities.
- Make the success of the SAAO-UCT collaboration a success of the wider SA community through the implementation of a long-term (10-year) SA Strategy for Astronomy. ☆

GOAD opening: Ministerial Address

Naledi Pandor

Address by the Minister of Science and Technology, Naledi Pandor MP, at the launch on the International Astronomical Union's Global Office of Astronomy for Development, SAAO, Cape Town 16 April 2011.

President and members of the Executive Committee of the International Astronomical Union; Programme Director; Distinguished Guests; Ladies and Gentlemen.

Good morning and welcome to you all and a special welcome to our visitors from abroad.

South African science has built up excellence in a number of fields, but two are of great importance to our celebration of the launch of what I am told is now to be called the Global Office of Astronomy for Development (GOAD) here today.

The SA Minister of Science and Technology, the Hon. Naledi Pandor addresses guests at the launch.

The one has to do with the question of identity and has led to world-first research into the ancestors of humankind and the origins of our species in Africa. The other has to do with our understanding of the universe and has led to bleeding-edge research into astronomy and the cosmos.

Few things related to science capture the imagination of people more than the study of deep time. This includes the origins of life, the worlds of dinosaurs, mass extinctions, meteorite impacts, as well as the evolution of humans.

In South Africa research on hominin origins has a rich tradition and is recognized as one of our most visible and most acclaimed field of science. The South African fossil record of hominin evolution is arguably one of the most complete and spans more than four million years. Given the uniqueness of this heritage resource, South Africa has become a global leader in the study of the palaeoworld. We share our research with the rest of Africa, uniting us in promoting a new awareness of life in the past through the study of the continent's rich heritage in fossils, artefacts and human genetics for the intellectual enrichment and empowerment of all Africans.

The other field also has to do with the study of deep time and has exerted a global fascination for as long as people have looked at the stars. It has to do with – to borrow from Stuart Clark – a number of big questions. How big is the universe?

How old is the universe? How many things does it contain? We don't know.

It's very big out there. But it will be amazing to find out the answers in the fullness of time. How far can we travel in the universe? Will we ever get close to strange, enormous and faraway objects, like black holes or pulsars? We don't know.

Then there are those other questions that tie up with our identity. Is the Universe eternal? Has it always been as it is and will it always be as it is? We don't know.

We do know that the Universe is constantly changing because it is expanding. Astronomers are busy finding out the answers to these big questions in scientific institutions around the world. Without complex measuring instruments, we would be unable to find answers to these questions. We can make ground-based telescopes that are far larger than anything we can launch into space. We hope to be able to host another one of these complex instruments here in southern Africa in the near future.

We are not here to celebrate the launch of a complex measuring instrument. We are here to celebrate the launch of a development office that will spread astronomy throughout the length and breadth of Africa. It's the best place for the office to be. We have some 60 astronomers working in South Africa (25 here at the SAAO) and they are a half of Africa's 120 astronomers.

But more than numbers, we also have the political will. We are committed to enhancing south-south relations, as our presence at the BRICS meeting in China this week has shown. We have invested in astronomy. We have invested in complex measuring instruments. We have SALT (Southern African Large Telescope), MeerKAT (Karoo Array Telescope) and the bid to host the SKA (Square Kilometre Array).

We chose to invest heavily in science and astronomy, because of its role in development, not only within South Africa, but all across Africa. Big astronomy projects such as SALT, MeerKAT and SKA entail major capacity development programmes in order to train the next generation of engineers and astronomers from all over Africa.

We have not stopped at investments though, and have also put in place forward-thinking legislation in the form of the Astronomy Geographic Advantage Act, for the long term protection of the excellent astronomical sites in South Africa. In South Africa, people in the astronomy field, from those working on the ground to the highest levels of government, share the vision that astronomy will play a significant role in the development of society.

I should say, in conclusion, that over the years the SAAO has built a reputation for producing global, cost-effective research

and astronomical instrumentation. It also has a significant fraction of the SA astronomy PhD contingent on its staff, including postdoctoral researchers and SALT astronomy operations personnel. It's part of an extensive network of international collaborations and uses its position in the global community to further the training of PhDs in Astrophysics and Space Science on the African continent.

With the commissioning of SALT, I have no doubt that the SAAO will continue to pursue exciting new areas of research that are only made possible by a 10m-class telescope. SALT is testimony to Southern Africa's competitive advantages as a venue for capital intensive 'big science' initiatives.

Thank you. ☆

Comments for the OAD Inauguration

Robert Williams
President, International Astronomical Union

Today's launching of the Office of Astronomy for Development (the OAD) is historic, not only for South African astronomy and the South African Astronomical Observatory (SAAO), but also for the International Astronomical Union. The IAU has been in existence for almost 100 years and for the first half-century of our existence its focus was primarily on the advancement of professional astronomy. The majority of our effort and resources were devoted to meetings and published proceedings that were oriented toward astronomical research. As a professional society the IAU first attended to the welfare of its members.

President of the IAU, Robert Williams congratulates Kevin Govender and the SAAO during the launch.

As the IAU matured and astronomy thrived with the advent of the space age there was increasing public interest in space and astronomy. The IAU responded by initiating education and outreach programs and becoming more engaged with the public. Astronomy is unique in having a huge following of amateurs who are educated and enthusiastic and knowledgeable about astronomy to the extent that they can teach and motivate others.

As is so often the case in the history of an organization a single event caused a fundamental change in the outlook and focus of the IAU: the International Year of Astronomy (IYA) in 2009 which

celebrated the 400th anniversary of Galileo's use of the telescope in 1609 to study the heavens. The IAU conceived of the idea to celebrate Galileo's anniversary by conducting an International Year of Astronomy in partnership with UNESCO and the United Nations to draw attention to astronomy and the place of humanity in the cosmos. The IYA initiative represented a huge change in perspective for the IAU. We had previously concerned ourselves largely with the world's 10 000 professional astronomers. With the IYA we expanded our domain to 7 billion earthlings.

Led by my predecessor Catherine Cesarsky the IAU helped develop and then coordinated an extensive organizational network that allowed us to work with individuals and groups in 145 countries. The IYA was a spectacular success, directly touching 800 million people at a total cost of only €12 million. It was amazing value for the money. The Office of Astronomy for Development that we are inaugurating today is to a certain extent an outgrowth of the world-wide IYA effort.

Even before the IAU commitment to the IYA some of us on the Executive Committee were advocating that the IAU should formulate a strategic plan to work with nations who were interested in using astronomy as a vehicle for science education and technology development. This planning effort, led by IAU Vice President George Miley, did take place over a 2-year period and resulted in a Strategic Plan that envisioned various programs being undertaken and led by IAU members world-wide, that involved teacher training, visiting lectures, development of university curricula, institute twinning, and international short courses that would enhance the scientific infrastructure of countries.

An important part of the IAU plan was that these programs would be coordinated and overseen by a global office. Over one year ago we invited proposals from organizations interested in hosting this office, which would serve as an international nexus of education, outreach, and development activity. The SAAO with the support of the South African National Research Foundation (NRF) submitted a very strong proposal to host the OAD in Cape Town that included offering important resources of space and personnel and funds that were sufficiently attractive that the IAU awarded the OAD to the SAAO for its first 5-year period. A governing board appointed by both the IAU and the NRF will set policy for the OAD and do oversight. Board members participated in the search for the initial director of the OAD that has resulted in an outstanding and experienced professional, Kevin Govender, who is known to all of you from his work in past years at the SAAO.

The IAU is excited to be launching this new initiative in partnership with the SAAO, the NRF, and the Department of Science & Technology. On behalf of the IAU I thank these three organizations for

your commitment to this enterprise and the important role of science in global development. I can promise you that because of the importance of astronomy education and development that our IAU commitment to the OAD and the programs it will coordinate is strong. We look forward to working for the success of the OAD in association with all of you. And we thank those of you in attendance for the support many of you will be giving to this enterprise.

We have every confidence that the OAD will be successful and will reflect credit on the IAU and South Africa. ☆

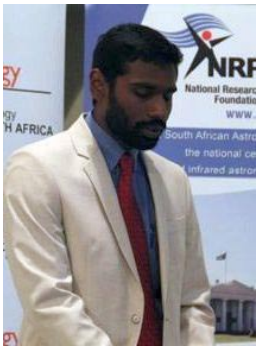
Welcoming and Opening Address by the Director of the OAD

Kevin Govender

Minister of Science and Technology, Mrs Naledi Pandor
President of the International Astronomical Union, Prof Robert Williams
Director General of Science and Technology, Dr Phil Mjwara
President and CEO of the National Research Foundation, Dr Albert van Jaarsveld
Director of the South African Astronomical Observatory, Prof Phil Charles
Director of Hartebeesthoek Radio Astronomy Observatory, Dr Michael Gaylard
Vice President of the IAU, Prof George Miley
General Secretary of the IAU, Dr Ian Corbett
Deputy Director General of DST, Dr Molapo Qobela
President of the Institute of Physics, Jocelyn Bell Burnell
Director of the Intl Science Programme at Uppsala Univ in Sweden, Dr Ernst van Groningen
President of the African Astronomical Society, Prof Pius Okeke
Chairman of the Ethiopian Space Science Society, Mr Tefera Waluwa
Members of the National Society for Black Physicists, Charles McGruder & Hakeem Oluseyi
Director of the Cape Town Science Centre, Ms Julie Cleverdon
Representative of the Intl Centre for Theoretical Physics, Dr Ravi Sheth
Representative of the US Consul General, Nathan Holt
Representative of the British Council, Melissa Nefdt
Council members of the Astronomical Society of Southern Africa
Delegates of MEARIM conference from Africa and the Middle East
Members of the media
Colleagues from the South African Astronomical Observatory
Colleagues from the University of Cape Town and University of the Western Cape
Students of Astronomy
The additional staff who helped put this event together
Ladies and Gentlemen

The International Astronomical Union Global Office of Astronomy for Development. Quite a mouthful. But what does it mean? What does development mean to you? And what does astronomy have to do with it?

Because we exist, fundamentally, at the centre of our own observable universes, let us calibrate our perspectives from the human point of view.



Kevin Govender, GOAD Director addresses guests at the launch.

Every society, every culture, every group of human beings, no matter where they live, no matter what their skin colour, no matter what their languages, beliefs, traditions – they all have had, and still have, a few things in common.

One of those things, in fact one of the most fundamental things, that they've had in common, and still do, is the drive to live a better life. First and foremost we seek a better life for ourselves and our closest family – and then a better life for our community and the people around us – and then, eventually, a better life for all humankind. It is one of our most significantly defining characteristics. We seek betterment. We seek improvement. We seek... development. Whatever the complex psychology that has injected this insatiable pursuit into our veins – we can debate ad infinitum – the fact is that we want to make the world a better place. This is what "development" means in the context of this Office. Making a better life for all human beings. Making the world a better place to live in.

There is of course another thing that all these societies, cultures, groups of human beings have in common. That is... wait for it... a deeply embedded connection with the sky. On the one hand that's a fairly obvious statement right? Everyone on earth is subject to day and night. Everyone has to deal with the changing seasons throughout the year. And everyone sees this moon go through its cycles – not to mention big events like eclipses. But this connection goes much deeper into our combined consciousness. The changing nature of the sun and moon bring natural questions. Where does the sun go at night? What happens to the rest of a crescent moon? Why is the sun so low during winter months? And then there's the night sky! The amazing incredible awesome inexplicable night sky. What are those things? Where do they go in the day? How far are they? Why do they move? Why do some move differently from others? What is "out there"?

These questions lead to more questions – and more questions – and even more questions – questions then not just about stars, but about the blue sky, about rainbows, about lightning, about rain, about plants, about everything around us. And when

we start trying to answer those questions, we become scientists. The sky and stars have been an incredible catalyst of scientific thinking and reasoning. Such thinking, such science, has brought us technology and ideas that reach well beyond the dreams of our younger selves. Technology and ideas that have made our lives better – that have led to our "development"!

Astronomy, as we call it today, has always played a role in our development, be it our scientific, technological or cultural development. However, somewhere along the way, as we dig deeper and deeper into our science, and try harder and harder to figure out the big questions in the universe, somewhere along the way we may have forgotten about the incredible power of astronomy, the incredible role that astronomy has played in shaping the human mind – or others around you may have forgotten – and all that power is not efficiently harnessed.

Astronomy is an endless source of sustainable renewable energy for our minds!

The purpose of this OAD is simple. It aims to use astronomy as a tool for global development. Remember that this is not simply about developing the field of astronomy – that comes as a by-product because one has to obviously sharpen ones tools – but the main point is that astronomy is a tool for development. This is why the name is very specifically the Office of Astronomy FOR Development – and not the Office for Astronomy Development! OAD!

In recognition of the great strength of astronomy to expand our minds, the three targeted areas that the OAD will focus on are: (1) school level education; (2) university level education and research; and (3) public understanding of science.

Now there is no way that one small office could achieve global development on its own. The structures that need to be established are regional nodes across the world (and the definitions of regions has to be a dynamic procedure) as well as sector task forces who will lead efforts on the three targeted areas mentioned before (school, university, public). All these people would initially, in all likelihood, be volunteers. There is much goodwill amongst the international community, especially after a very successful International Year of Astronomy – so we feel very positive that there will be many volunteers. However this Office will coordinate and strategise such that those efforts can be optimised.

Today this office is being opened on this land in Africa. It is truly an honour for our continent to host and lead this global development activity, which reaches out to every corner of the world. It is a greater honour for South Africa to have been the country selected as the hosts. And it is a most humbling honour for me personally to have been selected to direct these activities and drive the vision. Thank you to the IAU for trusting our continent, our country, our organisation, with this responsibility. Thank you to the South African Depart-

ment of Science and Technology for their recognition of the importance and their support. Thank you to the National Research Foundation for embarking on this project together with the IAU, by hosting the OAD at its facility, the South African Astronomical Observatory. I can assure you that the actions of this office shall be carried out with a spirit of transparency, inclusion (traditionally bottom-up), humility (no egos), and hard work for the benefit of all. This office is here for you to use in order to make your ideas happen in the most effective ways possible. I call upon you, our colleagues present here and from all over the world, to put our minds together and join hands in making the world a better place. ☆

Minister of Science and Technology launches the IAU Global AOD

On 16 April in Cape Town, the South African Minister of Science and Technology, Mrs. Naledi Pandor, launched the IAU Global Office of Astronomy for Development at the headquarters of the South African Astronomical Observatory.

Prof Phil Charles, Director of the SAAO, welcomes guests at the launch of the Global Office for Astronomy Development, GOAD.

The Global Office of Astronomy for Development (OAD) is a partnership between the IAU and the South African National Research Foundation to coordinate a wide range of worldwide activities designed to use astronomy as a tool for education and development. This is part of the realization of a visionary decadal plan by the IAU entitled "Astronomy for the Developing World". This plan aims to use astronomy to stimulate development at all levels including primary, secondary and tertiary education, science research and the public understanding of science, building on the success of the International Year of Astronomy 2009. In a strong partnership between the IAU and the South African government, the OAD began its work on 1st March 2011.

According to Minister Pandor, "In South Africa, people in the astronomy field, from those working on the ground to the highest levels of government, share the vision that astronomy will play a significant role in the development of society."

The President of the IAU, Prof. Robert Williams, who also spoke at the launch, said: "Astronomy has incredible potential to impact on the developmental aspirations of Africa and the rest of the world. It is appropriate that this global coordinating office be situated in Sub-Saharan Africa as this is a focus region for the IAU's strategic plan."

This event took place immediately following the second IAU regional meeting for the Middle East and Africa (MEARIMII), which brought together astronomers and astronomy students from this vast region. Many of these conference participants were in attendance at the launch.

Pheneas Nkundabakura, a young astronomer from Rwanda, said: "This is a very important occasion for all of Africa, as it represents a project where the continent will take on a leadership role in coordinating a global development activity. South Africa has demonstrated its capacity to host this office on behalf of Africa, through the training of astronomers like myself and in supporting astronomy development across the continent."

Kevin Govender, the first Director of the OAD, expanded on this: "Although Africa will remain a region of strong focus, which is in accordance with the IAU strategic plan, the OAD actually has a global role to play, and lessons from developments in Africa and other parts of the world will be used to impact on every part of the world. I look forward to interacting with the broader astronomy community, both amateur and professional, to see how we can together realize the incredible potential of astronomy for development."

The OAD will mobilize talented professional and amateur astronomers, engineers and teachers around the world in the service of developing countries. The wide range of activities that will be coordinated by the OAD include the education of young disadvantaged children, science education at all levels, the training of school teachers and building up research capacity in university departments throughout the developing world.

Visit the OAD website at http://www.astro4dev.org/ ☆

GOAD Director Kevin Govender with Minister Naledi Pandor during the unveiling ceremony which officially launched GOAD.
Picture credits: DST Marketing department

Hubble turns 21

To celebrate the 21st anniversary of the Hubble Space Telescope's deployment into space, astronomers at the Space Telescope Science Institute in Baltimore pointed Hubble's eye at an especially photogenic pair of interacting galaxies called Arp 273. For 21 years, Hubble has profoundly changed our view of the universe, allowing us to see deep into the past while opening our eyes to the majesty and wonders around us. After all this time, new Hubble images still inspire awe and are a testament to the extraordinary work of the many people behind the world's most famous observatory.

Hubble was launched on 24 April 1990, aboard Discovery's STS-31 mission. Hubble discoveries revolutionized nearly all areas of current astronomical research from planetary science to cosmology. Hubble is America's gift to the world. Its jaw-dropping images have rewritten the textbooks and inspired generations of schoolchildren to study math and science. It has been documenting the history of our universe for 21 years. Thanks to a successful servicing mission in 2009 gave Hubble new life and we can look forward to Hubble's amazing images and inspiring discoveries for years to come.

The newly released Hubble image (see cover) shows a large spiral galaxy, known as UGC 1810, with a disk that is distorted into a rose-like shape by the gravitational tidal pull of the companion galaxy below it, known as UGC 1813. A swath of blue jewel-like points across the top is the combined light from clusters of intensely bright and hot young blue stars. These massive stars glow fiercely in ultraviolet light. The smaller, nearly edge-on companion shows distinct signs of intense star formation at its nucleus, perhaps triggered by the encounter with the companion galaxy. Arp 273 lies in the constellation Andromeda and is roughly 300 million light-years away from Earth. The image shows a tenuous tidal bridge of material between the two galaxies that are separated from each other by tens of thousands of light-years.

A series of uncommon spiral patterns in the large galaxy are a tell-tale sign of interaction. The large, outer arm appears partially as a ring, a feature seen when interacting galaxies actually pass through one another. This suggests the smaller companion dived deep, but off-center, through UGC 1810. The inner set of spiral arms is highly warped out of the plane, with one of the arms going behind the bulge and coming back out the other side. How these two spiral patterns connect is not precisely known.

The larger galaxy in the UGC 1810 - UGC 1813 pair has a mass about five times that of the smaller galaxy. In unequal pairs such as this, the relatively rapid passage of a companion galaxy produces the

lopsided or asymmetric structure in the main spiral. Also in such encounters, the starburst activity typically begins in the minor galaxies earlier than in the major galaxies. These effects could be because the smaller galaxies have consumed less of the gas present in their nuclei, from which new stars are born.

The interaction was imaged on 17 December 2010, with Hubble's Wide Field Camera 3 (WFC3). The picture is a composite of data taken with three separate filters on WFC3 that allow a broad range of wavelengths covering the ultraviolet, blue, and red portions of the spectrum. ☆

Willard Boyle, 1924 – 2011

Willard Boyle, who shared the 2009 Nobel Prize for Physics, died on Saturday, 7 May 2011, at the age of 86. Boyle was awarded one half of the prize with George Smith for inventing the charge-coupled device (CCD). Boyle and Smith were both working at Bell Laboratories in New Jersey when they made their discovery in 1969 – Boyle was director of device development at the lab and was Smith's boss; Smith was a department head. The other half of the 2009 prize went to Charles Kao for his work on optical fibre.

Boyle was born in Amherst, Nova Scotia, on 19 August 1924, to Bernice and Ernest Boyle. At the age of three, his family moved to northern Quebec, where his father, a doctor, set up a practice in a logging community, where he was home-schooled until Grade 9. For high school his parents sent him to Lower Canada College, a private school in Montreal. After graduating, he joined the Royal Canadian Navy and became a Spitfire pilot. Boyle went on to study at McGill University in Montreal, where he received his bachelor's degree in

In a 1970 photo, Willard Boyle and George Smith, creators of the technology behind digital photography, demonstrate the use of a charge-coupled device, or CCD. Credit: Bell Laboratories

1947, his master's degree in science in 1948, and a PhD in physics in 1950, after which stayed on to work as a postdoctoral fellow in the school's radiation laboratory. This was followed by a teaching stint at the Royal Military College in Kingston, Ontario, after which he joined the research staff of Bell Labs in Murray Hill, N.J., in 1953. He spent the rest of his career there before retiring in 1979 and returning to his native Nova Scotia.

There was some controversy over his Nobel prize as two colleagues at Bell labs claimed that the original purpose of the work was to develop a memory circuit, and that that was what Boyle and Smith first thought they had accomplished. Eugene Gordon and another Bell labs researcher, Michael Tompsett, claimed they were at were at least as responsible for determining that the CCD could revolutionize all sorts of imaging. But Boyle and Smith's patent was registered four years before that of Tempsett. While Boyle defended his work, Smith merely called them liars!

Earlier, in 1962 Boyle and colleague, Don Nelson, developed the ruby laser in 1962, and with another colleague, David Thomas, he helped to develop the semiconductor injection laser, which is found in many electronic appliances. In 1962 he was assigned to a Bell subsidiary that offered technical support to NASA. There he helped select lunar landing sites before returning to Bell labs in 1964.

The invention of the CCD revolutionized photography because the devices allow images to be converted directly into digital data rather than using film. CCDs once formed the basis of all digital cameras, but have since been replaced by CMOS sensors in most low-cost applications such as mobile phones and some digital cameras. CCDs are also widely used in astronomy, with the Hubble Space Telescope, for example, having several CCD cameras on board, including in the recently upgraded Wide Field Camera. CCDs have also revolutionized amateur astronomy, in that it has enabled amateurs to do work in imaging and photometry, that was previously only done by professional observatories.

Boyle was made a Companion of the Order of Canada in 2010 and received several other awards for his CCD work – including the IEEE's Morris N Liebmann Memorial Award, which he shared with Smith. He is survived by his wife Betty of 65 years and three children. His eldest son died last year. ☆

Fireball and Bolide Observations; 2009-2010

T P Cooper
Director, Comet and Meteor Section

Southern African Fireball Observations 2009-2010, including accounts of the 21 November 2009 bolide.

Catalogue of Recent Sightings

This article continues the sequential numbering of reported fireball sightings from southern Africa, and covers fireballs observed during 2009 and 2010. By definition, a fireball is any meteor event with brightness equal to or greater than visual magnitude -3. The following events were reported to the author and details are reproduced as given by the observer. All times were converted to UT, and all coordinates are for epoch J2000.0.

Event 218 – 2009 January 20 – Brackenfell, Western Cape

Observed by Auke Slotegraaf at 20h57, who reported m_v = -5. Duration was about 1.5 seconds. The path started at RA 01h00, Dec -39° and ended at RA 00h20, -65°. Colour definitely not white, and it appeared to have a slight orange cast.

Event 219 – 2009 March 30 – Pretoria, Gauteng

Observed by Michael Poll at 20h35. m_v=-5. Colour white. Fell straight down from about 2° to the west (right) of Crux. No disintegration, just "went out".

Event 220 – 2009 April 26 – Makhado, Limpopo

Observed by Kos Coronaios around 16h00. m_v=-3.5. Duration 2 seconds, path length 30-40° from 20° above the southern horizon moving towards the southeast where it disappeared about 5° above the horizon. Colours were yellowish-white with a definite orange/red centre or slightly in front of the meteor.

Event 221 – 2009 August 3 – Cape Town, Western Cape

Reported by Juanita Daniel. 'I live in Southern Suburbs, Cape Town and early Monday morning around 23h40 I spotted the biggest and brightest shooting star I have ever seen. It had a huge long tail that burned for quite a few seconds after it passed over the Silvermine Mountains'. No further details.

Event 222 – 2009 August 24 – Western Cape

Four independent sightings from Cape Town to Sutherland, where 39 individuals witnessed the event. Time between 17h40-17h45. Duration 3-4 seconds. The object was observed by Auke Slotegraaf, from whose report I deduce start and end alt/az roughly 268°, +26° to 190°, +20° as seen from Sutherland. That is looking SW, from right to left, west to south, path length 68° and descending 6°. A screen print

from Google earth submitted by Andre du Preez as seen from Woodstock yields very approximately 330°, +30° to 020°, +25°, that is looking N from left to right, NNW to NNE, path length 40 and descending 5°. The best path I can deduce from these observations has the meteor crossing roughly from Vredenburg - Ceres- Mossel Bay. The following individual reports were received of this object:

From Auke Slotegraaf: 'On Monday evening, 2009 August 24, there were 39 members of the public outside under the stars, gazing at constellations and deep sky objects. At one point, I was standing facing south and my half of the group was mostly looking northward. A flash of light in the west caught my attention and I turned to see, near the moon, a pretty neat meteor, heading south. I watched for the briefest moment and then saw that it was growing brighter. The meteor reached maximum brightness and then abruptly faded. Its colour at maximum was orange-yellow, not unlike Arcturus. After the sudden fade, from the leading edge of the fireball, a train of four fragments continued for a brief moment before disappearing. The time may be out by a minute or so, which I recorded as 17h41. The duration of the event was at least three seconds. I first noticed it out of the corner of my eye at roughly near the moon (very uncertain; RA 13h50m Dec -15°40') and the maximum brightness abruptly vanished at about (RA 09h15m, Dec -75°)'.

From Andre du Preez: 'I live in Woodstock and have a balcony facing the harbour. The meteor appeared over the harbour and came at an angle of about 15 deg from Lions Head side towards the Hex Mountains. The Meteor entered the sky in the centre between the Signal Hill and the right side of bay.

From Mark Allderman: 'I saw a meteor this evening at about 17h40 that lasted about 3 or 4 seconds. It had a distinct tail and glowed red and yellow before disappearing. I was in Hout Bay just below Constantia Neck. It started to the North East of me and moved in a South Easterly direction'.

From Handa Zeller via Auke Slotegraaf: 'saw the fireball from Somerset West at 17h45. She described a similar colour to what we saw'.

Event 223 – 2009 October 17 – Western Cape

Reported by Tony Jones. m_v= -7.0 to -8.0 at 18h13. Path was from alpha Ophiuchi, passed 109 Herculis and toward alpha Lyrae (15° to 20°). Two second train and broke up at end of travel into a shower of pieces. Colour was white.

Event 224 – 2009 November 11 – Henley on Klip, Gauteng

Observed by Brian Fraser at 21h29. Path roughly from Taurus at altitude 30-40° towards the west. The colour was distinctly green. Duration 2-3 seconds

and estimated it to be maybe 20-30 times brighter than Sirius (i.e. about m_v = -4 to –5).

Event 225 – 2009 November 21 – 56 separate reports

The event that occurred late in the evening of November 21 was clearly one of the most energetic meteoric events for many years, and certainly since the Thuathe fireball and meteorite fall in July 2002. However, unlike the latter event there is no evidence that the most recent event produced any meteorite fall, and so the event is classified here as a very bright bolide. The author has catalogued 56 separate eye witness accounts of visual sightings of the bolide. The following summary is gleaned from the most useful accounts received.

Visibility, time and duration:

The geographical spread in visibility ranged from as far south as Ladysmith KZN (latitude 28.5 S) to Gweru in Zimbabwe (19.5 S), and from near Rustenburg in the west to Ezulwini in Swaziland in the east. The greatest concentration of sightings was in Gauteng (also the most populous area of South Africa) and Limpopo, from Polokwane to the border between South Africa and Botswana. The separation in latitude between the southernmost and northernmost sightings is 9°, corresponding to approximately 1000 km on the earth's surface. There is a wide range of times reported for the event. Most of these times were reported by members of the public and can therefore only be regarded as approximate. In general the time was reported as about 23h00 SAST, with the earliest as 22h45 and the latest as 23h30. From the 56 reports I considered the following as the most accurate times. Anton Minnaar was travelling in his car and noted the time as 22h54 from Johannesburg. Visiting amateur astronomer Greg Campbell noted the time as 22h55 from Mabelingwe. Magda Streicher obtained the time of brightest illumination from the surveillance camera at Polokwane radio station as 22h49m42s. As the state of calibration of these times could not be ascertained, the best estimate of the appearance time is somewhere between 22h50 and 22h55 SAST. Seven reports quoted the duration of the flight in seconds. These range from 2-5 seconds, with a mean duration of 3.6 seconds.

Visual Reports:

The most valuable reports which may be of further scientific value were from Andrew Morgan and Greg Campbell. Andrew Morgan is a game ranger at Lions Valley Game Lodge, Nambiti Conservancy, just north of Ladysmith, KwaZulu Natal. His location was 28°28.5' S, 30°00.1' E. Andrew is conversant with the stars and often presents star talks to guests at the Lodge. He provided details which enabled me to determine the altitude and azimuth of the start and end points of his sighting. Greg Campbell, a visiting Australian amateur astronomer,

witnessed the event from Mabelingwe, Limpopo Province. His location was 24°50.8' S, 28°02.8' E. From his description of the path relative to bright stars I was similarly able to determine the start and end points of his path. This data will hopefully allow a tentative assignment of a pre-atmospheric orbit to the object.

The perception of colours in meteors is highly subjective and depends, amongst other things, on the observer and the brightness of the event. There were no consistent reports of colours seen as the bolide moved north, descending all the while and decreasing in velocity and temperature. So from Gauteng the range in colours was red, orange, green and blue, with one report of white turning to red. From the more northerly sites the colours were reported as red, white, blue and purple. From colour video recordings taken from Gauteng the colour change from white to red as the object descended towards the horizon is apparent.

Sounds heard:

Sounds from meteors are generally of three types; sharp cracks and rumbling like thunder, which are heard after the visible passage and electrophonic hissing heard simultaneously with the visible passage. No sounds were heard south of latitude 23.5 S, or if they were they were not associated with the bolide. The first definite reported sound was a dull boom, like a tremor, by Peter Straughn at Leshiba Wilderness Area, latitude 22 47' S. From this point northwards, nearly all sites reported noise of some sort, described variously as explosions, tremors and rumbling, ranging from 1-10 minutes after the passage. The airburst was detected by two seismic recorders outside South Africa, and allowed a tentative location of the airburst over Botswana. Attempts to obtain records from South African stations were frustrated by most of these being in a state of disrepair or inoperative.

Event 226 – 2010 May 31 – Hermanus Golf Club, Cape

Observed by Danie van der Spuy and Paul Richards at 15h55 (it was still light). Danie was inside and saw the object through an east-facing window. He reported 'a bright object suddenly appeared, heading towards the ground at approx 50°, right to left. I could only see it for say 2 seconds. It was still light outside, and yet it was very bright. Paul was outside at the time and reported the main body being followed by a long tail and many smaller fragments. Duration given as 3 seconds. Colour was distinctly red. Brightness estimated as 10 times brighter than Venus or about the brightness of the full moon (ie between $m_v = -7$ to -13).

Event 227 – 2010 July 26 – Cape Town, Western Cape

Probable fireball, observed by several individuals, just after 20h00 UT.

From Lise Sloan: 'huge object slowly descending in the night sky. It had a long tail of what looked like fire and seemed to disappear directly behind the Sir Lowrys pass mountains'.

From Nicole Shea: 'driving along the R310 from Muizenburg direction to Somerset West when we witnessed a large, streaking light in the sky. It lasted about 10 seconds and was most definitely larger than the light of a planet in the sky'.

From Justine Ward: I saw the most amazing fireball with a tail in the sky just after 22h00 SAST. The meteor was moving from Cape Town towards Plattekloof area where it disintegrated'.

From Avril Michelle White: 'seen at 22h25 SAST when I was leaving Canal Walk – I was on the main road that bends towards the Shell garage towards the N1 and the meteor was about 1 o' clock in front of me, pretty low down on the horizon. It had green and red colours with sparks'.

From Mark Runtzler: 'seen at approximately 22h15 in the direction 170-180°, at an elevation of around 40-50°, the trajectory was from left to right at an angle around 15° down from horizontal. The object was burning a very bright orange/red, leaving a long burning orange/yellow tail. It lasted about 4 to 5 seconds from the time I saw it until it appeared to disintegrate into sparks of smaller pieces'.

From Vivian van der Merwe: 'Last night at about 10h20 SAST, while standing on my stoep in Jamestown, Stellenbosch, I observed an unusually bright and large fireball plummeting out of the eastern night-sky. Unfortunately I only glimpsed the last part of its trajectory, from about 30° above the horizon. It's path was at angle of about 15° to the right of vertical. It disappeared over Haelkop Peak, that is about 20-30° south of due east. The centre was bright white-yellow in colour and the peripheral outer layer (about 5-10% of the visible area) consisted of very clear turquoise and indigo-blue flames. The section between the outer and inner areas burned an orange-yellow colour. What struck me as unusual were the very distinctive "flames" emanating from the "ball". In relation to the overall size of the ball they were not very long or large but nevertheless very visible. The immediate tail was conspicuous but not long. I listened carefully for about 40 minutes after the sighting and heard no sound of any kind'.

Also Steve Kleyn collected the following reports from the Hermanus area:

From George Lombardi, Wortelgat Nature Reserve, Stanford. 'He was working on his computer and a bright light overhead made him look up (bearing in mind that the moon was very bright that night). It seems that it appeared more or less directly overhead or perhaps a little south of the zenith until dropping below horizon due E of

observation point over Stanford. Duration was about 5 seconds. Colour red in front changing to yellow behind at first then going bright white all over just before falling below horizon. It had the appearance of pieces breaking off and sparking. No smoke trail noticed and no sounds were heard.'

From Denis Grace who was walking his dog, Westcliff, Hermanus. 'The object appeared directly overhead, dropping below horizon over Stanford. Colour was red, leading to yellow trailing becoming all white just before disappearance. Had the appearance of bright sparks and pieces breaking off before burning out. No smoke trail noticed, and no sound was heard'.

Event 228 – 2010 August 5 – Howick, KZN

Observed by Carol MacDougall at 18h38, facing north north east towards the Karkloof Nature Reserve from the centre of Howick, saw a pinkish/red ball with orange tail. It seemed to explode in a reddish ball with a lime greenish edge and disappeared from sight straight after the explosion. Duration was very short, perhaps 1-2 seconds.

Event 229 – 2010 October 21 – Bredell, Gauteng

Observed by Tim Cooper at 00h40, m_v= -3, a sporadic fireball observed during an Orionid watch, colour white, speed fast, path from approximately 04h15, -10 to 01h20, +04.

Event 230 – 2010 October 22 – Bredell, Gauteng

Observed by Tim Cooper at 02h23, an Orionid fireball, m_v= -4, colour white, speed fast and left a persistent train.

Event 231 – 2010 December 30 – Hopefield, W Cape

Observed by Mary Fanner at 23h23 UT. Path was from approximately 11h40, -14° to 13h00, +10°, or from the open end of Crater towards the eastern horizon for a path of 25°. m_v= -5, brighter than Venus, duration about 2.5 seconds giving an angular velocity of 10°/second. Colour white, but reddish tint as meteor separated into two balls (red colour could have been due to low altitude above horizon). Mary reported 'first seen as a very bright pinpoint, widening as it descended before splitting out into two balls, one small bright reddish ball wider than the train, and, almost immediately below it, on the same path as the train, one larger ball, the same colour as the first but about twice its diameter. The two balls appeared joined in the middle with a very thin wire like train. After the second ball appeared the whole apparition abruptly disappeared. I got the impression of a long dangling silver earring with two reddish beads hanging from the end. There was no persistent trail and no sounds heard'. ☆

Astronomical Colloquia

The following colloquia were presented since March 2011.

SAAO and Combined Colloquia
Title: Recent advances in cosmological model building
Speaker: Dr Roberto Trotta (Imperial College)
Date: Wednesday 30 March, 2011
Venue: Main lecture theatre at AIMS
Abstract: As we enter the second decade of the 21st century, precision cosmology has become a mature science. The focus is now shifting from the determination of the parameters characterizing our Universe (which are now measured to sub-percent accuracy) to testing fundamental models and competing theories to explain the large variety of data at our disposal. In this talk I will review recent advances in cosmological model building, presenting the current observational situation and the statistical tools used to compare different theoretical models. As illustrative examples, I will focus on the questions of whether the Universe is infinite, whether dark energy is a cosmological constant, and how to decide which is the "best" model of inflation.

Title: The Factory & The Beehive: Stellar Rotations at 600 Myr
Speaker: Marcel Agüeros (Columbia University)
Date: Tuesday 19 April 2011
Venue: SAAO Auditorium
Abstract: In a classic 1972 paper, Andrew Skumanich showed that stellar rotation decreases over time --- as does chromospheric activity, a proxy for magnetic field strength. This relationship between age, rotation, and activity has been a cornerstone of stellar evolution work for over 40 years. However, rotation periods are scarce for stars with ages greater than 500 Myr, complicating the calibration of an age-rotation-activity relation that can be applied to field stars. The Columbia/Cornell/Caltech Palomar Transient Factory (CCCP) survey of open clusters is an effort to systematically map stellar rotation in open clusters. I will present the first CCCP results for Praesepe, a rich, nearby, 600 Myr open cluster. With light curves containing >150 measurements over more than three months, we have measured rotation periods for ~40 K & M-type cluster members. These rotation periods span the gap between the periods measured for the solar-type and lowest-mass Praesepe members, and indicate that the orderly mass-rotation relation seen for higher mass Praesepe members begins to break down at ~0.6 Msun. In addition, I will discuss our on-going effort to complete the portrait of the 600 Myr age-activity-rotation by measuring H-alpha emission for cluster stars.

Title: The IAC and Space Activities in South Africa
Speaker: Mr Pierre van Heerden
Date: Wednesday, 16 March 2011
Venue: MCB 2 (Molecular Biology building)
Abstract: This year, the International Astronautical Congress (IAC) will be held in Africa for the first time ever, along with various other events to be held in Cape Town during September and October - a series of events sure to be the highlight of the year. Naturally, this is a unique opportunity for interested individuals and organisations to gain international exposure, but also means that increased attention is being paid to the emerging South African space sector. During the presentation, I will take a step back to give a brief summary of space activities in South Africa - the people, organisations and projects aimed at making South Africa a key player in space - and why increased involvement in space is important. I will also highlight several ways by which students can become more active in the space arena and in events to be held during the time of the IAC.

Title: Double White Dwarf Mergers and the surface abundances of extreme helium and R Corona Borealis stars
Speaker: Simon Jeffery (Armagh Observatory)
Date: Thursday 31 March
Venue: SAAO Auditorium
Abstract: The theory of binary star evolution suggests that double white dwarf binaries will form in short-period orbits, and that these orbits decay to the point where substantial numbers will merge within the lifetime of a galaxy. The majority of these mergers will have combined masses below the Chandrasekhar limit, and will not explode. It has been proposed that the products include AM CVn, sdB, RCrB and Extreme Helium Stars. Theoretically, the evolution may be divided into three stages: binary star evolution leading to a double-degenerate (DD) binary, a dynamical merger phase, and subsequent evolution of the product. The latter is of particular importance for the identification of stars which might have been produced by DD mergers. Merger products provide several observables which may be used to test the theory, to identify the DD progenitors and potentially to explore the physics of the merger itself. Using observations of current surface abundances, together with models for the chemical evolution of AGB stars, and linear approximations for other constitutuents of a DD merger, we provide constraints on the past history and, in particular, the progenitor masses of EHe and RCrB stars.

Title: Radio interferometry, selfcal, and other horrors
Speaker: Oleg Smirnov (ASTRON)

Date: Thursday 7 April
Venue: SAAO Auditorium
Abstract: I'll give a brief overview of the basics of radio interferometry, and discuss the evolution of calibration approaches, from early radio observatories that were massively overdesigned on the hardware side so as to make calibration easier (and thus exceeded design requirements by orders of magnitude once self-calibration and other techniques were invented), to the new approach of building the telescopes as cheaply as possible and routinely expecting miracles from the software side. With the new generation of instruments such as MeerKAT, LOFAR, APERTIF and ASKAP, and with the SKA on the horizon, these problems are becoming especially interesting and important.

Title: Detecting lensing of the cosmic microwave background with the Atacama Cosmology Telescope
Speaker: Prof Kavilan Moodley (UKZN)
Date: Tuesday 10 May 2011.
Venue: UWC - School of Public Health, Lecture Hall 1
Abstract: In this talk I describe the phenomenon of gravitational lensing of cosmic microwave background (CMB) photons by the large-scale mass distribution in the universe. Techniques for reconstructing the lensing field using high resolution maps of the cosmic microwave background are discussed. The recent detection of the CMB gravitational lensing signal by the Atacama Cosmology Telescope is highlighted.

At NASSP
Title: The Current State of the Earth's Magnetic Field
Speaker: Dr Pieter Kotze
Date: Wednesday, 8 March 2011
Venue: MCB 2 (Molecular Biology building
Title: The IAC and Space Activities in South Africa
Speaker: Mr Pierre van Heerden
Date: Wednesday, 16 March 2011
Venue: MCB 2 (Molecular Biology building)
Abstract: This year, the International Astronautical Congress (IAC) will be held in Africa for the first time ever, along with various other events to be held in Cape Town during September and October - a series of events sure to be the highlight of the year. Naturally, this is a unique opportunity for interested individuals and organisations to gain international exposure, but also means that increased attention is being paid to the emerging South African space sector. During the presentation,

I will take a step back to give a brief summary of space activities in South Africa - the people, organisations and projects aimed at making South Africa a key player in space - and why increased involvement in space is important. I will also highlight several ways by which students can become more active in the space arena and in events to be held during the time of the IAC.

Title: Dusty Plasmas in Space and in the Laboratory
Speaker: Dr Shimul Maharaj
Date: Wednesday, 23 March 2011
Venue: MCB 2 (Molecular Biology building)
Abstract: I will give an informative overview lecture on dusty plasmas, defining a "dusty" plasma, and mentioning where these plasmas occur in space environments. I will talk about two fundamental wave modes that propagate in a dusty plasma such as the dust-acoustic wave and the dust-ion-acoustic wave. I will then go on to discuss the experimental observation of the dust-acoustic wave and how the observed frequency matches with the theoretical dispersion relation for the mode. I will also discuss interesting observations of plasma crystal formation in strongly coupled dusty plasmas. I will then discuss some results from a current research topic of mine where I will discuss existence domains of large amplitude solitons in a dusty plasma based on a model composed of both positive and negative dust, non-thermal ions and Boltzmann electrons.

Title: The Dark Universe
Speaker: Prof Roy Maartens
Date: Wednesday, 20 April 2011
Venue: MCB 2 (Molecular Biology building)
Abstract: The current model of the Universe, based on Einstein's General Relativity and the Standard Model of Particle Physics, is very successful in many ways - but there are deep puzzles at its foundations. The galaxies that we observe cannot grow fast enough and cannot be held together - unless there is a new form of matter, which so far has not been detected on Earth, called "Dark Matter". The accelerating expansion of the Universe cannot be explained by Dark Matter - and so we need another form of matter, called "Dark Energy". For Dark Matter, the particle theorists at least have some possible particles. But for Dark Energy, there is still no satisfactory model. We live in a Dark Universe that we do not understand properly. Or perhaps there is something else wrong with our model of the Universe. Maybe the Universe is not as smooth as we think. And maybe Einstein's theory breaks down when we go beyond the solar system and the Milky Way.

Title: Testing the equivalence principle
Speaker: Jean-Philippe Uzan
Date: Wednesday, 4 May 2011
Venue: MCB 2 (Molecular Biology building)

Abstract: The equivalence principle is at the heart of the geometrisation of gravity and one of the building block of general relativity. It is tested to a high accuracy in the Solar system but poorly on astrophysical and cosmological scales. This seminar will summarized the role of the equivalence principle and its tests in the Solar system. It will then discuss the possibility to test it with the constant of nature and describe the various constraints that have been obtained from the comparison of atomic clocks in the lab to big-bang nucleosynthesis.

Speaker bio: Jean-Philippe Uzan has obtained its PhD from Paris XI university in 1998 and was a student of Nathalie Deruelle. After a postdoc at Geneva university he was hired by the CNRS, where he is now *directeur de recherche* and works at the Institut d'Astrophysique de Paris. His main works concern the tests of the underlying hypothesis of the standard cosmological model. It includes study of the topology of the universe, tests of general relativity and tests of the Copernican principle. He has also worked on scalar-tensor theories, as well as on inflation and CMB theory, focusing mostly on non-Gaussianity. He has been teaching physics at the Ecole des Mines de Paris and Cosmology at the Ecole Normale Superieure de Paris. He has co-authored the monography "Primordial cosmology" (OUP) and written several popular science books, among which books for children. ☆

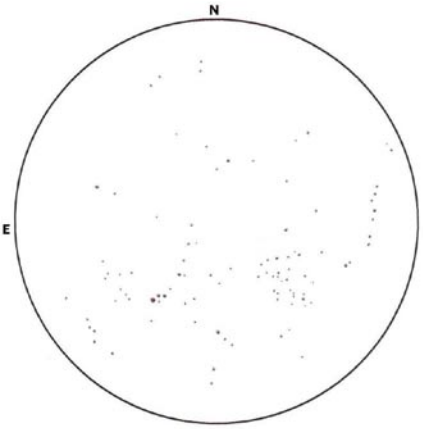
A Flame rises from the Altar

by Magda Streicher
magdalena@mweb.co.za

Image source: Stellarium.org

According to tradition Ara was the altar used by Centaurus the Centaur to offer sacrifices of animal origin. Ara, ranked number 63 in terms of size, is located between Norma to the west and Telescopium to the east.

Fire and water are arguably among the most dramatic phenomena that form a part of our daily existence in this world. Fire is often seen as a symbol of destruction, yet the torch-bearer still speeds on his way. It is difficult for us to grasp the anxiety and chaos that humans of antiquity must have experienced when a human sacrifice was brought to the altar.

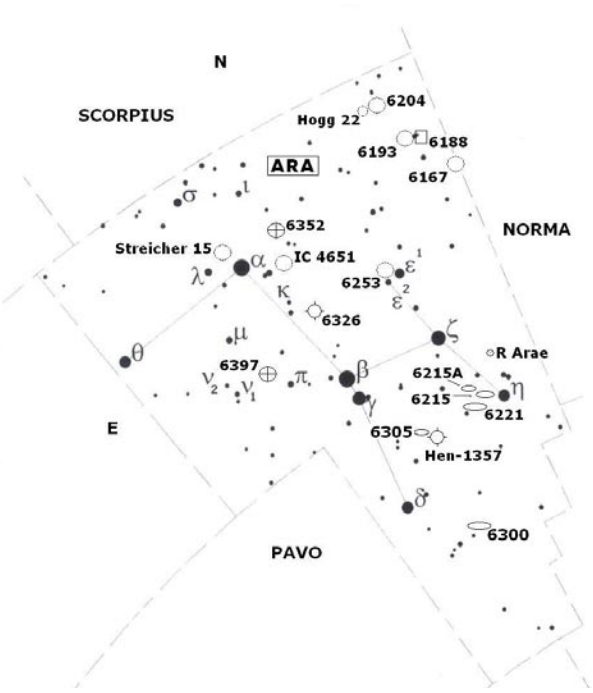


NGC 6204 is a well balanced cluster with about two dozen stars of mixed magnitude and the Hogg clusters.

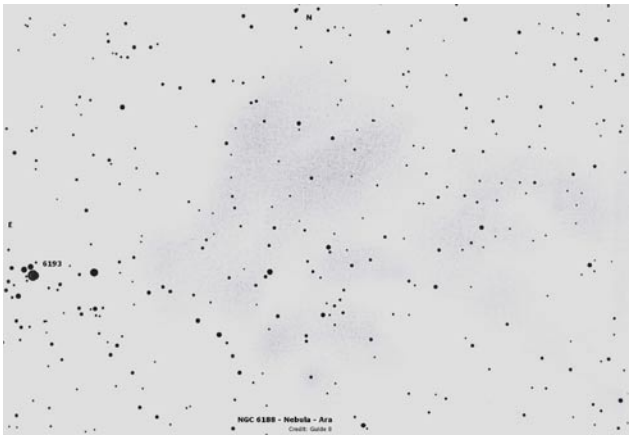
The north-western area of Ara is the obvious place to start if one wants to get to know more about this constellation. This part of Ara, nestling on the outskirts of the Milky Way, is very dense and rich.

A mere two degrees from the boundary with Norma and Scorpius is the open star cluster **NGC 6204** (*New General Catalogue of Nebulae and Clusters of Stars*). One of the most outstanding compositions with two groupings can be seen here. NGC 6204 is a well balanced cluster with about two dozen stars of mixed magnitude: brighter ones mingled with fainter ones. It is a lovely cluster displaying a tight centre and a notable double-star in the extreme south. The group **Hogg 22**, about 5 arc-minutes towards the east, resembles a tight knot of stars towards the southern point of a long string draped from north to south in a perfect half-moon shape. If one continues along this line, the stars become increasingly fainter, with the faintest one marking the end of the line at the northern point (see combined sketch with NGC 6204). However, Mati Morel, an Australian astronomer, has determined that Hogg 22 is a separate physical cluster

from NGC 6204, although some sources list the stars concerned as all in the same cluster, namely NGC 6204. Two more Hogg clusters can be found just further south: Hogg 20, situated on the southern brink of the cluster NGC 6200, which lies only 20 arc-minutes south of NGC 6204, and Hogg 21, only 20 arc- minutes further south-east from NGC 6200. Arthur Robert Hogg was born in Victoria Australia in 1903, and at the age of 43 he became an astronomer. Hogg graduated with a Masters of Science in 1925.



Continuing along the boundary between Ara and Norma southwards there is another interesting combination with a cluster and a diffuse nebula. **NGC 6188** displays a range of nebulosity with shades from really dark to a light, flimsy haze. The almost transparent nebulosity hangs on both sides of the darker nebula, which runs from north to south, with the eastern hazy section the brightest. The whole area is covered in smoke-like gas and dust, with small parts



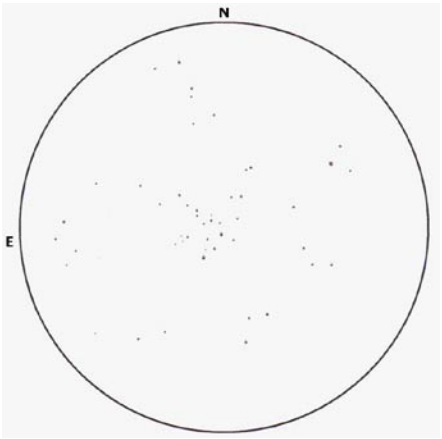
NGC 6188 displays an almost transparent nebulosity. NGC 6193 in contrast stands out clearly.

of the dark nebula quite well defined against the very dense star-field (see combine sketch with NGC 6139). Make every effort to search out very dark night sky conditions to appreciate this network of mixed dark and bright nebulosity to the full.

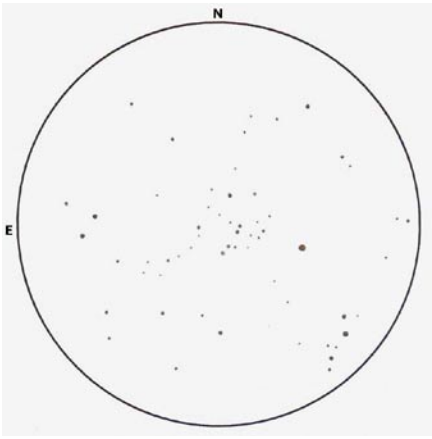
The cluster **NGC 6193** shines like an illuminated shopping centre on the south-eastern tip of this region covered in emission and reflection nebulosity. The cluster, with a few outstanding bright blue stars and a mist of fainter light points, is clearly demarcated and outstanding and could indicate a much larger group than anticipated. The beautiful double-star DUN 206 (*Dunlop Catalogue*) is situated on the western edge of the cluster and contains two magnitude 6 and 7 blue stars with a separation of 10 arc-seconds in a position angle (PA) of 14.

A special cluster can be found a further 1.5 degrees south along the Ara and Norma boundary. **NGC 6167** is just a pretty open cluster with an outstanding shape. The group also known as Bennett 79a, displays a very prominent upside down or otherwise *W* shape, which could also be seen as a sort of zigzag running in a north-south direction (see sketch). Star clusters in different patterns and shapes can be very interesting and provide endless pleasure to the observer.

More or less towards the centre of Ara we find epsilon Arae, which can also be seen as the western supporting pillar of the altar dish. The open cluster **NGC 6253** is situated just 35 arc-minutes north from magnitude 4 epsilon[1] and magnitude 5.2 epsilon[2]. The cluster, which is also known as Bennett 84, is a large, rich, swarming group of faint stars in an



NGC 6167 is a pretty open cluster with an outstanding shape.



NGC 6253 is a is a large, rich, swarming group of faint stars in an elongated cone shape open cluster, and is also known as Bennett 84.

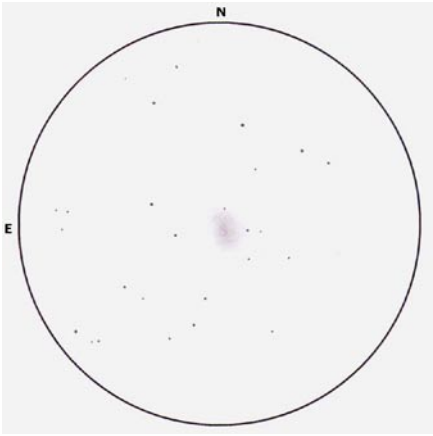
elongated cone shape spreading out from a point from east to west. Close to the western rim of the cup-shaped opening is a magnitude 9 star. The northern part of the cluster displays a slightly bulgy shape with a more flattened southern part. Although a faint attractive cluster of modest brightness, it does stand out against the background star-field (see sketch). With some imagination it is also possible to see it as the shape of an Australian kangaroo.

The star zeta Arae is situated 3 degrees further south of epsilon and is like no other star in this constellation. Although this orange star proudly displays a magnitude of 3 and represents the western part of the altar dish it is also very distant.

Still further south, halfway between zeta and eta Arae is the very interesting **R Arae** (HD149730 – *Henry Draper Catalogue*) the visual duplicity of which was discovered by John Herschel (HJ 4866) who called it 'a beautiful star'. The star is in fact an Algol type system with HD149730A being an eclipsing binary with a magnitude varying between 6 and 6.9 over a period of exactly 4 days, 10 hours and 12 minutes. The companion star, HD149730B, of magnitude 8 is just 3.5 arc-seconds away to the south-east. But be particularly sharp in your observation, because the star-field surrounding this star is packed with stars of various magnitudes. It would be best to make use of a star map.

NGC 6215 is situated barely 10 arc-minutes east-north-east from the magnitude 3.8 eta Arae. A lovely orange-coloured star, which points the way to the galaxies we are dealing with in this constellation. If you can obscure the star, the galaxy, which displays a hazy oval shape and slightly brighter nucleus, will be easier to observe. What is not so easy to spot is the companion galaxy **NGC 6215A**, which is a further 12 arc-minutes eastwards and visible only as a faint, hazy smear of light.

The third galaxy in the field, and perhaps the easiest of the trio to spot, is **NGC 6221**, situated 25 arc-minutes south-east from eta Arae. The galaxy is fairly large and bright and appears to form an oval from north to south. Careful observation brings to the fore an uneven surface with a patchy feeling to it, which hints at a spiral structure. The nucleus is relative-



NGC 6221 is fairly large and bright galaxy that appears to form an oval from north to south.

ly bright, and with high magnification it brightens up to a stellar point. Strings of faint stars are wrapped around the western side of the galaxy (see sketch). This galaxy is about 70 million light-years away.

The stars delta and eta Arae are in a fiery line, as they represent the brim of the volcano-like cooking pot. A very special planetary nebula is situated virtually in the midst of the flames, so to speak, halfway between the two stars. This object is special, because it is one of Hubble's greatest images and bears the name Stingray Nebula, also known as **Hen-1357**. It is so named because it is the 1 357th object in a list of unusual stars compiled by astronomer Karl Henize in the 1960s. The planetary nebula is in the final stages of its life and one of the youngest known formed possibly as recently as 200 years ago and lies about 18 000 light-years away from us. The central magnitude 8.4 star (SAO 244567 – *Smithsonian Astrophysical Observatory*) has a companion at a position angle (PA) of 70. Hubble pictures of the planetary nebula show a ring of green coloured gas towards the centre. Curved red lines represent gas heated by a shock wind interacting with surrounding gas. The galaxy **NGC 6305** is situated only 25 arc-minutes towards the north-east and displays a soft, circular glow. However, two lovely yellow stars flank the galaxy on the south-eastern and north-western sides.

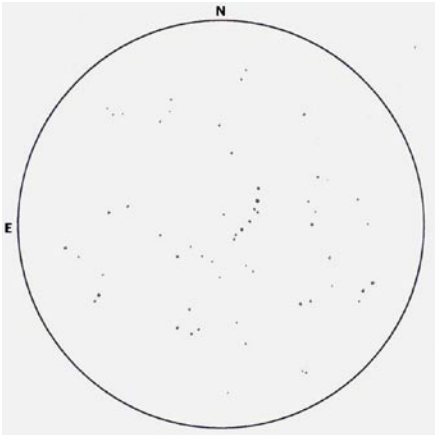
The magnitude 3.5 star delta Arae situated at the eastern part of the brim is also a double-star with the primary a super white and the companion with a slightly yellow tinge. The ringed barred spiral galaxy **NGC 6300** is situated 2.5 degrees south of magnitude 3.5 delta Arae. The galaxy displays a nice oval in a north-west to south-east direction. With higher magnification the surface hints some structure and a relatively bright bar-like nucleus.

Move away from this burning spot of the Altar into the eastern part of the constellation to discover Ara's showpiece, the globular cluster **NGC 6397**, situated towards the east of the two brightest stars alpha and beta Arae. This is a exceptional object with all the observing elements that one could found in a globular clusters. NGC 6397, also known as Bennett 98, is large, bright and round in shape. It has well-resolved star trails intermittently shaped like arms, as well as speckled dark sections in between. It appears slightly elongated in a north-west to south-east direction, which gives it a three-dimensional feeling. The globular cluster displays a mass of various magnitude stars with a few blue stragglers bunched together. The core impresses me most: it appears completely tight, but higher magnification reveals very faint pin-point stars barely visible. A smaller unresolved knot of faint stars can be seen towards the north-east edge. Three estimated magnitude 9 stars with a yel-

lowish tint found there home toward the southern periphery between star streamers. What a breath-taking naked-eye object, only about 8 700 light-years away!

Well out of the fiery danger zone, situated between the pillars that hold the burning altar pot, is the planetary nebula **NGC 6326** about 2.5 degrees south of alpha Arae. The planetary nebula displays a soft misty disc in a slightly grey colour. Higher magnification brings out a more defined round shape and can be "lifted out" from the background star-field with the help of an oxygen filter (O^{III}). An uneven half-moon string of stars runs from north to south on the eastern side of the planetary nebula for almost 10 arc-minutes long.

The exceptional silver metallic magnitude 3 alpha Arae is also a double-star with a magnitude 11 companion, a separation of 55 arc-seconds and a position angle (PA) of 172. To have the brightest star as a close neighbour is quite something, and on top of that, an open cluster with a difference. **IC 4651** (*Index Catalogue*) is situated only one degree west of alpha Arae. The focus of the grouping is a very dense knot of stars towards the middle area, which also contains the most stars. The northern part displays a handful of brighter stars that mingle well with the fainter members. Again the southern and eastern parts of the cluster contain handfuls of faint stars that display a few nice strings in formation. Dark areas are very obvious between the cluster members. The cluster is well outstanding against the background star-field. Maybe it should be called the Patchy Cluster!



Streicher 15 contains eight stars and is well defined against the star-field.

One of the first asterisms searched out during observations so far is also a close neighbour to alpha Arae and is situated 1.5 degrees north of the star. **STREICHER 15** (*Deep-sky Hunters Catalogue*) contains eight stars, with an average brightness of roughly magnitude 7 to 8 and is well defined against the star-field. The brightest star, magnitude 6.3, appears light yellow and visible to the north of the string of stars snaking southwards. A magnitude 10 double-star ends off the southern tip of the string (see sketch). Star strings may resemble different shapes, and to me this grouping resembles a swallow diving in flight. One could also see it as a Chinese hat.

Another 2.5 degrees further west from the asterism is the globular cluster **NGC 6352**, situated inside the diffuse emission nebula GN 17.24.4 (*General Nebula Databank*). The globular cluster appears as a soft round smear, unresolved and embedded among the faint field stars. With averted vision it looks somewhat like blasted sand, and with higher magnification the identity comes to life with faint pin-point stars resembling frosted glass. The twinkling stars give this globular a glitter-ball effect, with a faint hazy outer envelope. With even higher magnification dark spots and thin dark lanes are visible in the slightly more compact centre, with noticeable star trails on the outer edges. The south-western part of the cluster seems much "busier" with star light. James Dunlop discovered this magnitude 8 globular from Wales, Australia, and adds it as number 417 on his list. His remarks were: "Rather faint nebula, round figure, easily resolvable in slight compression of stars to the centre". The globular cluster is also known as Bennett 94 and is approximately 25 000 light-years distant.

The stake and sacrifices have long died out, but the constellation Ara is a quiet reminder of a practice that justified such phenomena. Fortunately the constellation offers a wealth of splendid objects that will warm the heart on warm southern summer evenings. ☆

Object	Type	RA (J2000.0)	Dec	Mag	Size
NGC 6167	Open Cluster	16^h34^m4	-49º36′	6.7	7′
R Arae	Eclipsing Binary	16 39 7	-57 00	6 & 6.9	-
NGC 6188	Diffuse Nebula	16 40 5	-48 47	-	20′
NGC 6193	Open Cluster	16 41 3	-48 46	5.2	14′
NGC 6204	Open Cluster	16 46 5	-47 01	8.2	5′
Hogg 22	Open Cluster	16 46 6	-47 05	6.7	2′
NGC 6215	Galaxy	16 51 1	-58 59	10.9	2.7′x2.2′
NGC 6215A	Galaxy	16 52 8	-58 56	13.4	1.9′x0.6′
NGC 6221	Galaxy	16 52 8	-59 13	10.1	4.9′x3.2′
NGC 6253	Open Cluster	16 59 1	-52 43	10.2	5′
Hen-1357	Planetary Nebula	17 16 4	-59 29	-	-
NGC 6300	Galaxy	17 17 0	-62 49	10.1	5.2′x3.3′
NGC 6305	Galaxy	17 18 0	-59 10	13	1.8′x1.2′
NGC 6326	Planetary Nebula	17 20 8	-51 45	11	14′
IC 4651	Open Cluster	17 24 7	-49 57	6.9	12′
NGC 6352	Globular Cluster	17 25 5	-48 25	8.1	7.1′
STREICHER 15	Asterism	17 34 7	-48 35	6	17′
NGC 6397	Globular Cluster	17 40 7	-53 40	5.8	25.7′

astronomical society of southern africa

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

Publications: The Society publishes its own electronic journal, the *Monthly Notes of the Astronomical Society of Southern Africa (MNASSA)* bimonthly and an annual printed *Sky Guide Africa South*.

Membership: Membership of the Society is open to all. Enquiries should be addressed to the Membership Secretary, ASSA, PO Box 9, Observatory, 7935, South Africa or to the e-mail address below. Potential members should note that because of likely changes in the Society's Constitution, subscription rates can only be announced, probably on the ASSA homepage, in June or July.

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

Sky & Telescope: Both Full and Local members (proof of Centre membership required) may subscribe to *Sky & Telescope* at a significant discount. Please contact membership secretary for details.

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