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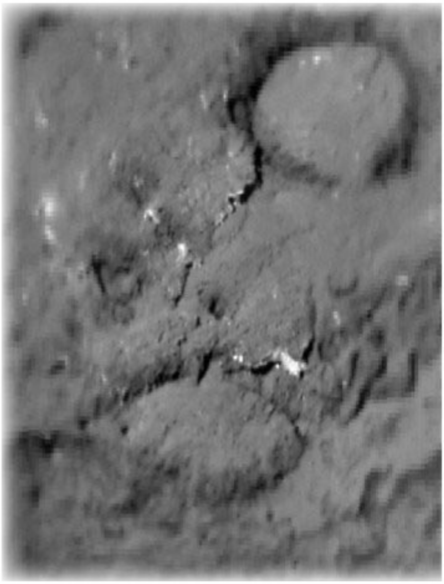
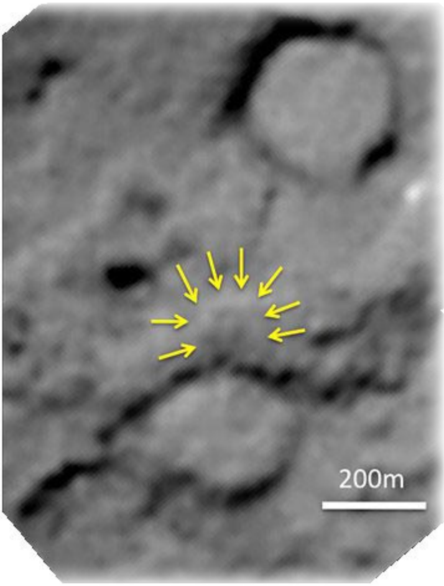
monthly notes of the astronomical society of southern africa
Vol 70 Nos 3 & 4 April 2011

Comet Tempel 1 revisited





Deep Impact, 4 July 2005

Stardust NExT, 14 February 2011

• SA enters Space Age • Birth of the Southern Star Party •
• Yuri Gagarin, 50 years on • SALT's Image Quality Fix •

monthly notes of the astronomical society of southern africa

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contributions | Contributions for the respective issues should reach the editorial address by the due dates below. **Please include the word *MNASSA* in the subject line of all e-mail communication.** A *Style guide and instructions to authors* is available from the editor on request, or from the website.

Deadlines:

Vol 70 Nos	5 & 6	(Jun 2011 issue),	01 May 2011
Vol 70 Nos	7 & 8	(Aug 2011 issue),	01 Jul 2011
Vol 70 Nos	9 & 10	(Oct 2011 issue),	01 Sep 2011
Vol 70 Nos	11 & 12	(Dec 2011 issue),	01 Nov 2011

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Stardust NExT flyby of Comet Tempel 1

The left-hand image is a composite made from images obtained by Deep Impact in July 2005. The right-hand image shows arrows identifying the rim of the crater caused by the impactor as imaged during the Stardust NExT flyby on 14 February 2011. The crater is estimated to be 150 metres in diameter.

Image Credit: http://stardustnext.jpl.nasa.gov

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errata

Saturn by Barbara Cunow. *MNASSA* Vol 70 Nos 1 & 2, p.19

The captions for the figures were omitted, and whilst some were covered in the text of the article, others weren't. The editor apologizes for the oversight. Below are the figure numbers with their captions.

Figure 1. Saturn on 14 December 2006. North is up and east to the left.

Figure 2. Drawings of Saturn between 1980 and 2010, covering a complete cycle of seasons on the planet. The dates of observation are: 1 November 1980, 8 May 1982, 11 June 1984, 6 August 1987, 26 August 1991, 28 August 1993, 25 June 1994, 20 September 1997, 14 February 1999, 24 April 2003, 1 November 2005, 23 December 2007, 25 March 2009 and 3 November 2010. North is up and east to the left.

Figure 3. Drawings of Saturn between 2003 and 2010. The dates of observation are: 15 February 2003, 26 March 2004, 26 April 2005, 11 March 2006, 20 April 2007, 24 March 2008, 15 April 2009, and 13 April 2010. North is up and east to the left.

Figure 4. Change of viewing angle between 1996 and 1998. The drawings show Saturn on the following dates: left column from top to bottom: 11 July 1996, 1 December 1996 and 13 June 1997; right column from top to bottom: 19 November 1997, 28 August 1998 and 4 December 1998. North is up and east to the left.

Figure 5. Changing appearance of the shadows on Saturn in 1998. The drawings show Saturn (from top to bottom) for 28 August 1998, 26 October 1998 and 4 December 1998. North is up and east to the left.

Figure 6. Drawings of Saturn in 1995 and 1996 when the rings turned edge-on. The dates of observation are: left column from top to bottom: 30 January 1995, 3 June 1995, 1 September 1995, 19 October 1995, 6 November 1995, 5 December 1995, 23 May 1996 and 11 July 1996. North is up and east to the left.

Figure 7. Drawings of Saturn in 2009 when the rings turned edge-on. The dates of observation are: left column from top to bottom: 10 May 2009, 12 June 2009 and 8 July 2009; right column from top to bottom:

28 July 2009, 4 August 2009 and 11 August 2009. North is up and east to the left.

Scholarships News *MNASSA* Vol. 70 Nos. 1 & 2, p.1

The editor was asked to change the third paragraph to read as follows:

Rocco Coppejans, who held a SAAO-ASSA Scholarship in 2008 and 2009, obtained his BSc degree with distinctions from the University of Pretoria at the end of 2009, and was accepted into the National Astrophysics and Space Science Programme (NASSP) at UCT in 2010 and was studying for his BSc (Hons) degree. He was joined by Mpati Ramatsoku, who held the SAAO-ASSA Scholarship in 2007 and 2008, and who completed her BSc at UCT in 2009. She was also in the NASSP at UCT and was also studying for her BSc (Hons) last year. ☆

assa news

New Members

The following new members were officially accepted at the ASSA Council Meeting held on 5 February 2011:

Mr C.A. Abrahams, Grassy Park
Mr S Badari, Kempton Park
Ms LM Botha, Durban North
Mr P Casado, Wilgeheuvel
Mr R Cronje, Irene
Mr AB Du Plooy, Langenhovenpark
Dr PR Du Toit, Hatfield
Mr JDJ Figueira, Umgeni Park
Mrs JM Figueira, Umgeni Park
Mr T Ferreira, Cape Town
Dr EH Gouws, Stellenbosch
Mr M Hess, Paarl
Mr WL Kok, Germiston
Mr GJ Krige, Hermanus
Ms S Lock, Tyger Valley
Mr JR Potgieter, Doonside
Mr JAL Schreuder, Monte Vista
Mr RH Suberg, Malvern
Mr T Van Der Merwe, Bloemfontein
Mr S Van Der Walt, Stellenbosch
Mr H Viljoen, Wierdapark
Mr J Visser, Westville ☆

news notes

Educational Astronomy Project awarded grant of 1.9 Million Euros

The European Union (EU) has granted 1.9 million euros to support the 6-country educational program EUNAWE, based on Universe Awareness (UNAWE). UNAWE is an IAU-endorsed program that uses the beauty and grandeur of the Universe to encourage young children, particularly those from an underprivileged background, to have an interest in science and technology and foster their sense of global citizenship from the earliest age. Although UNAWE was only founded five years ago, it is already active in 40 countries and comprises a global network of almost 500 astronomers, teachers and other educators.

The grant has been allocated to European Universe Awareness (EUNAWE), a European branch of the global Universe Awareness (UNAWE) program, and is aimed at the implementation of Universe Awareness programs in six countries over three years: Germany, Italy, the Netherlands, the United Kingdom, South Africa and Spain. The project will include organizing teacher-training courses and developing hands-on material for children. In the long term, EUNAWE aims to help produce the next generation of European engineers and scientists and to make children from underprivileged areas realize that they are part of a much larger European community.

Leiden University Professor George Miley, Vice President of the IAU and founder and Chairman of UNAWE, is delighted by the news: "With its combination of social, educational and scientific goals, UNAWE can play a unique role in furthering education and development. The allocation of this grant is a recognition by the EU of the importance of UNAWE and is an important step towards realizing our ambition to have an active UNAWE program in every country in the world by 2020."

UNAWE was founded in 2006 at Leiden University in the Netherlands with support from the Royal Netherlands Academy and the Netherlands Ministry of Education, Culture and Science. It became a Cornerstone project of the successful UN-ratified IAU/UNESCO International Year of Astronomy in 2009 (IYA2009). During IYA2009, thousands of UNAWE activities were organized in more than 45 countries. For example, in Venezuela, 43 teacher training sessions reached more than 1,500 teachers and well over 60,000 children. The grant will empower UNAWE to continue to inspire a passion for astronomy as part of the legacy of IYA2009.

UNAWE is also an integral part of the IAU Strategic Plan 2010-2020, which is called Astronomy for the Developing World. This is an ambitious blueprint that aims to use astronomy to foster education and provide skills and competences in science and technology throughout the world, particularly in developing countries. The Plan is being implemented by the IAU Office of Astronomy for Development (OAD) at the South African Astronomical Observatory in Cape Town. UNAWE is the first activity of the IAU Strategic Plan to receive external funding and it is a good indicator that additional funding for other activities may be available.

Kevin Govender, who was recently appointed Director of the OAD, adds: "Introducing very young children to the beauty and scale of the Universe stimulates a sense of awe and wonder which plays a significant role in their development. We are delighted that the EU has decided to support the implementation of this unique program."

EUNAWE will be officially presented during a public event held at the European Parliament in Brussels, Belgium, on the 24 of May 2011.

European Universe Awareness is coordinated by Leiden University (the Netherlands) in collaboration with partners in Heidelberg University (Germany), UniversitatPolitecnica De Catalunya (Spain), INAF - Arcetri Observatory (Italy), the South African Astronomical Observatory SAAO (South Africa) and the Armagh Observatory (United Kingdom). The new grant for EUNAWE was awarded under the auspices of the European Union's Seventh Framework Program. ☆

NASA finds Earth-size planet candidates in habitable zone

NASA's Kepler mission has discovered its first Earth-size planet candidates and its first candidates in the habitable zone, a region where liquid water could exist on a planet's surface. Five of the potential planets are near Earth-size and orbit in the habitable zone of smaller, cooler stars than our Sun.

Candidates require follow-up observations to verify they are actual planets. Kepler also found six confirmed planets orbiting a Sun-like star, Kepler-11. This is the largest group of transiting planets orbiting a single star yet discovered outside our solar system.

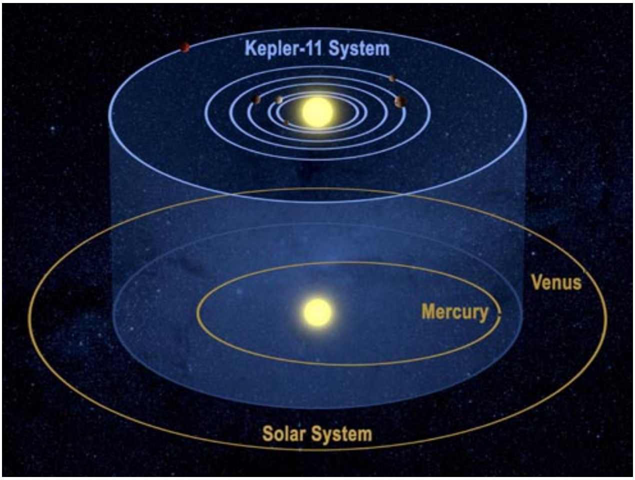
In one generation these discoveries have gone from extra-terrestrial planets being a mainstay of science fiction, to the present, where Kepler has helped turn science fiction into today's reality and discoveries underscore the importance of NASA's science missions, which consistently increase understanding of our place in the cosmos.

The discoveries are part of several hundred new planet candidates identified in new Kepler mission science data, released on Tuesday, 1 February, 2011. The findings increase the number of planet candidates identified by Kepler to-date to 1 235. Of these, 68 are approximately Earth-size; 288 are super-Earth-size; 662 are Neptune-size; 165 are the size of Jupiter and 19 are larger than Jupiter.

Of the 54 new planet candidates found in the habitable zone, five are near Earth-sized. The remaining 49 habitable zone candidates range from super-Earth size – up to twice the size of Earth – to larger than Jupiter.

The findings are based on the results of observations conducted 12 May to 17 September 2009, of more than 156 000 stars in Kepler's field of view, which covers approximately 1/400 of the sky.

The fact that so many planet candidates have been found in such a tiny fraction of



This artist's conception shows the Kepler-11 planetary system and our solar system from a tilted perspective to demonstrate that the orbits of each lie on similar planes. Image credit: NASA/Tim Pyle

the sky suggests there are countless planets orbiting Sun-like stars in our galaxy. The tally went from zero to 68 Earth-sized planet candidates and zero to 54 candidates in the habitable zone, some of which could have moons with liquid water.

Among the stars with planetary candidates, 170 show evidence of multiple planetary candidates. Kepler-11, located approximately 2 000 light years from Earth, is the most tightly packed planetary system yet discovered. All six of its confirmed planets have orbits smaller than Venus, and five of the six have orbits smaller than Mercury's. The only other star with more than one confirmed transiting planet is Kepler-9, which has three.

Kepler-11 is a remarkable system whose architecture and dynamics provide clues about its formation. These six planets are mixtures of rock and gases, possibly including water. The rocky material accounts for most of the planets' mass, while the gas takes up most of their volume. By measuring the sizes and masses of the five inner planets, we determined they are among the lowest mass confirmed planets beyond our solar system."

All of the planets orbiting Kepler-11 are larger than Earth, with the largest ones being comparable in size to Uranus and Neptune. The innermost planet, Kepler-11b, is ten times closer to its star than Earth is to the Sun. Moving outward, the other planets are Kepler-11c, Kepler-11d, Kepler-11e, Kepler-11f, and the outermost planet, Kepler-11g, which is half as far from its star as Earth is from the Sun.

The planets Kepler-11d, Kepler-11e and Kepler-11f have a significant amount of light gas, which indicates that they formed within a few million years of the system's formation. The historic milestones Kepler makes with each new discovery will determine the course of every exoplanet mission to follow.

Kepler, a space telescope, looks for planet signatures by measuring tiny decreases in the brightness of stars caused by planets crossing in front of them. This is known as a transit. Since transits of planets in the habitable zone of Sun-like stars occur about once a year and require three transits for verification, it is expected to take three years to locate and verify Earth-size planets orbiting Sun-like stars.

The Kepler science team uses ground-based telescopes and the Spitzer Space Telescope to review observations on planetary candidates and other objects of interest the spacecraft finds.

The star field that Kepler observes in the constellations Cygnus and Lyra can only be seen from ground-based observatories in spring through early fall. The data from these other observations help determine which candidates can be validated as planets.

More information about the Kepler mission: www.nasa.gov/kepler ☆

South Africa: New space era lifts off

Jacquie Withers

The recent launch by government of the South African National Space Agency marked the dawn of a new space era in the country's history. The agency will begin operating in April. Meanwhile Africa's bid to host the global science initiative, the Square Kilometre Array telescope, was boosted this month with an announcement of significant breakthroughs.

The South African National Space Agency, or SANSA, launched as part of the country's national space strategy, has been a long time coming.

Speaking at the launch of SANSA and the national space strategy in December, Science and Technology Minister Naledi Pandor said the primary purpose and policy driver of the space programme is to "leverage the benefits of space science and technology for socio-economic development". According to a recent article in Engineering News, the agency is set to have a head office and four operational units: the Earth Observation Centre, the Space Operations Centre, the Space Science Centre and the Space Engineering Centre.

The operational units are born out of existing and established space initiatives; for example, the Earth Observation Centre and Space Operations Centre emerge from the current Satellite Applications Centre of the Council for Scientific and Industrial Research (CSIR).

The space agency will use both ground-based and satellite-borne platforms to operate in the areas of earth observation, navigation and positioning, communications, and space science and exploration.

An important cross-cutting theme that will underpin all of the agency's activities is human capital development, to develop rare and transferable skills in space science and engineering. A second crucial theme is science advancement and public engagement - nurturing awareness of and interest in science among the general public, including the youth.

Government will rely on the agency to initiate centres of competence, which will focus on the development of technology platforms, and also to leverage "strategic international partnerships to address any inherent weaknesses of the local space sector" .

SANSA also aims to "grow South Africa's contribution to the global space value chain", according to the agency's website.

An integral part of the agency's earth-observation activities is South Africa's own Earth-observation satellite, SumbandilaSat (Sumbandila, from the Venda language, means 'lead the way'), which was launched in 2009. Commissioned by the Department of Science and Technology (DST), it was developed over three years by Stellenbosch University and Sun Space and Information Systems, in conjunction with the CSIR.

The satellite plays a key research role in investigating the viability of affordable space technology. Providing high-resolution images of Earth, it also allows the effects of drought, flood and fire on crops and vegetation to be easily discerned, thus being highly suited to agricultural monitoring. This has positive implications for food security in Southern Africa.

The *SumbandilaSatmission* blog provides regular updates on activities, including historic footage, such as the satellite's first earth-observation video.

South Africa is working closely with eight other African countries to develop its bid for the massive Square Kilometre Array (SKA) telescope project. It has been short-listed along with Australia to host the multi-billion dollar instrument, which will be 50 times more sensitive than the current most powerful radio telescopes.

This month the DST announced that South Africa had made two break-throughs that bolster its campaign for

SKA, which is a global initiative involving 16 countries.

First, scientists combined data from two radio telescopes at separate locations, 900 kilometres apart, using ‘very long baseline interferometry’ without assistance from foreign countries. The data was then correlated in Cape Town to produce the first-ever African ‘detection of fringes’ - on the first attempt.

Second, scientists have finished building the computer hardware that will provide the data-processing capabilities for SKA. South Africa’s SKA project director Dr Bernie Fanaroff said this has been essential preparation for the SKA project.

“SKA is expected to collect more data in one week than humankind has collected in its entire history,” he said. “SKA will revolutionise science. It will be the world’s largest radio telescope and probably capable of answering questions that we haven’t even thought to ask yet.”

Fanaroff added that South Africa and its eight African partner countries - each of which will host some of SKA’s 1 000 radio dishes - will “pull out all the stops” this year to show the world that Africa should play host to the super-telescope. A decision on the bid is expected next year, with SKA aiming to be fully operational by 2024.

* South Africa will host “the largest annual space exhibition in the world”, the 62nd International Astronautical Congress, at Cape Town’s International Convention Centre from 3-7 October. ☆

South African Council for Space Affairs

SACSA

Minister appoints SA Council for Space Affairs

The South African Council for Space Affairs is established in terms of the Space Affairs Act (Act 84 of 1993) to oversee space-related activities of South Africa. The Council is mandated to take care of the country’s space-related interests and to ensure compliance with international agreements, conventions and treaties ratified by South Africa. In terms of international law, states are responsible for supervising the space activities of their nationals and companies.

Council Chairman, Dr Martinez, explained: “The Council falls under the Department of Trade and Industry and is complimentary to the South African National Space Agency (SANSA) of the

Department of Science and Technology. The Council will address policy, industrial development, legal and regulatory aspects of space activities. The space agency, which falls under the Department of Science and Technology, will implement programmes."

SACSA will be chaired by Dr Peter Martinez of the National Research Foundation's South African Astronomical Observatory. Nomfuneko Majaja of the Department of Trade and Industry was appointed its vice-chair. The body will advise Davies on all space and space-related activities in the country, as well as implement South Africa's National Space Policy through the creation of a supportive regulatory and international business environment for the South African industry.

SACSA's mandate will include legal, policy, scientific, technical and advocacy matters relating to space activities. South Africa is one of a small number of countries that has adopted national space legislation governing space activities. Although the basic legal framework is in place, some gaps remain. One of these gaps is in the area of regulating and supporting commercial space activities.

The Council began its term with a series of visits to all the space-related entities in the country in late 2010. It is finalising its strategic plan for the next three years, beginning with the new financial year that starts in April 2011. Among its immediate plans, the Council will review the current Space Affairs Act to address the evolution in the local and global space arena since the Act was passed in 1993, and also to develop the licensing framework for space activities.

The other members of the council are Kim Victor Gorringe, an aviation law expert; Advocate Phetole Patrick Sekhula, an advocate of the High Court; Dr Sandile Malinga CEO of the South African National Space Agency; Pontsho Maruping, a space expert; Valerie Matlou from the Department of International Relations and Cooperation; and Andiswa Mlisa, who is a director of Earth Sciences consultancy Umvoto; Wabile Motswasele from the Council for Scientific and Industrial Research; Dr Valanathan Munsami from the Department of Science and Technology; Ron Olivier, Sun Space's business development director; Linden Petzer from the Department of Communications; Hennie Rheeder from the Information Systems, Electronics and Telecommunications Technologies Sector Education and Training Authority; Jo-Ansie Van Wyk from the University of South Africa and Themba Tenza from the Department of Transport.

More information is available on the Council's website: www.sacsa.gov.za ☆

South African National Space Agency Launched

Peter Martinez
South African Astronomical Observatory, PO Box 9, Observatory 7935

South Africa, like all other countries nowadays, is critically reliant on space technology. Space applications are so embedded in our modern lives that most people are unaware of how much use they make of space technology, every day. Government is also a very significant user of space technology and is often the actor in the space value chain that picks up the costs of space applications and infrastructure. This is certainly the case for "public good" space activities, such as Earth observation. In 2003, a number of government Departments started to consider South Africa's reliance on space technology as a country, and how government could use its resources in this domain more effectively. These discussions led to the conclusion that South Africa needed a national space agency to coordinate all the previously disparate space-related activities carried out by a number of government Departments and their agencies. Thus was the concept of the South African National Space Agency born.

The discussions gained momentum in 2005, and by 2007 the idea was presented to Parliament by the then Minister of Science and Technology, Mosibudi Mangena, in his Departmental Budget Vote speech on 25 May 2007, where it gained the support of all political parties. Draft legislation was duly presented to Parliament and was subsequently endorsed by Parliament and Cabinet. On the 11 December 2008, President Kgalema Motlanthe signed into law the South African National Space Agency Act.

The Act provides for "the promotion and use of space and co-operation in space-related activities, foster research in space science, advance scientific engineering through human capital, support the creation of an environment conducive to industrial development in space technologies within the framework of national government policy, and for that purpose to establish the South African National Space Agency."

With this legislative mandate in place, the process of setting up the agency commenced in earnest in 2009. This process was driven by the Department of Science and Technology. The agency was to be established through the amalgamation of existing activities and facilities, and this entailed numerous discussions with a wide number of other Government Departments and their entities. The process was concluded in 2010 and the South African National Space Agency was officially launched by the Minister of Science and Technology, Naledi Pandor, on the 9 December 2010, (see press release on page 44) with Dr Sandile Malinga as its Caretaker CEO. The National Space Strategy was also launched on that day.

The National Space Strategy promotes research in astronomy, Earth observation, communications, navigation and space physics. It fosters international cooperation in space-related activities and aims to advance scientific, engineering and technological competencies through human capital development and outreach programmes. The three main objectives set out in the strategy are:

1. To capture a share in the global market for small to medium-sized space systems. Expansion of investment in microsatellites, building on the existing SumbandilaSat platform.
2. To improve decision making by providing data through the integration of space-based systems with ground-based systems.
3. To develop applications for the provision of geospatial, telecommunications, timing and positioning products and services.

The strategy also provides the implementation framework for a national space programme that will be undertaken by the Space Agency. The Strategy is in effect an "implementation manual" for the National Space Policy, which was launched in 2009 by the Minister of Trade and Industry, and which provides high-level guidance for the development of the South African space arena.

SANSA's mandate is described as "Promoting the peaceful use of space, fostering international cooperation and creating an environment conducive to industrial development in space technology through research, human capital development, outreach programmes and infrastructure development."

The agency will act as a technology platform to grow the local space industry and to develop space applications programmes that support environmental and resource management, enhance society's health, safety and security and stimulate innovation, economic growth and social development to increase productivity and address social needs. The agency's activities will fall into six key focus areas:

1. Earth Observation;
2. Space Operations;
3. Space Science;
4. Space Engineering;
5. Human Capital Development; and
6. Science Advancement

The focus areas are the building blocks for creating a viable and effective space programme, as envisaged by the National Space Strategy.

SANSA will work closely with the science councils and the higher education sector to develop the requisite human capital to support the country's requirements and also to create and test technology platforms for the agency. This approach is envisioned in the National Space Policy and is intended to ensure that the national space programme is implemented through industry and the academic and research community to the greatest extent possible. In this regard, SANSA will play a coordinating and programme definition and management role and will not be a "closed shop" that plans, develops and executes space programmes internally, with little outside involvement.

SANSA will start operating as a public entity on 1 April 2011. On that date, SANSA will also acquire two entities. The Satellite Applications Centre, which has been one of South Africa's leading space institutions for the past 50 years, will be transferred from the Council for Scientific and Industrial Research to SANSA. The Hermanus Magnetic Observatory (HMO) will also be transferred from the National Research Foundation to SANSA. On Friday 10 December 2010, the day after the launch of SANSA, Minister Pandor officially opened the Space Weather Operations Centre at the Hermanus Magnetic Observatory. The HMO will in future lead the Space Science focus area of SANSA.

The Houwteq facility established near Grabouw in the Western Cape during the 1980s will also be used to support SANSA's programmes in future. Houwteq is a specialised satellite assembly, integration and test facility that was established by Denel in the 1980s to develop a low-orbit Earth observation satellite. The programme was terminated in the mid-1990s, before the satellite was launched. The facilities are currently operated by the Institute for Satellite and Software Applications (ISSA), a government facility managed by South Africa's Department of Communications.

On Wednesday the 2 February 2011, Dr Sandile Malinga was confirmed as the CEO of SANSA by Cabinet. With the head of the agency now appointed other positions in the agency are being filled. SANSA is being established in three phases. Phase 1, the Establishment Phase, runs from 1 of April 2010 to 31 March 2011. During this phase the basic governance structures are being established and arrangements are being made for the migration of entities to SANSA. Phase 2, the Foundational Operating Phase (1 April 2011 – 31 March 2012), will see the formal migration of institutions into SANSA and the implementation of foundational operational plans and procedures. This will be a period of "settling in" for the new agency. Operational plans and procedures may be modified, based on early operational experience gained during phases 1 and 2. Phase 3, the Full Operational Phase, will commence on 1 April 2012 and will define the steady state of SANSA operations.

Space activities are by their very nature global in character. Hence international cooperation is very well developed in the space area. SANSA lost no time in fast-tracking South Africa's role in international space activities. In the same function at which SANSA was officially launched by the Minister, the newly created agency signed agreements with Brazil's National Institute for Space Research (INPE) and China's Centre for Resources Satellite Data and Application (CRESDA) for direct reception and distribution of Earth observation data from the Sino-Brazilian CBERS-03 satellite on a cost-free basis to African countries. This was followed a few days later by an inter-agency agreement with the Algerian Space Agency (ASAL) to cooperate in space science and technology. Algeria, Kenya and Nigeria are partnering with South Africa to develop an African Resource Monitoring Satellite Constellation.

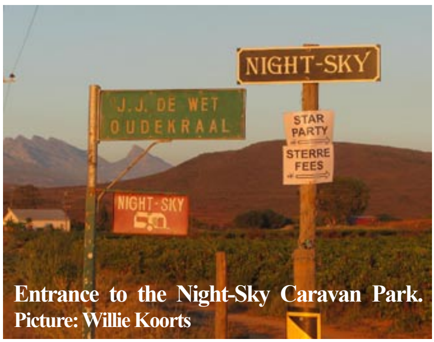
With the hosting of the International Astronautical Congress in Cape Town from 3-7 October 2011, SANSA will be in the international spotlight and will be the local host to all the world's space agencies. This will no doubt provide SANSA with many more opportunities for cooperation with other space agencies. ☆

the astronomical traveller

Birth of the Southern Star Party

The weekend of 4-6 March 2011 saw the birth of the Southern Star Party (SSP), held at a dark campsite on a farm between Bonnievale and McGregor in the Western Cape. A weekend filled with talks, workshops, demonstrations, stargazing, astrophotography and overall camaraderie was shared by 55 stargazers from as far as George and even Limpopo. Attendees' experience levels were a good mix, ranging from novice through to expert. Even though a number of valuable lessons were learnt, judging by the feedback received, the first ever Southern Star Party was generally regarded as a resounding success. Another SSP is already being planned for September this year.

It all started during the International Year of Astronomy in 2009 when Auke Slotegraaf and Martin Lyons attended the Karoo Star Party at Britstown. During the long drive there and back they were sharing their fantasies of Stellafane, the Winter Star Party, and the Texas Star Party. Back home, more discussions with a mutual friend, Edward Foster, followed. After sussing out a number of dark sites, by August 2010 it was settled that there would be a star party in the McGregor area. It is within two hours drive from Cape Town with very good skies. Edward and his wife, Lynnette, suggested the aptly-named 'Night Sky Caravan Park' outside Bonnievale, and a few night-time visits confirmed its suitability. It was realised that, due to the ignorance towards light pollution of your



Entrance to the Night-Sky Caravan Park. Picture: Willie Koorts

average camper, that the whole campsite needs to be booked out in order to control the lighting – to which the owner was agreeable under certain conditions.

By January 2011, Auke, Martin, Ed and Lynnette realised the daunting task of arranging an American-like star party, and decided to expand the organising committee further by inviting Willie Koorts and Suki Lock. Suki's husband, Kevin, soon got roped in as well. The first planning meeting was held on 21 January, followed by a visit to the Night Sky Campsite that weekend. An avalanche of emails later settled on the name "Southern Star Party", the program, accommodation arrangements, site layout, etc., eventually down to the last detail of what should be included in the info-pack at registration.

Acting as a social focal point towards which people would naturally gravitate, but also as a venue for presenting daytime talks, the idea of a "Social House" developed. Here campers would have access to a kitchen during the day, but more importantly stargazers would have a place to relax during the night while waiting for the next interesting object to rise. Stocked with coffee, tea, rusks, etc., the social house would be available for anyone needing a break at night, a place to share information or simply just to hang out. Its windows had been blacked out (to prevent light from interfering with ongoing observations) and had low red lighting so that you could check star charts and the like, while making re-dark adaption of your eyes quicker.

It soon became apparent that there was a lot to do. Besides designing a logo, setting up a website, advertising, planning talks, and coordinating schedules, sponsors had to be found as well as speakers and presenters. The latter turned out to be surprisingly easy, resulting in the program soon bursting out of its seams, so much so that a number of sessions had to run in parallel. The communal domain was therefore expanded to a shaded lecture area outside the social house which worked very well. The luxury of a wide range of talks, workshops and demonstrations could thus be offered.

(above) SSP organising committee; Kevin, Suki, Ed, Lynnette, Auke and Willie. (right) Suki at the Admin table. Picture: Auke Slotegraaf

More general talks ranged from "Astronomy for the Beginner" and "Fossils, Light and Time" to "Light Pollution and the GLOBE at Night". Almost at the last minute, it was suggested asking Johan Uys, laser-expert at the Department of Health, to give a brief talk. Johan explained the background to laser legislation, leading up to why you to need to register your powerful green laser. A number of talks focussed on astrophotography, spanning the full rage from beginner, intermediate to advanced levels, presented by Lucas Ferreira, Double-Star Section director and enthusiastic astrophotographer from George and Kos Coronaios from the Soutpansberg Astronomy Club, way up north in Louis Trichardt. The key-note address, presented by astrophotographer Dr Dieter Willasch, was titled "What Astrophotography teaches us about the Deep-sky", happened on Saturday night during peak attendance.

A range of demonstrations were given. Auke explained how to use two of his wonderful creations, the Southern Star Wheel, a multi-purpose planisphere and 'ConCards' (Constellation Cards), star-maps highlighting deep-sky objects worth searching for in every constellation. Ed Foster presented "Choosing and Using Binoculars for Astronomy". When asked in the feedback form what were the best ideas people learned the weekend, a response by someone who attended Ed's presentation was to test binoculars by defocusing them. Willie Koorts sussed out the optical specialists who recently fixed SALT's optics on the proper methods of "How to Clean your Telescope and Binoculars". On the ATM-

Picture: Kos Coronaios

Picture: Richard Ford

Talks, demonstrations and workshops, inside and outside of the Social House.

Pictures: Auke Slotgraaf

(above) Braai, (right) raffle winners (by W. Koorts) and (below) the Astro Pub Quiz in full swing (by Kos).

front, Johann Swanepoel explained the steps involved in creating his massive 20-inch Obsession-like Dobbie, the biggest scope at the SSP, in "Designing & Building a large Dobsonian". Auke also presented his "Deep Sky Observing Workshop" which was well attended.

A number of practical sessions were held at night. After Willie took party-goers on a tour of the night-sky, spiced up with some Greek and local star-lore, Kos went through the motions of the steps involved in astrophotography. A very well attended session was a Guided Binocular Tour of the sky, led by deep-sky guru, Auke Slotegraaf, where he pointed out some more familiar, but often some very obscure objects within the grasp of an ordinary pair of binoculars. One such example is the 'Dark Doodad' which was a good test for the SSP site's darkness, and found to be easily visible. An interesting alternative (better) name for it was suggested, when one imaginative person recognised it as a pair of lips! Judging by the comments on the returned feedback forms, this was one of the most popular sessions, enjoyed by novice and expert alike.

The Night Sky Campsite proved to be ideal, particularly when the weather played along. It is situated in a slight bowl, surrounded by low mountains, and is truly dark with no roads nearby to be bothered by car headlights. The worst light pollution came from nature itself, from a mountain fire, raging on a distant horizon. Accommodation options were grassy, shaded campsites as well as half a dozen wooden houses, yielding 24 beds all together, in a beautiful setting, overlooking a dam. A well grassed, central, open area, just begged to become the main telescope field. Since everybody bought in on strictly controlling the lighting, some folks set up their equipment right next to where they stayed. Part of the lighting-control was to offer ready coals for a communal braai every evening before it got dark, offering yet another opportunity for social interaction.

Another item that worked out very well with lively interaction and some good fun was the Astro Pub Quiz. Six teams of five people each had to answer sets of questions, mainly based on information from the *Sky Guide*. Competition was stiff and after the first round, first and second places were both tied by two teams each. After another round, the formidable "The Winning Team" (Wim Filmalter, Hans van der Merwe, Chris de Coning, Evan Knox-Davies and Richard Ford) tied against Willie Koorts' more social "Sterremanne-en Vroue" team who were leaning heavily on Willie's knowledge to answer some obscure questions at times. Prophetically, "The Winning Team" finally won a quick tie-breaker by one point and walked off with their prizes.

Special mention has to be made of the generous donations received. Oleg Toumilovich of FOTON Optoelectronics convinced Graham Lynch of G&L Agencies to donate an awesome prize – 20x80 Celestron binoculars mounted on Oleg's heavy-duty binocular mount worth about R5 000! Andrie van der Linde of Eridanus Optics also supported the SSP, as did the Soutpansberg Astronomy Club, SAASTA, and the SAAO. Various other prizes were awarded throughout the day; Roger Wyatt got a webcam (donated by Eridanus Optics) for his interest in astrophotography, Magi Sutherland got an astro-sketch board and Bella Clayton a pair of Newtonian Binoculars (latter two prizes donated by Martin Lyons). A raffle of a 5-inch equa-

(left) Astrophotographer Dr Dieter Willasch receiving his complementary SSP cup (picture by Auke) and delivering the key-note address (right – pic. by Willie).

Orion setting over the SSP telescope field. Picture: Willie Koorts

torially mounted Newtonian (donated by Ed and Auke), proved very popular. The delighted Eddy and Jonny Nijeboer who won the raffle, just started the hobby and brought along a similar telescope on appro, with the option to buy it if they liked it. Needless to say, they returned it after also receiving a telescope driving course, capably presented by Kos. The Nijeboer's first night's observing with their new toy was finally terminated by daybreak!

Apart from the comments received via the feedback forms, valuable lessons were learnt by the organisers. Unfortunately Auke's data projector did not survive an alternative 25 km dirt road he decided to take to get there, which almost ruined the talks, was it not for a second projector Ed brought. Faultfinding delayed events, resulting in a bit of a shaky start on Friday afternoon but luckily most people were still settling in. The social house proved very hot during the day, so a different venue for the multimedia talks will have to be found for next time. Alternatives were already discussed by the organisers during post-mortem discussions. And somehow the sale-table disappeared into the noise.

However, the overwhelming feedback was very positive with everyone who responded via the feedback form rated the SSP as "great" or better; 9 out of 17 called it "outstanding"! The organisers are thus very pleased about their first attempt at arranging a star party. Have a look at Auke's report and photo gallery on his website (www.psychohistorian.org). Full information and pictures are also on the SSP website (http://southernstarparty.wordpress .com) Keep an eye on it as details of the next event (probably around September) will appear there as it becomes available. Book early to avoid disappointment. ☆

Neptune turns One!

Case Rijsdijk

Neither Uranus[1] nor Neptune[2] are visible to the naked eye, and it was the advent of the telescope that made their discovery possible. Sir William Herschel, arguably the father of observational astronomy, discovered Uranus by accident, using his home-made telescope, on 13 March 1781. However the prediction of its position proved difficult, even taking into account the perturbations produced by the other known planets and by 1845 astronomers began to suspect that the answer to the problem was due to another planet orbiting beyond Uranus[3].

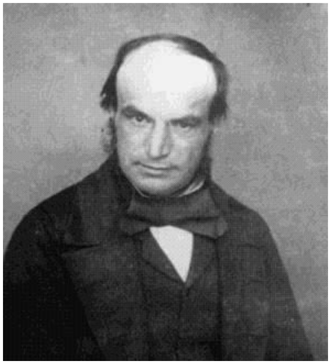
Sir William Herschel who discovered Uranus on 13 March 1781 with his own home made telescope.

Urbain LeVerrier in France and John Couch Adams in England began to try and calculate where this other planet would be. They solved the problem virtually simultaneously, with Adams being first. However, Johann Galle, an astronomer at the Berlin Observatory, was urged by Le Verrier, to look for the planet. Galle actually found the 8th magnitude planet on 23 September 1846, the night he received Le Verrier's letter! His position was only 1° out, whilst Adams' calculations showed the planet to be 12° from its discovery position.

Urbain Le Verrier who calculated the position of Neptune in 1846.

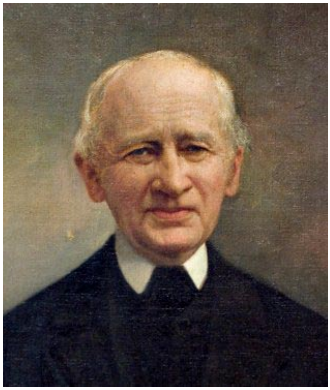
The naming of these planets is interesting. Herschel wanted to name Uranus *Georgius Sidus* or "George's Star" after King George III, but the nationalistic naming was unacceptable. The French were particularly in favour of the name *Le Verrier* and were prepared to rename Uranus as *Herschel* to achieve this! But eventually Uranus was decided on since Uranus was Saturn's father. Similarly Le Verrier wanted his discovery to be named after him and initially it was known as "the planet exterior to Uranus" or "Le Verrier's planet". Galle proposed *Janus* whilst Challis in England proposed *Oceanus*. On 29 December 1846 Otto Struve supported the name Neptune[4] and it became internationally accepted.

Of course even though Neptune's orbital details were now known, Uranus still refused to behave! A similar mathematical approach was used to try and find another planet beyond Neptune to explain its unpredictable behaviour. These calculations were completed in 1915, but the missing planet, Pluto, was not discovered until 23 January 1930, by Clyde Tombaugh.



John Couch Adams who also calculated the position of Neptune.

Oddly enough, Neptune was observed on several occasions before its discovery, but recorded as a star. From Galileo's notes it is evident that he did spot it on 28 December 1612 and 27 January 1613[5][6] when it appeared close to Jupiter (it was actually nearly in conjunction with Jupiter), but he recorded as a fixed star. In June 1846 Sir George Airy, the Astronomer Royal, persuaded James Challis to look for the missing planet after seeing that Le Verrier's results were very similar to those of Adams. Challis searched for it during August and September that year, without success. It was only later that he realized that he had actually observed it twice in August[7]!



Johann Gottfried Galle of the Berlin Observatory who discovered Neptune on 23 September 1846.

Full details of Neptune's orbit, mass, composition etc. are readily available from many sources[8] and it is now well known that its average distance from the Sun is about 4.5 billion km (~30.1 AU) and that its orbital period is about 164.79 years. This means that it will have completed one orbit around the Sun, since its discovery, on 12 July 2011[9], but because the Earth's relative position will not be the same as it was on 23 September 1846, Neptune will appear in a different part of the sky. Its next heliocentric birthday will be on 4 May 2176[9].

Acknowledgement
The author thanks Mr John Humphrey, of GRASSA (the Garden Route Centre of the ASSA) for pointing out that 2011 would be Neptune's 1st birthday.

Notes and References

[1] Uranus has a magnitude ranging from about 5.6 – 5.9, so is theoretically visible to the naked eye. However its lack of movement against the background stars means it was never discovered as a naked eye planet. Small telescopes reveal its disk confirming its planetary status.

[2] Neptune's magnitude ranges from 7.7 – 8.0 and is therefore never visible naked eye.

[3] James B Kaler (2006). *The Ever Changing Sky – a guide to the Celestial Sphere*. Cambridge

[4] Hind, J. R. (1847). Second report of proceedings in the Cambridge Observatory relating to the new Planet (Neptune).*AstronomischeNachrichten***25**: 309

[5] Hirschfeld, Alan (2001). *Parallax: The Race to Measure the Cosmos*. New York.

[6] http://articles.adsabs.harvard.edu/full/1997BaltA...6...97S

[7] Airy, G. B. (November 13, 1846). *"Account of some circumstances historically connected with the discovery of the planet exterior to Uranus"*. MNRAS**7**: 121–144.

[8] Munsell, K.; Smith, H.; Harvey, S. (November 13, 2007). *"Neptune: Facts & Figures"*. NASA

[9] Numbers generated using the Solar System Dynamics Group, Horizons On-Line Ephemeris System. *"Horizons Output for Neptune 2010–2011"* ☆

Yuri Gagarin - The Columbus of Space

Greg Roberts

Fig. 1 A portrait of Yuri Gagarin taken on 13 April 1961, the day after his epic journey into space.

After the launching of the first unmanned artificial Earth satellite SPUTNIK 1 in October 1957, the next logical step was to place a man in orbit about the Earth. There were no ground rules as to how this would be done as it was virgin territory. It was decided to recruit COSMONAUTS – the Russian equivalent of an ASTRONAUT – from the Soviet Air Force in late 1959 and twenty Air Force pilots between the ages of 25 to 35 were selected on 25 February, 1960.

Of the first 20, only 12 flew and eight never made it to space at all. Two were drummed out after a drunken brawl in a railway station, one committed suicide, another was injured in a centrifuge test when he was exposed to 8G. Another died from a brain haemorrhage. One of the twenty was Yuri Gagarin who only had 230 hours flying under his belt but was one of the most ambitious and determined.

Yuri was born on 9 March, 1934 into the family of a collective farmer in the Gzhatsk District, Smolensk Region, Russian Federation. In 1951 he graduated with honours from a vocational school in the town of Lyubertsy, near Moscow, receiving a Foundryman's certificate. Yuri simultaneously finished an evening secondary school. He then studied as an industrial technologist and graduated with honours in 1955. He attended a flying school in his private time and joined the Soviet Air Force as a fighter pilot in 1956. Because of his short height (1,52m) he had to put a cushion on the seat of his MiG-15 fighter. In 1957 he married Valentina, a graduate of the Orenburg Medical school and they had two daughters, Yelena and Galya.

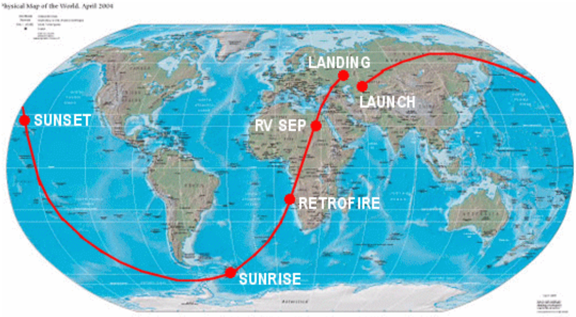
In 1959 he wrote to his superiors expressing his desire to become a Cosmonaut, if such a group existed, and was eventually selected on his 26th birthday in March 1960. In May 1960 six cosmonauts were selected to train for the first manned mission into space. The Chief Designer of the Soviet space program, Sergei Korolev, had long identified Gagarin as the brightest and most balanced of the team. Yuri had made it abundantly clear of his desire to be first and on 8 April 1961 this dream came true when he was chosen for the first flight.

Korolev requested permission for blastoff on 12 April. On this historic day a massive R-7 rocket lifted off from the launch site later named Baikonur in present Kazakhstan. The ICBM R-7 rocket was modified with an upper assembly that carried a heavy *bathysphere* type ball (Fig.5) inside which Gagarin was placed. The Vostok capsule was small and very cramped and the cosmonaut basically merely went along for the ride as it was preprogrammed and controlled from the ground. Gagarin's call-sign for this flight was KEDR.

Fig. 2 (left) Vostok 1 on top of the modified ICBM R-7 rocket, prior to launch on 12 April, 1961.

Fig. 3 Vostok 1 lift off!

Fig. 4 (below) The flight path of Vostok 1, carrying Yuri Gagarin on the first manned space flight.
Fig. 5 (right) VOSTOK 1, the "bathyscape" sphere that carried Gagarin into space – very cramped!



Liftoff took place at 06:06:59.7UT with the spacecraft heading north-eastwards. First stage separation took place about 2 minutes later, followed by second stage separation 3 minutes after that. Final separation of the spacecraft occurred at about 06:18UT. The rocket engine actually burned longer than intended and placed the craft in an orbit with a 327km apogee instead of the planned 230km. It reached the most northern part of its ground track and then headed southwards to cross the equator over mid-Pacific Ocean where it encountered sunset (at 06:42UT). He continued the flight towards the southern part of its orbit off the coast of South America. At about this time (06:59UT) Radio Moscow announced the flight was in progress. At 07:10UT the craft experienced sunrise as it headed towards the west-African coast where the braking engine ignition took place (07:25UT). The retrorocket failed to separate and burned away during the descent whilst above Egypt (07:35UT), about 10 minutes later than intended. The automatic backup system performed the separation when temperature sensors detected the rising heat of re-entry. Gagarin ejected from his capsule at an altitude of about 7km and parachuted to a safe landing, landing near Saratov at 07h55UT. The flight lasted 108 minutes and manned space flight had been achieved.

This caused a major shake-up in the United States when they realised that they had once again been beaten. President Kennedy is said to have said: "Just tell me how to catch up. Let's find somebody. Anybody. I don't care if the janitor over there has the answer, if he knows how."

After the flight Gagarin became a worldwide celebrity and visited many countries (Europe, America, Cuba, Britain and more) to promote the Soviet achievement.

The United States responded to Gagarin's Earth orbiting flight with the launch on 5 May of Alan Shepard when a Mercury capsule took him to an altitude of 180 km above the Florida coast in a 15 minute flight, but this was not enough and a favourite saying at the time was "Straight up and straight down!"

On 7 May Vice-President Johnson presented his Moon plans to President Kennedy who then presented it to a summoned special session of Congress and told them: "I believe that this nation should commit itself to achieving the goal, before the decade is out, of landing a man on the Moon and returning him safely to the Earth."

NASA then prepared a second mission to follow Alan Shepard and Virgil Grissom did another "straight up and straight down" to an altitude of 190 km but this time the Mercury capsule sank to the bottom of the sea as Grissom was rescued. This episode was referred to as "The unsinkable Molly Brown!" Getting a man into orbit was not that easy!

But, back to our hero Gagarin. He later worked on designs for a re-useable spacecraft and on 6 November, 1963 received the rank of Colonel in the Soviet Air Force. Officials tried to keep him away from any flights as they were afraid of losing their hero in an accident, however he was back-up pilot for the flight of Vladimir Komarov in the Soyuz 1 flight. Unfortunately the flight ended in a fatal crash on the 24 April,

Fig. 6 A MiG-15 UTI, similar to the one in which Yuri Gagarin was killed.

1967 and Komarov became the first man to die in a space mission. Gagarin was finally banned from training and participating in further spaceflights.

He was appointed deputy training director of the Star City Cosmonaut Training base and began to re-qualify as a fighter pilot. On 27 March, 1968 (aged 34 years) whilst on a routine training flight, he and flight instructor Vladimir Seryogin died in a MiG-15UTI crash. It was suspected that the accident was caused by a Su-11 "Fishpot-C" interceptor using its afterburners as it passed within 10 to 20 m of their craft while breaking the sound barrier. The resulting air turbulence caused them to lose control and crash. Two or three other reasons were put forward for the crash so there is some uncertainty as to exactly what went wrong.

Today the younger generation are virtually ignorant of the exciting early days of man's venture into space so it is fitting that on the 50th Anniversary of Gagarin's epoch flight that he is remembered. ☆

SALT Image Quality Fix

Lisa Crause

Following the inauguration of the Southern African Large Telescope (SALT) in late 2005, on-sky images revealed that all was not well... The telescope's image quality (IQ) specification was not met as stars showed a hideous variety of field-dependent aberrations and distortions. To add further insult, these mangled images appeared to be unstable as a function of time and most other parameters one could think of..

A comprehensive diagnostic effort ensued, with the goal of establishing whether the problem lay within the instruments (SALTICAM and/or the Robert Stobie Spectrograph, RSS), the primary mirror, or the complex secondary optics at the prime focus that make up the Spherical Aberration Corrector (SAC). This forensic investigation included further on-sky imaging, extensive modeling with optical design software, *in situ* optical testing and a variety of mechanical metrology exercises, all of which called for considerable patience, ingenuity and pain-staking attention to detail.

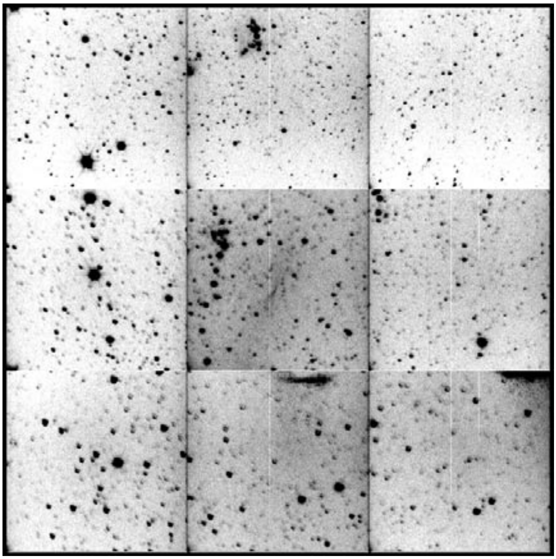


Fig. 1: September 2007 mosaic of the telescope's full field of view. These images were obtained with a bare CCD, so that only the primary mirror and SAC optics were involved. Ignore the stray light artifacts and scaling differences, but note the variations in the star profiles over the field (e.g. compare the top right and bottom left corners of the mosaic).

The daunting conclusion reached was that the SAC – the telescope's most complex and inaccessible sub-system – had to be responsible for the IQ crisis. The dominant effect was a severe focus gradient across the field of view, which could be simulated in optical models by introducing a huge (500 micron) misalignment or tilt (~0.1 degree), or a combination of these, between the top two SAC mirrors. While this alone could not account for all the strange features seen in the star images, it was at least a good place to start looking for more clues.

Dial gauges were installed within the SAC and used to monitor the mirrors while various tests were conducted. It became apparent that the interface ring that attaches the corrector to the non-rotating structure (NRS) of the payload was transmitting substantial forces into the SAC framework and hence perturbing the delicate mirrors. The reason for this was an unhealthy interface design which consisted of an aluminium ring attached to the carbon fibre shell of the NRS, to which the SAC's steel frame was bolted. The different thermal expansion coefficients of the steel and aluminium rings meant that the SAC was effectively being strangled by the unpredictable interface and hence the alignment of the mirrors had been compromised.

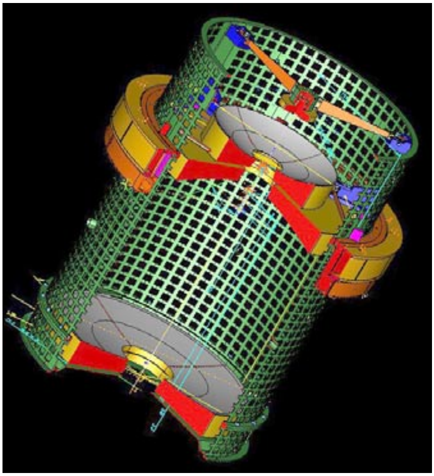


Fig. 2: A cut-away model of the SAC showing the four mirrors (from bottom to top: M3, M2, M5 and M4) attached to their steel cage support structure, as well as the replacement interface collars around the outside of the cage.

Having led the IQ campaign from the start, SAAO astronomer Darragh O'Donoghue then set about developing a detailed SAC repair plan. It was clear that the corrector would have to be brought down from the payload in order to address the interface issue, as well as re-align the four mirrors (known as M2, M3, M4 and M5 – M1 being the primary mirror) and to test absolutely everything. A clean-room was set up for this purpose, in the mirror segment coating facility beneath the telescope.

SAAO mechanical engineer James O'Connor led the efforts to design and produce a solution for the SAC/NRS interface. This took the form of a pair of collars, made of steel and aluminium, to attach to the SAC framework and the aluminium ring in the NRS, respectively. The two collars were then connected via a set of three bearing assemblies that would allow the two materials to expand and contract at their respective rates, without tormenting the SAC mirrors.

An impressive array of test equipment was acquired for the repair process. The list included a compact interferometer, a portable coordinate measurement machine (Faro Arm), an alignment telescope, a Shack-Hartmann wavefront camera and countless pieces of metrology gear and fixturing. The original null lens use to manufacture M2 was borrowed from the French company (SAGEM) that built the SAC and two custom-made optical elements known as Computer Generated Holograms

(CGHs) were obtained. To be able to trust and reliably interpret the results from these various tools, a great deal of time and effort had to be invested in characterising and understanding their performance and establishing their limitations.

The CGHs, designed at the University of Arizona's College of Optical Sciences and manufactured by a specialist in Russia, would be used to test M3's surface figure and to carry out the final system-test. These remarkable disks are made of the same ultra-low expansion glass as the SALT primary mirror segments (Astro Sitall) and each have in excess of 24 thousand, variably spaced and variable thickness chrome rings deposited upon their surfaces. The CGHs behave much like diffraction gratings and generate the same spherical aberration that would be present in light reaching the SAC from the primary mirror. This would allow testing of the optical alignment of the SAC before returning it to the tracker payload, and save us having to use impossibly cumbersome one metre diameter lenses and mirrors to generate the same input beam in the clean-room.

Having brought the SAC down from the tracker and installed the new interface collars, the entire contraption was transferred to a test rig and parked in the clean-room. The rig supported the SAC vertically, but also allowed it to be tested while tipped and tilted over its full operational envelope of 0 +/- 6 degrees in X and 37 +/- 6 degrees in Y. This was a critical improvement over the SAGEM effort, whereby the SAC was tested in the vertical, then tilted to 37 degrees, returned to the vertical and tested again. The clean-room would also allow testing over much of the telescope's operational temperature range.

The SAC had been up on the telescope for about six years and so the two upward-looking mirrors (M5 and M3) had accumulated a huge amount of dust and dirt. During the course of the alignment and testing, the necessary courage was summoned to remove and clean these two terrifying pieces of Zerodur. The mirrors were rinsed thoroughly with distilled water before wads of cotton wool soaked in a weak sodium lauryl sulphate solution were used to drag-wipe the optical surfaces. This was followed with extensive rinsing and then clean, dry air was used to herd away any remaining drops of water. The process was highly effective in restoring the reflectivity of these two mirrors.

M5 was also the first mirror to be tested, a process which required M4 to be removed. Since M5 is an ellipsoid, a point source (pinhole) placed at one of the mirror's foci produces a stigmatic image at the other focus. The wavefront camera was positioned so as to capture that image and provide a breakdown of the Zernike coefficients that describe the M5 wavefront. The surface figure of M5 was confirmed to be extremely good, with a RMS wavefront error of 0.046 waves (1 wave corresponds to the wavelength of the light used in the test, in our case, 633 nm for a HeNe laser). These results were also shown to be stable over the full range of temperatures and SAC attitudes.

M2 was used to define the coordinate system of the SAC (via the Faro Arm) and so it was never adjusted. M5 thus had to be aligned with respect to M2 and since these two mirrors are back-to-back, this could not be done optically. The two foci used in the M5 test (visible through the alignment telescope) marked the mirror's optical axis and so M5 could be adjusted in tip/tilt and decentre, with feedback from the Faro, until it was lined up with the optical axis of M2. Simple enough in principle, but a huge challenge to achieve!

In the meantime, M4 was integrated into a new mount that would allow this small, convex mirror to be detached and replaced in a repeatable way during the final system-test. Having aligned M5 to M2, next it was M4's turn to be aligned with M5, using a wavefront test. Along the way, Darragh developed a cunning new technique of balancing one of the astigmatism Zernikes (values obtained from the wavefront camera) in order to establish the appropriate decentre and tip/tilt for M4. Since M5's surface figure had been verified previously, the excellent result obtained for the M4/M5 pair (a RMS wavefront error of 0.037 waves) confirmed M4's good health.

M3 had to be removed to allow access to M2 for the null test that would check the mirror's surface figure. The original null lens used to figure M2 was borrowed for this purpose and installed in a custom-made frame that also supported the interferometer and fold mirror appropriately. This proved to be another epic alignment challenge, but again the results were extremely encouraging as M2's RMS wavefront error was just 0.040 waves.

Having completed the M2 null test and cleaned M3, the larger of the CGHs could be installed (mounted on a 5-axis stage assembly that located within the hole in M3) and M3 re-attached. After aligning the

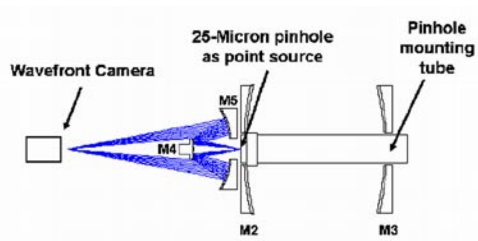


Fig. 3: The optical layout of the M4/M5 wavefront test. A pinhole positioned below the hole in M5 illuminates M4 and then M5 before forming an image on the wavefront camera.

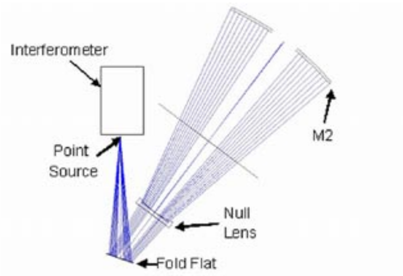


Fig. 4: The optical layout of the M2 null test. A diverging beam of laser light from the interferometer is directed through the M2 null lens (via a fold mirror) to M2 and then gets reflected back to the interferometer to produce fringes.

CGH, the system could be used to adjust M3 in tip/tilt and decentre to get it aligned with the rest of the SAC mirrors. This test verified the figure of M3, the most complex of the four mirrors – a general asphere with an aspheric departure of 1.5 mm. While it was fantastic news to confirm that all four mirrors are properly figured, this result eliminated one of the few remaining excuses for the inexplicable symptoms of the IQ problem, namely image-doubling and other strange deformations that could not be attributed to the original interface problem. The risk of incomplete diagnosis plagued us throughout the SAC repair process and seemed destined to catch up with us eventually…

The final alignment of M3 had to be done with the small CGH, which could be installed and removed through the hole in M3 and hence without disturbing the mirror. The RMS wavefront error for the system-test was a highly respectable 0.145 waves and so we felt reasonably confident that the main problem, the focus gradient, had been resolved.

Having completed all the alignment and testing in the clean-room, some additional baffles were installed and all the tie rods for adjusting the mirrors were locked in place with epoxy. The SAC, with its new collars, was then re-installed on the tracker on 10 August 2010, almost 16 months after being brought down for the repair.

Careful alignment of the SAC with the payload, primary mirror and the stage assembly carrying the CCD camera to be used for the on-sky testing took another week. The first images were obtained in poor seeing (>2.5 arcsec) and although the stars looked uniform over the full field, all that Darragh could say with any degree of confidence was "At least we haven't made things worse!".

The wait for better seeing was agonising and what we then found was quite horrifying. Although the star profiles were uniform over the whole field (the focus gradient was indeed gone), the image quality varied on timescales of seconds! Fortunately we realised that such instability could not arise within the SAC, or the primary mirror, and so the issue had to be related to the tracker somehow. The culprit turned out to be the auto-collimator, an instrument attached to the payload to provide feedback for keeping the SAC orientated perpendicular to the primary. Its mount was made more stable and then attached to the SAC's steel collar, instead of the NRS, and this

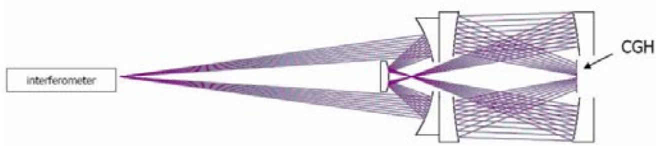


Fig. 5: The optical layout for the CGH system-test. A diverging beam of laser light from the interferometer reflects off M5, then M4, then M3, then M2 and lastly the CGH, before reversing its path and re-entering the interferometer to produce fringes.

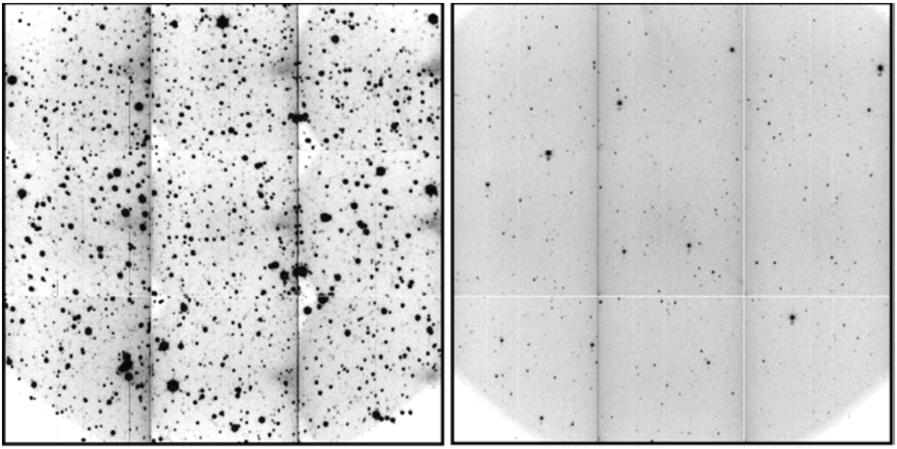


Fig. 6: On-sky images were obtained in poor seeing and the auto-collimator was found to be unstable, but at least the focus gradient was gone (left). Good seeing after having fixed the auto-collimator yielded 1.1 arcsec stars over the full field of the telescope (right).

made all the difference. The dreaded doubled-images had finally been explained.

On the IQ Team's scheduled last night in Sutherland (28 August 2010), the sky finally relented and we got wonderful seeing. The primary was re-stacked and SALT's best image to date was obtained – stable 1.1 arcsec stars over the entire field! Upon close inspection, one can see (Fig. 6, right) a very small amount of vertical elongation in all the stars, indicating some residual astigmatism which has to arise within the primary mirror. Subsequent efforts established the innocence of the mirror alignment instrument and point to this quirk being related to the alignment software.

The figures overleaf (from Darragh's last IQ report to the SALT Board) quantitatively summarise the "before" (Fig. 7) and "after" (Fig. 8) measurements. The tiled frames (Fig. 1 and the right-hand image in Fig. 6) were run through IRAF's SExtractor source extraction software, which is usually used to measure image parameters of asymmetric galaxies. The software outputs a catalog of objects from the input image with parameters such as full width at half maximum (FWHM), ellipticity, and position angle of the ellipticity.

The top left panel shows the FWHM plotted as a function of pixel on the CCD and the right panel shows the FWHM vs distance from the centre of the detector. The histograms show the FWHM, ellipticity (labeled eccentricity) and position angle of the ellipticity for all the objects in the catalog.

By systematically attacking the various problems in the right order, it was possible to resolve what had initially looked to be an impossible mess. The invaluable experience gained during the course of the IQ fix will stand us, and the telescope, in good stead as SALT proceeds toward full science operations.

Anyone interested in more detailed information about the SAC repair process can visit the photo-rich SALT IQ Blog (http://saltiqmission.blogspot.com), while the current status of the telescope is updated regularly on the SALT Astronomy Blog (http://saltastro.blogspot.com). ☆

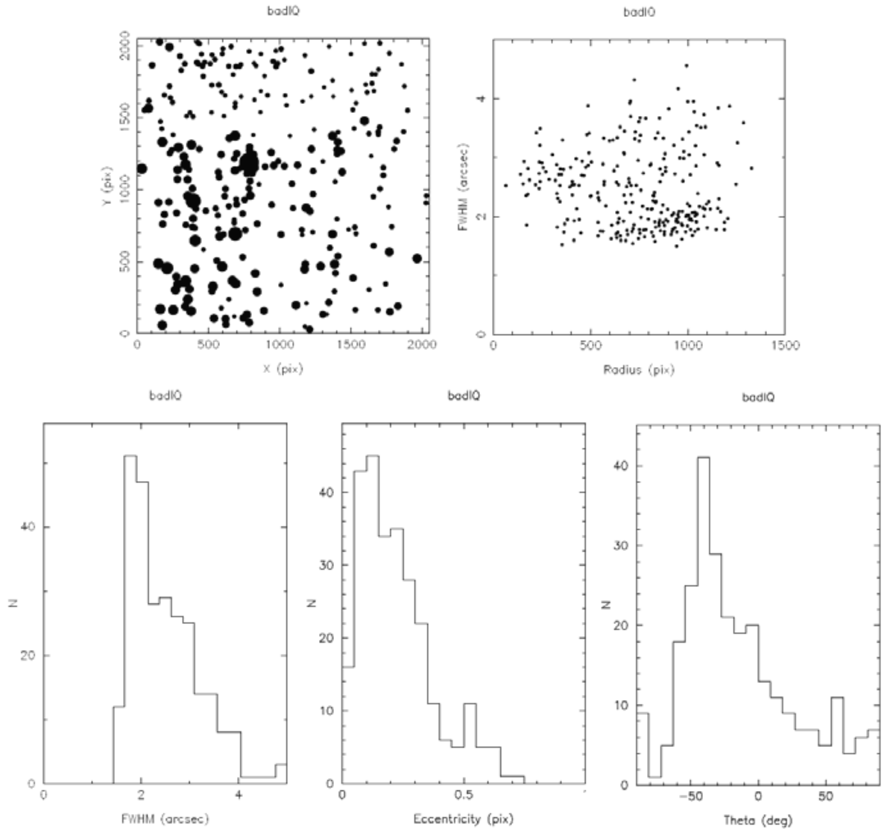


Fig. 7: These results from the September 2007 image (see Fig. 1) clearly show the focus gradient. Much larger stars are seen in the lower left of the frame than in the upper right, the variation of FWHM with distance from the centre of the detector is anything but flat, the stars have significant ellipticities with a large spread in them and the ellipticity has a preferred direction (-40 degrees).

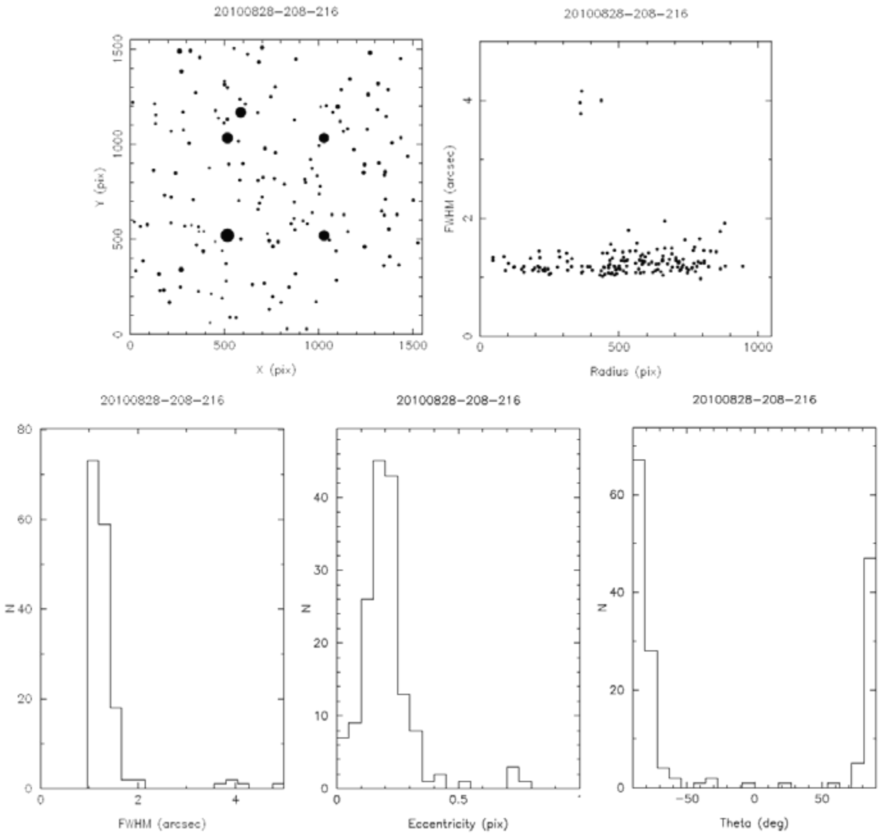


Fig. 8: These plots are derived from the right-hand image in Fig. 6. This was the best IQ seen so far: obtained in good seeing, having fixed the SAC and auto-collimator and with a freshly stacked primary mirror. The focus gradient is clearly gone as the stars are uniform over the whole field. The small, uniform ellipticity, orientated at + and – 90 degrees, is due to some residual astigmatism in the primary mirror.

Stardust-NExT mission success

Willie Koorts

Contrary to the present day disposable era we live in, Stardust-NExT was the second time that a spacecraft had been reused for a second mission, saving as much as 90% of the cost of a new mission. The first occurrence was when the original Deep Impact craft was redeployed as the EPOXI mission as was reported in *MNASSA* 68, 7&8, August 2009, p.129. It was this very same Deep Impact spacecraft which flew past Comet Tempel 1 on Independence Day (4 July) 2005, releasing a 370kg copper slug onto the comet's surface, taking data and pictures as if flew past, supplemented by Earth-bound observations. Due to the dust kicked up by the impactor, it was not possible to see the resultant crater, nor the effects it had on the comet surface.

In the meantime, the Stardust mission did its flyby of Comet Wild 2, collected dust samples and returned it to Earth, concluding its mission. With this spacecraft still in perfect health and with enough spare propellant to manoeuvre, the idea of reusing it to do another fly past of Comet Tempel 1 was investigated. Stardust is ideally suited for this task since the spacecraft is fitted with a tracking mirror and dust sensors to gather valuable data on the immediate environment around the comet. This would be the first time that a second flyby of the same comet would be done. Three main science objectives of Stardust-NExT (**N**ew **Ex**ploration of **T**empel) were to image the same region of the comet as seen by Deep Impact, now

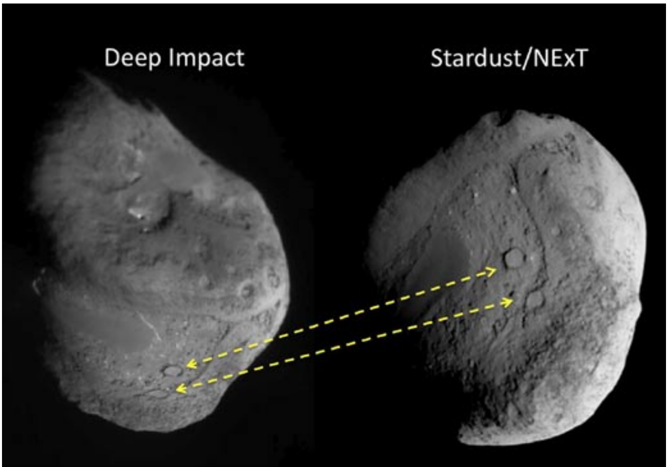
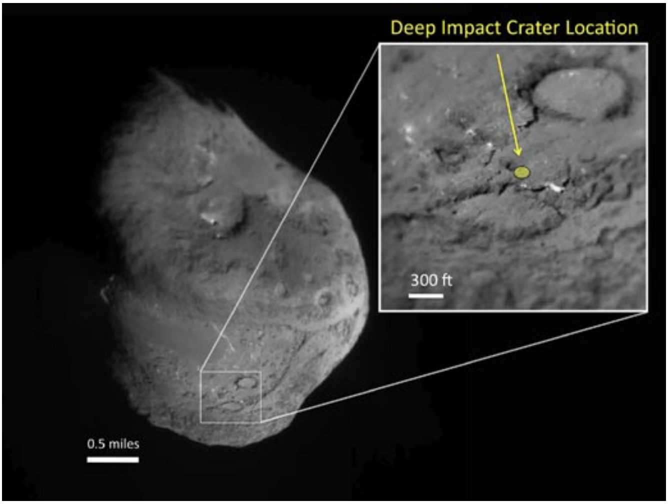


Image credit: NASA/JPL-Caltech/University of Maryland/Cornell

These two images show the different views of comet Tempel 1 seen by NASA's Deep Impact spacecraft (left) and NASA's Stardust spacecraft (right). Two craters, about 300 meters in diameter, help scientists locate the area hit by the impactor released by Deep Impact in July 2005. The dashed lines correlate the features.



This image shows the area where scientists predicted an impactor released from NASA's Deep Impact spacecraft in July 2005 would hit the surface of comet Tempel 1.

Image credit: NASA/JPL-Caltech/University of Maryland/Cornell

5½ years later, for comparison. Also to try and view the crater left behind by the impact which will tell us a lot about the makeup of the cometary material, and lastly, to image new territory on the comet's surface.

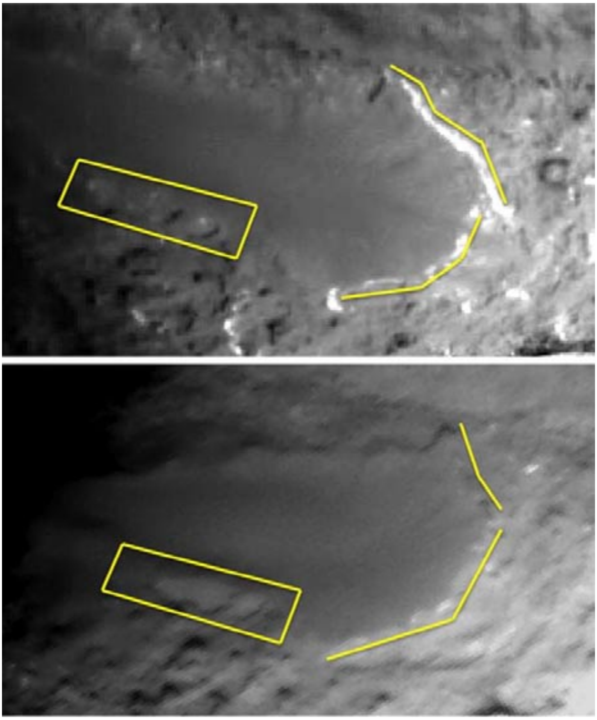
To achieve the first two goals, some very precise timing was required. It meant that the arrival of the craft at the comet must be exactly synchronised with its 42 hour rotational period, such that the correct face is presented to the spacecraft. The comet's rotation was studied in very fine detail over the past few years by an international effort to finally achieve an accuracy of ±1° of latitude.

The encounter finally happened on Valentine's Day (14 February) 2011. With the spacecraft approaching the comet at a relative speed of nearly 40 000 km/h, skimming past at a distance of 178 km, a total of 72 images were captured as well as 3Mbytes of dust data. The craft then turned its antennae towards Earth and spent the next 12 hours downloading the 78Mbyes of data and pictures. It was programmed to first send the most spectacular images, particularly those of closest approach, but somehow this request was ignored and the images came down in the order in which they were taken. This tested mission controllers and the crowd of anxious scientists' curiosity a little longer but at least no data was lost. The craft then turned its gaze back to Comet Tempel 1 to capture a series of outbound images.

There were huge smiles and great delight all round as the images showed surface features that changed in areas previously seen during the 2005 Deep Impact mission. Erosion on the scale of 20 to 30 m had occurred in the more than five years between missions. Other areas seen for the first time appear to show layers of material that have been deposited as erupting volatile subsurface gas brought small dust and ice particles to the surface. Several of the images provided tantalizing clues to the result of the Deep Impact mission's collision with Tempel 1. Although subtle, a 150m diameter crater left by the impactor is visible, complete with a small mound in the centre, as some of the ejecta went up and came straight down again (see cover picture). Useful information on the consistency of the material making up the comet's nucleus can be deduced from this. Consistent with cometary models, it is rather fragile and weak.

Engineering telemetry downlinked after closest approach indicates the spacecraft flew through waves of disintegrating cometary particles including a dozen impacts that penetrated more than one layer of its protective shielding. Instead of having a little stream of uniform particles coming out, they apparently came out in chunks and crumbled.

The mission of reusing the 12-year old spacecraft was declared 100% successful, achieving all its science objectives. In fact, it is still fully operational after being put through the ordeal of two close cometary encounters. ☆



This image layout depicts changes in the surface of comet Tempel 1, observed first by NASA's Deep Impact Mission in 2005 (top) and again by NASA's Stardust-NExT mission on 14 Feb. 2011 (bottom). The smooth terrain is at a higher elevation than the more textured surface around it. Scientists think that cliffs, illustrated with lines to the right, are being eroded back by as much as 20 to 30 metres. The box shows depressions that have merged together during the past 5½ years, due to erosion from volatile evaporations. Image credit: NASA/JPL-Caltech/University of Maryland/Cornell

Astronomical Colloquia

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

The following colloquia were presented at the SAAO and NASSP since 1 January 2011. All future colloquia will be recorded in *MNASSA*.

1. At the SAAO

Title: **Multiple Stellar Systems**
Speaker: Petr Zasche, Charles University, Prague, Czech Republic.
Venue: SAAO Auditorium
Date: 20 January, 2011

Abstract: Stellar populations comprise a large fraction of binaries. The systems of higher multiplicity forms also a majority among the binaries, therefore a study of such systems brings us an important information about the stars in general. The combined analysis of all available means - photometry, spectroscopy, and interferometry could reveal some of the interesting and hidden properties of such systems.

Title: **Asteroseismology with Kepler and SONG**
Speaker: Jørgen Christensen-Dalsgaard, Department of Physics and Astronomy, Aarhus University, Denmark
Venue: SAAO Auditorium
Date: 27 January, 2011

Abstract: The NASA Kepler mission was designed to characterise extra-solar planetary systems but the observing technique, photometric detection of transits, makes the mission ideally suited also for asteroseismology. Since the launch of the mission in March 2009 Kepler has provided a treasure trove of asteroseismic data and data on other types of stellar variability. I provide a short overview of the mission and present some of the results. In addition, I briefly discuss the next step in observational asteroseismology: the SONG network which is designed to make ground-based velocity observations of stellar oscillations, and detect exoplanets from gravitational microlensing, from 7 - 8 nodes suitably distributed around the world.

Title: **Matching stellar envelope models to ATLAS9 atmospheres for A-stars**
Speaker: Zolile Mguda, UCT
Venue: SAAO Auditorium
Date: 3 March, 2011

Abstract: The 20th century has seen a steady improvement in our knowledge of stellar astrophysics and no shortage of observations with which we can compare our models. The certainty with which characteristics of stars such as the radius have been measured has been dependent on our observations of binary systems and other photometric measurements which in turn depend on the precision of our instruments. With the improvement of those instruments has come better quality data with which we can test our theoretical measurements.

Asteroseismology has succeeded in using information from stellar oscillations to infer the internal structure of stars. The value that it brings in the study of stellar interiors has been that it is based on light variations which can be measured quite accurately. The theoretical framework for interpreting stellar oscillations has advanced to the stage where these interpretations have been compared very favourably with observations.

In this talk we will use ATLAS9 model atmospheres, OPAL opacity and OPAL (EOS) tables to create A-star models which can be readily compared with observations. Both of these tools have already been in use for decades and have already been compared successfully with observations by way of synthetic spectra and helioseismology models. We compare our work with existing models for validation and we find that the techniques we have used yield results that compare very favourably with existing models.

2. At NASSP

Title: **Frontiers in Classical Gravity**
Speaker: Mr Aaron Zimmerman, Caltech and Stellenbosch.
Venue: RW James C
Date: Wednesday, 2 March 2011

Abstract: The past decade has brought about many exciting developments in the field of General Relativity. Large scale experiments make the direct detection of gravitational waves likely within the next decade, and numerical methods have allowed researches to probe strong, dynamical, nonlinear gravity for the first time. I will give an overview of the current state of modern research in classical General Relativity, aimed at informing students about possible research directions relating to this field. ☆

The Flying Star-Dove

by Magda Streicher
magdalena@mweb.co.za

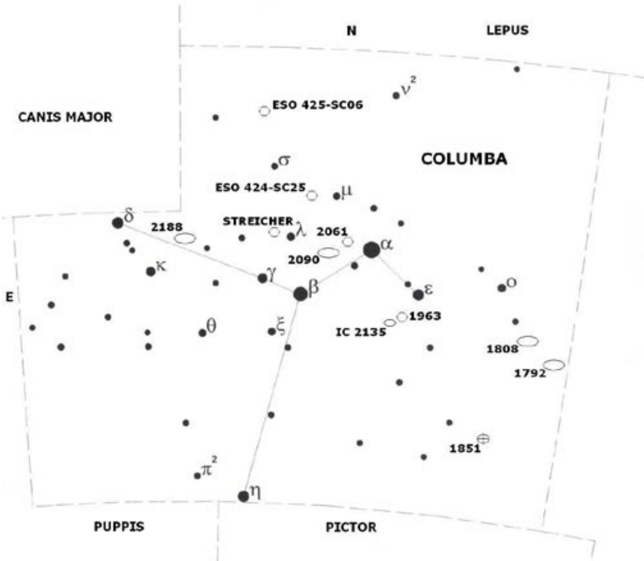
Image source: Stellarium.org

Columba the Dove, a small southern starry constellation of only 270 square degrees, is one that has many tales woven around it. The original name for this constellation was Columba Noae or Noah's Dove, with the starry bird appearing to be flying just off the compass of Jason's ship, the combined constellations of Vela, Carina, Puppis and Pyxis. The constellation appeared correctly on Bayer's plate of Canis Major but was formally published by Augustin Royer in 1679. According to ancient tales the starry dove was being sent out by Jason to search for dry land in the hope of bringing back the branch and leaf of an olive tree.

If we look at earthly doves and pigeons, there are quite a variety of different species all over the world. The million dollar question is which one inspired Bayer and the French astronomer Royer to create the constellation Columba. I would guess the most likely would be our plain garden dove, the Feral Columba Livia, or perhaps the Cape Turtle Dove. It is believed that this dove was once a tamed bird originally from North Africa and Europe (*Newman's Birds of South Africa*). Or to speculate further: Could it perhaps have been the speckled Columba Guinea, also known as the rock dove, known for its outstanding red eyes and speckled feathers? Then there is the so-called laughing dove that sings its storybook songs of love. Or wait a minute ... our starry Columba could possibly be named after the so-called carrier pigeon, used to convey mail, bringing good hope.

Fig. 1 Speckled Pigeon Columba Guinea chosen because of the star-like markings on its feathers.

Among the feathers of Columba can be seen one of the most beautiful deep-sky objects, **NGC 1851**, a rich globular cluster which is certainly not shy about displaying its outstanding qualities. Modern constellation reform moved NGC 1851 from the constellation Caelum into Columba. NGC 1851 is a large, compact and bright globular cluster situated below the dove's tail feathers in the far south-



western part of the constellation. The stars in this beautiful globular cluster, also known as Bennett 32 and Dunlop 508, extend unusually far into the field of view. The focus of this object hosts a very compact, small, hazy, unresolved core that gives the viewer the feeling of looking through frosted glass. A soft halo expands further out from the core, covering about two-thirds of the whole. A multitude of faint stars appear to burst outwards and work their way outwards to the outer edge, which is most interesting and displays splashes of faint star strings at random. One such, cuts through the southern edge of the globular (see sketch and picture by Lucas Ferreira). This globular reminded the author of a smaller version

Fig. 2 NGC 1851 picture, taken by Lucas Ferreira. By comparing this with Fig. 3, the pearl-like string of stars can be readily seen.

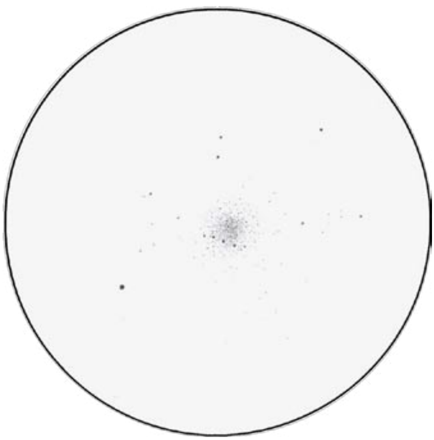


Fig. 3 The author's sketch of globular cluster NGC 1851 in which the stars referred to in Fig. 2 are clearly visible.

of the famous globular cluster NGC 104 situated in the constellation Tucana. Australian friend and astronomy working partner Jenni Kay has observed the globular through her 8x50 binoculars and sees it as a very bright, large, round glow with a brighter compact core. The late Walter Scott wrote that this ball of stars is quite bright and must be a fine sight from the southern hemisphere. According to well-known amateur Steve Coe, using averted vision makes this globular cluster appear much larger. Steve Gottlieb notes: "A good deal of resolution is evident in this globular, brightens evenly and then near centre steep to an almost stellar pip."

The constellation is not abundantly endowed with deep-sky objects, and even then most of them are fairly faint. However, a thorough search has revealed some very special objects that have produced some unexpected surprises.

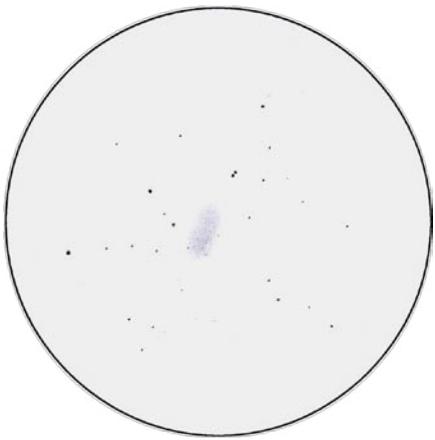


Fig. 4 NGC 1792 a cigar-shaped galaxy, also known as Bennet 29.

The galaxy **NGC 1792** is situated up against the western boundary between Columba and Caelum, about halfway between NGC 1851 and the double star gamma Caelum, is located literally on the imaginary line separating the two constellations. NGC 1792, appears as a beautiful oval glow, elongated in a north-west to south-east direction and seen quite well against an outstanding star field. The galaxy displays an even surface brightness with a soft, wool-like outer edge, which at higher magnification appears extended. The northern edge is slightly hazier and a few faint stars can be seen close to the western side (see sketch). This cigar-shaped galaxy, also known as Bennett 29, is a close neighbour of NGC 1808 situated 36 arc minutes to the north-east.

NGC 1808 is an outstandingly bright, barred spiral galaxy in a north-west to south-east direction, with a brightness that is uniform across the surface. Higher magnification reveals a somewhat rougher texture with mottled areas and a few brighter patches randomly seen on its surface. With careful observation the nucleus brightens rapidly to a small, compact light-point. With careful observation there also appears to be a flimsy outer envelope around the galaxy. South of the galaxy is a chain of magnitude 10 stars in a line almost east to west. The galaxy is, in fact, a somewhat abnormal galaxy, displaying nuclear hot spots and starburst activity rather reminiscent of the galaxy M82 in the constellation Ursa

Mayor. NGC 1808 is also known as Bennett 31 and Dunlop 549 and is included in the Arp and Madore's Catalogue of Southern Peculiar Galaxies and Associations.

Credit for the discovery of this peculiar galaxy has historically gone to the Scottish astronomer James Dunlop. Dunlop was born on 31 October 1793 at Dalry near Glasgow, and 33 years later found himself in Australia at the eyepiece of a 9-inch f/12 reflector searching the southern sky for nebulae and clusters. He produced a catalogue of 629 objects for the southern hemisphere.

The magnitude 3.8 epsilon Columbae, could possibly be said to indicate the beak of the heavenly dove, situated on the northern edge of the cluster **NGC 1963** (*New General Catalogue*), it is an outstanding group with a slightly confusing or controversial identification. John Herschel, who discovered the object, described it as a cluster of various magnitude stars, arranged almost exactly like a bow. Brighter stars representing the bow and another few distinct stars forming the tip of the V-shaped arrow point (see sketch). The galaxy **IC 2135/6** (*Index Catalogue*) is the indicated as the controversial object situated on the eastern tip of the star group. The galaxy displays a small soft ray of light in a north-west to south-east direction.

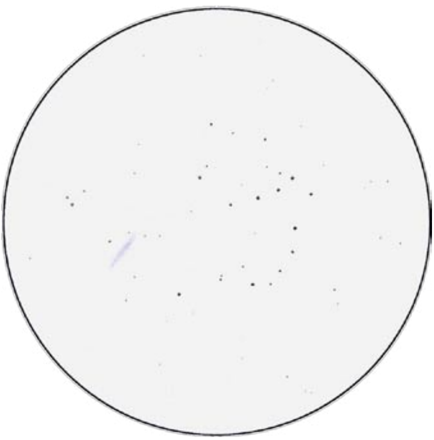


Fig. 5 The small open cluster NGC 1963, discovered by John Herschel, which is often confused with the galaxy IC21356.

Auke Slotegraaf says he does not know who originally described IC 2135/6 as NGC 1963. Initially, the thought was that such an object might have formed part of the Revised NGC Catalogue. The coordinates are roughly the same, but NGC 1963 is obviously a cluster according to the description given by John Herschel.

The first ESO/Uppsala survey of the ESO (European Southern Observatory) atlas indicated NGC 1963 to be a cluster. The Reference Catalogue of Galaxies did not list NGC 1963 at all. The Principal Galaxy Catalogue noted an object labelled PGC 17433 also as IC 2135, IC 2136, NGC 1963 and ESO 363-G to be the same object. The Second Catalogue ESO 363-G7 noted IC 2135 and IC 2136 as the same object, according to the astronomer Lewis Swift's inscription. Swift, who was well acquainted with Herschel's work, was looking for new objects that

Herschel had overlooked. Swift therefore would have known NGC 1963 as a cluster and not a galaxy.

Whatever the case may be, it is inappropriate to allocate the number NGC 1963 to the galaxy, as it is obvious what Herschel saw and described. The coordinates of the magnitude 13 galaxy (IC 2135/6) are RA 5h33m12.7 and DEC –36°23’59” and it is situated 12 arc minutes towards the east of the cluster NGC 1963.

The brilliant white-blue magnitude 2.6 alpha Columbae, which could be seen as the eye of the starry dove, is situated just 38 arc minutes to the west of the open cluster **NGC 2061**. The cluster, listed as a doubtful object, displays a loose irregular grouping of stars. The brighter magnitude 7.2 (HD 38253 – *Henry Draper Catalogue*) star, is situated on the far northern edge of the grouping, which also has a magnitude 11.6 companion towards the west. The eastern side is less busy with star-light.

Another relatively faint galaxy, **NGC 2090**, is situated 50 arc minutes further east of NGC 2061 and displays an extended spindle shape in a north-south direction. The galaxy displays a barely brighter centre. Although faint it can be detected with careful observation, dark skies and high magnification. This object has also been listed as Dunlop 594.

Another possible **STREICHER** asterism is situated only 20 arc minutes east of magnitude 4.8 lambda Columbae, but which has not yet been confirmed by the *Deep-sky Hunters Catalogue*. Seven magnitude 9 stars in a half square shape with the open end towards the east. This grouping is quite outstanding against the background star field.

The European Southern Observatory (ESO) is situated on the eastern slope of the La Silla mountains in Chile, close to the Atacama Desert, high up into the Andes Mountains. The magnitude 4.8 lambda and magnitude 5 mu Columbae stars are situated just north of alpha Columbae, the stepping stones to one such numbered ESO cluster. The various ESO clusters are in a class of their own and could be most aptly described as obscure. Stars in small groupings and strings read like a book full of surprises. Although

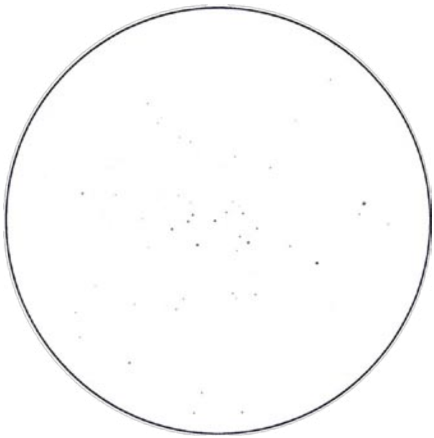


Fig. 6 The small open cluster ESO 424SC25 contains about 10 stars of the same magnitude.

these are not necessarily bright objects, they do have certain exceptional and unique characteristics and each one can be described as special. The cluster **ESO 424-SC25** is a lovely group of approximately ten stars ranging from magnitude 10 to magnitude 11. It is a very pleasing grouping showing a true arrowhead pointing east with a sling of faint stars curling away to the west (see sketch). What is special about this group is that most of the stars display a yellow to orange colour. The brightest star, situated at the southern end of the group, is magnitude 9.4 (TYC 7061915 – *Tycho-2 Catalogue*). The field stars are slightly brighter than the cluster itself.

Another **ESO 425-SC06** cluster can be found in the far north-east of the constellation barely 1.5 degrees west of the constellation Canis Major. A small string of four magnitude 12 stars in a north-south direction is slightly bent towards the east with the brighter magnitude 10.4 (TYC 6504813) star situated on the eastern end of the grouping. High magnification brings fainter stars to the fore which sprays out towards the west (see sketch). Not much of a cluster and very difficult to discern among the stars in the field.

In the author's "visualisation" of the constellation, the dove's fantail would be represented by the magnitude 3.8 delta Columbae. The galaxy **NGC 2188** appears to be riding on the back of the starry dove 2.5 degrees south-west of delta Columbae. The galaxy displays a beautiful elongated spindle in a north to south direction. The southern edge looks wider and more defined, whereas the northern part becomes fainter and thinner. The nucleus of this galaxy is obscured in the hazy surface, making it difficult to see. The brightest star in the field is a magnitude 8.1 star situated just south-west of the galaxy in a busy star field. In some ways this object reminds me of a very faint comet, and deep pictures show a little kink towards the southern tip of the galaxy.

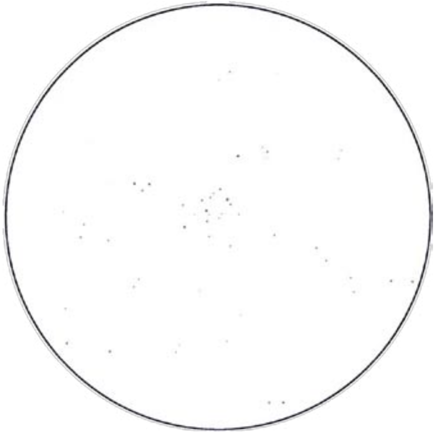


Fig. 7 This small open cluster, ESO 425SC06, has four bright stars with a string of fainter stars to the west.

While it may be difficult to find bird shapes among the stars, the ordinary dove is no stranger to local gardens. Little wonder, then, that an image of the common dove has found a place among the stars.

Object	Type	RA (J2000.0) Dec		Mag	Size
NGC 1792	Galaxy	05^{h}05.2	-37°59′	9.9	5.5′x2.5′
NGC 1808	Galaxy	05 07.7	-37 31	9.9	5.2′x2.3′
NGC 1851	Globular Cluster	05 14.1	-40 03	7.2	11′
NGC 1963	Open Cluster	05 32.1	-36 23	11	14′
IC 2135/6	Galaxy	05 33.2	-36 24	13	2.8′x0.6′
NGC 2061	Open Cluster	05 44.1	-33 56	11	10′
NGC 2090	Galaxy	05 47.1	-34 14	11	4.5′x2.3′
ESO 424-SC25	Open Cluster	05 49.8	-32 28	10.5	8′
ESO 425-SC06	Open Cluster	06 04.8	-29 11	12	5′
STREICHER	Asterism	05 54.7	-33 47	9	18′
NGC 2188	Galaxy	06 10.1	-34 07	11.6	5.5′x1.0′

Α	α	alpha	Ν	ν	nu
Β	β	beta	Ξ	ξ	xi
Γ	γ	gamma	Ο	ο	omicron
Δ	δ	delta	Π	π	pi
Ε	ε	epsilon	Ρ	ρ	rho
Ζ	ζ	zeta	Σ	σ	rho
Η	η	eta	Τ	τ	tau
Θ	θ	theta	Υ	υ	upsilon
Ι	ι	iota	Φ	φ	phi
Κ	κ	kappa	Χ	χ	chi
Λ	λ	lambda	Ψ	ψ	psi
Μ	μ	mu	Ω	ω	omega

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 journal, the *Monthly Notes of the Astronomical Society of Southern Africa (MNASSA)* (bimonthly) and an annual astronomical handbook, *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. Entrance fees are R25. Full members paying R100 per annum receive *MNASSA* and the *Sky Guide*. The subscription year runs from 1 July to 30 June. Persons joining during January to June need to pay only half the annual subscription, plus the entrance fee.

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.

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