The Future of Astronomy in South Africa

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1. Introduction

What I want to address tonight is why a country like South Africa should be involved in astronomy. What benefit can it possibly bring to the man in the street; what relevance does it have to the New South Africa?

In the near future I expect that there will be a debate in Parliament on the need for National Research Facilities in SA, such as the SAAO and HartRAO. This debate will not take the form of a debate by the whole of Parliament but rather by the Parliamentary Select Committee on Science and Technology. Such facilities are seen as "white, pre-democracy" facilities – do such facilities have relevance in the New South Africa? Parliament is entitled to ask these questions as these facilities are funded by public money. Tonight I would like to answer this question and demonstrate why such facilities are of importance and relevance to South Africa.

What I say will be aimed at why South Africa should have professional astronomers carrying out research with telescope facilities based in South Africa. But let me say right away that astronomy is a subject where both amateurs and professional astronomers have a role to play. Indeed there are many more amateur astronomers than professional astronomers. It is a subject that both amateurs and professionals can enjoy. You do not need expensive facilities to enjoy the heavens - even a simple pair of binoculars or small telescope brings untold enjoyment.

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Furthermore, it is a subject where amateurs can make really valuable contributions to furthering our understanding of the heavens. For example, most comet. discoveries are made by amateurs. South Africa is renowned for the contribution it makes to the study of variable stars –one person in particular, Danie Overbeek, has the world record for the greatest number of variable star observations and this was recognised by the award of a special medal to Danie by the American Association of Variable Star Observers.

2. What is astronomy?

Forgive me if I say a few words about this as not everyone in this room is either an amateur or professional astronomer. First of all I would like to make sure that everyone understands the difference between astronomy and astrology. I recognise that astrology is important to a large sector of the public and most newspapers carry a daily column on astrology. However, astrology is not based on any scientific facts or principles and quite frankly is bunkum.

Astronomy is quite different: it is a science based on fundamental physical principles. It really is a branch of physics – indeed we also call it astrophysics to emphasise this. I would say that astronomy is the study of physical phenomena beyond the confines of planet Earth. Thus the study of astronomy involves the study of our solar system, the Sun, the stars, our galaxy the Milky Way, the study of other galaxies and the study of the universe itself. It is a branch of physics that studies physics in extreme conditions – like in densities in space between the stars which correspond to conditions of a vacuum more extreme than any we can achieve on earth; like in temperatures and pressures at the centres of stars where nuclear reactions take place, which again are more extreme than any on earth.

It is interesting that the history of astronomy in South Africa goes back even earlier than 1820, when the Royal Observatory at the Cape was founded. At that time charting the southern skies and providing accurate time signals were the most important factors and indeed continued to be so for the next 100 years. Both aspects were vital for improving navigation at sea and preventing ships from foundering on coastlines unexpectedly (because they did not know their longitude). Nowadays navigation is not such a problem and astronomy is much more about understanding the physics of the universe and its constituent parts. Astronomy can be thought of as understanding our environment on the largest possible scale. It is one of the grandest aspirations of mankind to understand the universe within which we all live.

An infrared view of Jupiter, obtained with the 0.75m telescope at Sutherland, during the Shoemaker-Levy 9 cometary collision. Visible near the lower limb of the planet are three impact 'scars'. On the right hand limb the Great Red Spot is visible, whilst the bright feature to the top, left is the Jovian satellite Io. (SAAO photo)

3. Relevance of astronomy to South Africa

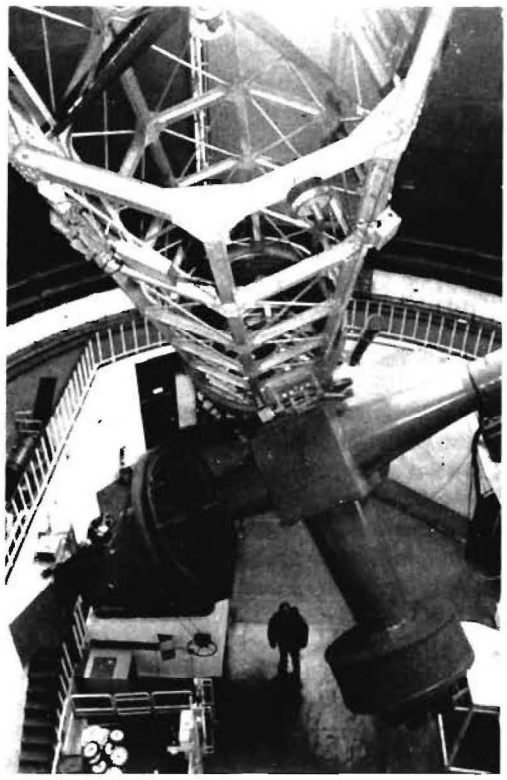
There is a great disparity in the distribution of large telescopes in the world. Of the optical/infrared telescopes of aperture greater than 2m, there are four times as many in the northern hemisphere as in the southern hemisphere. These northern hemisphere telescopes cannot study objects far south of the equator – yet half the universe lies south of the equator.

Our advantage depends on both our latitude and longitude. The southern sky contains objects of unique importance for modern astronomy. The two Magellanic Clouds (the nearest galaxies to our own) provide the basis for the extragalactic distance scale, on which estimates of the size and age of the universe are based. They also allow us to study the structure and evolution of galaxies quite different from our own. The central regions of our own Galaxy (with possibly a massive black hole at the very core) also lie in the southern sky, and pass overhead at the latitude of southern Africa. The southern sky contains, too, the majority of known globular clusters (stellar systems containing the oldest known stars).

The unique geographical location of South Africa is crucial for many astronomical projects, particularly involving time-critical phenomena. Because of the distribution in longitude of the major land masses in the southern hemisphere, certain time-critical observations which are not possible in South America or Australasia (because of daylight), can be obtained in southern Africa. Three examples when this was vital were when (1) the time of closest approach of the Giotto spacecraft to comet Halley was recorded by astronomers visiting South Africa; (2) the supernova 1987A, which was the brightest supernova for nearly 400 years (since Kepler's supernova of 1604), had its first spectrum taken in South Africa, and (3) more recently the impact of comet Shoemaker-Levy 9 with Jupiter in July 1994 had crucial observations taken at SAAO. Furthermore, time series observations of astronomical objects sometimes require 24-hour coverage to understand the complex phenomena. Such coverage is only possible with astronomical sites in all three major continents of the southern hemisphere.

4. National astronomical facilities in South Africa

There are two national facilities in South Africa for carrying out astronomical research. One is the Hartebeesthoek Radio Astronomy Observatory in the Magaliesberg mountains near Pretoria. It is situated in a valley in the mountains where it is isolated from man-made radio noise, which could affect the measurements. It studies the universe in radio waves and carries out important work on mapping the universe at radio wavelengths, studies of pulsars –



The 1.9m telescope at SAAO in Sutherland dwarfs an admiring astronomer. (SAAO photo)

rapidly rotating neutron stars – and carrying out VLBI observations of quasars.

The second national facility is the South African Astronomical Observatory which has its headquarters in Cape Town and its outstation at Sutherland, where the main telescopes are located.

Another important factor is that southern Africa has excellent sites from which to carry out astronomical observations. For optical/infrared astronomy, the optimum site requires a location well away from population centres so that the night sky is dark, a high percentage of clear nights and should be located on a relatively high mountain. Two excellent sites in southern Africa for optical/infrared astronomy are the Sutherland site of SAAO and the Gamsberg mountain in Namibia.

These national facilities are available to qualified scientists from SA universities. At present about six SA universities have research programmes in astronomy which make use of these facilities. These facilities are also used for training students in research techniques. However, the user base at present is quite small and strenuous attempts are needed, to extend this user base into other universities with physics departments where there is potential interest in astronomy. We have taken initiatives to visit such universities to give talks on astronomy, on the facilities available and to encourage collaborative research projects.

5. International links

Astronomy is a subject which has strong international links. Many of the projects undertaken at SAAO involve international collaboration. Of the 20% telescope time allocated to international users there is heavy demand for this time, demonstrating the high regard with which international astronomers view the facility. This policy to allocate international time greatly benefits South Africa by encouraging scientific collaboration and technological exchange. There are many examples where the SAAO has benefitted directly through access to advanced technology as a result. One example I can mention is the collaboration between SA and Japan to construct an infrared imaging camera – the one that obtained the infrared pictures of the SL/9–Jupiter impact.

As the premier observatory for optical/infrared astronomy on the African continent, the SAAO is in a unique position to act as the focus of the development of basic space science in the whole of Africa. It should be available to other African countries to aid in their scientific and technological development. South Africa can play a crucial role in this by the provision of world-class facilities for scientific research in addition to opportunities for training scientists and technologists from neighbouring countries.

6. Astronomy, education and public awareness

Just as South Africa has a major contribution to make to astronomy, so astronomy can play an important role in the general development of South African science. There is an urgent need to strengthen the basic sciences in this country as a foundation for technological progress. It is known from studies in

other countries that contact with astronomy at an early age excites young minds and acts as a catalyst in encouraging students to follow careers in science and technology.

Furthermore, astronomy is a subject that captures the imagination of the public and can, therefore, do much to raise the general level of scientific awareness in South Africa. Astronomy has a special advantage here. in that, compared to nuclear physics where you cannot see an atom, anyone can look up at the night sky and see objects like Jupiter, a comet, the stars and our own Galaxy the Milky Way. That the public interest in astronomy exists was demonstrated during the Jupiter–comet impact when the SABC TV- ratings went up by a factor 2 that week.

Future astronomers eyeing a model of the proposed Southern African Large Telescope. (SAAO photo)

7. The Future

The largest telescope for optical/infrared astronomy in South Africa is the 1.9m telescope at the Sutherland outstation of SAAO. It has been the largest telescope in South Africa for the last 45 years, indicating the long useful life telescopes can have. At one stage this was the largest telescope in the southern hemisphere, but no longer. For South Africa to remain competitive in astronomy into the 21st century a 4m-class telescope for optical/infrared astronomy must be located in southern Africa. This Southern African Large Telescope (SALT) has been recognised by national and international scientific committees as the highest priority item for the future development of optical/infrared astronomy in South Africa. Because of the realities facing South Africa it is likely that such a telescope could only be funded by an international collaboration between South Africa and some other (northern hemisphere) country. SALT should be seen as the premier facility on the African continent which would enable South Africa to remain internationally competitive in astronomy for the next 30–40 years.

After SALT the next most important step in optical/infrared astronomy, and one that will cost much less than SALT, is to re-vitalise the Boyden telescope. After all, with a mirror of 1.5m diameter, it is the second largest optical/infrared telescope in South Africa. Provided it is upgraded to the quality of a professional telescope, it is capable of carrying out first-rank science. You have an excellent climate in Bloemfontein in the winter season with month after month of clear skies. And most important you have physicists enthusiastic about carrying out research projects with this telescope and who wish to restore its capability. An important factor for the Boyden telescope is the planned public relations programme and visits, all of which greatly increase the level of public awareness of the importance of science and technology.

8. Conclusion

In conclusion let me say that astronomy is alive and well in South Africa. There are a number of important steps that we have to take to ensure that astronomy continues to thrive in the future – these steps are all within our capability. Furthermore, astronomy as a subject, its beauty and accessibility have been for too long denied to all South Africans. We have to take initiatives to bring astronomy to the public at large to ensure that they are aware of the contribution astronomy can make to the future South Africa.

Recent Comet Observations from southern Africa

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Abstract: Visual magnitude light curves, visual observations and CCD images are presented for several comets observed by the Comet and Meteor Section for the period April 1994 to September 1995.

1. Observers

Contributions to this paper were made by T Cooper (Director), A van Staden, D Overbeek, P van Blommestein, W Hollenbach, M Geyser, A Viljoen, L Barendse and M Begbie.

2. Comets appearing in 1994/95

In Table 1 I have summarised the comets that reached magnitude 12 or brighter and thus within reach of amateur instruments. The listing is in descending order of maximum brightness. Comets observed by the Section are shown in bold type, amounting to seven of the total seventeen. It should be noted that a number of the comets which became bright did so when they were not well placed for observation from southern Africa. Further details of the seven observed comets are given in Table 2.

The comets observed are discussed in this paper in order of appearance in Table 1.

3. Observations of comet Bradfield (C/1995 Q1)

Notification of the discovery of this comet was received from P Whitelock at SAAO on 1995 August 18. Despite phone calls to several observers in South Africa and Zimbabwe to confirm the comet's position all had cloud, though Barendse managed to observe the comet briefly that evening from Pretoria. Cooper estimated the magnitude as 5.5 on August 23 with strong central condensation (DC=6). After these few early days interrupted by cloud the comet headed too close to the sun for observation. Further observations of this comet as yet unreported may come to hand. At closest approach on July 27 the comet was located in Puppis, 20° above the horizon at 03h00 UT. Two weeks earlier it was in Fornax nearly 60° in altitude. In other words, we missed the show!

4. Observations of comet Borrelly (19P)

This periodic comet was recovered [IAUC 6009] on 1994 June 12 at magnitude 16.7. Cooper located the comet on 1994 September 5 as a magnitude 10 object in Orion, classing it as easy in a 40cm reflector. It was later observed by Overbeek and van Blommestein as the comet brightened to magnitude 8. Observations were few in the latter parts of 1994, as cloudy weather limited the number of useful observing nights. Cooper managed one final observation on November 26 as the comet headed rapidly northward and just before the comet made its closest approach to earth. Thereafter the comet faded for northern observers at about the same rate as it brightened. The complete light curve determined from mean world-wide observations [International Comet Quarterly, various issues] is shown in Figure 1. ASSA results are shown in comparison to mean magnitudes. Date of perihelion is shown as P and date of closest approach to earth is shown as C.

One striking characteristic of comet Borrelly was the highly elongated coma, a phenomenon noted at previous apparitions of this comet. The CCD image in Figure 2 taken by van Staden on October 31, the

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Table 1. Comets Brighter than m_v=12 during 1994/95

Comet	New Designation	Old Designation	Perihelion Date	Brightest Mag. m1
Bradfield	**C/1995 Q1**	——	**1995/08/31**	**5.0**
McNaught-Russell	P/1994 X1	1993v	1994/03/31	6.2
Encke	2P	1980 XI	1994/02/09	6.6
Machholz 2	P/1994 P1	1994o	1994/09/18	7.5
Mueller	C/1993 Q1	1993p	1994/03/24	7.8
Nakamura-Nishimura-Machholz	C/1994 N1	1994m	1994/07/12	8.2
Borrelly	**19P**	**1994l**	**1994/11/01**	**8.2**
Takamizawa-Levy	C/1994 G1	1994f	1994/05/22	8.3
Tempel 1	**9P**	**1993c**	**1994/07/03**	**9.0**
Mueller	**C/1993 A1**	**1993a**	**1994/12/01**	**9.2**
Machholz	C/1994 T1	1994r	1994/10/02	9.2
Takamizawa	**C/1994 J2**	**1994i**	**1994/06/29**	**9.5**
Kushida	P/1994 A1	1994a	1993/12/12	10.4
Schwassmann-Wachmann 2	31P	——	1994/01/23	10.5
Hale-Bopp	**C/1995 O1**	——	**1997/04/02**	**10.5**
Clark	**71P**	**1994t**	**1995/05/31**	**~11**
d'Arrest	6P	——	1995/07/27	~11

Table 2. Details of comets observed

Comet	Perihelion	r	Δ	Closest approach	Δ	Location at closest approach
Bradfield	95/08/31	0.44	1.33	95/07/27	0.46	Puppis
Borrelly	94/11/01	1.36	0.72	94/12/04	0.62	Lynx
Tempel 1	94/07/03	1.50	0.85	94/05/04	0.69	Virgo
Mueller	94/01/12	1.94	2.40	93/11/13	1.73	Draco
Takamizawa	94/06/29	1.95	1.60	94/05/23	1.00	Libra
Hale-Bopp	97/04/01	0.91	1.35	97/03/23	1.32	Andromeda
Clark	95/05/31	1.55	0.68	95/07/01	0.61	Sagittarius

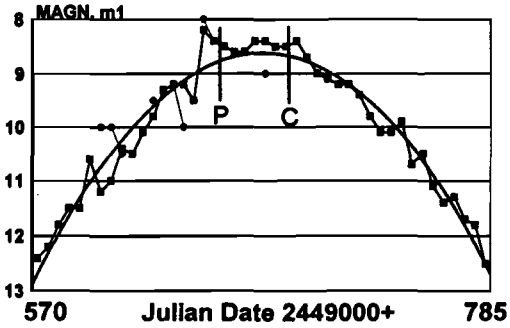

Figure 1. Light curve of comet Borrelly. The mean of world-wide observations are shown by a ■, whereas ASSA observations are represented by ●.

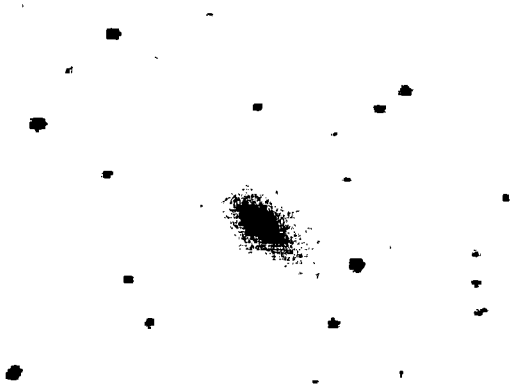

Figure 2. Comet Borrelly (19P) 1994 October 31, 00h22 UT, m1 = 8.5. Image by A D van Staden.