Boyden Observatory [A Concise History]

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Article which appeared in the University of the Free State's journal "*Acta Academica*" Nr. 12, 1979.

1. Harvard's need of a Southern Station

The history of Boyden Observatory covers nearly a century, of which for just over 50 years it has been at its present site at Mazelspoort. In 1879 Uriah A. Boyden, who was a mechanical engineer of Boston left in his will a sum of $238,000 to Harvard College for the express purpose of carrying out astronomical observations at such an altitude as to minimize so far as possible the troublesome effects of the earth's atmosphere. In 1887 it was transferred by the trustees of the fund to the President and fellows of Harvard College for the use of the observatory.

From the latitude of Harvard one could only hope to see approximately three quarters of the sky – in order to view the remaining part which is around the southern celestial pole – it is necessary to observe south of the equator. The Director of Harvard College Observatory at that time, Prof. Edward C. Pickering, was very keen to build a southern hemisphere observatory.

The establishment of the Boyden Fund made this a possibility. At his instigation one of the Harvard Observatory staff, Prof. Solon I Bailey visited South America in 1889 for the purpose of making preliminary studies for the selection of a station for observations of the southern sky. Help was sought from officials of the Central and Southern Railways of Peru, which reach high altitudes. Effort was concentrated along the west coast of South America as it presented the possibilities of high altitude plus a dry climate and clear skies.

Prof. Bailey (reference 1) , from the best information obtainable in the USA at that time, concluded that the valley of the river Rimac near Lima, Peru would give good conditions for the proposed station. However, this valley did not offer a sufficiently free horizon. At this latitude (approximately 12 degrees south of the equator) the western Cordilera extends parallel to distances from the coast varies considerably. In the mountains the rainy season is from November to April, whereas towards the coast the rainfall becomes less with virtually no rain at all within 20 miles from the sea. However there is coastal cloud which is prevalent throughout May to November. Prof. Bailey reasoned that it should be possible to choose a location where one would not be unduly worried by the rainy season clouds and also escape most of the dense coastal cloud.

2. Mount Harvard

With this in mind a site was chosen at a distance approximately 25 miles inland from the coast at an elevation of 6500 ft. Appropriately the site was named Mount Harvard – it was relatively isolated being about 8 miles from the nearest village. The buildings on Mount Harvard were of very professional nature, constructed from a light wooden framework covered with canvas and heavy paper. Life on Mount Harvard must have been extremely lonely when one bears mind that everything had to be conveyed on mules from the village of Chosica on track constructed specially for the purpose.

Observations were commenced right away and an extension was made of the Harvard photometry to the southern sky. This involved determining the brightness of the stars visible

to the naked eye: work which had been commenced by Prof. Pickering in 1879. Whilst climatic conditions at Mount Harvard from April to September were excellent, clouds later became troublesome. Consequently Prof. Bailey decided to make a climatic study of different localities in the hope of finding a better site. Studies were made at Arequipa, the region around Lake Titicaca, the Atacama Desert, Valparaiso, Santiago, and several other places in Chile.

Conditions in the Atacama Desert were found to be excellent. Whilst the cloudy season at Mount Harvard and Arequipa is in the southern summer that of the Atacama region is in the southern winter. So ideally if one could change from one to the other of these areas then it should be possible to stay in a region of clear sky most of the time.

3. **Arequipa**

As a result of these studies Arequipa was chosen at the site for the permanent station and the equipment was moved from Mount Harvard to Arequipa in October 1890. During January 1891, Prof. Pickering arrived in Arequipa along with the 33 cm Boyden telescope and several smaller instruments. The residence for the astronomer in charge and other suitable buildings were erected. Prof. Pickering stayed two years in Arequipa and during this time, assisted by Prof. A. E. Douglas, he made numerous observations of Mars and the satellites of Jupiter and Saturn along with lunar studies. Arequipa was found to have a very steady atmosphere which made it particularly favourable to using high magnification s for the study of faint planetary details. Conditions were also extremely good for double star observations. Generally speaking the work carried out in Arequipa was an extension to the southern sky of projects previously started at Harvard. An enormous amount of photometric work was carried out by the Director of the Arequipa station, Prof. Solon I. Bailey. The Bruce telescope was mounted at Arequipa in 1895 by Prof. Bailey. It was used extensively in the production of photographic atlases of stars to very faint magnitudes.

By 1904 the equipment at Arequipa included, in addition to the 24 inch (61 cm) Bruce photographic telescope which at that time was the most powerful instrument of its type in the world, the 8 inch (20 cm) Bache photographic telescope, a 5 inch (13 cm) refractor and several smaller instruments.

The 20 cm Bache photographic telescope had been in continuous use since 1886. After several years operation at Harvard it spent a year and a half on Mount Harvard and thereafter was at Arequipa. Spectra obtained with its aid were used by Prof. Pickering in his monumental work on the classification of stellar spectra. The much smaller 2.5 cm aperture Cooke telescope was used for photographic survey work of the sky.

The 33 cm Boyden refractor was used advantageously at Arequipa for studies of bright spectrographic binaries. Additionally it was used by Prof. Bailey in his studies of variable stars in globular clusters. He discovered more than 500 such stars. Incidentally this telescope, which is still in excellent order, was used during the total solar eclipse expedition of 1 January 1889 to Willows in California. From that time until 1890 it was set up by Edward S King and R. Black on Mount Wilson under primitive conditions, as no decent road existed at that time to the summit. This Harvard pioneer station was sited near the later buildings of the famous Mount Wilson Observatory of the Carnegie Institution.

The 33 cm refractor proved extremely useful owning to its unusual construction. In one configuration of the objective lens it can be used visually, and by merely reversing one of the components it becomes corrected for photographic work. This ingenious scheme was proposed by Prof. Pickering in association with the famous telescope makers Alvan Clark and Sons. From Mount Wilson the instrument was returned to Arequipa.

A side line at the Arequipa station concerned meteorology. In fact, for nearly 10 years several auxiliary stations were operated, reaching from the Pacific coast across the Andes to the low lying country at the upper levels of the Amazon. The highest station was on the summit of El Misti at an altitude of 19 000 ft. (5 791 m). This station was set up by Prof. Bailey in 1893 and remained in operation for approximately 7 years. However, shortage of funds made it quite impractical to operate this chain of meteorological stations on a continuous basis.

It is extremely interesting to quote from Prof. Bailey's 1904 article that "there are also problems in astronomy and physics, which could be investigated at a well-equipped station at such an altitude, which perhaps can never be solved at sea level". How correct this statement has proved in the relatively recent field of infra-red astronomy and also studies of the feeble radiations from the Earth's upper atmosphere! The observatory at Arequipa is at an elevation of 8 043 ft. (2452 m). Its longitude is 4h 46m 12s west and its latitude 16° 22' 28" south.

4. Drawbacks at Arequipa

However good the site for an observatory may appear, it often turns out that it is seldom ideal. Very few localities in the world are entirely free of clouds and it is desirable that the clouds which do occur should be distributed evenly throughout the year. At Arequipa the clouds occurred in one cloudy season from December until March generally speaking. There are other desirable requirements additional to freedom from cloud, the most important of which perhaps is steadiness of the air. Also freedom from high winds and a small diurnal temperature range plus a moderate altitude are desirable. Last but by no means is least reasonable accessibility and some of the comforts of civilization.

Prof. Bailey wrote (reference 2) that although Arequipa proved to be a fairly satisfactory site from the point of view of the results obtained there it was indisputable that the amount of cloud was often considerable and its distribution inconvenient. Thoughts were accordingly given to moving the station somewhere else in the southern hemisphere. It was realised that the semi-arid belt of low rainfall which crosses Peru and northern Chile also crosses the high plateau of South Africa.

The excellent climatic conditions of South Africa were fairly well known and had already been brought to the attention of the Director of Harvard Observatory by Sir David Gill. Unfortunately cloud records were very few and no observations at all seemed to have been made concerning the steadiness of the transparency of the atmosphere. Accordingly an expedition was sent to South Africa in 1908 under the leadership of Prof. Bailey to investigate the possibilities. (Reference 3).

5. Exploring astronomical possibilities in South Africa

The expedition travelled via Cape Town and Worcester to Hanover, which was the first seriously considered site for an observatory. Then Bloemfontein and Kimberley were also visited. The expedition penetrated as far north as Bulawayo but it was realised that cloudiness and rainfall increased the further north one went.

Having made a provisional survey of the entire region it was decided to fix upon a site for the main station. Hanover was selected, primarily because in the opinion of Sir William Morris who had made observations for geodetic purposes in the region it offered the best conditions. This viewpoint was also shared by Dr. RTA Innes, the hen Director of the

Johannesburg Observatory. Bloemfontein and Worcester were decided upon as secondary stations.

Plans were made to test the seeing conditions in both these places. In Bloemfontein appreciable voluntary help was given to the expedition by Mr. James Lyle.
Systematic testing commenced at Hanover early in February 1909, a small observatory being established at the edge of town. The instrumentation consisted of a 20 cm visual telescope, a 13 cm visual telescope and a small photographic instrument. At all the stations equatorial stars were photographed each clear night as a test of the transparency and steadiness of the atmosphere. Exposures were also made for several hours on polar stars as a check on the cloud conditions. Approximately 1 500 photographs were obtained from the three stations. An interesting conclusion from the observations was that there was very little difference in the night cloudiness between Worcester, Hanover and Bloemfontein.

However, it was noted that the cloudy and rainy season for Hanover and Bloemfontein is in the [southern] summer whereas at Worcester this was not the case. This of course might be expected since Worcester is located between Cape Town and the Karoo. Cape Town's cloudy season is in the [southern] winter whereas the towns in the Karoo have their cloudy season in the [southern] summer.

A large diurnal range of temperature was evident at the three sites. During this time it was found very advantageous to make observations from one of the koppies in the neighbourhood of Hanover – the diurnal range of temperatures was significantly reduced (being about 4° Celsius less than that on the surrounding plains).

As regards the steadiness of the atmosphere or seeing as it is called, it was found that there was very little difference between Hanover and Bloemfontein, Worcester being somewhat inferior in this respect. Again there was very little difference between Hanover and Bloemfontein in the transparency of the atmosphere: it was definitely superior to the experienced at Worcester.

The conclusion of the site testing expedition was that Hanover and Bloemfontein appeared to be more or less equal from the astronomical standpoint. Although the seeing may be a little better at Hanover it does seem from all consideration that Bloemfontein was preferable and Prof. Bailey goes on to say "that it is probably not surpassed by any other locality in South Africa as a sit for an astronomical observatory".

Dr. John S Paraskevopoulos became astronomer in charge of the Arequipa station in 1923. As has been mentioned the observing conditions at Arequipa were quiet good for six to eight months of the year, but from December until March a cloudy situation usually prevailed at night. At the request of Dr. Harlow Shapley, the then director of Harvard College Observatory, Dr. Paraskevopoulos undertook an expedition in December 1923 to Chucquicamata in the desert region of north-east Chile. A second expedition from 1925 to 1926 confirmed the excellent conditions prevailing in this area.

An investigation was also made of conditions at San Jose, in the desert between Arequipa and the Pacific. Since San Jose was served by a railway it would have proved much more convenient than Chile had the observing conditions been worthwhile. Unfortunately they turned out to be very poor.

6. The Boyden Station moves to South Africa

Bearing in mind the loss each year of four or so consecutive months and the inhospitable conditions at Chucquicamata, Dr. Shapley made the decision to move the Arequipa station to South Africa.

Harvard University contributed approximately 200 000 US dollars towards the transfer Arequipa station to South Africa, and the International Education Board put up a similar sum. The site at Arequipa had been in active use for 36 years. In November 1926 the task of dismantling was commenced at Arequipa, and in February 1927 the instruments were shipped to Bloemfontein. An exception was the Bruce telescope which was sent to Pittsburgh, Pennsylvania, for construction of a new mounting before being sent to South Africa.

Dr. and Mrs. Paraskevopoulos arrived at Bloemfontein in July 1927. They inspected several possible sites in the area and finally decided on a koppie overlooking Mazelspoort some 25 km northeast of Bloemfontein.

Professor R.A. Rossiter, the superintendent of the by then already established Lamont-Hussey Observatory at Bloemfontein, helped extensively in the preliminary site surveys. The city authorities of Bloemfontein were most generous with assistance in the setting up of the observatory. They arranged for the construction of a road up the koppie and laid on water and electric power and telephone lines to the site. The observatory is located 20 °, 02' 18" south latitude and 26° 24' 18" east longitude at an elevation of 1 387 m above sea level. Observing work commenced in September 1927 but it was not until 1933 that the initial instrumentation was complete. At that time instruments in operation were:

1) The 60 inch (152 cm) aperture Rockefeller reflector
2) The 24 inch (61 cm) Bruce Astrograph
3) The 13 inch (33 cm) Boyden refractor
4) The 10 inch (25 cm) Metcalf photographic refractor
5) The 8 inch (20 cm) Bache photographic refractor, plus some smaller instruments.

7. The 152 cm reflector

The 152 cm reflector has an interesting history. It was purchased by Harvard in 1904, since Prof. Pickering intended to continue the Harvard visual photometry down to as faint stars as possible with this instrument. The telescope had formerly been used by Common in England. It was found that the definition was far from satisfactory, and in fact very little use was indeed made of it as around that time there occurred the rapid development of photographic stellar photometry, making visual techniques less attractive. However, Dr. Shapley required access to a large telescope to further his researches on the limits of the visible universe and one of the Common mirrors was refigured. Also a new mounting was constructed by the firm of J.W. Fecker in 1927.

Even in its new form (from 1933 onwards) the 152 cm telescope was difficult to use. The trouble inherently lay in the primary mirror which was much too thin – it was only 9 cm thick (25 cm would be more appropriate for a mirror of 152 cm diameter), and in its normal configuration gave highly astigmatic mages. Dr. Paraskevopoulos devised an ingenious arrangement of applying selective pressure to three additional pads at the back of the mirror. Effectively the mirror was refigured as one observed! With plenty of patience good images were obtainable in this way.

In the early 1960's a new cell, with a better support system, was made for the 152 cm mirror, but with this new cell in position it was not practical to adopt the old Paraskevopoulos pressure pad arrangement. During 1968 it came to light that the new cell had been made on the assumption of housing a prefect mirror. Clearly the only way to proceed was to discard the old primary mirror and have new optics fitted. Accordingly a new optical system was ordered from Customs Optics of Tucson, Arizona. The new set-up gives the possibilities of a Cassegrain as well as a Newtonian observing position.

Along with the new optics the occasion was taken to renovate the by then (in 1968) badly won drive mechanism of the telescope.

8. Other instruments at the Boyden Station

A few words on some of the older instrumentation would not perhaps be out of place. The 20 cm Bache objective was originally a Voigtländer portrait lens. It was refigured by the Clarks to make a plate scale of 2 cm equivalent to 1 degree, the scale of Durchmusterung charts. It went to Peru in 1889.

The 61 cm Bruce telescope was completed, also by Clarks, in 1894. After preliminary trials at Cambridge it was shipped to Arequipa and remained there until the closing of that observatory in 1927. The original mounting, of the open fork type, was found to flex in use. So a more rigid two pier arrangement was made on transfer of the instrument to South Africa.

The 25 cm Metcalf has a triplet objective giving unusually good definition over a large field. It was ground and figured by the Reverend J. H. Metcalf who later in his life lived at Tauton, Massachusetts where he became associated with Professor Pickering.
In 1950 the Bruce telescope was replaced by the 91 cm Baker Schmidt telescope. This particular telescope was a co-operative venture by the observatories of Armagh, Dunsink and Harvard – it is known as the ADH telescope.

9. Boyden as a joint venture

Boyden functioned for several decades as Harvard University's southern observatory, but in the early 1950's Harvard announce that it could no longer continue to bear the finances associated with the establishment. The observatory was on the point of closure when it was suggested by the late Dr. Eric Lindsay of Armagh observatory and Prof. Herman Brück of Dunsink observatory that it might be possible to continue Boyden under international sponsorship. The Director of Harvard College observatory at that time (Dr. Donald Menzel) was extremely enthusiastic and the result of the suggestion was the formation in 1955 of the Boyden Council.

The members initially were Harvard, Armagh, Dunsink, Belgium, West-Germany and Sweden. The consortium operated for several years with this membership, but in 1966 Sweden announced that she would have to withdraw because of commitments in astronomy elsewhere.

10. UOVS becomes a partner

The vacancy arising from Sweden's withdrawal was offered to the University of the Orange Free State. This possibility was welcomed by the Rector at that time (Prof. P.W. Groenewoud). The proposal was that the Boyden Council would recommend a Director of the observatory to the University authorities, whereupon he would also be appointed as professor of astronomy at the University of the Orange Free State; in this way it was hoped to give stability to the venture. In 1968 such an appointment as professor was made (Prof. A.H. Jarret).

Later, in 1971, West Germany withdrew her membership.
Although these withdrawals were regretted, the observatory was nevertheless able to continue at a reasonable level of activity. In fact under the auspices of the Boyden Council

the observatory flourished as is evident from the several hundreds of publications emanating from the establishment in most of the international astronomical journals.

In 1974 the Americans (by this time Harvard had transferred its interest in Boyden to the Smithsonian Astrophysical Observatory) announced that as from 1876 they would be unable to remain associated with Boyden. Belgium announced a similar intention shortly afterwards. This left only Ireland (Dunsink Observatory), Northern Ireland (Armagh Observatory), plus South Africa (University of the Orange Free State). The result of these withdrawals was that the Boyden Council ceased to exist after 30 June 1976.

The owners of the Boyden Observatory (the recently formed Centre of Astrophysics comprising the former Harvard College Observatory and the Smithsonian Astrophysical Observatory) announced that they would be willing to give the observatory to any organization prepared to take it; in particular they hoped that the University of the Orange Free State would see their way to accepting the gift of the observatory for its department of astronomy. In April 1976 the University Council announced that they were prepared to accept the observatory.

11. Research activity at Boyden

Throughout the years there has been a steady stream of overseas astronomers making use of the facilities at Boyden. Many of these visitors have been of international repute and have added enormously to the high prestige of the establishment. In fact the visitor's book at Boyden reads like an international Who's Who of astronomy.

From its earliest days the research activity at Boyden has encompassed photographic and photoelectric observations of stars and star fields in the Southern Milky Way, the Magellanic Clouds and Southern hemisphere variable stars. Located 29 degrees south of the equator, Boyden is ideally suited for studies of the centre of our galactic system and the and the Magellanic Clouds.

Among the noteworthy projects carried out at Boyden must be mentioned the studies of Henrietta Leavitt of Harvard during the first decade of this century on particular types of variable stars known as Cepheids. This led to the formulation of the Period-Luminosity relationship which was undisputable one of the building stones of modern astrophysics. The photographs for this investigation were taken with the 25 cm Metcalf telescope at Arequipa. The research by Shapley in the 1920's into the limits of our galaxy – perhaps one of the outstanding contributions to the science of astronomy this century – was also based on Metcalf telescope photographs taken at Arequipa.

In more recent times Lindsay devoted much of his time to studies of the Magellanic Clouds, and Boyden became a major centre for these investigations.
To these names must be added those of Haffner, Menzel, Velghe and Wayman, astronomers of international acclaim who as members of the Boyden Council did their utmost to keep Boyden abreast of the times. Together with their colleagues they have been responsible for many of the several hundreds of publications based on Boyden observations which have appeared in the international astronomical journals over the years.

Recently stellar spectroscopy has been given an added impetus at the observatory by the acquisition of a new high speed spectrograph for the 152 cm reflector.
For many years a Sky Patrol programme was operated from the observatory, being complimentary to a similar programme initiated by Harvard for the Northern hemisphere. Routine surveys were made of transient phenomena such as variable stars and novae. Comets have been discovered on several occasions; our longest serving staff member, Mr. M. J. Bester, has personally discovered six.

The association with the University of the Orange Free State has led to additional research fields, including studies of flare stars and hydrogen emissions from nebulae, the Sun and interplanetary space. Some forty publications on flare stars have been made over the past decade as part of a cooperative research programme under the auspices of the International Astronomical Union.

Hydrogen emissions from solar prominences have been examined over the past few years with emphasis on the part they play in energy transfer processes from the solar interior to the outermost regions of the solar atmosphere.

We enter the second half-century of Boyden's existence with renewed hopes for the continuation of the research which has for decades been a traditional part of the Boyden scene.

References

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