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Karoo Time Machine

***Ruben Mowszowski** witnesses a project to build the largest telescope of its kind in the southern hemisphere*

Some people say it happened the first time they saw pictures of our blue planet from space - the realisation that space is not something that is out (or up) there, but that we are embedded in it and constituted of it. It is our origin and increasingly it seems, our destiny.

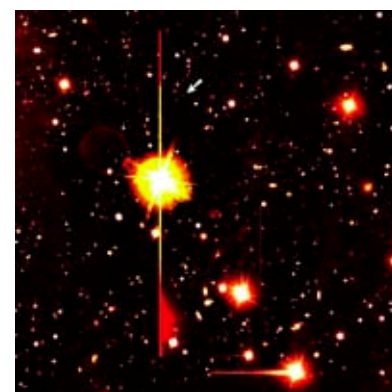
The library in the fading 175-year old Royal Observatory building is where the astronomers gather each morning at 10.30 for tea. Book-lined and wood-panelled it holds history yet there is the palpable sense of a frontier, of being at the edge of uncharted territory.

That territory is simultaneously out there and right here. Space is our environment, says astronomer Patricia Whitelock. The constituents of our body, indeed of everything there is, were 'cooked up' in the interior of stars. Studying the stars is studying ourselves. She quotes from the Joni Mitchell song : "We are stardust, we are golden, and we've got to get ourselves back to the garden".

Astronomer David Laney speaks in more matter-of-fact language. "You need a large enough light-bucket to collect enough light", he says. The bucket is the mirror. The larger the mirror, the more light that can be collected, the fainter the object that can be observed. We are talking about the new large telescope that is going to be built in South Africa.

It was going to be the largest of its kind in the southern hemisphere . Now with some improvements to its optics, it looks like it might turn out to be the largest in the world. Its location, in the remote Karoo , is an echo of the other frontier beyond which is the unknown and, quite possibly, the unknowable. This is where mystery lies and we are all equal before it.

Because light takes time to reach us and the distances are immense everything an astronomer sees belongs to the past. The present moment, the one we are in, is about 15 billion years old according to current estimates of the age of the universe. When one lies on one's back under a stary sky, one is looking at history.



[Click to Enlarge](#)

Seeing far back in time, supplied by the European Southern Observatory. For a very hi-res look at this images, [click here](#).

The stony Karoo ground around the observatory holds another kind of history. It is an archaeological record of the /Xam, an indigenous San people, who lived here for 30 000 years before they were dispossessed, hunted down and almost obliterated out of history. (The word 'Karoo' is derived from their word for 'dry place').

In some ways the /Xam's cosmology seems closer to our own current understandings than the European notions from which our astronomy evolved. Their idea, for instance, of certain stars as 'people of earlier times' (they belong to the distant past yet something of them reaches us,) seems closer to what we now know than the medieval notion of celestial objects rotating around our planet on crystal spheres.

Studies by biologists using mitochondrial DNA suggest that we all descend from a single mother who lived in Africa around 150 000 years ago. A set of fossilised footprints found a few years ago on the sandy west coast is an archaeological link to that moment. But beyond this is the realisation that we share a physical origin with everything in the universe. The contemplation of our common origin through astronomy leads inevitably to an awareness of our common destiny.

Patricia Whitelock calls it "the study of the environment on the largest possible scale." Cosmologist George Ellis calls it "humanity's great mission of understanding our position in the universe." The /Xam spoke about stars sailing across the sky. Others have described large telescopes as ships in which to sail through the cosmos.

Great ships like great ideas have history. At Arecibo in Puerto Rico, the world's largest radio telescope dish, constructed within a bowl-shaped valley, is being used to listen for signs of life in distant space. When MacDonald Observatory in Texas wanted a large telescope at an impossibly low cost, an astronomer thought of Arecibo. The outcome was the Hobby-Eberly Telescope (HET).

Conventional telescopes are designed to point at any star within the range covered by the observatory. The Hobby-Eberly primary mirror, like the Arecibo dish, is fixed. Instead of moving the dish, you wait for the stars to come into view. The heavens move so why move the telescope? It has its limitations but more than 70% of the sky is accessible.

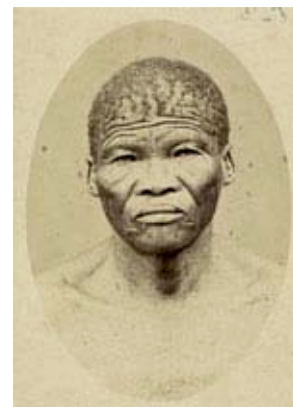
In Cape Town, Bob Stobie, director of the South African Astronomical Observatory, was charged with the job of taking this country's astronomy into the next century at a time when conventional deep-space telescopes were costing upwards of a \$150 million to build. A visit to Texas convinced him that the Hobby-Eberly design, at about one seventh of that cost, was the one to adopt. The Hobby-Eberly astronomers were enthusiastic as between the two facilities they would have nearly complete coverage of both northern and southern hemispheres. The Southern African Large Telescope (SALT) was born.

The cost (\$22 million) and the use of the telescope is to be shared between South Africa and academic institutions in the USA, Poland, Germany, New Zealand and the UK.

"The design makes it possible for us to have a world class facility at a cost that the country can afford" says Stobie. "It will see back to a time when the universe was 10% of its current age, when galaxies are thought to have been forming - around 1.5 billion years after the Big Bang".

We are talking about stars, galaxies and quasars a billion times too faint to be seen with the unaided eye, reading light that was emitted 13.5 billion years ago and which has taken that length of time to reach us. (If you want to know how far that is in kilometres, just multiply by nine trillion!)

The 11-metre giant mirror will be made up of 91 hexagonal segments. Each mirror segment will have three computer-controlled edge sensors which will keep it in position in relation to the other segments by reference to a device mounted on a tower near the dome, the distance to which is precisely the radius of curvature of the mirror. Its light gathering capacity will allow it to deliver an image as faint as a candle flame at the distance of the moon.



[Click to Enlarge](#)

Picture of the Kabbo,
©National Library of South
Africa.



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New telescope (computer generated
image) © South African Astronomical
Observatory.

The mirror's shape will be spherical (most conventional telescopes use accurate focusing but more costly parabolic mirrors) which means that not all the reflected light will come to focus at the same point. This is corrected by a series of small mirrors mounted on a tracker arm above the primary mirror through which the reflected light is passed. It is called a spherical aberrations corrector and it is the local redesign of this small piece of optics that has, almost embarrassingly, turned a telescope which is a copy of the American original into something far superior. (Local astronomers are at pains to point out that they had the benefit of hindsight.)

Designed by South African astronomer Darragh O'Donoghue, our corrector will be nearly 2.5 times sharper than the one used in the Hobby-Eberly - able to show details as small as a two rand coin ten kilometres away. It will also double the diameter of the field of view, quadrupling the area of the sky that can be seen at one time. When the tracker is on axis the entire 11-metre mirror array will be in use (as compared with 9.2 metres in the case of the American original) giving it the largest effective mirror of any telescope on the planet.

Two spectrographic instruments, one on the tracker arm and the other in the basement, will split light into its various colours: high resolution for detailed analysis of bright stars within our galaxy; low/medium resolution for studying faint stars and distant galaxies. There will be also a camera to produce the kind of star pin-ups that astronomers love to have on their walls, (or so Laney tells me.)

I ask cosmologist George Ellis what the new telescope will let us do that we cannot do now. Ellis has worked collaboratively with Stephen Hawking. He is excited about the possibility of being able to measure radiation from incredibly bright exploding stars ('supernovae') in very distant galaxies. Measurements apparently indicate that, contrary to our expectation, the rate of expansion of the universe is speeding up. "If this is correct, it has profound implications for cosmology. It means that the universe will expand forever, rather than recollapsing to a time-reversed 'big bang' in the future. It might necessitate revision of our fundamental theories of physics".

But something is bothering me. An American science writer has suggested that the quest for the origin of the universe is a male 'priestly' fantasy and deep space telescopes the contemporary version of beautiful but extravagant Renaissance cathedrals.¹ I ask a friend of mine if she is curious about the origin of our universe. I haven't got the slightest interest in it, she says. What's it got to do with me?

Patricia Whitelock gives me her answer. We are children of the universe, she says, comprised physically of elements formed in stars. Without the evolution of stars that followed the Big Bang, we would not be here. One day the continuing evolution of the sun will make life untenable and we will have to leave this planet. Her aim is not to frighten us but to show that the history of the cosmos is our history. It is also our future.

In the Carl Sagan movie 'Contact' an astronomer who visits another planet says on her return: "I was given something wonderful, something that changed me forever.....a vision that tells us we belong to something that is greater than ourselves, that we are not alone".

It has been said that the discovery of life on other planets would be the most profound scientific, social and religious event ever to take place in human history. The big telescope will allow us to detect the existence of distant planets from the motion of stars in response to the gravitational 'tug' of planets orbiting around them. In recent years 50 such planets have been identified by observatories around the world. Sagan suggests that there may be 100 billion planets in our galaxy which are or have been capable of sustaining life of some kind.

If life forms are found on a nearby planet - Mars for instance - then life is likely be widespread throughout the cosmos. A discovery like this will bring to an end the fantasy that we, as humans, are central to the universe and return us to the cosmic web of life. It is a state which the /Xam, if I am to judge from the accounts we have, never left.

Most of what we know about the /Xam comes from information given by a small group of prisoners who were released into the care of ethnologists William Bleek and his daughter Lucy Lloyd in the late 19th Century.

While it is clear the /Xam had an intimate knowledge of the night sky - their mirror was "the water which is like the pool in which we see all things"² - the accounts of the Bleek-Lloyd informants reveal an affinity with the stars that goes well beyond the purely observational. //Kabbo, a convict from Cape Town's Breakwater Prison and one of the last of his people, in a story told to Lucy Lloyd said: "We (the Bushmen) are the Day Hearts. We who are stars, we must walk the sky. We are the sky's things."³ In another account fellow-convict Dia!Kwain spoke about the wind of a star as being "one with the wind of the man".

Cape Town poet Stephen Watson translated his account into contemporary poetic language.

Even in summer, when the Pleiades come out, when the eye of the sun is burning, whitening, and the plains of our place are dry, dry as horn; even then, when these stars, the Pleiades come out, and being summer stars, what we call summer's things, they burn small, very white in our night skies - the wind, even then the wind is one with the man. 4

Vaclav Havel could easily be talking of the /Xam when he says "...we may know immeasurably more about the universe than our ancestors did, yet it increasingly seems they knew something more essential about it than we do, something that escapes us." 5

In squatter townships near Cape Town, the stars are gone, washed out by stadium-type lights which stay on all night. In Los Angeles, people who have rushed into darkened streets after an earth tremor report unfamiliar lights in the sky which turn out to be stars seen by them for the first time. Our teachers teach us about galaxies which they have learned about in books written by other people who have learned about them from books. It is time we came home to the cosmos.

A couple of thousand years ago, at the other end of Africa, an astronomer called Eratosthenes, using just a few sticks of wood, arrived at conclusions that changed the world. With a mirror, a few electronic instruments and a star-filled sky, there is no reason why we cannot do the same here.

Thebe Medupe, an astrophysics researcher in the final year of his doctoral studies, points out that there is a long tradition of the use of star knowledge for practical purposes in southern Africa. This, he says, can be a platform from which we begin our deeper voyage to the stars.

I am coming to the end of my space journey, speaking to astronomer Peter Martinez in his office down the corridor from the library. We have been talking about the advantages that the new telescope will bring to local industry, the training of people in high-end technology, the 'Stargate' visitor centre, the exchange of information with international scientists. The telescope is costing about a tenth of the cost of a movie like 'Contact' and it's clear that we are getting a very good deal. And then he uses the word 'leapfrog'. It is a word I happen to like.

Space technology, Martinez is saying, can help the continent leapfrog over its problems. The space sciences include astrophysics, the study of the outer atmosphere, the study of the sun, satellite communications and its precocious offspring, information technology. The space sciences, he says, will allow Africa to participate in the global economy. SALT will be the catalyst.

It's 10.30. Time for tea.

 Got Something to Say?

WANT TO KNOW MORE?...

1. Margaret WERTHEIM in correspondence.
2. William BLEEK and Lucy LLOYD, "Specimens of Bushman Folklore" (George Allen 1911)
3. Pippa SKOTNES, "Heaven's Things" (LLAREC The Museum Workshop at the University of Cape Town 1999)
4. Stephen WATSON, Extract from "The Wind is One with the Man" "Return of the Moon: Versions from the /Xam" (Carrefour Press, 1991)
5. Vaclav HAVEL, "The Miracle of Being" (Sunrise Magazine, Oct/Nov 1994.) Havel is president of the Czech Republic.

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