

Astronaissance: communicating astronomy & space to the African imagination

Keith Gottschalk

Abstract

Astronaissance neatly conceptualizes the crossover between the African Renaissance, the re-emergence of Astronomy in Africa, and the rise of cognate space sciences and astronautics.

Story-telling, painting, engraving, writing, and above all, viewing the heavens above, have always been amongst the strategies for communicating this excitement and wonder. Today, astronomy societies, the internet, media and mobile phone apps, and other public outreach projects are crucial when, for the first time ever, a majority of Africa's people now live under the light-polluted skies of our continent's towns and cities.

Space-related products and services are woven into the fabric of our daily life as never before. Policy-makers, budget-allocators, and managers need to see as essential to their strategy communicating to Africa's citizens, voters, and taxpayers, the necessity of Astronomy, the other space sciences, and Astronautics.

Introduction

*It is also important to maintain a basic competence in flagship sciences such as physics and astronomy for **cultural** reasons. Not to offer them would be to take a negative view of our future – the view that we are a second class nation chained forever to the treadmill of feeding and clothing ourselves*

- White Paper on Science & Technology, 1996 p.16

A bold bid led by the astronomer Dr. Peter Martinez in 2009 culminated in the International Astronautical Congress being held in Africa for the first time in its six decades during world space week in 2011. It only succeeded due to enthusiastic support from the Department of Science and Technology with both the budget and organization. The University of the Western Cape, Sunspace company and others, were early supporters co-signing the bid. Remarkably, the Africans achieved this on a shoestring – for most of the time Dr. Martinez was funded for only three fulltime organizers working with him, in contrast to the previous IAC in Prague, whose organizer was resourced with a team of over a dozen subordinates.

During an early brainstorming session, the organizers coined the slogan

Astronaissance, which neatly conceptualized the potential synergy between the African Renaissance, the re-emergence of Astronomy in Africa, and the rise of

cognate space sciences and astronautics. Astronautics is a mode of transport, a means to an end, and this end includes launching space-based astronomical observatories such as the Hubble and Chandra telescopes, space probes advancing planetary astronomy, and innumerable satellites for earth observation or measuring our magnetosphere and solar-terrestrial physics.

Story-telling, painting, engraving, drawing diagrams, and writing, and above all, viewing the heavens above, have always been amongst the strategies for communicating this excitement and wonder. This paper focuses on the theme of communicating through the ages the wonders of Astronomy and its sister space sciences, and concludes with some policy recommendations for the way forward.

Prehistory: the Big Screen - & Star Lore, Cosmology, & Theology

We are the first generation in 200 000 years of humans in Africa where the majority of people will never see the Milky Way in their lives - because the majority are now urbanized, living and working in towns where our nights are light-polluted. This author's own garden is trespassed by street lights from the front, the north side, and the back. Neighbours' security floodlights blind the eyes in both most of his front and back gardens.

Because of this we need to make a conscious effort to visualize the big screen that dwarfs Imax - to imagine again seeing the horizon-to-horizon heavens above that so enchanted our ancestors with its wonders. The most widespread of all star lore are story-telling about our Sun and Moon, our planets, and our galaxy – the Milky Way. Tantalizing scraps of evidence survive to suggest that Astronomy, as looking heavenwards and musing about it, began in Africa at least 35 000 years BCE.

The Lebombo bone from Swaziland, around 35 000 BCE, has twenty-nine notches carved into it.¹ Centuries later, two bones in Siberia, and the Blanchard bone from France, show similar notation. Astronomical historians deduce that these are recordings of the lunar cycle, while feminist historians deduce that these are recordings of the menstrual cycle. This paper considers that other evidence tilts the balance to an early astronomical explanation, but that these competing hypotheses are not mutually exclusive. Note in how many cultures the Moon is personified as feminine, so both sides of this debate may claim honours.

Supporting evidence for a prehistoric start for astronomy derives from analysis that tries to correlate the water-related names of some of the northern constellations with the months of rain and flood in the fertile crescent of Sumer and Babylon (that is, today's Iraq), and the precession of the equinoxes, which indicates that these constellations started to be named around eight thousand years ago.² More startling is the debate sparked by the Ishango bone, found in the Democratic Republic of Congo, and currently re-dated to 20 000 BCE. The notations on this bone are most

probably explained as a prime numbers table running along one edge.³ Bone and wood almost never survive in a continent riddled with termites. The statistically improbable survival of the Ishango bone is due to the rare event that it was buried in an ash layer before insects could eat it or bacteria could decompose it. This is a sober reminder that we only know of geometry and trigonometry amongst the ancient Egyptians and Greeks due to the double fluke that they were literate, and that samples of their manuscripts and paintings survived. How many prehistoric intellectuals in other parts of Africa also conceptualized multiplication tables, and prime number sequences, which we are still ignorant of, because none of their notations survived? Was the Hellenic African Eratosthenes the only intellectual amongst his contemporaries to make his deductions and discoveries of the Earth's circumference and the distance to the Moon? This is one case where it is legitimate to argue that the current absence of African evidence is not evidence of African absence.

The earliest chroniclers of Khoikhoi rituals record ceremonies around the new moon, which are of unknown antiquity. Also not yet easily datable are rock paintings and pictograms in caves that are most probably a comet or fireball (bolide), and in another case a comet or fireball that split into two heads.⁴ These and other African cultures attempt to explain heavenly objects as stories of legendary people or supernatural beings living in the heavens above. Seeing is best in semi-desert areas such as the Karoo, and it is from such regions that prehistoric star-lore mentions Jupiter spitting out and swallowing a daughter.⁵ In such areas, the minority of star-gazers with the best visual acuity could discern one or more of the Galilean Moons in the pre-telescopic era.

This stone-age recording of lunar cycles, multiplication tables, and prime number sequences seems less improbable when we note that both some African and other pre-literate cultures constructed solar observatories to record solstices and equinoxes.

In Africa, the oldest astronomical observatory in stone is an honour going to Egypt from at least 4 500 BCE at a place today named Nabta Playa.⁶ This is some two thousand years before the more widely popularized British Stonehenge. The Nabta Playa solar observations appear connected to cow sacrifice, which latter practice is still found in many African cultures. Kenya has another prehistoric stone astronomical observatory, with a preliminary dating around 300 BCE, probably delineating alignments with Sirius and other bright stars.⁷ The Stonehenge in Britain appears to be preceded by a wooden antecedent dating to around 8000 BCE.⁸ This raises the question: how many millennia earlier did Africa also have woodhenges, later devoured by termites, just as the earliest stone temples in Egypt were copies of earlier wood precedents? The Neolithic revolution deserves its name.

History: Calendars and Coins, Paintings, Books

Already, from the time of the most ancient surviving hieroglyphic inscriptions, before 3000 BCE, in the four kingdoms in Lower (downstream) Egypt and the Kingdom of Upper (upstream) Egypt, we find an elaborate theology including a sky goddess. Because of today's mass tourism and coffee-table books, it is important to remind ourselves that in ancient Egypt the sky goddess Nut in ceiling paintings in royal tombs and on inner temple walls was only seen by the royal family, palace officials, and clergy. However, we can presume that preaching and prayer popularized this belief amongst wider congregations of worshippers.

Notwithstanding the antiquity of the earliest solar observatories confirming solstices, the earliest calendars are based on moon cycles, so periodic re-synchronization with our solar year necessitated the invention of the concept of epagomenal days, later called inter-calendar days.⁹ These are the ancestor of our contemporary leap day the 29th February, and our leap second inserted at midnight once every few decades. It is striking how widespread is the calendar concept of dividing the solar year or lunar month into seven day weeks, millenniums before the biblical Sabbath. The week concept is based on the seven moving celestial objects, as our seven days are named after the sun, moon, and five planets of our solar system that are visible to the naked eye.

Many cultures, including some pre-literate cultures, note which bright star's annual reappearance above the horizon coincides with the start of some season in the agricultural cycle of cultivation. In the case of the north of our continent, from the earliest times of ancient Egypt they recorded Sirius' heliacal setting (star setting soon after sunset) and acronical rising (star rising soon before sunrise).¹⁰ From the south of our continent, Venda star lore orally teaches every family that the rise of the pointers and Southern Cross signals the time to complete hoeing and planting.¹¹

The symbol of the star above a crescent moon lying on its back long pre-dates both Islam and Christianity. The earliest-known African coins, minted in the Kingdom of Axum (corresponding to today's northern Ethiopia, Eritrea, and the Red Sea coast of Yemen) show this astronomical icon above the head of the king.¹² Only after the monarchy converted to Christianity after 333 CE is this crescent moon and star replaced by the cross. These are silver coins, traditionally perceived as the moon's colour.

Lunar-based calendars were so strongly based in African cultures, that they outlasted the Christian-dominated era of six centuries in north Africa, and were entrenched in Islamic Africa. The whole of north Africa west of Egypt was originally Amazigh (Berber) right across the continent to the pre-colonial Canary islands. Both the year and its depiction on calendar boards were called *Acano*, and cave paintings of such boards survive today.¹³

The official conference programme circulated in August to all speakers draws the presenters' attention to one Timbuktu manuscript by al-Kunti¹⁴ which probably dates to the last decades of the eighteenth century. Ptolemaic astronomy and astrology are recorded in medieval Timbuktu manuscripts, and one of them has marginalia chronicling a meteor shower. These Timbuktu manuscripts teach us two lessons. First, they provide an Afrocentric corrective debunking two centuries of colonial racist historiography which denigrated Africa as without literature, devoid of learning, and indoctrinated eight settler generations with racist stereotypes. Centuries of west African scholars, much in the style of today's graduate students, sought out the manuscripts and mentors with the greatest reputations from whom they learnt.

Second, we need to note that the material circumstances which bred such ideologies of racial superiority were more than the colonial military conquest of our continent. They include the fact that by the time al-Kunti wrote these manuscripts, astronomy in Europe had gone through the Copernican revolution, and divorced itself from astrology belief systems. Mathematics and physics had advanced through the Newtonian revolution and Kepler's laws. The invention of the telescope and thermometer - another Galilean invention - enabled Willem Herschel to discover both the planet Uranus and infra-red.

This lesson is that African astronomers must never again lag behind because they lack subscriptions for the latest astrophysics publications. Essential for the African renaissance is that astronomy must always be nurtured and sustained with the budgets for necessary equipment updates, and for new generations of instrumentation, if we wish it to be an *astronaissance*.

The Colonial Epoch

When the British Royal Navy founded what is now the South African Astronomical Observatory in 1820, colonial rule in Africa extended out of sight of the sea only at the Cape Colony, in Angola, and up the Zambezi valley. SAAO was the first permanent telescopic observatory in Africa, to be followed by a few others. This paper concentrates on the history of popular communication of astronomy in Africa, and 1912 saw amateurs included in the founding of what is today the Astronomical Society of Southern Africa (ASSA). This reached out to its members and the public through publishing the *Monthly Notes of the Astronomical Society of Southern Africa* (MNASSA). ASSA also facilitated discount subscriptions for its members to be posted the monthly *Sky and Telescope* magazine from the USA.

The South African Museum in Cape Town included in its public displays a collection of stony and iron meteorites. After Sputnik launched the Space Age during International Geophysical Year 1957-58, the SAM acquired a bell-tent type planetarium seating an audience of barely over a dozen persons. During the apartheid decades, the operator kept the lights switched off between shows, as well

as during shows in the planetarium. The reason was to prevent white racists in the audience spotting that there were also some Coloured persons on the seats, and demanding that the Museum make their shows “whites only”.

A colonial and settler social order demands social distance not only between persons of different colours, but also imposes other hierarchies of distain. In the democracies, astronomers organized numerous public nights and permanently open visitors’ centres. During the apartheid epoch, the observatory directors considered themselves generous in allowing the public to enjoy one public viewing night per year at Sutherland. This was usually booked out over four months in advance, so inadequate was it to satisfy public demand.

1994: Democracy and Public Outreach

After lobbying by the author and others in the ANC Science & Technology Policy Group in 1992, the democratically elected Government created South Africa’s first Department of Science and Technology, headed by its own minister. This in turn led to the creation of the South African Association for Science and Technology Advance (SAASTA). The launch in 2009 of both the South African National Space Agency (SANSA), and the NGO the South African Space Association (SASA), boosted the astronomy and astronautics components of science popularization that SAASTA coordinated.

At the author’s urging, the new SAAO Director Dr. Bob Stobie created for the first time a full-time post for a public education officer. Gifted charismatic edu-tainers such as Case Rijdsijk (formerly the Diocesan College physics teacher of Mark Shuttleworth) and Kevin Govender stepped into the breach. The amateurs of the Cape Centre, and other ASSA centres, volunteered to guide visitors and operate the older telescopes with eyepieces on Saturday evenings once per fortnight, running a roster. Other volunteers took their own telescopes to schools crossing the full class spectrum from private suburban schools charging R30 000 per year to no-fee townships schools. This professional-amateur cooperation in public outreach grew dramatically after 1994.

SAAO and Stobie from the start ensured that lobbying the Government to fund the Southern African Large Telescope (SALT) included the SALT Social Collateral Plan to address the requirement:

“You’ve given me the scientific case for SALT. Now give me the *political* case to take to cabinet” - quoted by Roger Jardine, first Director-General of the DST.

The SAAO observatory site was opened to the public throughout the year with daytime tours, with routine night time access to a few modest public viewing telescopes. SAAO also allocated part of its own budget to top up the salary for scarce-

skill science and maths teachers at the Sutherland township school, which resulted in immediately filling posts that had lain vacant for years.

While the Dennis Titos and Mark Shuttleworths get the headlines, note that 99% of space-related tourism is on the ground. The public initiatives of SAAO birthed astronomy tourism in South Africa. In Sutherland, as well as boosting guests for the sole hotel, half a dozen B&Bs opened after 1990 as farmers and town home-owners sought to supplement their income from these space tourists. Also, far beyond those B&Bs, property prices rose to significantly higher than in other rural towns of the same size. Just like new-age mystics move to or holiday in Nieuw Bethesda or Ixopo, so amongst young pro-S&T couples, the astronomy buzz around SALT made Sutherland become perceived as a trendy place to buy a plot or holiday home. Since there is still around 80% unemployment in Sutherland, every cleaning and cooking job created by astronomy tourism is a lifeline for a working class family.

More recently, Sutherland ushered in the International Year of Astronomy (IYA 2009) with a new year star party at the top of the koppie alongside their telescopes. By 2010 Chris de Coning and Kechil Kirkham of ASSA's Cape Centre had formed their astronomy tourism company, Over the Moon Tours.¹⁵

The Cape Centre was also the first in ASSA to realize the synergy between Astronomy and Astronautics to create a space buzz and space hype in public outreach. In 2006, when the author was its chair, he led it to become the first in South Africa to join yurisnight.net, a US-based global group facilitating annual 12th April youth parties to celebrate the 1961 flight of Yuri Gagarin, the first cosmonaut to orbit the world. The more recent invention of April as Global Astronomy month offers another useful opportunity for synergy that will increase the public excitement around Astronomy and everything else space-related.

Astronomy and Astronautics were honoured parts of the Sciencentre established in Cape Town's largest shopping mall, Century City – Canal Walk. Access was largely limited to the middle and corporate classes, due to both high admission fees and the lack of easy public transport to this venue.

Twenty-First Century: Outreach In The Internet Epoch

The internet epoch made widely accessible a wealth of visual pleasures to partly compensate for the obliteration of the Milky Way and stars in our towns. The US Space Science Institute placed on its website a treasury of Hubble images, while NASA places on its website the Astronomical Picture of the Day (APOD). Today, there are a growing number of astronomy and space-related mobile phone applications, such as telling the public what is visible in the heavens that night, as well as GPS and other services.

Alongside this digital revolution, the older public outreach modes so far continue. ASSA membership has grown to over eight hundred paid-up enthusiasts. SAAO won its bid against tough competition in 2009 to host the International Astronomy Union's Office of Astronomy for Development. SAAO and the country's two planetariums have designated a staff member as public relations officer for the media. Bookshops continue to stock Astronomy books ranging from children's literature to coffee-table tomes with large format colour images.

While this section has focused on only one country out of fifty-five states in Africa, it may be seen as a representative sample of the growth of continental astronomy. Simultaneously with permanent posts for astronomers growing from a score to one hundred in South Africa, astronomy programmes have started up in many African universities, typically within Physics or Applied Mathematics departments from Morocco to Zambia. Doctoral graduates of SKA bursaries are now returning home to start up university programmes in astronomy in both Mozambique and Madagascar.

Nigeria became the first African country to found a national space agency, NASDRA in 1998, followed by Algeria's ASAL in 2002. One NASDRA division is a dedicated Astronomy Centre. Egypt is completing maintenance and renovation of its 1.9m Kottamia Astronomical Observatory, which is a twin of the SAAO 1.9m reflector. The excitement generated by South Africa winning the SKA bid in 2012 was preceded by the Mauritius Radio Telescope. More than a score of African countries from Senegal to Kenya have opened national remote sensing institutes to process data from earth observation satellites. The African Astronomical Society (AfAS) was launched at the 2nd Mideast Africa Regional IAU Meeting in Cape Town in April 2011.

Conclusions. The Way Forward: Policy Recommendations

1. The Astronomy Geographic Advantage Act, 21 of 2007 covers a polygon bordered by Uppington, Calvinia, Fraserburg, and De Aar, empowering the Government to limit light and radio pollution. Years earlier, the Cape Town municipality joined the International Dark Sky Association, but has forgotten this to the extent that it floodlights Table Mountain at night. When there is a tablecloth (orographic cloud) above, the cloud itself ALSO glows brightly luminous. This is one main cause of the sky glow on the south-western horizon seen from the SAAO optical telescope facility.

It is urgently overdue to become more assertive to protect our cultural heritage of viewing the Milky Way and other heavenly treasures. The employer of one Karoo farm worker brought her to De Waal Drive at night time to show her all the pretty lights shimmering below. She commented:

“All the stars have fallen out of the sky onto the ground.”

She could see very few stars left in the sky. All these myriad street lights shine upwards, wasting ever higher-priced electricity. It is good that new buildings, such as

the 2010 soccer stadium, have no upwards-shining lights. But South Africa, as well as SAAO, has a pressing need for dark sky laws *at the national level*. We need statutory legislation to require all outdoor light fixtures and lit adverts to be full cut-off under lampshades as a condition of passing all building plans; and as a condition of sale of any property, to be rectified by either seller or buyer.

The Czech Republic was the first country in the world to protect Kepler's heritage by a national statute to conserve dark skies.¹⁶ We need to follow now, for even after such a statute is gazetted, it will take four decades before the property churn reduces the hold-out light pollution back to the 1940s. Tight budgets also mean that municipal retrofitting of street lamps with full cut-off, or replacing them with LEDs and new lampshades every time a bulb fails, will realistically also be stretched over decades. This makes it all the more urgent to start now. Our key lobbying point is that full cut-off fixture reduces the electricity needed for a down-focused light, so saving expense.

2. Many professionals in their fields do not deem that Astronomy (a science) is a cognate discipline with Astronautics (an engineering field like aeronautics). Indeed, in 1912 there was no overlap between the work of Astronomers and rocketeers. But by 2012 the digital revolution is creating more convergences than the obvious ones of orbiting observatories, planetary and lunar space probes, and other science-dedicated satellites. In both disciplines, major research projects begin with software development, then deploy computer hardware and require serious bandwidth; both need to source detectors, sensors, and other instrumentation. Infrared astronomy additionally requires cryo-coolers, as do satellite launch vehicles.

But above all, for purposes of this paper and conference, it is in public outreach, and popular science education, where indisputably the optimum cost-effective strategy is to cluster together Astronomy, the other space sciences, and Astronautics. The author testifies from his own experience as a volunteer guide on observatory public nights how each spaceflight spectacular immediately arouses more public interest in Astronomy, more media queries and publicity for Astronomy, and buying of telescopes and binoculars. Reflect on how Mark Shuttleworth adroitly used his April 2002 space tourism to launch his "It's hip 2B²" campaign, focussed on schoolchildren.

Just as South Africa's Astronomy tourism centres around Sutherland, and after the SKA is built, will also spread around Carnarvon, so South Africa can launch a broader-based space tourism on the ground. Until now, tours of the Overberg Test Range (OTR) and the Institute of Satellite and Software Applications (ISSA) have been limited to private groups of students and visiting space professionals. Arrangements should be organized to have daily tour groups of our space heritage, without interfering with their work.

World Space week 4 – 10 October cannot be used for school, college or university students in South Africa, as it falls during the start of final exams. But it could be focussed on adults of all ages, who comprise the voters and taxpayers whose approval and support is a prerequisite for all budget increases to SAAO, SKA, and SANSA. Clearly, it will be optimal for budgets and organization if any school tours by the Office of Astronomy for Development, and SANSA, share the same minibus or midibus and other facilities in common.

3. Until now, a major limitation of SAAO tours of Sutherland, and the proposed space camp, is that they are all limited to middle and corporate class families who can afford to pay for overnight accommodation. Neither sponsorships nor education budget could possibly stretch to transport and accommodate in Sutherland millions of schoolchildren from all over South Africa, never mind the rest of Africa. It is far less expensive to transport astronomy and other science exhibits to the schoolchildren.

While all of this can, and should, be broadcast through streaming video and the social media on the internet, the emotional impact remains far bigger when contact is face-to-face. Shuttleworth's pioneering pop-science tour covered one hundred schools with a truck and trailer, full of stage props for a juggler, and charismatic science teachers. This is a pilot run demonstrating what could be done with state resources, led by SAAO, the IAU OAD, and SANSA, coordinated by SAASTA.

To reach working class schoolchildren and their families, needs as a start nine mobile provincial sciencentres, each on trailers as Mark Shuttleworth pioneered, touring schools throughout their province. Each will need to have permanent posts for S&T edu-tainers speaking the most widespread languages of their province. Part of this ought to be pavement astronomy as pioneered by US amateurs, set up in township high school grounds and shopping mall car parks, with appropriate security.

4. Working through the African Union's African Ministers Conference on Science and Technology (AMCOST), which has identified space S&T as a priority area, we should urge the AU to seek international partnerships to set up mobile sciencentres travelling in each of the fifty-five other African countries, with a strong Astronomy and astronautics component. This would truly launch an African *Astronaissance*.

5. This author is the only person who performed his poems at both the National Arts Festival and the National Science Festival in Grahamstown. We should recommend that the DST, DAC, SAASTA, and NAC should set up a standing committee to sponsor the popularization of Astronomy and the other space sciences, and Astronautics, through murals and the plastic arts, the performing arts, sci-fi, poems and other literature. This paper concludes with two examples of how Astronomy and Astronautics may be popularized through poems ranging from the satiric to the tragic.

True Confessions: Who Really Gave Nic Copernicus The Idea That Ptolemy & The Church Had Got It All Wrong

one moonful night
mrs Copernicus whispered:
“darling, the *earth* moved”

Shuttle

28 January 1986

1 February 2003

these are the laws of physics
immutable as those of Medes & Persians:

you, frailness of flesh & skin
wrapped in only blueprints & hope
to plunge through furnace of plasma
burning, blasted, luminous beyond mach-molten:
torn molecules, pink & purple,
cremating you as *sati* to the sky.

if all goes well, you shall fly
as a butterfly bolted to a bullet.
if not, your only grave shall be
Schlieren lines across a shocked sky.

to strangers,
your death shall be as beautiful as fireworks.
but to those who knew you:
grief.

they vanished
became sky:
a rain of metal tears
upon the land.

breaking,
that contrail became cenotaph:
a wreath we laid
on our voyage to worlds.

- Keith Gottschalk

Poem Endnotes

plasma – air or anything heated to several thousand degrees, tears apart as individual atoms, ionised, electrically charged.

sati- Hindu custom of widow throwing herself on husband's funeral pyre.

“Columbia was a butterfly bolted to a bullet”

- Robert Lee Hotz, Los Angeles Times December 2003.

Schlieren – apparatus to make supersonic shock waves visible in wind tunnel

Endnotes

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