september 2008

canopus

monthly newsletter of the johannesburg centre of assa

Old Republic Observatory, 18a Gill Street, Observatory, Johannesburg
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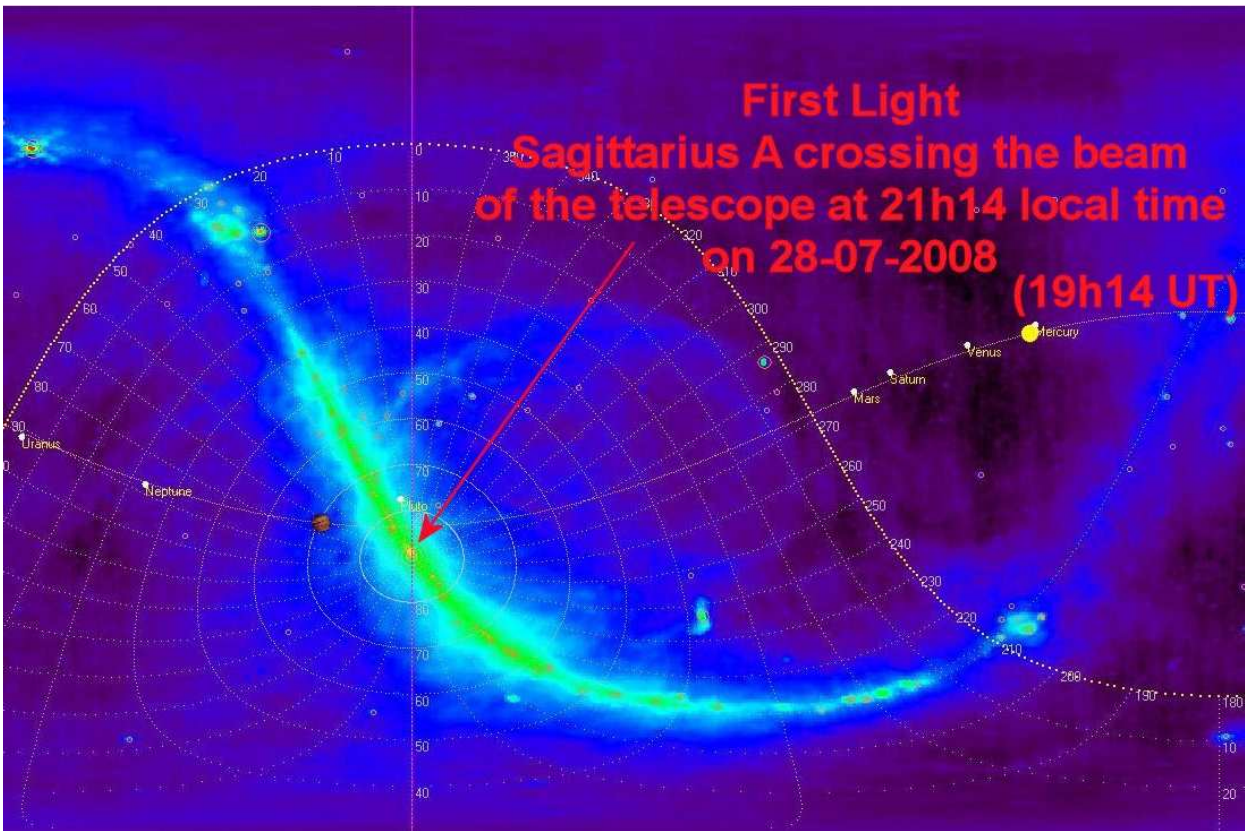

Schematic showing Sagittarius A crossing the beam of DUT's Indlebe telescope on 28 July 2008.

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notice of next meeting – assa johannesburg

The next monthly meeting of the Johannesburg Centre of the Astronomical Society of Southern Africa will be held at the Johannesburg Planetarium, University of the Witwatersrand, Johannesburg on Wednesday, 10 September 2008 at 20h00:

Planetarium Show

assa johannesburg calendar

Date	Event	Details
6 September	Committee meeting	Observatory @ 14:00
10 September	MONTHLY MEETING	Observatory @ 20:00 – Planetarium
4 October	Committee Meeting	Observatory @ 14:00
8 October	MONTHLY MEETING	Observatory @ 20:00 – Trevor Gould: "Meteorite Types"
8 November	Committee Meeting	Observatory @ 14:00
12 November	MONTHLY MEETING	Observatory @ 20:00 – Claire Lee: "Exploring the Universe through Particle Physics"

assa johannesburg committee members 2008/2009

Portfolio/Interest	Name	E-mail	Contact details
Chairman & Treasurer	Robert Groess	groess@gmail.com	083 365 8092 011 902 9293 (FAX)
Vice-chairman	Gary Els	gels@randwater.co.za	
Secretary	Alec Jamieson	arjam@iafrica.com	082 654 5336
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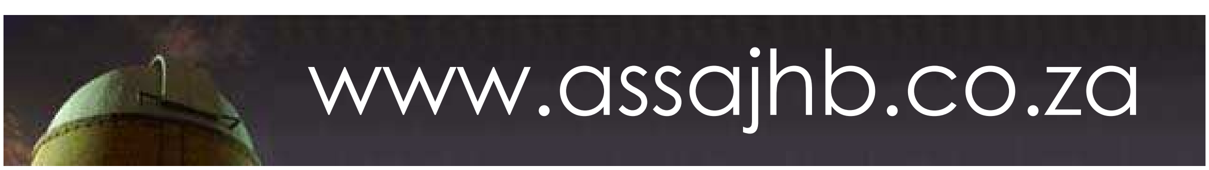
PR & Media Liaison	Sharon Tait	labelconnection@mweb.co.za	082 455 0819

ASSA Jhb. Library:

The library opens from 6 PM to 7:45 PM, before monthly meetings (8PM) held at the Observatory. The library is situated in the building behind the large telescope dome. Instead of parking in front of the telescope dome, one can drive round to the back of the telescope dome and park close to the library. The library is a good place for new members to come and introduce themselves and find out more about the society.

Telescope making classes:

ATM classes are held on the premises of Parktown Boys' High School on most Saturday afternoons.



editorial

by Claire A. Lee

It's an extremely exciting time for science these days, and "firsts" are popping up like spring flowers – a particularly apt description for us, I thought, as spring seems to have hit us head-on all of a sudden.

On our own home turf, at the Durban University of Technology, their Indlebe radio telescope saw its first light on the 28th of July (see cover picture, and article on page 6), while HartRAO is in the middle of a global geodesy experiment (page 8). Another telescope celebrating first light is NASA's Gamma-ray Large Area Space Telescope (GLAST) satellite, though by the time you read this that will no longer be its name (see *Canopus*, March 2008). NASA is due to announce the new name and the first light results during a teleconference on 26 August. I wonder if the new name will be more imaginative than the first?

And in the physics world (of course, I couldn't resist) we have the long awaited start-up of the Large Hadron Collider (LHC) happening on September 10. This is the day when they will first attempt to circulate beam round and around the 27 km long tunnel, keeping it stable at an energy of 450 GeV. (On 8 August the first beam was shot into the LHC to test the beam injection process from the smaller SPS (Super Proton Synchrotron) accelerator, but they didn't circulate the beam all the way around – they stopped it after about a quarter of the track). September 10 will be an exciting day for all the scientists involved in the planning, building and commissioning of the LHC (as well as everyone else involved on any of the experiments), and should be followed in 1-2 months by the most exciting event of all in the start-up: the first proton-proton collisions!

Currently the LHC looks good to go, with all eight superconducting sectors at their operating temperature of 1.9 degrees above absolute zero (ie 1.9 Kelvin, or -271°C). This makes the LHC beam pipe the coldest place in the known universe (unless, of course, there are other life forms out there with their own particle accelerators) because the Cosmic Microwave Background – that background radiation left over from the Big Bang and permeating all of space – has a temperature of 2.73 Kelvin!

On a completely different note, I thought I'd draw your attention to Wordle - http://wordle.net/ - a fun online tool that creates pretty word clouds out of a bunch of text, such as the one on page 16. The size of the word depends on how many times it appears in the text, and you can customise the colours, fonts and layout of the cloud (the one on page 16 was made by Sean Carroll using the text of his article). Go play with it – it's a lot of fun!

Well, that's all from me for this issue. All the best for the spring season, and bring on the science! ■.

chairman's chat

by Robert Groess

I was sitting at my computer, installing the latest version of Stellarium (0.9.1) when I happened to look at some bright object just off the screen. I panned the "view" to get a better look. And what I saw was intriguing. The Moon with Antares almost in occultation! Really? Could this be true? So I went outside to have a look. And yes, the drama was unfolding in reality much the same as it did on my computer screen. Sadly I had missed the opportunity to set up my telescope to have a closer look, for it sure would have been a dramatic sight. The darkened limb of the waxing Moon scraping by Antares – at least from my vantage point near the south-east corner of the greater Johannesburg area.

Not six days later and the Moon would almost completely disappear behind the shadow of the Earth. As lunar eclipses go, this one was fairly convenient. Perhaps some good astrophotos were taken of the event? If you have any such gems that you wish to post on the ASSA Johannesburg website *(Ed – and in Canopus!)*, please email them to our webmaster or myself and we will gladly put them up for you.

I remember a lunar eclipse or two which was not placed so conveniently in the evening. These were days where camera and tripod were prepared the night before and the alarm clock was set for 2:30am. It takes dedication and passion to get up so early on a chilly August morning. And of-course with so much going on, no one else would get a decent night's sleep in the house either. But it was well worth it. At least, I thought so.

Eclipses can be viewed from the heart of cities, but if you want to find a place where heaven and earth tangibly meet, that would be out in the Kalahari. The experience of looking at the Milky Way blazing overhead, with an arid landscape aglow from alien suns, really puts a whole new emotion on seeing the Earth's place in our cosmos. Such vantage points sport their uniqueness and make it seem that the entire show has been put on for you and you alone. Getting up at 4:00am here is quite a different experience. Venus rising in the East. A distinct triangular Zodiacal glow. And nothing but a vast expanse of the sky where the air is so clear, stars simply appear in the East and disappear in the west. I have yet to see a planetarium successfully imitate such a view.

To go and take a telescope out at night allows you to visit worlds and celestial majesties which could not be done not so long ago. You don't need fancy equipment to make it all worthwhile. You don't need expensive accessories to make the most of a viewing evening. A humble appreciation of the facts, and a smattering more than a casual interest is all that it requires. Next year will be the International Year of Astronomy, commemorating the 400th anniversary of Galileo being credited with being the first person to point a telescope skyward. And while Galileo's view of the heavens pales in comparison with what a modest scope is capable of these days, as a wise old astronomer has said, the type and size of telescope matters far less than the observer behind it.

Until next month,
Robert. ■

DUT Indlebe Radio Telescope sees first light

Indlebe project press release, 4 August 2008

The Zulu phrase 'indlebe zikhayi langa' literally means those whose ears glow in the sun. This phrase gave rise to the project name Indlebe, which means ear.

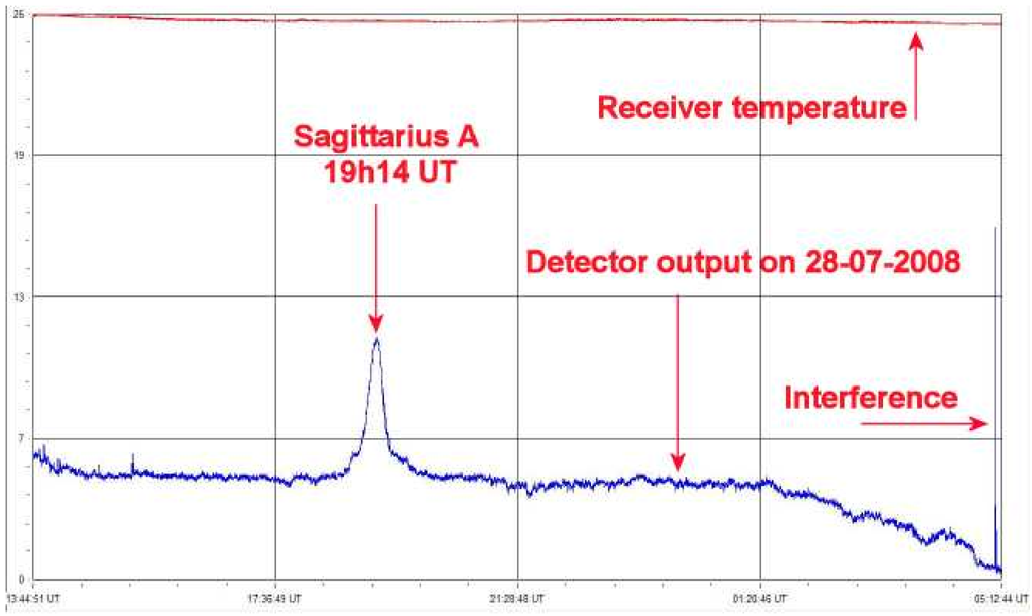
On the evening of 28th July 2008, at 21h14 local time the Indlebe Radio Telescope, situated on the Steve Biko campus of the Durban University of Technology, successfully detected its first radio source from beyond the solar system. A strong source was detected from Sagittarius A, the centre of the Milky Way Galaxy, approximately 30 thousand light years away.

It should be noted that this is not an intelligent source, i.e. it is not a source that could be considered as having been transmitted by alien intelligence. Furthermore, it is certainly not a new discovery. The electromagnetic radiation emanating from Sagittarius A is well documented and an entirely natural phenomenon. A similar signal, although of a much larger magnitude, would be received by simply pointing the telescope at the Sun.
However, to put this achievement into perspective, the energy gained by a grain of rice falling 2 cm in the earth's gravity to a plate is more than the total energy received by all the radio telescopes in the world operating since 1960. This means that very sensitive radio receiving equipment is required to detect these faint sources.

The Indlebe project was initiated in 2006 by the Department of Electronic Engineering with the primary object of providing engineering projects and research opportunities to undergraduate and postgraduate students working on a real-world complex electronic system. A secondary objective was to provide a vehicle to increase awareness and interest of secondary school students in the fields of Science, Engineering and Technology (SET), and to promote local awareness of the celebration of the International Year of Astronomy in 2009 (IYA2009).

Indlebe is the Zulu word for ear, an appropriate name for the project when one views the 5 m diameter parabolic reflector antenna of the telescope from above. The telescope is a transit instrument which operates at the Hydrogen Line frequency of 1420 MHz and uses a very sensitive radio receiver to detect extra terrestrial radio sources. A remarkable aspect of the project is that all the hardware, from the antenna and feedhorn to the final analog to digital converter providing a digital representation of the detected source to a pc, has been designed by students and constructed on campus. It is intended that the received data will shortly be made available in real time to interested persons who will be able to graph the data using freely available software.

For further information contact the project leader Stuart MacPherson via email on stuartm@dut.ac.za or by phone on +27 31 373 2538, or visit the Indlebe website at http://indlebe.dut.ac.za/ ■



Plot showing the detected output from Indlebe on 28 July 2008

Milestones of the Indlebe Project:

February 2006	Project initiated
April 2006	First MTech student registered
December 2006	NRF Research Grant funding secured
January 2007	Visit to HartRAO by staff and students
May 2007	Second MTech student registered
July 2007	Three BTech student projects registered
August 2007	Parabolic reflector installed
September 2007	Indlebe website activated
September 2007	Indlebe project recognised as a resource by the IYA
September 2007	Paper presented at SAIEE Africon 2007
October 2007	Receiver prototype completed
December 2007	Visit to Indlebe facility by HartRAO/SKA/KAT team
April 2008	Presentation at SA AMSAT Space Symposium, UKZN
28 July 2008	**First Light - Sagittarius A**

HartRAO takes part in global geodesy experiment

HartRAO News

For two weeks in August 2008, a global network of radio telescopes uses quasars in the distant Universe as radio beacons that provide a reference frame for continuously measuring the rotation and orientation of the Earth, in an experiment called CONT08. The technique of networking radio telescopes on different continents is known as Very Long Baseline Interferometry (VLBI). The 26m Hartebeesthoek telescope is normally used for 24 hours once a week for these measurements.

CONT08 is part of a series of special campaigns to obtain the highest possible quality data for two weeks. These are used to measure a variety of geodetic parameters. One example is the vertical tidal motion of the Earth's surface caused by the Sun and Moon, for comparison with the predictions of numerical models of the effect. Another aim is to measure the Total Electron Content (TEC) of the ionosphere - the upper part of the Earth's atmosphere where the Sun's radiation ionises the gas ("knocks" electrons off the neutral molecules).

The locations of eleven radio telescopes participating in CONT08 are shown to the right. The long baselines in the north-south and east-west directions are essential to maximise the data quality. Only two participating telescopes are located in the southern hemisphere to provide the long north-south baselines - the 6m diameter TIGO near Concepcion in Chile, and the 26m Hartebeesthoek telescope in South Africa.

As CONT08 progressed, technical problems inevitably occurred. The 13cm and 3.5cm wavelength receivers used for these geodetic VLBI experiments are cooled to -257 degrees Celcius using helium gas. The compressors for the helium are located in a room below the antenna. On the evening of Sunday 17 August the helium line to the refrigerators cooling the two receivers starting leaking badly in the telescope structure. Without proper helium flow the receivers started warming up. Rapid action was taken by technician Jacques Grobler who was running the VLBI. He and technician Piet Louw changed the hose and Jonathan Quick started the vacuum pump on the antenna from home via the internet. The situation was retrieved with just a 30 minute gap in observing.

HartRAO was also involved in the successful CONT02 and CONT05 campaigns. ■

progress on MeerKAT: the XDM antenna

by Adriaan Peens-Hough

MeerKAT is South Africa's technology demonstrator and prototype to the Square Kilometer Array (SKA). The first phase, a one-dish prototype, has already been constructed at the Hartebeesthoek Radio Astronomy Observatory (HartRAO) in Gauteng. KAT-7, a seven-dish engineering testbed and science instrument near Carnarvon in the Northern Cape Province, will be commissioned towards the end of 2009, and the full array of 50 or more dishes should be ready to do science by 2012. A high speed data transfer network will link the telescope site in the Karoo to a remote operations facility.

The XDM (eXperimental Development Model) single-dish radio telescope at the Hartebeesthoek Radio Astronomy Observatory in South Africa is the first fully functional prototype to have been built leading up to the MeerKAT array telescope. The telescope was designed and built in less than two years. Detailed operational evaluation started in January 2008 and is continuing. Scientific interest in the preliminary results has led to a proposal to use the XDM, when not being used by the engineers, to monitor the Vela pulsar as part of a study of the spin mechanics of neutron stars.

A brief history of the making of the XDM

- Early 2006 - Design work on XDM antenna started
- November 2006 - Ground breaking ceremony at the Hartebeesthoek Radio Astronomy Observatory in Gauteng
- June 2007 - Field testing performed on the antenna & feed horn
- September 2007 - Laboratory testing and integration started as major subsystems were being completed
- November 2007 - Laboratory integration completed
- December 2007 - On-site installation & integration completed by 12 December 2007

The composite dish being lifted from the mould, to be fitted to the antenna positioner.

Highlights of the XDM antenna

The XDM antenna implemented novel technologies to deliver a relatively inexpensive reflector. The key innovation is surely the dish made from composite materials, which results in a very stiff yet relatively light-weight reflector. Testing at 1.4 and 12 GHz confirmed that the design goals have been achieved, with ~ 65% aperture efficiency at 1.4 GHz and ~ 33% at 12 GHz.

Highlight of the XDM RF front end

The radio frequency front end, which includes the feed horn and the analogue receiver electronics, was installed at the vertex of the antenna in early December 07. Tests show that the front end contributes approximately 45 K to the overall system noise temperature. Excellent temperature stabilization was achieved with off-the-shelf components, including the first ever application of "heat pipes" in radio astronomy, to conduct heat away from the sensitive components in the system. The receiver also incorporates a novel solar shield to reduce the heat loading on the electronics.

The RF receiver package after installation on the antenna, showing the solar shield as well as the scattering cones that were installed in the place of the five non-fitted receivers.

The radio frequency signal is transported from the vertex to the back-end receiver, which is housed in the HartRAO control room, via a fibre-optic transmission system. This minimizes the risk of the signal being contaminated by radio frequency interference in the environment and also minimizes the amount of interference generated by the system itself.

Highlights of the XDM back-end receiver

The digital back-end supports full polarimetric data capturing at rates up to 312 Mbyte/sec. It allows for accurate measurements of the radio continuum spectrum as well as good time resolution measurements of the Vela pulsar. Preliminary results obtained on the Vela pulsar have attracted the attention of some of the local pulsar scientists, leading to a proposal to request that the XDM telescope to be used to monitor the pulsar between engineering evaluation sessions. The back-end receiver has recently been upgraded with the capability to record base band data, which will support studies of spectral line emission.

Highlights of the XDM analysis software

Custom analysis software was produced to support the engineers in assessing the telescope's performance. This software incorporates a novel technique to propagate uncertainties and errors along with the calculations, giving a clear indication of the level of confidence that may be associated with the results.

Highlights of the XDM telescope control software

With the exception of the RF front end, the telescope is completely remote-operable. Not only is this very convenient for the engineering team, who are based in Cape Town, but it will also be a crucial determinant of the success of the KAT and MeerKAT telescopes, to be built in the remote Northern Cape Province.

The default control interfaces of the telescope control system have catered for the vast majority of the needs of the engineering team up to date. The control system has also proven to be sufficiently flexible to allow for unforeseen requirements to be met without necessitating re-development or upgrades.

Find out more about the SKA and KAT at www.ska.ac.za and www.kat.ac.za.■

The RF signal connects to the back end receiver via the unit in the bottom right. These two racks contain the digital receiver, the PC running the analysis software and all of the telescope control PCs.

The XDM telescope at HartRAO with all subsystems installed, integrated and tested.

does time run backward in other universes?

by Sean M. Carroll for *Scientific American*

Sean Carroll is a Senior Research Associate in the Department of Physics at the California Institute of Technology. His research interests include theoretical aspects of cosmology, field theory, and gravitation, and he blogs regularly on Cosmic Variance http://cosmicvariance.com/

The basic laws of physics work equally well forward or backward in time, yet we perceive time to move in one direction only - toward the future. Why?

To account for it, we have to delve into the prehistory of the universe, to a time before the big bang. Our universe may be part of a much larger multiverse, which as a whole is time-symmetric. Time may run backward in other universes.

The universe does not look right. That may seem like a strange thing to say, given that cosmologists have very little standard for comparison. How do we know what the universe is supposed to look like? Nevertheless, over the years we have developed a strong intuition for what counts as "natural"—and the universe we see does not qualify.

Make no mistake: cosmologists have put together an incredibly successful picture of what the universe is made of and how it has evolved. Some 14 billion years ago the cosmos was hotter and denser than the interior of a star, and since then it has been cooling off and thinning out as the fabric of space expands. This picture accounts for just about every observation we have made, but a number of unusual features, especially in the early universe, suggest that there is more to the story than we understand.

Among the unnatural aspects of the universe, one stands out: time asymmetry. The microscopic laws of physics that underlie the behavior of the universe do not distinguish between past and future, yet the early universe—hot, dense, homogeneous—is completely different from today's—cool, dilute, lumpy. The universe started off orderly and has been getting increasingly disorderly ever since. The asymmetry of time, the arrow that points from past to future, plays an unmistakable role in our everyday lives: it accounts for why we cannot turn an omelet into an egg, why ice cubes never spontaneously unmelt in a glass of water, and why we remember the past but not the future. And the origin of the asymmetry we experience can be traced all the way back to the orderliness of the universe near the big bang. Every time you break an egg, you are doing observational cosmology.

The arrow of time is arguably the most blatant feature of the universe that cosmologists are currently at an utter loss to explain. Increasingly, however, this puzzle about the universe we observe hints at the existence of a much larger spacetime we do not observe. It adds support to the notion that we are part of a multiverse whose dynamics help to explain the seemingly unnatural features of our local vicinity.

The Puzzle of Entropy

Physicists encapsulate the concept of time asymmetry in the celebrated second law of thermodynamics: entropy in a closed system never decreases. Roughly, entropy is a measure of the disorder of a system. In the 19th century, Austrian physicist Ludwig Boltzmann explained entropy in terms of the distinction between the microstate of an object and its macrostate. If you were asked to describe a cup of coffee, you would most likely refer to its macrostate—its temperature, pressure and other overall features. The microstate, on the other hand, specifies the precise position and velocity of every single atom in the liquid. Many different microstates correspond to any one particular macrostate: we could move an atom here and there, and nobody looking at macroscopic scales would notice.

Entropy is the number of different microstates that correspond to the same macrostate. (Technically, it is the number of digits, or logarithm, of that number.) Thus, there are more ways to arrange a given number of atoms into a high-entropy configuration than into a low-entropy one. Imagine that you pour milk into your coffee. There are a great many ways to distribute the molecules so that the milk and coffee are completely mixed together but relatively few ways to arrange them so that the milk is segregated from the surrounding coffee. So the mixture has a higher entropy.

From this point of view, it is not surprising that entropy tends to increase with time. High-entropy states greatly outnumber low-entropy ones; almost any change to the system will land it in a higher-entropy state, simply by the luck of the draw. That is why milk mixes with coffee but never unmixes. Although it is physically possible for all the milk molecules to spontaneously conspire to arrange themselves next to one another, it is statistically very unlikely. If you waited for it to happen of its own accord as molecules randomly reshuffled, you would typically have to wait much longer than the current age of the observable universe. The arrow of time is simply the tendency of systems to evolve toward one of the numerous, natural, high-entropy states.

But explaining why low-entropy states evolve into high-entropy states is different from explaining why entropy is increasing in our universe. The question remains: Why was the entropy low to start with? It seems very unnatural, given that low-entropy states are so rare. Even granting that our universe today has medium entropy, that does not explain why the entropy used to be even lower. Of all the possible initial conditions that could have evolved into a universe like ours, the overwhelming majority have much higher entropy, not lower [see "The Arrow of Time," by David Layzer; *Scientific American*, December 1975].

In other words, the real challenge is not to explain why the entropy of the universe will be higher tomorrow than it is today but to explain why the entropy was lower yesterday and even lower the day before that. We can trace this logic all the way back to the beginning of time in our observable universe. Ultimately, time asymmetry is a question for cosmology to answer.

The Disorder of Emptiness

The early universe was a remarkable place. All the particles that make up the universe we currently observe were squeezed into an extraordinarily hot, dense volume. Most important, they were distributed nearly uniformly throughout that tiny volume. On average, the density differed from place to place by only about one part in 100,000. Gradually, as the universe expanded and cooled, the pull of gravity enhanced those differences. Regions with slightly more particles formed stars and galaxies, and regions with slightly fewer particles emptied out to form voids.

Clearly, gravity has been crucial to the evolution of the universe. Unfortunately, we do not fully understand entropy when gravity is involved. Gravity arises from the shape of spacetime, but we do not have a comprehensive theory of spacetime; that is the goal of a quantum theory of gravity. Whereas we can relate the entropy of a fluid to the behavior of the molecules that constitute it, we do not know what constitutes space, so we do not know what gravitational microstates correspond to any particular macrostate.

Nevertheless, we have a rough idea of how entropy evolves. In situations where gravity is negligible, such as a cup of coffee, a uniform distribution of particles has a high entropy. This condition is a state of equilibrium. Even when particles reshuffle themselves, they are already so thoroughly mixed that nothing much seems to happen macroscopically. But if gravity is important and the volume is fixed, a smooth distribution has relatively low entropy. In this case, the system is very far from equilibrium. Gravity causes particles to clump into stars and galaxies, and entropy increases noticeably—consistent with the second law.

Indeed, if we want to maximize the entropy of a volume when gravity is active, we know what we will get: a black hole. In the 1970s Stephen Hawking of the University of Cambridge confirmed a provocative suggestion of Jacob Bekenstein, now at the Hebrew University of Jerusalem, that black holes fit neatly into the second law. Like the hot objects that the second law was originally formulated to describe, black holes emit radiation and have entropy—a lot of it. A single million-solar-mass black hole, such as the one that lives at the center of our galaxy, has 100 times the entropy of all the ordinary particles in the observable universe.

Eventually even black holes evaporate by emitting Hawking radiation. A black hole does not have the highest possible entropy—but just the highest entropy that can be packed into a certain volume. The volume of space in the universe, however, appears to be growing without limit. In 1998 astronomers discovered that cosmic expansion is accelerating. The most straightforward explanation is the existence of dark energy, a form of energy that exists even in empty space and does not appear to dilute away as the universe expands. It is not the only explanation for cosmic acceleration, but attempts to come up with a better idea have so far fallen short.

If dark energy does not dilute away, the universe will expand forever. Distant galaxies will disappear from view [see "The End of Cosmology?" by Lawrence M. Krauss and Robert J. Scherrer; *Scientific American*, March]. Those that do not will collapse into black holes, which in turn will evaporate into the surrounding gloom as surely as a puddle dries up on a hot day. What will be left is a universe that is, for all intents and purposes, empty. Then and only then will the universe truly have maxed out its entropy. The universe will be in equilibrium, and nothing much will ever happen.

It may seem strange that empty space has such a huge entropy. It sounds like saying that the most disorganized desk in the world is a completely empty desk. Entropy requires microstates, and at first glance empty space does not have any. In actuality, though, empty space has plenty of microstates—the quantum-gravitational microstates built into the fabric of space. We do not yet know what exactly these states are, any more than we know what microstates account for the entropy of a black hole, but we do know that in an accelerating universe the entropy within the observable volume approaches a constant value proportional to the area of its boundary. It is a truly enormous amount of entropy, far greater than that of the matter within that volume.

Past vs. Future

The striking feature of this story is the pronounced difference between the past and the future. The universe starts in a state of very low entropy: particles packed together smoothly. It evolves through a state of medium entropy: the lumpy distribution of stars and galaxies we see around us today. It ultimately reaches a state of high entropy: nearly empty space, featuring only the occasional stray low-energy particle.

Why are the past and future so different? It is not enough to simply posit a theory of initial conditions—a reason why the universe started with low entropy. As philosopher Huw Price of the University of Sydney has pointed out, any reasoning that applies to the initial conditions should also apply to the final conditions, or else we will be guilty of assuming the very thing we were trying to prove—that the past was special. Either we have to take the profound asymmetry of time as a blunt feature of the universe that escapes explanation, or we have to dig deeper into the workings of space and time.

Many cosmologists have tried to attribute the time asymmetry to the process of cosmological inflation. Inflation is an attractive explanation for many basic features of the universe. According to this idea, the very early universe (or at least some part of it) was filled not with particles but rather with a temporary form of dark energy, whose density was enormously higher than the dark energy we observe today. This energy caused the expansion of the universe to accelerate at a fantastic rate, after which it decayed into matter and radiation, leaving behind a tiny wisp of dark energy that is becoming relevant again today. The rest of the story of the big bang, from the smooth primordial gas to galaxies and beyond, simply follows.

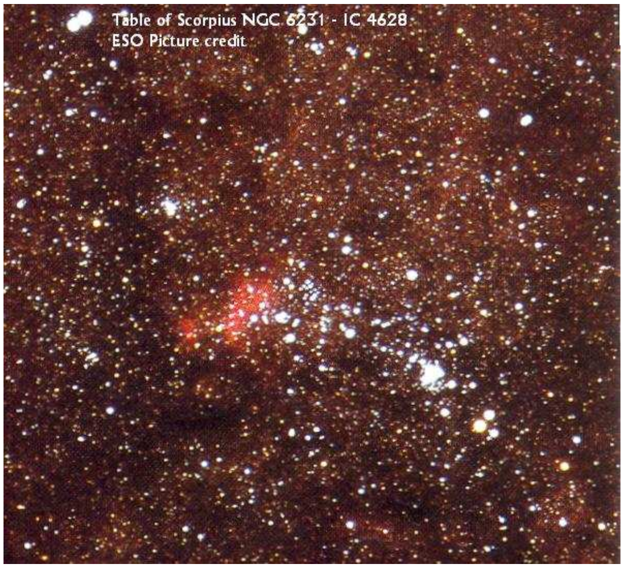
The original motivation for inflation was to provide a robust explanation for the finely tuned conditions in the early universe—in particular, the remarkably uniform density of matter in widely separated regions. The acceleration driven by the temporary dark energy smooths out the universe almost perfectly. The prior distribution of matter and energy is irrelevant; once inflation starts, it removes any traces of the preexisting conditions, leaving us with a hot, dense, smooth early universe.

The inflationary paradigm has been very successful in many ways. Its predictions of slight deviations from perfect uniformity agree with observations of density variations in the universe. As an explanation for time asymmetry, however, cosmologists increasingly consider it a bit of a cheat, for reasons that Roger Penrose of the University of Oxford and others have emphasized. For the process to work as desired, the ultradense dark energy had to begin in a very specific configuration. In fact, its entropy had to be fantastically smaller than the entropy of the hot, dense gas into which it decayed. That implies inflation has not really solved anything: it “explains” a state of unusually low entropy (a hot, dense, uniform gas) by invoking a prior state of even lower entropy (a smooth patch of space dominated by ultradense dark energy). It simply pushes the puzzle back a step: Why did inflation ever happen?

to be continued next month… ■

focus on: the table of Scorpius

by Magda Streicher



Much discussion and speculation has been woven around the reference known as Table of Scorpius. The part just off Zeta 1/2 Scorpii is located where Scorpius displays that elegant turn in its tail. The area is rich in star clusters bathing snugly in the nebulosity membranes of the Milky Way. In ideal dark-sky conditions the environment is a veritable feast for the eyes, with outstanding character.

To be more precise: it is probably the area around Trumpler 24 that accounts for the reference Table of Scorpius. Robert J. Trumpler was a Swiss-American astronomer who discovered this cluster, which covers a large area with various-magnitude stars. It is partly suspended, and embedded in the southern nebulosity of the faint nebula IC 4628. Included in this Table senario is the outstanding bright cluster NGC 6231 south of Trumpler 24, which contains a combination of various-magnitude stars (127x).

Dark lines can be seen between the star points, with a more prominent uneven line running through the cluster from NW to SE. The SW part shows up well with brighter stars, whereas the NE part has far fewer stars and is not so outstanding. Seen with the naked eye the cluster and environmental nebulosity exhibit comet-like characteristics, making the additional name, False Comet, quite fitting. The cluster was discovered by Sir John Herschel, who was probably responsible for the names Table of Scorpius and False Comet.

With Table Mountain in mind, a few of us have speculated quite widely on whether Trumpler 24 and IC 4628 might represent the mighty Table Mountain, with the cluster NGC 6242 possibly being a reference to the Mountain's northern peak (Signal Hill) and NGC 6231 referring to the southern peak (Devil's Peak). Table Mountain with its usually cloud cover must have made a great impression on John Herschel’s thoughts. This area in Scorpius with its wonderful objects may well have inspired his thoughts and led him to mentally linking what he saw in the stars with the beautiful scenery around Table Mountain and its impressive surrounding peaks. ■

Name	Object	RA	DEC	Magnitude	Size
NGC 6231	Open Cluster	16h54.0	-41o48’	2.6	14’

the sky this month

site location: lat. **26.0 deg S** long. **28.0 deg E** local time = UT **+2.0 hrs**.

september 2008

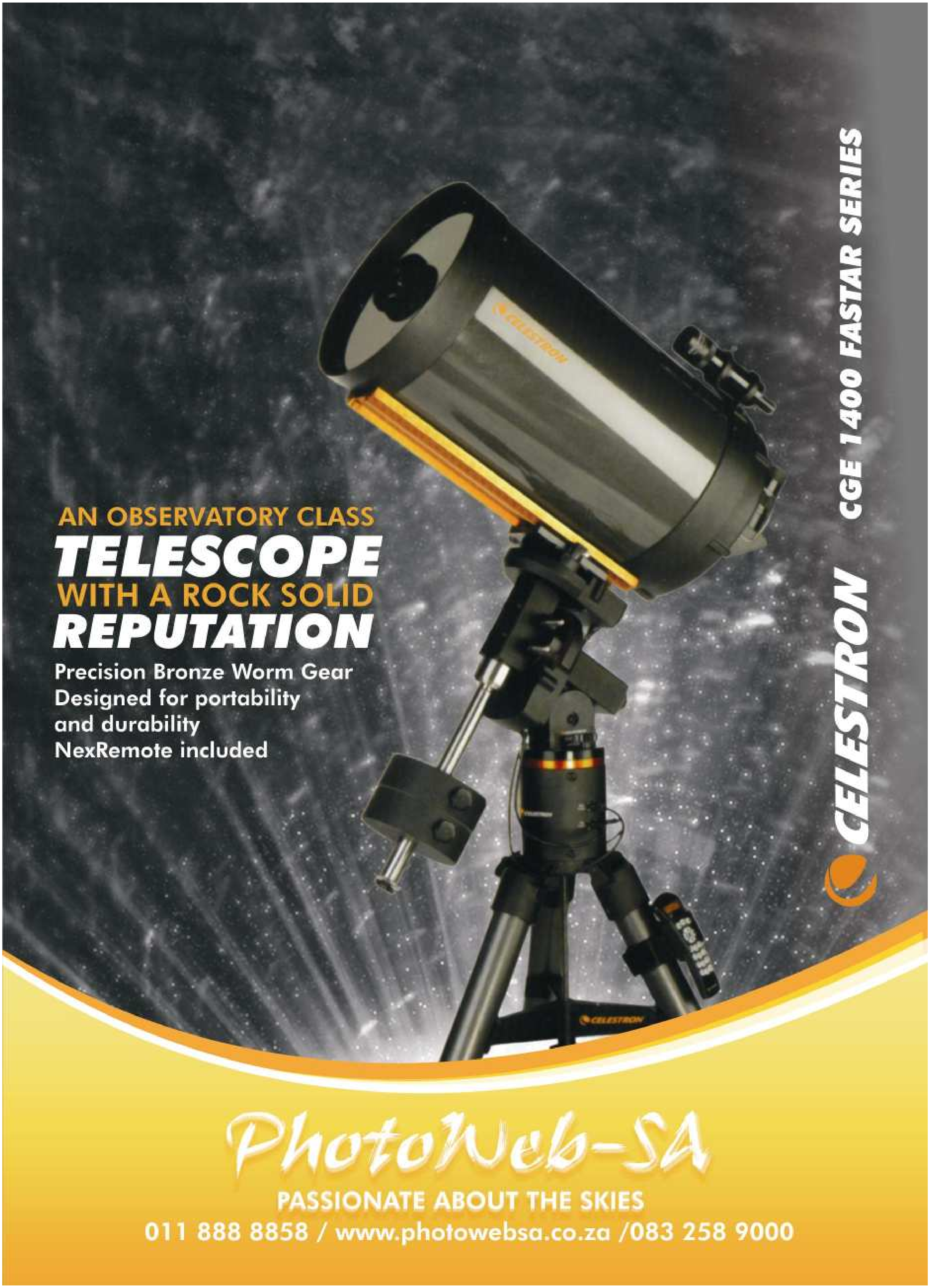
dd hh			dd hh		
1 17	Venus 4.7N of Moon		14 20	Mercury 3.6S of Venus	
1 22	Mercury 2.5N of Moon		15 06	Uranus 3.6S of Moon	
2 05	Mars 4.5N of Moon		15 10	FULL MOON	
3 09	Spica 2.7N of Moon		19 05	Venus 2.4N of Spica	
4 02	Saturn at conjunction		20 04	Moon at perigee	
7 04	Antares 0.3N of Moon	Occn	22 06	LAST QUARTER	
7 15	FIRST QUARTER		22 16	Equinox	
8 04	Jupiter stationary		23 03	Mercury 4.0S of Mars	
8 19	Mercury 2.6S of Mars		23 22	Pollux 4.6N of Moon	
9 07	Pluto stationary		24 03	Mercury stationary	
9 21	Jupiter 2.7N of Moon		25 05	Mars 2.3N of Spica	
11 03	Mercury greatest elong E(27)		27 17	Saturn 4.1N of Moon	
12 03	Venus 0.3N of Mars		29 09	NEW MOON	
13 02	Neptune 0.7S of Moon	Occn	30 11	Mercury 1.0N of Moon	Occn
13 03	Uranus at opposition		30 17	Spica 2.6N of Moon	

october 2008

dd hh			dd hh		
1 01	Mars 5.0N of Moon		21 04	Pollux 4.7N of Moon	
1 23	Venus 4.8N of Moon		21 12	LAST QUARTER	
4 12	Antares 0.1N of Moon	Occn	22 18	Mercury greatest elong W(18)	
5 12	Moon at apogee		23 20	Regulus 1.7N of Moon	
6 21	Mercury inferior conjunction		25 05	Saturn 4.5N of Moon	
7 08	Jupiter 2.4N of Moon		26 23	Venus 3.1N of Antares	
7 10	FIRST QUARTER		28 00	Spica 2.6N of Moon	
10 10	Neptune 0.8S of Moon	Occn	28 23	NEW MOON	
12 13	Uranus 3.6S of Moon		29 23	Mars 4.9N of Moon	
14 21	FULL MOON		31 19	Antares 0.1S of Moon	Occn
15 06	Mercury stationary		31 21	Mercury 4.0N of Spica	
17 09	Moon at perigee				

local times of rise and set for the sun & major planets

Date	Sun		Mercury		Venus		Mars		Jupiter		Saturn	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
Sep 07	06.14	17.50	07.15	19.58	07.21	19.45	07.27	19.59	12.39	3.09	06.16	17.35
Sep 17	05.59	17.57	06.53	20.04	07.12	20.05	07.04	19.51	12.00	2.30	05.40	17.01
Sep 27	05.45	18.05	06.17	19.36	07.04	20.25	06.42	19.44	11.22	1.52	05.03	16.28
Oct 07	05.31	18.13	05.23	18.12	06.58	20.47	06.20	19.38	10.46	1.16	04.27	15.54
Oct 17	05.17	18.21	04.40	17.00	06.56	21.08	06.00	19.32	10.11	0.40	03.55	15.24
Oct 27	05.05	18.30	04.28	17.03	06.58	21.30	05.41	19.27	09.38	0.06	03.18	14.49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