CANOPUS

The Astronomical Society of Southern Africa

Johannesburg Centre

Monthly Newsletter for October 1999

Contents:

The Sir Herbert Baker Library, 18a Gill Street, Observatory, Johannesburg
P.O.Box 93145, Yeoville, 2143

Editorial

Well, even though we didn't see it down here in South Africa, the astronomical news was greatly taken up with the Total Solar Eclipse on the 11th August. Your editor managed to view a really magnificent picture (one of the last to be taken) shot from the soon to be deliberately de-orbited Russian space-station Mir. This station, notwithstanding its checkered history, has performed some really good science, and it is a pity that funds to prolong its useful life cannot be found. All available funding is, of course, now being channeled into the project to create the new International Space Station (the ISS) which will hopefully have a centuries long life.

Talking of the Eclipse, we have included a couple of articles submitted by our ever-vigilant reporters….read them for some interesting viewpoints.

Danie has supplied a good variable for all you VSOs - but even if Variable Star Observations are not your own personal cup of tea, we recommend that you observe this star for your own edification - who knows, it might set you on the Variable path!

Maureen Chitters reports back on the Annual trip to the Boyden Observatory and some very interesting snippets of astronomical information are included for your perusal. Interested in information regarding "Skyhooks" - then read Bill Wheaton's intriguing article which shows how this may be accomplished. Brian in addition to submitting a couple of good articles, has supplied the Astronomical Calendar for the next 2 months and Melvyn's eagle eye always manages to spot something on astronomical interest..

For those of you who still have to pay your annual subs, the October issue will unfortunately be your last until the monies arrive. So if you enjoy our efforts at keeping you informed of matters astronomical, please pay your subs and advise Constant so that we can keep you on the mailing list. *Canopus costs in excess of R500-00 per month to print and post and we cannot afford to produce what we can't pay for.*

We have a regular core of authors who supply some pretty good articles - but we'd still like to get articles from any and all of you out there - we promise never to reject any article out of hand - remember, this is ***Your*** magazine so all submissions will be included with the absolute minimum of editing.

The Editor

Chris chris@aqua.co.za

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Notice of Meeting

The **October** meeting of the Johannesburg Centre of the Astronomical Society will be held in the Sir Herbert Baker Library, 18a Gill Street, Observatory, on Wednesday the 13th of October, 1999 at 20:00.

Topic:

How to use Setting Circles

Ed Finlay

Future Meetings

November 10th	The Leonids	One of the T's
December 11th	Year End Star Party	At Tom's Farm
January 12th	METSOC 1999	Trevor Gould
February 9th	Computers in Astronomy	Chris[2]

Dark Sky Viewing

On the Saturday nearest New Moon at Tom Budge's Farm in the Magaliesberg.

11th September	6th November	*Year End Star Party*
9th October		11th December

Haartebeeshoek

Set aside Saturday the 23rd of October for a group visit to the Haartebeeshoek Radio Telescope Facility. Remember that there will be a small charge levied for this privilege (R5), and please give your name to Constant so that the number of visitors can be communicated to the Haartebeeshoek admin people beforehand.

Annual Subscription Fees

At the AGM, some of changes to the structure of the annual subscription fees were introduced and passed by a majority vote. The joining fee has remained unchanged at R50-00, But the annual subscription fee has been raised to R100-00. However, to offset this increase in fee, we have introduced a family membership fee of R125-00. With a family membership, the main difference is that although all family members receive full rights as members of the Centre, only one copy of the monthly magazine, Canopus, will be posted to the family address. Also, family membership is restricted to a couple and their dependants. Please post your subscription fee, or deposit/transfer it directly into the Society's bank account at **NEDBANK**. The Account information is as follows:-

Bank:	NEDBANK
Branch Name:	Park Plaza
Code:	19 21 42 44
Account Type:	Current Account
Number:	1921 013761
Name:	ASSA Johannesburg Centre

Please remember to write your name on the deposit slip or to include your name as a reference on a direct transfer. Then fax the details to the Chairman to let him know that you have paid via direct deposit or transfer so you will be kept on the Canopus mailing list**.**

Our Fax Number is (011) 339-2926

Variable of the Month:

2338-15 R Aquarii

Advancing age forces me to draw in my variable star observing horns and I do this by dropping certain old friends from my observing repertoire. One such is R Aqr, which I had been observing since the early 1950's. I hope that one or more Canopus readers will now take over this fascinating star.

Burnham, who devotes two pages to it, describes it as "An interesting and peculiar variable star . . . it sometimes reaches 6th magnitude and has an average period of 386 days, but individual periods may be very erratic.

R Aqr is a red pulsating giant of spectral class M7e, resembling the long period variables . . . the existence of a companion star seems definitely established . . .There is little doubt that both stars are intrinsically variable. FW Merrill has applied the term 'symbiotic stars' to objects of this type."

Burnham gives a good light curve of the variable, showing just how much its variability changed during a period of eight years.

R Aqr lies near some 5th magnitude stars and is easily found with the aid of Nortons. Enjoy it.

Danie Overbeek.

Professor Brian Warner's Talk

As I felt that we are miles behind our Antipodes friends in photometry activities, I suggested to Professor Warner that he address the Johannesburg Centre on the recent amateur/professional Southern PEP Conference, held in New Zealand, and on the activities of the celebrated "Centre for Backyard Astrophysics" (S&T, 1998 October). He obligingly changed his travel plans and gave us a talk on September 1. The talk proved me wrong: We are light years, not miles behind.

Professor Warner suggested that we look at the possibility of organising a Southern Africa conference on amateur photometry. This is a good idea but I think we should have a preliminary meeting to establish just how much commitment there is in our ranks to an activity which will be no pushover. I suggest that the Johannesburg Centre Committee organise a meeting, perhaps associated with a regular monthly meeting, in order to sound out members. The committee should try to ensure the presence this time of the five capable, computer-knowledgeable senior members who were invited to the Warner talk and who did not seem to be able to make it, so that we can have the benefit of their experience, knowledge and judgement.

Pretoria Centre members should be invited to the preliminary meeting, especially Sarel P Wagner. As a curtain raiser to the ASSA AGM on July 28, Sarel gave us a fascinating talk on TASS (S&T, 1998 February). TASS, the amateur sky survey, is up and running under the enthusiastic leadership of Tom Droege, who has been incredibly generous to promising beginners. Tom plans to visit South Africa next year in order to deliver one of his specialised CCD cameras. If a conference does get off the ground, it should be organised so as to include him. Perhaps Sarel Wagner has already done some work in this regard.

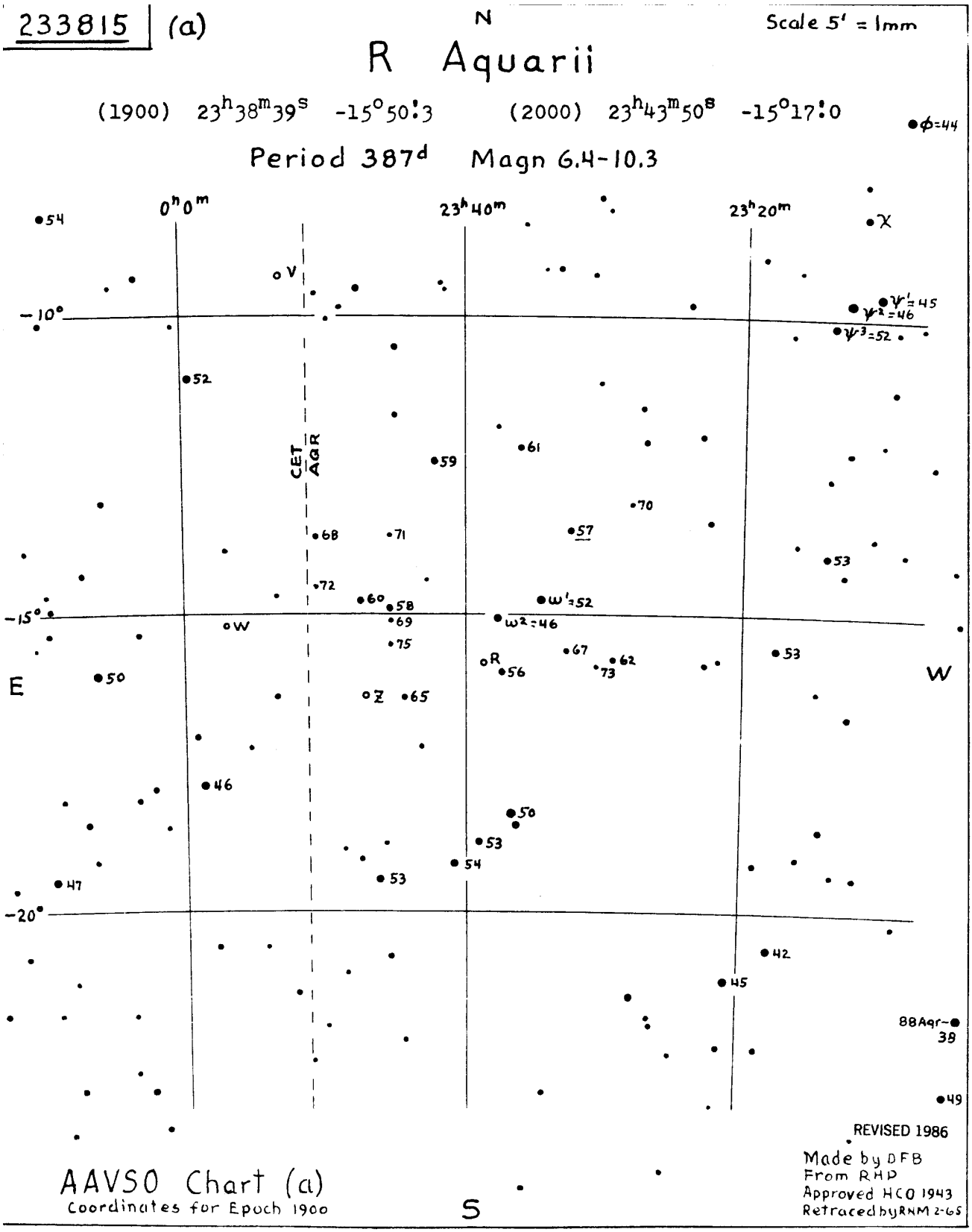
I am not active or computer-literate enough to take a leading part in this exciting new field but feel very strongly that we should start right now in an attempt to catch up with the civilised world, and not hide behind the usual excuses such as an unfavourable Rand-Dollar exchange rate and crime.

Danie Overbeek

Chart for Variable of the Month

2338-15 R Aquarii

(North at the top of the chart)



JPL and NASA News

Bill Wheaton, IPAC 1999 October

Progress

Despite what often seems like endless problems, the past month or two has seen a substantial advance in a number of programs and projects. The great Chandra X-ray Observatory has been checked out in orbit and recently returned a beautiful image of the Cas A supernova remnant, including as a bonus, the discovery of a unresolved X-ray source near the center which seems likely to be the neutron star (or possibly black hole) remnant of the explosion. Cas A exploded about 1680 (based on the expansion rate of the ring of debris, as seen, for example, in the radio) but was never observed optically at the time. The observatory is now in its final orbit and all the experiments aboard seem to be working well. Then again, Cassini took some nice pictures of Earth and Moon during its flyby on 18 August, and collected science and calibration data from several other instruments as well; by the time you read this it will be near crossing the orbit of Mars on its exit from the inner Solar System.

Lunar Prospector crashed into the Moon on schedule but nothing whatever has been detected so far. It is, I hope, fairly obvious that, despite some negative media comment, this says practically *nothing* about the presence or absence of ice on the Moon! Further analysis may reveal something, but for now we are simply left with the previous strong evidence from the on-board instrumentation that ice has been detected. Meanwhile, NEAR (Near Earth Asteroid Rendezvous) is easing towards its delayed encounter with 433 Eros, now due in February. In early September it was 426,000 km out, and by the time you read this it will be substantially closer than the Earth/Moon distance. Of course a 40 km object as far away as the Moon is not exactly an awesome sight; but neither is it any longer point in a small telescope. So we are making progress. DS1 had some last-minute problems with its autonomous pointing that caused it to miss the best pictures of 1992 KD (which has lately been renamed "Braille", in honor of the inventor of the system of printing for the blind). Nevertheless, a spectrum was obtained which indicates Braille is likely to be a fragment knocked off of Vesta, one of the largest and most interesting main-belt asteroids. Vesta has been seen to have a large crater, and it is suspected that Braille may have been ejected in the event that created it.

Finally, an exciting JPL shuttle payload is awaiting launch at the Cape. It is curious that the outstanding radar images we have of Venus, with a planet-wide resolution of the order of 100 m, do not exist for Earth. The Shuttle Radar Topography Mission (SRTM), next in line to fly, should remedy this deplorable situation, using the same sort of synthetic aperture radar that gave us our wonderful topographic maps of Venus. The mission has been delayed while the orbiter *Endeavour* and all the other orbiters in the fleet have the condition of their wiring checked, as a result of a scary situation that arose during the Chandra launch. The two of the computers that control the main engines dropped off-line due to a fault in the wiring, caused by mechanical abrasion to wiring in the orbiter payload bay carry-through. Fortunately each engine has an redundant backup controller, and those took over so there was no actual effect on the flight. However, loss of even one main engine so early in a flight would be an extremely serious situation. To make the situation even more alarming, other independent wiring damage was discovered in follow-up inspections, so the entire fleet is being checked. Troublesome as this may seem (and is), we should count ourselves fortunate to have received such a clear warning of something amiss. From a certain point of view, every anomaly is an opportunity to follow-up and learn about the system *without* paying the full price, the awful *Challenger* price, of bitter experience.

The Skyhook Dream

Many years ago, in 1967, a famous letter appeared in *Science* that proposed the idea of an orbital "skyhook", an idea which Arthur C. Clarke later made into the basis for his novel "The Fountains of Paradise". The idea is elegant and beautiful, but has never come to fruition because of a few ugly and inconvenient facts about engineering materials. Fairly recently a crack has opened in what seemed an impossible

barrier, so I shall use the remainder of my column this month to review the skyhook idea, show why it has never quite been workable, and describe the developments that give grounds for hope that this marvelous dream may yet come true.

Of course nowadays everyone understands that low-altitude satellites orbit quickly, in as short a time as 90 min, while high altitude ones take longer, up to over 27 days for Luna, the Earth's Moon. Thus there must be some altitude at which a satellite orbits in exactly 24 hours, or one day, and thus appears stationary in the sky, eternally fixed over one point on the Equator. Almost the entire space communications industry and much of the global communications network is of course based on these commonplace facts.

One simple way to view the situation is to notice that as the altitude increases, the Earth's gravitational pull drops as 1/*R²*, where *R* is the distance from the center of the Earth. This is just Newton's Law of Gravitation, informing us that if we increase *R* by some factor, say 10, then the gravitational force will decrease by that same factor squared (10 × 10 = 100), to 1/100 of its previous value. Furthermore, as gravity decreases, the "centrifugal force" increases with *R* like *R/P²* for a given orbital period *P*. For a circular orbit, these two forces are in balance; and thus *P* must decrease as *R* increases.

Now consider a long, thin satellite in geosynchronous orbit (GSO):

A long thin rod, in a 24-hr orbit of the Earth,
viewed looking down from the North Pole.

The entire rod, being rigid, must orbit in 24 hours, yet the portions inside the GSO circle at 42,242 km are moving too slowly to maintain an independent orbit. Likewise, those portions at the other end outside the GSC circle are moving too quickly. The inner portion will then find itself out of balance between gravity and centrifugal force, with gravity the stronger; it will therefore tend to fall farther in. The outer portion, for which the centrifugal force will exceed gravity, will likewise tend to move further out. The end result will be that the rod as a whole will rotate itself along a radius vector, pointing at the center of the Earth Notice that the entire rod would be in tension due to the excess of centrifugal force at the outer end, and gravitational force at the inner.

Now suppose that instead of a rod, we were to use a long flexible cable. The same argument would apply, and the cable--assuming it did not become hopelessly tangled--would also take up a radial orientation, pointing towards the center of the Earth. Finally, imagine that the cable were made very very long, so that the inner end approached the Earth and the outer end moved far out beyond GSO, the whole still maintaining its 24 hr period. Evidently the tension in the cable might be very considerable.

However the really interesting thing is that the inner end, being stationary with respect to the surface, could even reach the atmosphere, and finally touch the ground, where it would appear to be simply hanging out of the sky, stretching up into infinity. Impossible as it may seem at first, one could then seriously consider attaching the hanging end to the Earth, and finally *climbing the cable into space, with no expenditure of rocket power at all!*

If all this sounds incredible and too good to be true, you are almost right -- almost no real available engineering material is strong enough to withstand the tension needed. A uniform steel cable, with a typical working strength of 100,000 psi (about 700 MPa), could only support its own weight to a length of 90 km or so. To be sure, it is possible to make cables longer than this by tapering them, so that as the weight increases, the cross-sectional area and strength do too. Then the cable grows in area (and mass) exponentially with height; a 1 cm dia steel cable would grow to roughly 10^{10} km before it reached GSO: hardly promising! Fortunately, there are better materials than steel to consider.

It turns out that the figure-of-merit for a cable material is its tensile strength divided by its density; which is essentially equivalent to the longest length for a uniform cable mentioned above. Richard Smalley, Nobel Prize-winner for the fullerene carbon "buckeyball" discovery, believes carbon nanotubes can be expected to have a strength of the order of 130 GPa, and a density several times less than steel. With such characteristics, the mechanical problems would essentially disappear. Smalley is optimistic that such fibers can be produced in sufficient lengths, although this has not yet been achieved. Finally, according to Dr. Robert L. Forward, the best currently available material is already over 40 times superior to steel in the critical strength/density parameter, (in particular, AlliedSignal Spectra(R) 2000, which he quotes as having 4 GPa tensile strength, density 0.95) and has already been tested in orbit. This is sufficient to bring the GSO cable into the realm of serious possibility. Thus, after decades of living in the realm of unicorns and other fabulous mythical beasts, space cables seem to be poised at the edge of revolutionizing the possibilities for inexpensive space access.

Mounting required

Philip Hawkins of the Midlands Centre has an 8" F6 Tasco Newtonian and is looking for a suitable mounting for it.

Any “Canopus” reader who may be able to assist him, can contact him on 0331 460 0303.

Photography? Photometry? CCD Camera?

Do you need a good telescope mount?

Prof Brian Warner gave an interesting talk at the observatory on Sept 1st, which was, as always, much enjoyed by those who attended.

The gist of the lecture centred around the wonderful work amateur astronomers are doing with modest equipment, mostly collaborating with professional astronomers. Indeed some of the results obtained are of professional quality. All you have to do is put a CCD camera on your telescope and you too can do high quality serious astronomy. Well, sort of.....

What you need to do this type of astronomy is this :-

1. A decent telescope.
2. A good mounting with a very good motor drive.
3. A CCD camera or Photometer. This will probably be connected to
4. A computer.

Now quite a number of us have items 1 and 4. Obviously the bigger your telescope the fainter the objects you can see - with a 12-inch telescope you can get down to about 18th mag with a CCD camera - but a 10-inch or even 6-inch will enable you to join some of the serious programs that are currently under way. Prof Warner talked about item 3 and there are lots of alternatives on the market.

But item 2, the mounting with a good, accurate motor drive is one item few people have on their telescopes. Certainly not the quality to do long term photography or photometry.

This talk has prompted us to make enquiries about having a batch of motor driven mountings made up by an engineering firm.

We are looking for a German equatorial mounting that will have an accurate motor drive and probably digital setting circles. It may also have motor adjustment on both axes.

It will be a standard size but will have different attachment plates to fit any size tripod/pier and any size telescope.

Perhaps the Mark 2 version could have connections to a PC so that you could automatically move to any object in the sky

If you are interested in acquiring a good mount for your telescope then please contact me ASAP. The more we have made up the lower the cost will be.

Brian Fraser
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Science from Young People

I'm not sure how clouds are formed, but clouds know how to do it, and that's the important thing.....

Water vapor gets together in a cloud. When it is big enough to be called a drop...it does.

Rain is saved up in cloud banks.

Mushrooms always grow in damp places, which is why they look like umbrellas.

Some people can tell what time it is by looking at the sun, but I have never been able to make out the numbers....

When planets run around and around in circles, we say they are orbiting. When people do it we say they are crazy.

Submitted by **Melvyn Hannibal.**

Report back on the Trip to Boyden Observatory

by Maureen Chitters

My teenage children share little of my interest in astronomy, but we all eagerly await the annual trip to Boyden. To look *at*, never mind *through*, the 60-inch is fascinating, and the library is a treat! As keen campers, we find the relative luxury of the accommodation available at the facility part of the attraction of this expedition. We plan what food, utensils, layers of clothing and selected friends to take with us well in advance. This year, however, the friends let us down, and so my children decided not to join me. I don't miss Boyden (3 years now), so ended up travelling as Constant's passenger, rather than taking another car. Constant is a very careful driver, and with nothing to worry about for the next two days, I relaxed as we chatted the whole way down. And so began an astonishing weekend…

The first astonishing thing was that there were very few takers for this trip. Johan van Niekerk with two friends (for Friday night only), and Rob, whose wife accompanied him for the trip but stayed in her room working, were the only other members from the Johannesburg Centre. Solly, an eager and capable assistant at living at Boyden, and Marty Hoffman welcomed us, and joined in stargazing on both nights, and a braai on the second night.

Astonishing too was the sky. It was dark and wonderfully clear on Friday. Marty opened the 60-inch telescope, which has had a new computer upgrade to make for easy finding. We looked at Omega Centauri, the Lagoon Nebula, the Swan Nebula and Centaurus A. Marty showed us the Metcalf(?) scope, but we didn't use it.

Solly took us on a sky tour with the 13-inch. We looked at many of the same areas we had seen through the 60-inch and then again using the binoculars to get the full spectrum of views. On Rob's advice for apprentice astronomers like me, we concentrated our sky tour to a small piece of the sky - mostly in the vicinity of Crux and Scorpuis.

On Saturday, (after a long bath, there being little bathroom competition!), Constant took me on an astonishing tour of Bloemfontein. We started at a very well-stocked but quaint, antiquarian-looking bookshop, and then did the tourist bit at the Woman's Memorial and the Anglo Boer War Museum. After lunch we did and the Orchid House (and a brandy-and-coke with some friendly local braaiers in the park), and Naval Hill's ex-observatory (now theatre) and nature reserve. We saw a couple of giraffe and two varieties of buck.

On Saturday night, there was a problem with the right ascension drive on the 60-inch, and we were unable to use it. However, using the 13-inch I experienced the most astonishing of all for me - looking at Venus, something I had never seen through a telescope before. Solly put it into tracking mode, and we gazed at it while we braaied. The moon-like crescent was wondrously bright (apparently it will be full again in mid September). To see that the bright star hanging so visibly in the low western sky was but *a small illuminated piece* was astounding. We made extensive use of David Levy's *Skywatching*, and some 'observing fluid' (Old Brown's).

Like Johannesburg, Bloemfontein's weather was mild for July, with warm days. This made for an even more comfortable trip. Thanks to Boyden for their hospitality. It was a most extraordinary experience!

The Magic of an Eclipse

What is it really like to witness a total eclipse of the sun?

I have never seen one but more and more I am getting the message that it is a fantastic, emotional event to see. Here is a report from a friend in Switzerland. He is an amateur astronomer and a science teacher. As he says, he knew exactly what to expect but was totally overwhelmed by the emotions he felt.....

His home language is not English but I think he describes the event magnificantly.

Hello Brian

Yes, I saw the eclipse but it was really great luck!!!

We decided to travel to the path of totality a day before the event. Due to the wheather forecast which was terrible we then took off to the only place where a 50 - 60 % chance of reasonable good wheather was expected. We headed towards the border of Germany / France along the Rhine river which is protected by hills on both sides, so that some breaks in the cloud cover sky were expected.

By that time the freeway was quiet and we arrived 4 hours early, but the sky was black, full of clouds. We drove further west to France but up the hills the weather got worse. Many people gathered along the roads and had build up their telescopes etc. (they didn't see anything as we found out later).

We decided to return to the Rhine valley and got there just before 11.00 o'clock when the moon was supposed to start covering the sun. We found a place surrounded by corn fields and not many people standing in the way and asking silly questions!

By that time nothing was functioning anymore: 50 to 80 kilometers traffic jams, overloaded trains (people who tried to go to a better place) etc.

We watched the eclipse through thin clouds with our eclipse-glasses and by projection.

The kids were quite enthusiastic and the clouds somehow managed to get around our place most of the time. The light was strangly pale and the shadows got sharper, the women felt cold and I looked for other natural signs showing the upcoming total eclipse. The only thing I noted was a huge black cloud piling up in the NW but not moving very fast. I mentioned to change our observing site once more. Nobody wanted to move...

Then things happened so quickly that it took me a quarter of an hour to recover from all those impressions. I took out the big binoculars (25x100) to observe the totality without filter. Some minutes before the great event we called all the children to come out of the corn fields to watch the sun go. The huge black cloud had moved very close to us.Then somebody turned the dimmer of our sun slowly and then ever faster. I haven't felt so lonely and tiny for a long time if ever. In the west (the sky thickly covered with black cumulus) a black shadow rose and grew quickly. No noise was heard but the darkness fell across the land like a blanket. And then we saw the corona and many huge beautifully red protuberances. Everyone wanted to take a look and so I looked around and tried to grasp as many impressions as possible of this absolutely fantastic natural phenomenon. My daughter Seraina was holding Astrid's hand and didn't look quite healthy anymore! It really shaked every single one of us and touched something very deep inside us. I didn't ever expect to feel that way because as an amateur you know exactly what's going to happen in terms of celestial mechanics etc. but the emotional part is hard to describe and I only know I want to see that again!!!

Two minutes is a short time and the eclipse was over and you could actually feel - not hear - a deep sigh, a relief that the sun was still there and quickly lighten the scenery. We meant to see some bats but are not quite sure.

Exactly 2 minutes later the huge black cloud covered the sun for the next hour or so!

We were absolutely lucky to have witnessed this great event and it took several minutes until life was something like back to normal.

Back home we found out about some friends that managed to get very close to our site and didn't see a thing!!! (only about 1,5 km away!!)

On the way back we got plenty of rain and storm but it didn't bother us at all.

I haven't been impressed so deeply by a natural phenomenon before and I really understand people of ancient times who were afraid etc.

Thanks for listening and best regards,

Mike

Submitted by: **Brian Fraser**

Another Eclipse viewpoint from an old Friend

Hi guys,

Well, I stood in the shadow of the moon last Wednesday. If I had only been a kilometre away (in the vertical direction), I could have seen the whole event. As it was, there was heavy cloud and rain until five minutes AFTER totality, whereupon it cleared up somewhat.

The arc of the sun which points in the opposite direction from all the others, is a glimpse of the sun through heavy cloud just moments before totality. The corresponding one pointing in the other direction, is just moments after totality. You can see a group of sunspots near the centre of the sun, and an isolated one near the limb, on the other two pics. The "night" shot is taken at totality, about 12h23 local time.

In the self-portrait, Severine is to my left (the right of the picture), and Elke on the other side.

I suppose we shall have to try for Zim in 2001.

Cheers,
Chris Stewart

A Belated Response

At the last meeting you read out a question from an enquirer. I immediately forgot about it, until now. You've probably got some answers but, and I may be wrong, I thought the book by R H Allen entitled “Star Names: Their Lore and Meaning” might be the sort of book he's looking for, being all about their history and mythological origins. I'm sure I've seen it being sold in the Planetarium. It's also sold by Sky Publishing Corp.

Cheers

Tony (Golding)

[vsnet-chat 2271] A new cosmology site!

Hello, this is **Ikuya Yamada** of Project Plus Net.

I am writing this to inform you that our team opened a brand new educational site about astrophysics,
"THE COSMOLOGY - EXPLORE THE LARGEST MYSTERY."

Its URL is
<http://library.advanced.org/28181/>
Please visit our site!

This mail can be reprinted.
If you could reprint this mail to mailing lists, news groups, and BBS related to physics, astrophysics, and educational sites, that would be very helpful.

Following article is the overall description of our site.

This site is an educational web page designed to teach precisely about the most recent cosmology.

The contents are based on texts about the universe today, the history of the universe, and the future of the universe. Also we have added several images, photographs, animations, and simulations to make easier understanding for students in high school.

All texts are supervised by Toshiyuki Kanazawa at University of Tokyo, Theoretical Astrophysics Group (UTAP). We based the contents of the texts, on the lectures of assistant professor, Masayuki Umemura, at Center for Computational Physics at Tsukuba University. So the contents are up-to-date and can be trusted.

Our site stresses on the point of cooperative learning with other users.

The users can take part in Virtual School on the web, and can cooperate studying with other users.

Once you visit our site, please register in the Virtual School.

You can participate in courses opened by proposers. Also you can open a course yourself.

Users can grasp which registered user is logged in, so users can send/receive personal messages and communicate in real time. Also, by using the forum, chat and BBS set for every course, and whiteboard that can be share through network, users can exchange opinions on cosmology in a most up-to-date style.

To support your studies, there is a glossary you can register and a search engine. There is a BBS and related links you can register on the bottom of every text, so you can always study the most recent information precisely.

After studying, you can review the whole studies by Shockwave animation, and you can deepen your understanding through these; simulations of red shift and universal gravitation by Java, animations on the structure of universe, four forces, and Hubble's law, virtual particles, quarks, and evaporating black hole.

Also, in order to get in touch with the most recent cosmology, we visited the Center for Computational Physics at Tsukuba University, and took videos of CP-PACS that appeared on the Book of Guinness as the world's fastest computer in 1997.

If you have any comments on this site or this mail, please inform us at
28181@advanced.org

If you want to use this site as educational material, please inform us at
28181@advanced.org

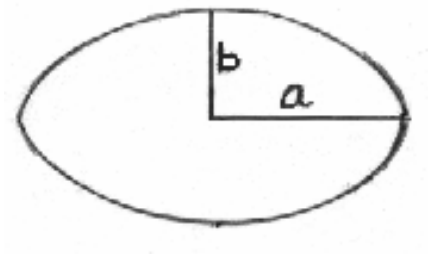
Submitted by **Brian Fraser**

CLASSIFICATION OF THE GALAXIES

During the 1920's E P Hubble, assisted by M L Humason and V M Slipher, using the 2,5 metre (100 inch) Mount Wilson telescope, found that the galaxies are all receding from each other and the fainter they are (and thus the further) the faster they are receding. This was known because their redshifts got greater as the galaxies got fainter. The H- and K- lines of ionised calcium in the spectrum, were the phenomena that made this determination of redshift possible.

Hubble noticed that there were many and varied forms (shapes) of galaxies and he decided to classify the galaxies according to their shapes and forms, a morphological classification. This classification implied no evolutionary sequence.

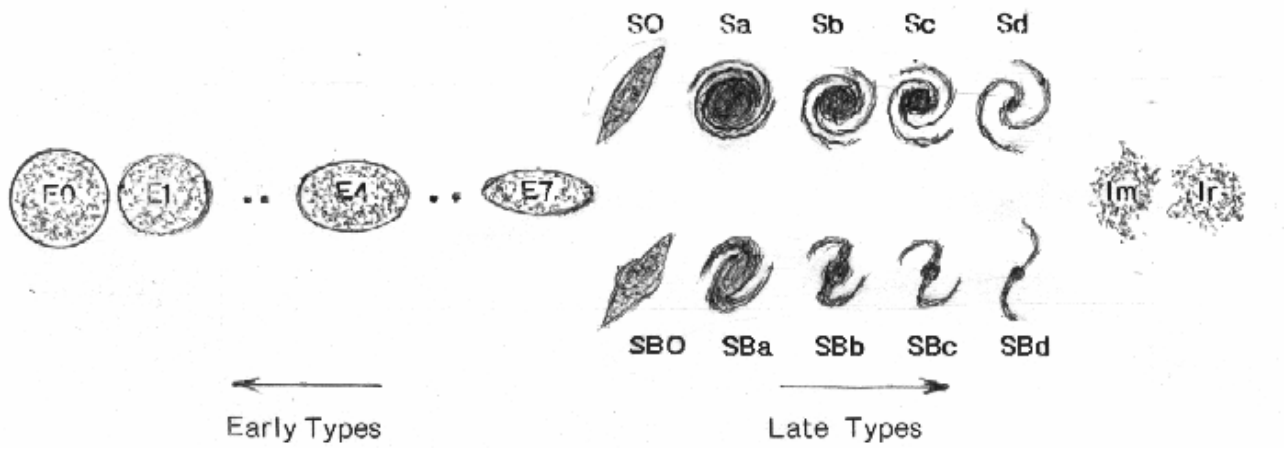
Firstly, some galaxies were found to be evenly filled with stars. They were spherical and elliptical in form. Hubble classified the sphericals as E0 and the ellipticals as El, E2,..E4...E7, the numbers increasing with increasing flatness. If a and b are the semi-major and minor axes of the ellipse, the ellipticity is given by (a - b) ÷ a. The diagram illustrates the relative amount of flattening of an E4 galaxy. The flattest ellipticals are the E7 types. The remaining galaxies were not evenly filled with stars but had streams of stars in the form of spiral arms. Of these, some had a bar through the middle with spiral arms trailing from the ends of the bar. The galaxies with spiral arms were typified by Hubble as Sa, Sb and Sc for the types in which the spiral arms sprout from the nucleus of the galaxy, and SBa, SBb and SBc for those in which the spiral arms sprout from the ends of the bar.



There were also intermediate types of lenticular shape. These lens-shaped galaxies he typified as S0 and SB0, the latter having a semblance of a central bar. Galaxies that were irregular in shape, such as the two Magellanic Clouds, were typified by Hubble as Irr.

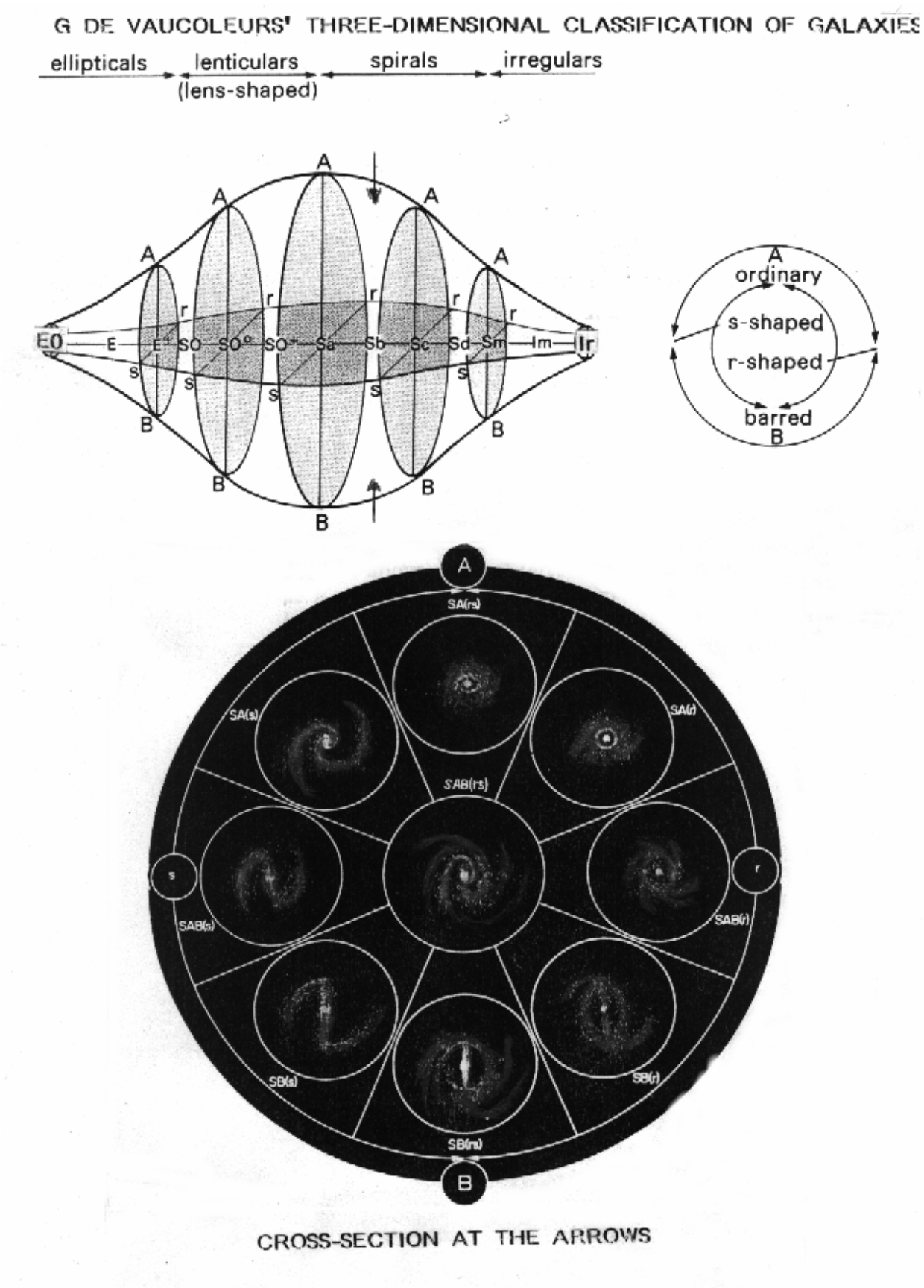
Diagrammatically the Hubble Classification had the appearance of a two-pronged fork as shown in the diagram, which also contains types Sd and SBd, which were added later.

Although Hubble implied no evolutionary sequence, galaxies to the left of the classification became known as "early types" and those to the right as "late types" (not including the irregular types).



The amounts of interstellar gas and dust increase from Sa to Sd and from SBa to SBd and this may, or may not, be an indication of greater age. Different types of galaxies contain all classes of highly-evolved stars (red supergiants) so that they must all be around the same age, 10^{10} years (ten thousand million years). In the article on the Evolution of the Galaxies we saw that this age is concomitant with a Hubble constant of 100 kilometres per second per megaparsec (km s^{-1} Mpc^{-1}).

Since the masses of the galaxies differ greatly, there can be no talk of one type of galaxy evolving into another type. The angular momentum (speed of turning multiplied by mass) increased from type Sa to Sd and from type SBa to SBd and from El to E7. Greater angular momentum is responsible for an increase in the spread of the spiral arms.


G DE VAUCOLEURS' THREE-DIMENSIONAL CLASSIFICATION OF GALAXIES
ellipticals
lenticulars
(lens-shaped)
spirals
irregulars
E0
E
E+
SO
SO°
SO+
Sa
Sb
Sc
Sd
Sm
Im
Ir
A
B
r
s
ordinary
s-shaped
r-shaped
barred
SA(rs)
SA(s)
SA(r)
SAB(rs)
SAB(s)
SAB(r)
SB(s)
SB(r)
SB(rs)
CROSS-SECTION AT THE ARROWS

The diagram shows that (i) the nuclei of the galaxies get smaller from a to d, and (ii) the spread of the spiral arms gets greater, from tightly wound in a to very loose in d.

Over the years more detail has been introduced into the classification, particularly by A Sandage and G de Vaucouleurs. The S0 classes have been divided into three and labeled $S0^-$, S0° and $S0^+$. These can be considered as running parallel to the S a b c d sequence but without any spiral arms and containing much less gas and dust. S van den Bergh has described a sequence of gas-poor "anaemic" spirals intermediate between S and So which are common in clusters of galaxies. Van den Berg found that the appearance of an Sb, Sc or irregular I galaxy is related to its luminosity, for example the most luminous galaxies have the longest, most fully developed spiral arms. He therefore introduced luminosity classes I to V in increasing order of brightness. His luminosity classification of galaxies gives a simple method of obtaining the relative distances of large numbers of spiral galaxies. The irregular types have been split into two: Im and Sm, the latter containing slight but definite traces of spiral structure. The Large Magellanic Cloud is typified as SBm.

Intermediate types have been indicated by combining symbols such as Sab or SBab, etc. Also small s has been added to indicate that the spiral arms sprout from the nucleus and small r to indicate that the spiral arms sprout from a ring around the nucleus, giving types such as Sb(s) or Sb(r) etc, using (rs) for intermediate types.

De Vaucoleurs also calls for the ordinary spirals to be typified SA, keeping SB for the barred spirals. The two series are thus SAa, SAb, SAc, SAd and SBa, SBb, SBc, and SBd, with provision for intermediate types such as SAB. Strong, dense spiral arms are to be indicated by m or f.

De Vaucouleurs has developed his system into a three-dimensional diagram consisting of a series of circles with SAB(rs) in the centre, with ordinary spirals A, above and barred spirals B below. Left of the centre there is SAB(s) and to the right SAB(r). The (rs) indication thus spans the circle from top to bottom. The A and B types to the left are all (s) and the A and B types to the right are all (r).

Through the centres of the five vertical circles, De Vaucouleurs has E^+ , $S0^-$, $S0^0$, $S0^+$, Sa, Sb, Sc, Sd and Sm with E0 and E to the left of the vertically standing circles and Im and Ir to the right of the circles.

The top diagram gives the isometric view, of the circles seen obliquely and the lower diagram gives the cross-section of the central circle.

W Morgan has called for giant ellipticals to be placed in a special class cD. They are large and bright and have extended envelopes and most of them are strong radio sources.

Among the bright galaxies, spirals account for about 75% of the total; ellipticals and S0 types for 20% and Irregulars for 5%. The relative numbers vary with limiting magnitude, far when the galaxy is very faint, it cannot with certainty be classified. There are many dwarf ellipticals, classed as dE. For galaxies as a whole, the number of ellipticals probably exceeds 60% and there are probably three times as many spirals as irregulars.

The three groups, Spirals SA; barred spirals SB and the intermediate group SAB are present in about equal numbers.

Eben van Zyl

BARRIERS TO INNOVATION: HOW SPECS LIVE FOREVER

The US Standard railroad gauge (distance between the rails) is 4 feet, 8.5 inches. That's an exceedingly odd number.

Why was that gauge used?

Because that's the way they built them in England, and the US railroads were built by English expatriates.

Why did the English people build them like that?

Because the first rail lines were built by the same people who built the pre-railroad tramways, and that's the gauge they used.

Why did "they" use that gauge then?

Because the people who built the tramways used the same jigs and tools that they used for building wagons, which used that wheel spacing.

Okay! Why did the wagons use that odd wheel spacing?

Well, if they tried to use any other spacing the wagons would break on some of the old, long distance roads, because that's the spacing of the old wheel ruts.

So who built these old rutted roads?

The first long distance roads in Europe were built by Imperial Rome for the benefit of their legions. The roads have been used ever since.

And the ruts?

The initial ruts, which everyone else had to match for fear of destroying their wagons, were first made by Roman war chariots. Since the chariots were made for or by Imperial Rome they were all alike in the matter of wheel spacing.
Thus, we have the answer to the original questions.
The United States standard railroad gauge of 4 feet, 8.5 inches derived from the original specification for an Imperial Roman army war chariot. Specs and Bureaucracies live forever.
So, the next time you are handed a specification and wonder what horse's ass came up with it, you may be exactly right. Because the Imperial Roman chariots were made to be just wide enough to accommodate the back-ends of two war horses.

Why do YOU do the things you do?

Plus:

There's an interesting extension of the story about railroad gauge and horses' behinds. When we see a Space Shuttle sitting on the launch pad, there are two big booster rockets attached to the sides of the main fuel tank. These are the solid rocket boosters, or SRBs. The SRBs are made by Thiokol at a factory in Utah.

The engineers who designed the SRBs might have preferred to make them a bit fatter, but the SRBs had to be shipped by train from the factory to the launch site. The railroad line to the factory runs through a tunnel in the mountains. The SRBs had to fit through that tunnel. The tunnel is slightly wider than a railroad track, and the railroad track is about as wide as two horses' behinds.

So a major design feature of what is arguably the world's most advanced transportation system was determined by the width of a horse's backside.

Submitted by: **Melvyn Hannibal**

Snipperts from the Astronomical Press

RELEASE: 99-93

BALLOON-BORNE INSTRUMENT COLLECTS ANTIMATTER

It almost sounds like a science-fiction movie: NASA launched a 60-story-high balloon to the upper fringes of Earth's atmosphere to collect precious particles of some of the rarest stuff in the Universe -- antimatter -- and, just possibly, evidence that entire anti-galaxies exist.

It wasn't science fiction, but cutting-edge science. Carrying a Japanese-built instrument, NASA's largest balloon -- 39 million cubic feet in volume -- lifted off from Lynn Lake, Manitoba, Canada, at 9:22 a.m. EDT Aug. 11 for a 38-hour flight more than 20 miles above Earth. The 5,000-pound instrument was recovered Aug. 12 and will be prepared for another flight next year. The BESS project (Balloon-borne Experiment with a Superconducting Solenoidal magnet), led by Prof. Shuji Orito of the University of Tokyo, is sponsored in the U.S. by NASA and by Monbusho in Japan.

NASA Space Science News for 18th August 1999

Just Passing By Earth: Earthlings bid farewell to the Cassini spacecraft last night as the Saturn-bound mission successfully completed a highly accurate pass of Earth. The flyby gave Cassini a boost in speed, sending the spacecraft on toward the ringed planet.

This story includes a tutorial on gravity assist maneuvers. FULL STORY at:-

http://science.nasa.gov/newhome/headlines/ast18aug99_1.htm

RELEASE: 99-98

NASA UNVEILS FIRST IMAGES FROM CHANDRA X-RAY OBSERVATORY

Extraordinary first images from NASA's Chandra X-ray Observatory trace the aftermath of a gigantic stellar explosion in such stunning detail that scientists can see evidence of what may be a neutron star or black hole near the center. Another image shows a powerful X-ray jet blasting 200,000 light years into intergalactic space from a distant quasar.

Released today, both images confirm that NASA's newest Great Observatory is in excellent health and its instruments and optics are performing up to expectations. Chandra, the world's largest and most sensitive X-ray telescope, is still in its orbital check-out and calibration phase.

The first Chandra images will be posted to the Internet at:

http://chandra.nasa.gov and http://chandra.havard.edu

RELEASE: 99-102

NEW NASA OCEAN RADAR WATCHES FOR BREAKUP OF GIANT ICEBERG

A NASA satellite instrument is keeping an eye on an iceberg the size of Rhode Island, the first time this space technology has been used to track a potential threat to international shipping.

NASA's new orbiting SeaWinds radar instrument, flying aboard the QuikScat satellite, will monitor Iceberg B10A, which snapped off Antarctica seven years ago and has since drifted into a shipping lane.

Iceberg B10A, which measures about 24 miles by 48 miles, was spotted by the instrument during its first pass over Antarctica, demonstrating SeaWinds' all-weather and day-night observational capabilities. The massive iceberg extends about 300 feet above water and may reach as deep as 1,000 feet below the ocean's surface. It is breaking up into smaller pieces that could pose a threat to commercial, cruise and fishing ships if the pieces are blown back into the shipping lane by high winds.

"Although the iceberg isn't posing a threat to ships in the area right now, pieces of B10A could be blown back into the shipping lane and become a danger to ships using the Antarctic's Drake Passage," said Dr. David Long, a member of the SeaWinds science team from Utah's Brigham Young University, Provo, UT. Long said that the SeaWinds instrument will be able to help scientists at the National Ice Center, Suitland, MD, track pieces of the iceberg down to about 2.5 miles in size.

B10A, which took hundreds of thousands of years to form, broke off the end of the Thwaites glacier of Antarctica in 1992, and has been drifting in the ocean ever since, driven by ocean currents and wind. In 1995, the iceberg broke in half, but was being tracked on a regular basis. Although conventional methods of tracking sea-surface ice -- using ships' radar, shipping reports, optical images from satellites and microwave sensor data -- are usually sufficient for tracking large pieces of ice, icebergs can sometimes disappear in the poor visibility of dark, cloudy Antarctic winters.

"That happened earlier this year, when we lost track of B10A's exact whereabouts," Long said. "Even though a ship was dispatched to the iceberg's last known position, we were unable to find it until we started receiving data from the SeaWinds instrument in July."

Scientists were surprised at its location when they found B10A, but it was clearly identified as a very large iceberg that posed a considerable threat to ships in the area. A check with the Naval Ice Center confirmed the iceberg's identity and has enabled scientists to continue tracking its journey through the Drake Passage. When it was rediscovered earlier this month heading northeast between Tierra del Fuego at the southern tip of South America and the Antarctic Peninsula, the National Ice Center issued an iceberg navigation warning to the Argentine government.

Ironically, the iceberg that took many millennia to form is expected to break up within about three months because it is drifting into warmer waters, Long said. "We will be able to watch the iceberg's breakup for the first time with daily radar observations and better understand the effects of ocean winds and climate on melting polar ice," Long said. "The polar regions play a central role in regulating global climate and it is important to accurately record and monitor the extent and surface conditions of Earth's major ice masses."

More information about the SeaWinds mission and observations is available at the following URLs:

http://photojournal.jpl.nasa.gov

http://winds.jpl.nasa.gov/news/newsindex.html

The orbiting SeaWinds radar instrument is managed for NASA's Office of Earth Science, Washington, DC, by NASA's Jet Propulsion Laboratory, Pasadena, CA, which also built the SeaWinds radar instrument and is providing ground science processing systems.NASA's Goddard Space Flight Center, Greenbelt, MD, managed development of the satellite, designed and built by Ball Aerospace & Technologies Corp., Boulder, CO. The National Oceanic and Atmospheric Administration has contributed support to ground systems processing and related activities.

NASA's Earth Science Enterprise is a long-term research and technology program designed to examine Earth's land, oceans, atmosphere, ice and life as a total integrated system.

In the Sky this Month

October 1999

dd	hh	
2	05	LAST QUARTER
5	18	Venus 4.5 S of Moon
5	22	Regulus 1.3 S of Moon Occn.
8	20	Venus 3.1 S of Regulus
9	12	NEW MOON
11	03	Mercury 7.1 S of Moon
13	18	Neptune stationary
14	15	Moon at apogee
15	13	Mars 5.2 S of Moon
17	15	FIRST QUARTER
18	07	Neptune 0.6 S of Moon Occn.
19	05	Uranus 0.5 S of Moon Occn.
23	07	Uranus stationary
23	19	Jupiter at opposition
24	14	Mercury greatest elong. E(24)
24	18	Jupiter 3.6 N of Moon
24	22	FULL MOON
25	19	Saturn 2.5 N of Moon
26	16	Moon at perigee
27	12	Aldebaran 1.1 S of Moon Occn
31	04	Venus greatest elong. W(46)
31	13	LAST QUARTER

November 1999

dd	hh	
1	09	Mercury greatest brilliancy
4	00	Venus 3.2 S of Moon
5	06	Mercury stationary
6	14	Saturn at opposition
8	04	NEW MOON
9	07	Mercury 6.6 S of Moon
11	08	Moon at apogee
13	17	Mars 3.1 S of Moon
14	15	Neptune 0.3 S of Moon Occn.
15	13	Uranus 0.2 S of Moon Occn.
16	00	Mercury in inferior conjn.
16	09	FIRST QUARTER
20	23	Jupiter 3.7 N of Moon
22	02	Saturn 2.5 N of Moon
23	08	FULL MOON
24	00	Moon at perigee
25	01	Mercury stationary
28	14	Mars 1.8 S of Neptune
29	03	Venus 4.5 N of Spica
29	23	LAST QUARTER
30	05	Mercury greatest brilliancy

Canopus is printed by the Wits University Printing Department