CANOPUS

The Astronomical Society of Southern Africa

Johannesburg Centre

Monthly Newsletter for April 1999

Contents:

The Sir Herbert Baker Library, 18a Gill Street, Observatory, Johannesburg

Editorial

At this time of the year, we have normally started to feel the days becoming a little cooler as we "pass through" the Autumnal equinox on our way to the clear skies of Winter. This year , however, many of us have wondered if perchance we were just arriving at mid-Summer with blazing temperatures sometimes well into the 30's. It appears as though we have had the old Chinese curse placed upon us and are indeed "living in strange times".

The above observation notwithstanding, we are presenting you with a bumper "Autumn" issue of Canopus, with a lot of articles from you, our readers.

Our regular contributors, Danie, Bill, Eben and Brian, have been joined by Chris Stewart, who has provided an excellent article on observing matter moving faster than light, and Eric Brindeau and Peter Baxter, who have submitted another Southern Sky Star Hopping guide to cover the sky over the next two or three months. They are going to attempt to provide us with quarterly SSSH articles and this is much appreciated. Danie has written on the recurrent Nova U Sco, and this appears as our Variable of the Month. Brian has, as always, given us the Sky happenings for the next two months, and has submitted an update on our Telescope making class. Bill keeps us up-to-date on some of NASA's high profile projects including WIRE and DS1, and Eben has given two articles, one an update to his previous Mars article and another on the recent close (apparent of course) passing of Venus and Jupiter.

Hmmmm…..no letters to the Editors this month..…(we feel unloved, unwanted and insecure). Well…maybe next Month!

The Editors

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Notice of Meeting

The **April** meeting of the Johannesburg Centre of the Astronomical Society will be held at the Sir Herbert Baker Library on Wednesday 13th April 1999 at 8:00 p.m.

Topic:

"History of the Observatory"

by

Constant Volschenk.

Future Meetings

May 12th	To be advised	Tom Budge
Jun 9th	Planetarium - special show	T.B.A.
Jul 14th **at 19:00**	Bring & Braai at Observatory	A.G.M.

Dark Sky Viewing

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

17th April	7th August	*Year End Star Party*
15th May	11th September	11th December
12th June	9th October	
10th July	6th November	

THANKS

We have received a PC on loan from Tony Golding - *THANKS TONY* - and it has been set up in the Library. We will be using this machine to create a database of the Library contents, and will also use it to keep a backup of the membership database.

New Members

We would like to welcome the following new Member to the Johannesburg Centre:

Ms. Sharon Tait

Telescope Driver's Licence

There are still some places available for those wishing to attend the Telescope Driving Course. The dates are 24th April 1999 and 8th May 1999, both Saturday afternoons. The courses are limited to six (6) persons each and bookings for places have already started. Please contact Constant at the Planetarium (011) 716-3199 to book your place on the course.

Dial in for ASSA Jo'burg News

Evan is experimenting with a facility to allow you to ***dial in*** for the latest news from the Jo'burg centre. Keep watching for updates on this exciting development.

Swinburne 1999

Our annual trip to Swinburne will be held on the long weekend of 7th to 9th August 1999. If you are interested in this trip, please contact Ed Finlay for further details.

Other outings are in the process of being set up including an overnight jaunt to Suikerbosrand, the annual trip to Boyden and a Sunday afternoon outing to Haartebeeshoek. More information will be published in subsequent issues.

Obituary Monty Northam

We have learnt of the death, in England on January 1st 1999, of one of our past chairmen, Monty Northam.

Monty was chairman of the Transvaal centre of ASSA in 1987 and served on the committee for a number of years. He had his own small electronics business and specialised in making precision shaft encoders. However business was not always so good and he returned to England to try his luck there.

Monty had many family problems, health problems and business problems and dropped out of the astronomical fraternity many years ago. Although he came back to South Africa for a while, his health was not good and he never resumed his astronomical activities.

We offer our condolences to his family.

VARIABLE OF THE MONTH:
U SCORPII

During 1987, a couple of modest headlines in the astronomical press announced an outburst of the recurrent nova U Sco. The outburst had been discovered by me after years of uneventful monitoring.

Subsequently I have monitored the field well over a thousand times, and then. . . During the small hours of 1999 February 25, I checked the sky three times, only to see wall to wall cloud. A few hours later an Email announced that our colleague Patrick Schmeer of Belgium had discovered the beginning of an outburst that morning. Such is the luck of the draw!

Astronomers with access to advanced equipment are having a field day observing the star in various wavelengths, taking spectra and investigating its orbital eclipses. The outbursts are not predictable and it makes good scientific sense to check the field even when an outburst is not expected, as I did up to 1987 and subsequently. So here is a chance for CANOPUS readers to help the astronomical community by reporting the next outburst. You do not need any brightness estimating skills, it is only necessary to check whether the star is visible or not.

The field is not as easy to identify as some of the fields which I have described but then we cannot have everything, can we? Finding the field may not be easy the first time but if you look often enough, finding it will become second nature to you. I shall be glad to supply additional finding information to anyone interested.

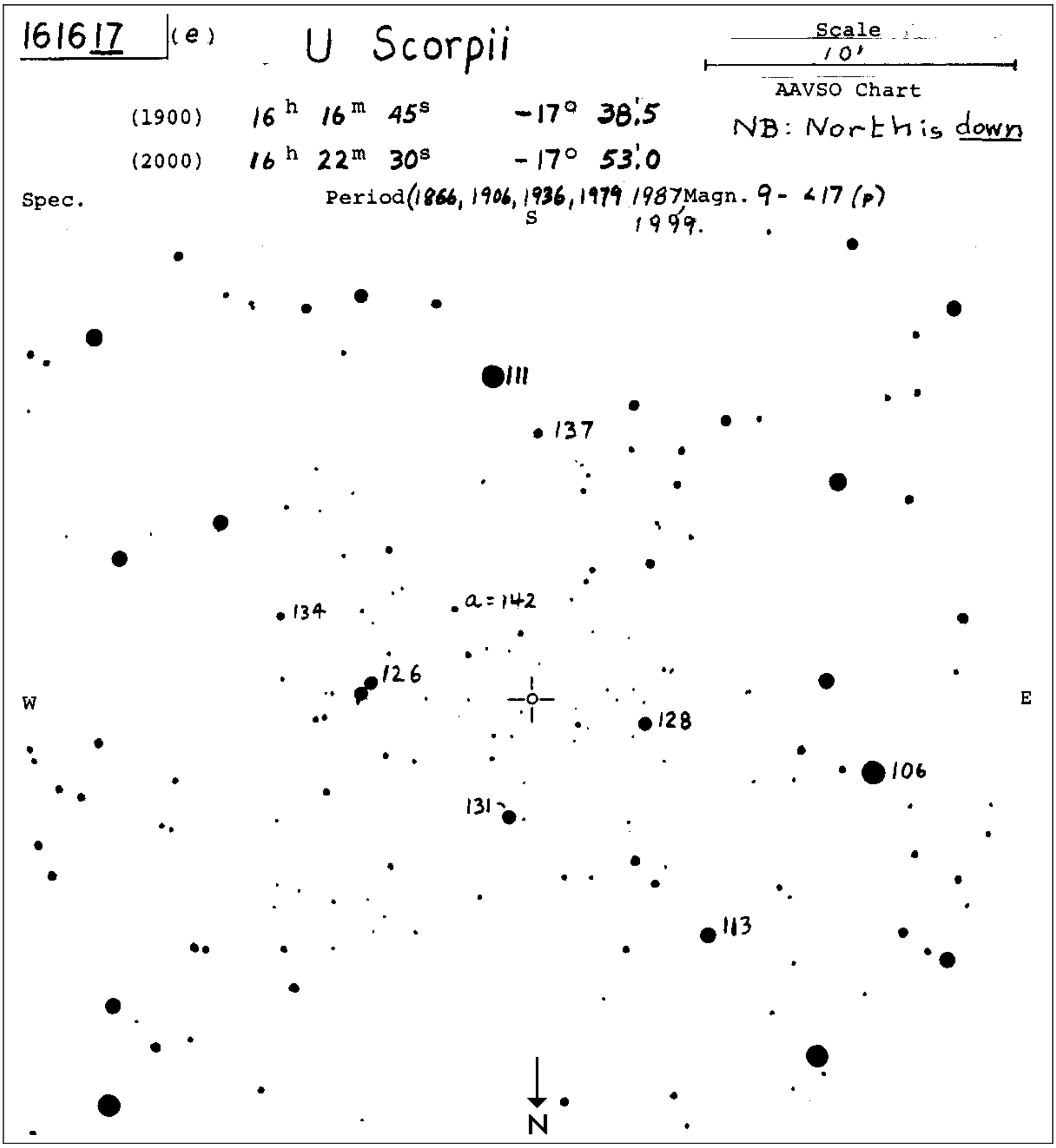
Enjoy recurrent nova hunting!

Danie Overbeek

Sky Map

Variable of the Month

U Scorpii



JPL and NASA News

Bill Wheaton, IPAC

1999 April

WIRE Lost

The NASA Small Explorer (SMEX) program is intended to provide frequent opportunities for the flight of modest missions at low cost. An important part of the SMEX concept is a cultural shift within NASA to accept increased risk of failure, by deliberately reducing the stringent and extremely expensive layers of quality control that had previously been the agency rule. Since the program began, four SMEXs (SAMPEX, FAST, TRACE, and SWAS) have been launched, and all have been successful. On 4 March the odds finally caught up with WIRE, the Wide-field InfraRed Explorer, an IPAC and JPL mission which we described just this last February.

After a successful launch in a Orbital Sciences Pegasus XL air-dropped rocket, we all went home from IPAC feeling great. Unknown to us (but apparent to mission scientists and controllers later that night) the 3-axis stabilized spacecraft failed to stop its slow spinning as expected. A complete understanding must await the findings of a review board assembled to analyze the failure. However, according to NASA, it appears that for reasons unknown the cover on the cryostat (an elaborate thermos bottle, designed to hold the telescope, detectors, and the solid hydrogen intended to keep everything cold for the four months required to complete the observations) was ejected shortly after launch, three days early.

As the spacecraft was not yet safely pointed at deep space, radiation from the Earth and probably sunlight were able to enter the cryostat, so that unexpectedly large amounts of energy reached the solid H2 cryogen. The hydrogen then vaporized and vented into space at a much higher rate than designed, and reaction from the venting caused the spacecraft to spin faster and faster. An heroic effort by controllers led to quick uploading of a software patch that cycled the magnetic torque coils used for slow control of spacecraft orientation, in such a way as to act against the spin. This was ultimately successful, and by 11 March, 3-axis lock was achieved. But too late: the hydrogen was exhausted several days earlier, effectively ending the possibility of accomplishing the mission science. The $79 million cost may be appreciated better perhaps if we think of it as a few score of life-work equivalents, although spread among hundreds of people. Now that control has been regained, some technological return is expected from a plan to use WIRE's advanced communications and data handling systems for engineering tests. According to Dr. Ed Weiler, NASA associate administrator for space science, future missions such as SIRTF, the Space InfraRed Telescope Facility (described here in October 1998), will eventually accomplish much of the science WIRE was expected to do. Inevitably this will be later (SIRTF is currently scheduled for launch in December 2001), and more slowly due to SIRTF's narrower field-of-view.

So, four successful missions in five launches, or 80% success: not a bad ratio considering the prohibitive cost of an old-style mission's draconian quality control measures. It seems one can hardly advocate abandoning the SMEX concept, but of course such abstract calculation does nothing to mitigate the pain those who have devoted many years of effort to WIRE and now find their baby still-born.

Deep Space 1

Deep Space 1, the technology development mission launched on an interplanetary trajectory last October 24, is now over 50 million km from Earth. Since launch DS1 has been testing its suite of 12 new technologys:

Solar Electric Propulsion:

This is the ion drive, which we discussed here in detail in July 1998. It has by now accumulated over 850 hours of successful operation in space. A comet landing mission using ion drives, DS4, is now being considered for 2004 launch as a follow-on application.

Solar Concentrator Arrays:

With its ion drive, DS1 requires plenty of power. The solar concentrator arrays supply about 2.6 kW, and were tested early in the mission. They have cylindrical Fresnel lenses to increase the effective solar flux by a factor of over 7, yielding a big decrease in the required area of the solar cells, and also a reduction in their cost.

Ion and Electron Spectrometer:

An important question addressed by this experiment is whether the ion drive so disturbs the local environment that valid space physics measurements of particles, plasmas, and electromagnetic fields cannot be made. The package also tests a new integrated, low-mass instrument design, and returns cruise and encounter science data.

Miniature Integrated Camera and Imaging Spectrometer:

The MICAS camera and spectrometer uses a common 10 cm telescope, and provides the imaging information for the AutoNav system, described below. It includes two 500-1000 nm visual channels and two imaging spectrometers, one in the UV (80-185 nm with 50 spectral channels), and one in the IR (1200-2400 nm, with 100 channels).

Autonomous Navigation:

In the past, spacecraft navigation has been performed by the Deep Space Network of large radio antennas which JPL operates in California, Spain, and Australia. Because operation of this system is expensive, and as it is taxed to the limit by present and planned missions, onboard navigation is very attractive. AutoNav is accomplished by optical observation of asteroids against the field of background stars, with computation on board the spacecraft. AutoNav had some trouble at first analyzing images from MICAS, but after modification of the on-board software, it has recently been able to determine its position to within 2000 km, sufficient for deep-space cruise requirements, completely without external aid.

Ka-Band Solid State Amplifier:

Operating at a frequency four times higher than the X-band system used previously, this amplifier will reduce both antenna size and the power required at a given data rate on future missions.

Beacon Monitor Operations:

This system allows the spacecraft to monitor its own status and evaluate its need for ground-based assistance, reducing demands on the DSN. Four discrete status signals can be transmitted: one meaning "all well, no assistance needed", one meaning "tracking needed when convenient", one requesting more extensive telemetry within a certain time, and one indicating a situation exists requiring immediate ground assistance and intervention.

Small Deep Space Transponder:

This is a compact new design intended to be widely applicable in future deep-space missions, which is also has the ability to use the Ka-band amplifier and to generate the signals needed by the beacon monitor system.

Autonomous Remote Agent:

Again to reduce the ground costs associated with missions, but also to permit quicker response to circumstances that may develop on a spacecraft very distant from Earth, the Autonomous Remote Agent is a virtual member of the ground team, on board the spacecraft. An on-board mission manager carries the mission plan, expressed as high-level goals. A planning and scheduling engine uses the goals and a comprehensive knowledge of the spacecraft state and mission constraints to develop a plan which an executive translates into commands to spacecraft systems. The system has the ability to respond to unexpected situations, and has access to much more complete information about the spacecraft and instrument systems than would be available to ground controllers, so that it can recover from all but extraordinary faults.

Low Power Electronics:

A special test set of 0.9 V, 0.25 micron feature-width electronics is included to validate new very-low power micro electronics, with particular attention to effects due to the space radiation environment.

Power Activation and Switching Module:

This includes 40 V, 3 A power switches and custom integrated circuits providing voltage and current sensing, current limiting, and switching control, in a package that quadruples the density of previous practice.

Multifunctional Structure:

A test of a new packaging technology combining load-bearing elements with electronic housings and thermal control is incorporated which will greatly reduce the mass of future spacecraft cabling and chassises.

DS1 recently started a 150 hr ion drive maneuver that will set it on course for a flyby on about 28 July 1999 of asteroid 1992 KD, at a closest approach distance expected to be less than 10 km. If all remains well, a possible mission extension may then take it to two comets.

Other News

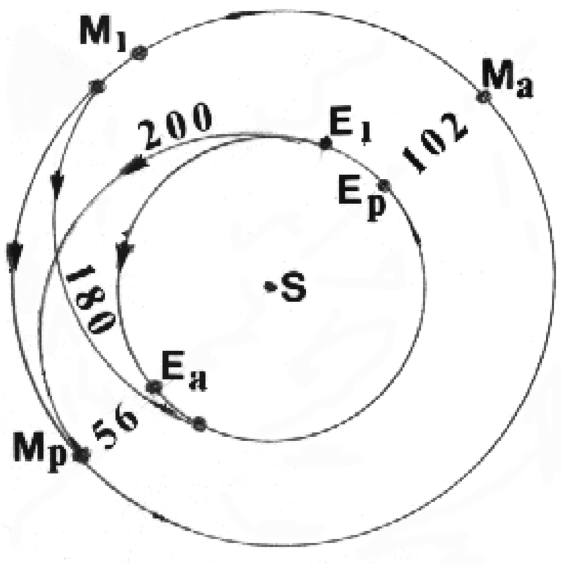
Concern about gyro failures on the Hubble Space Telescope HST has caused NASA to split a planned summer 2000 revisit into two parts, and schedule the first next October or late September. HST has 6 gyros, and can operate with only 3; however, with the failure of a third gyro in January, loss of just one more would put the observatory into a "safe" mode, precluding all science observations until the next servicing mission.

According to NASA administrator Dan Goldin, in testimony about the NASA budget given before the House Subcommittee on Space and Aeronautics, science spacecraft flights are due to increase from an annual rate of two in the early 1990s to seven at the present time to an average of fourteen per year during FY 2000 to FY 2004.

MARS IN FOCUS

by Eben van Zyl

In Canopus of September 1997 I sketched in broad outline a manned trip to Mars. Now Sky and Telescope far April 1999 features the caption "Mars in Focus", so things are hotting up. Sky and Telescope mentions same of the steps that have to be taken to "ready" Mars for Man's first landing, which, according to the dynamics of the orbits of Mars and the Earth, could be slated for July 2018 when the two planets came closest together at opposition, their separation E_a to M_p then being as little as 56 million km. (The date 2025 1 mentioned in the 1997 article is palpably incorrect and I hasten to apologise for this mistake). The favourable or advantageous oppositions recur every 15 years. The spaceship with the explorers on board must be launched when the planetary configuration is such that the Earth is at E_l and Mars at M_l with the Sun at S during January / February 2018.



The spaceship which will have been assembled in orbit around the Earth in the precincts of the International Space Station, now being constructed, will use the "window" in January/February 2018 so that it can easily drift into the Hohmann Transfer Ellipse from $E_1$to M_p . This is the most economical orbit to "lift" the spaceship through the 56 million kilometres between the Earth at E_a to Mars at M_p , i.e. the Earth at aphelion and Mars at perihelion. The trip will take about 200 days.

Oppositions at other points in the two orbits can be as much 102 million kilometres apart. The eccentricity of the Earth's orbit is 0,017. Take the average distance of the Earth from the Sun as I AU. Earth's aphelion distance from the Sun is thus 1 + 0,017 x I, namely 1,017 AU. Mars's average distance is 1,524/lU and the eccentricity of its orbit is 0,093. Therefore Mars's perihelion distance from the Sun is equal to (1,524 - 0,093 x 1,524) AU, ie 1,524 - 0,1417 = 1,382 AU. At opposition with Mars at perihelion M_P and the Earth at aphelion E_a, the distance between the two planets is:

$$1{,}382 - 1{,}017 = 0{,}3753 \text{ AU}$$
$$= 0{,}3753 \times 149\,600\,000$$
$$= 56{,}14 \text{ million kilometres.}$$

The two planets are furthest apart when opposition takes place with Mars at aphelion M_a and the Earth at perihelion E_p. This distance is

$$(1{,}524 + 0{,}093 \times 1{,}524) - (1 - 0{,}017) \text{ AU,}$$
$$\text{namely } 1{,}524 + 0{,}1417 - 0{,}983$$
$$= 1{,}6657 - 0{,}983$$
$$= 0{,}6827 \text{ Au}$$
$$= 0{,}6827 \times 149\,600\,000$$
$$= 102 \text{ million kilometres.}$$

Once the spaceship has reached escape velocity of 11,2 km per second relative to the Earth, its motors can be shut off and the ship will drift along the transfer ellipse E_1 to M_p. When it reaches Mars at M_p, the Earth will be at E_a,

The spaceship will then go into orbit around Mars and from there it will launch a landing vehicle to take the (wo)men down to the surface of the planet. The first priority is that the landing site will have been correctly chosen. This must be a spot where there is a plentiful supply of water in the form of permafrost, in the Martian soil - the nearer to the equator of

Mars, the better. On the equator the midday temperature reaches 27°C, rising from 5°C at l0 AM and falling to 0°C at 3.PM. The Mars Global Surveyor craft has found spots where water must have been abundant in bygone ages. If it is still there in the frozen state in the soil, the hydrogen atoms in the ice molecules will reveal their presence by the way they reflect radar waves from the orbiting monitoring craft. The task of selecting the site where there will be enough water has been allocated to a committee headed by Director Charles Leach of the Jet Propulsion Laboratories' Space and Earth Science programs. He will have to see to it that enough Mars Ascent Vehicles (MAV'S) ferry enough samples into orbit around Mars. The French "Centre National d'Etudes Spatiales " (CNES) is to build craft which will rendezvous with the MAV'S and return the soil samples to Earth for analysis. Methods may be developed for analysing the samples in situ without the necessity of bringing them to Earth.

When the (wo)men land on Mars, they will find, already deployed all the things that are necessary for building their living quarters as well as the items required for the exploration of Mars.

Sunshine is very plentiful on Mars. Solar panels and other items will be sent from Earth during the next 18 years so that the explorers can easily connect the modules together to build their living quarters and also to build a **solar power station**. That is to say, if such a solar power station has not already been robotically constructed by the time the first landing takes place - a sort of "home from home". The power from the power station will be used to heat the living quarters and will drive the drills to be used in retrieving ice-containing soil.

All the necessary apparatus and reagents for analysing soil and rocks, physically, chemically and geologically will have been sent beforehand and will be ready at hand for use by the explorers.

It is also possible that apparatus for the extraction of hydrogen from the underground ice will have been launched from Earth to the landingsite. This hydrogen and oxygencould be used as fuel for the return journey to Earth which will take place in good time to reach the Earth when the next opposition occurs in 2020. The return journey will take about 180 days so that the explorers will have to leave Mars orbit by the middle of April 2020, after having spent all of 1 year 9 months exploring Mars. (l'm so sorry that I have to live in these primitive times - think of the excitement which lies ahead!).

The more equipment that can be sent in advance to the landing site, the more (wo)men that can be accommodated in the space ship. Some of the food required during the journey can be cultivated hydroponically and this can also be done on the surface of Mars. So, whom should we select to make the journey?

First to stake a claim is the hydroponics expert. He/she will also have to be dietician and chef!

Second and third selections will have to be the two pilots. They must also be experts in radio and electronics.

Fourth, must be the geologist cum physicist, cum chemist cum metallurgist.

Fifth the mining, electrical and mechanical engineer.

Sixth: the medical man, doctor cum dentist cum psychiatrist!

Seventh**:** and what about an astronomer, who on the surface of Mars will be only one-quarter of Earth's distance from the Minor Planets?

All of the seven (wo)men should be experts in more than one field so as to be able to serve as backups. Most important, they should have to be persons who would make the presence of a psychiatrist unnecessary.

When the spaceship gets back to Earth, it will be left in orbit to be readied for the next expedition and the explorers and the samples which they would bring back will be ferried down to Earth by shuttle craft.

By 2033 when the next favourable opposition after 2018 takes place, technology will have developed to such an extent that Man's first planetary exploration will be considered as very primitive

SOUTHERN SKY STAR HOPPING

DEEP-SKY OBSERVING

by

Peter Baxter & Eric Brindeau

This month we introduce two constellations, **CORVUS** and **LEO**. Both constellation shapes are easily recognisable in our evening skies. Among these stellar beacons, situated on the Coma – Virgo border, lie prominent galaxies – the ultimate deep sky target.

CORVUS can be found almost directly overhead; it's squashed box shape defined by bright 3rd magnitude stars.

Although a Northern Hemisphere constellation, **LEO** is well placed on our northern horizon with it's characteristic sickle shape hinging on bright Regulus.

GALAXIES

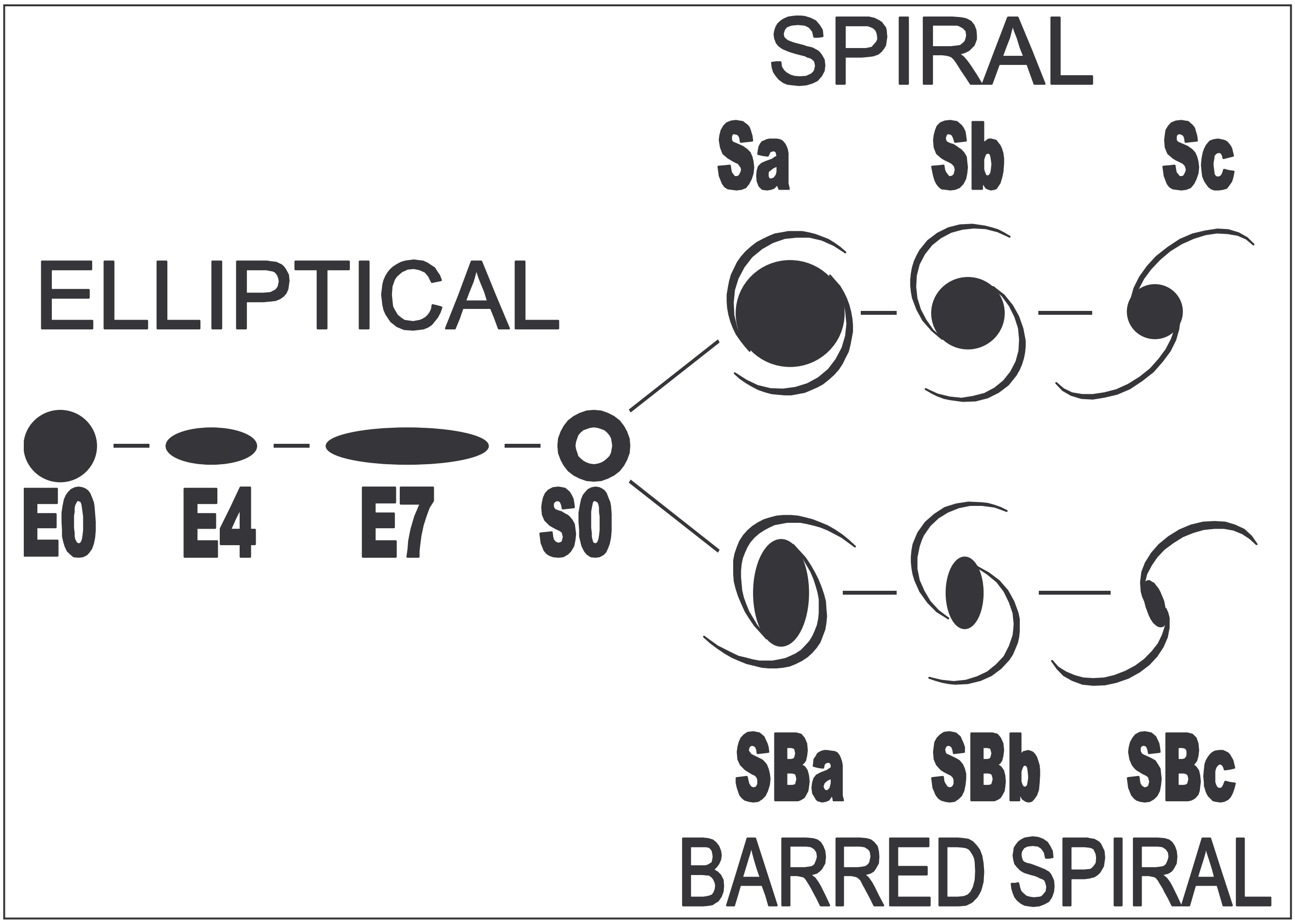
Galaxies are awe-inspiring, ***the*** faint fuzzies fuelling our imagination of other galactic neighbourhoods. By studying the galaxies in the universe, we have come to a clearer understanding of galaxy dynamics and the forces which have formed our spiral " the Milky Way ".

Photons that have travelled millions of light years, brought into focus – is one of the pleasures enjoyed only by an astronomer. As a deep sky target, you will be rewarded with a variety of shape and detail, and ultimately test your observing skills. Although challenging, galaxies can be enjoyed starting with the naked eye (Andromeda at 2.2 million light years appears as a fuzzy spot in the sky; the large and small Magellanic Clouds are clearly visible right on our doorstep), binoculars and finderscopes (M83 and Centaurus A are easily seen in 7x50's in a dark sky) and telescopes where one can start to detect detail in a 6" scope. Capturing the faint light on film or CCD is the ultimate in achieving maximum detail.

What can one expect to see when hunting down galaxies ?. The myth that you require a massive light bucket is only partly true, the enjoyment is firstly in finding these collective swarms of stars and dust. A 6" inch telescope will start to show distinctive shape and structure in some of the brighter galaxies, fainter one's appearing as fuzzy blobs and smudges against the background sky. Larger scopes increase the detail dramatically, with definite spiral arms and dark dust lanes discernible in many of the brighter galaxies. More aperture gives you a license to chase down galaxy clusters, where up to as many as two or more galaxies can fill an eyepiece field ! (one of our favourites is the IC 4239 group in Centaurus, counting five in this excellent Southern sky example using a 12" f/7 – from a very dark Drakensberg).

While perusing magazines and essential companions such as Burnham's Celestial Handbook for possible galaxy targets, it is useful to keep in mind galaxy classification. Not only does this information increase your knowledge of the objects that you are studying, it also gives you an idea of the shape you might expect to see in the eyepiece (e.g. round or elliptical). Galaxies come in all shapes and sizes which tell you much about their development and nature. The tuning fork diagram best explains this graphically, and you will soon get used to the terminology.

EDWIN HUBBLE devised the ***tuning fork*** diagram in 1925 as a simple classification of galaxies. This is still widely used today even though more complex schemes have since been devised.



Hubble's scheme catagorised galaxies into three main groups, namely elliptical, spiral and barred spiral. Each of these are divided into subtypes according to observable characteristics. The **E** group are the ellipticals which is followed by a classification number from 0 to 7, depending on the degree of flattening. The **S** group are the spirals which are divided into two distinct groups, spirals **S** and barred spirals **SB**. These are followed by the classification letters **a, b or c**. In both of these categories the **a** would classify a galaxy with a dominant nuclear bulge with tightly wound spiral arms progressing to **c** which would have a lessor central bulge with more open spiral arms.

The less commonly observed ***irregular*** galaxies like the large and small Magellanic Clouds, were not included in Hubble's original diagram.

We would like to take this opportunity to promote a real observing gem. This useful collection of information is an essential deep sky companion. It does not cost an arm or an eyepiece and can fit into the palm of your hand or tucked away in a pocket. It is the "**NIGHT SKY**" in the "Collins Gem" miniature series of the world at your fingertips (other titles include survival and the world of dinosaurs – R39.95 Estoril Books). This is by no means a Mickey Mouse publication, with detailed star charts of all 88 constellations by Will Tirion, the world renowned astrocartographer. This little book can be used as a quick reference at the eyepiece (you might need to know which star is "*mu*" Orionis to find the planetary nebula Abell 12/ PK198-6.1 which is almost on top of it). The "NIGHT SKY" contains a wealth of information especially useful for the smaller telescope. All the star charts contain descriptions of double and multiple stars, brighter deep sky objects and what you can expect to see, and accompanying articles on various astronomical terminology and paraphernalia. With some knowledge of the constellations, the "**NIGHT SKY**" is a cost effective alternative set of star charts for the beginner and advanced alike.

THE DEEP SKY STAR HOP

CORVUS the crow is an autumn constellation for the Southern hemisphere. In Greek legend it is connected to Hydra and Crater, and seems to be the beginning of political agenda prevalent of today – " the crow (**CORVUS**) is sent to fetch water in a cup (**CRATER**), but returns with the water snake (**HYDRA**).

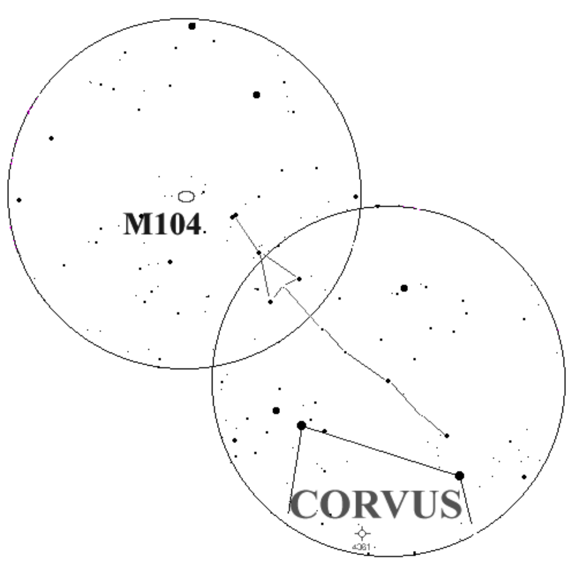
CORVUS can be found by drawing an imaginary line starting at Alpha Crucis (the bottom South-pointing star), go through Gamma Crucis (the top North-pointing star), carry on past Centaurus and the next brightest constellation will be **CORVUS**. One of the bright corners of the box can be seen to have a naked eye companion. The brighter of the two is Delta Corvi, a beautiful easy double for the small telescope. **CORVUS** is an excellent starting point to find the famous "Sombrero" galaxy **M104** by using a cosmic arrow which points the way

Most of you will be familiar with the "**M**" designation of astronomical nomenclature being awarded to **Charles Messier** (1730-1817), the 18th century French astronomer. His catalogue of nonstellar objects is well known to us amateurs, as many of his catalogued objects (found using his small scope) are the brighter of the deep sky objects that are easy to find. Messier had not set out to produce what became his "CATALOGUE OF NEBULAE AND OF STAR CLUSTERS", but began recording fuzzy objects that did not change position while on his search for comets.

NGC 4594 (the New General Catalogue classification for M104) caused a stir in the astronomical circles in 1921, when it was added to Messiers original 103 objects, and essentially the beginning of a series of modern additions to his catalogue. Controversy still surrounds some of these objects today, his list having grown to 110. Apparently there is evidence for certain objects which Messier knew about, but had not actually observed.

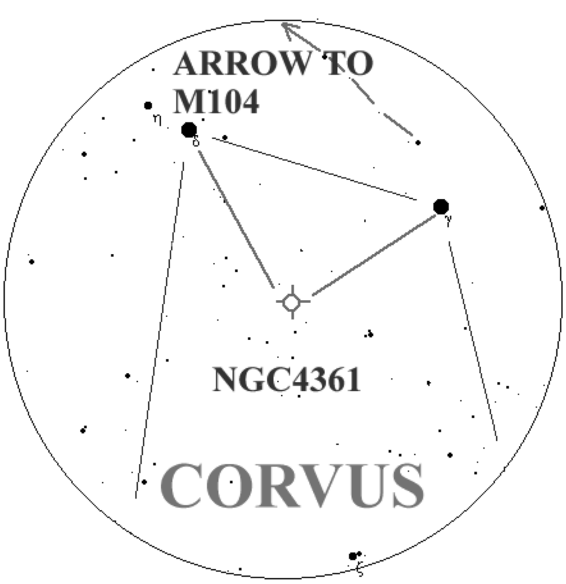
M104 is an excellent example of a galaxy seen nearly edge-on, with many catalogues classifying it as an **Sa**. The galaxy has a massive nuclear bulge, with an almost stellar central region. An interesting feature of this galaxy which first became visible on long exposure photographic plates, is the more than 2000 globular clusters that surround it's halo. If you can recall a previous article, globular clusters are very old spherical associations of stars which seem to populate the halos of galaxies – the Milky Way only has about 160. The prominent feature of **M104** is the dark lane bisecting this bulge, visible in amateur telescopes.

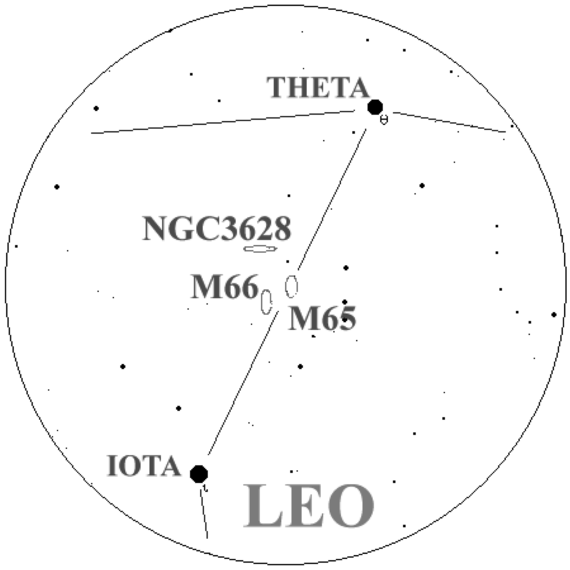
Starting at Gamma or Delta Corvi, find the head of the arrow as can be seen in the accompanying star chart. If you can find this grouping, it is an easy hop to the galaxy. **M104** lies a little to one side in a grouping of six 7th magnitude stars. The galaxy is magnificent and appears as a fairly bright oval in small amateur telescopes. Depending on sky conditions, the dark lane can be visible in a 4 inch scope.



NGC 4361 is a 10th magnitude planetary nebula located near the center of the **CORVUS** box. This is one of the brighter and larger of planetaries in the sky, and has been seen in telescopes as small as 4 inches. It appears as a large halo of 80 arcseconds surrounding the 13th magnitude central star, the disk a little larger than Jupiter. Due it's large size it is a challenging object, as one requires higher magnification to increase the contrast of the background sky. Imaging an equilateral triangle with Gamma and Delta Corvi as the base and **NGC 4361** will lie at the apex. Try to identify the small triangular grouping as is visible in the accompanying star chart and 7 x 50 finder view, the planetary nebula lies to one side.

LEO has been associated with the Lion since ancient times, and represents the Lion slain by Hercules as the first of his twelve labours. Alpha





Leonis, also known as **Regulus**, is the brightest star of the constellation. Regulus shares the ecliptic with the planets, and eventually all the solar system objects will pass it by. The easiest way to find **LEO** is to face the northern horizon. Using bright **Rigel** in the setting constellation of **Orion** on the west horizon as your starting point, draw an imaginary line through **Procyon** in Canis Minor, continuing east in the same direction, will point to Regulus. Regulus is the bright star situated at the top of the sickle or upside down question mark.

LEO contains a number of excellent galaxies and a beautiful pair that is visible in a single low power eyepiece. Gamma is a beautiful double for the small telescope, consisting of two orange – yellow stars of 2nd and 3rd magnitude at a separation of 4.4 arcseconds.

M65 (**Sb**) and **M66** (**Sb**) are seen at magnitudes of 9.3 and 9.0 respectively, making them fairly bright galaxies for the small scope. Using either Theta or Iota Leonis as the starting point, imagine a line connecting the two. About midway you will find a distinctive chain of about five stars, the two galaxies can be found just to one side. With your finder on target, pan around using a wider field eyepiece until you find the two slightly elongated grey smudges. If you are viewing with a 6 inch or larger scope, you might bump into a nearby galaxy NGC 3628 (Sb) at magnitude 9.5, photographically this makes for a stunning grouping.

Objects which were covered in the July '98 article of Southern Sky Star Hopping are also visible again at this time of the year:

NAME	**TYPE**	**CONST**	**R.A.**	**DEC**	**MAG**	**SIZE**
NGC4361	Planetary	Corvus	(12h24.5m	-18deg 46’)	10	80”
M104	Galaxy	Virgo/Corvus	(12h40.0m	-11deg37’)	8.3	8.9’x4.1’
M65	Galaxy	Leo	(11h18.9m	+13deg05’)	9.3	10.0’x3.3’
M66	Galaxy	Leo	(11h20.2m	+12deg59’)	9.0	8.7’x4.4’
NGC 5286	Globular	Centaurus	(13h46.4m	-51deg 22’)	7.6	9.1’
NGC5139	Globular	Centaurus	(13h26.8m	-47deg 29’)	3.65	36.3’
NGC4755	Open Clu	Crux	(12h53.6m	-60deg 20’)	4.2	10’
NGC3918	Planetary	Centaurus	(11h50.3m	-57deg 11’)	8	12”

"How can one see matter moving faster than light?"

By Chris Stewart

(Inspired by an article of the same name by Jean-Marie Vigoureux
-- published in Ciel et Espace, March 1999 --
with apologies to my friend and fellow Guzzi rider, Charlie Cooper.)

Modern observing techniques and technologies allow us to see farther into space, to measure the properties of the bodies we observe with unprecedented accuracy, to see more clearly, with higher resolution and in a greater range of wavelengths than ever before. Consequently, an astounding range of truly remarkable astronomical discoveries is with increasing frequency being announced. Yet the discovery of luminous jets of matter ejected by certain quasars, and which are apparently travelling at speeds significantly in excess of that of light, is without doubt one of the most unexpected, puzzling and yet generally ignored of the last two decades. These measurements, notably by means of very long baseline interferometry, constitute some of the most painstakingly performed and accurate ever attempted. Given our current understanding of the physics of the universe, the results are at first glance in total conflict with our best models of how matter can behave. How can this be? As it turns out, the jets are indeed travelling extremely fast. The quasars have enormous energy reserves and are in fact quite capable of accelerating the jets to a significant percentage of the speed of light. That we see them as travelling faster, is simply a quirk of perspective coupled with the finite speed of light itself. Let us indulge now in a little story to illustrate the point by way of analogy.

Imagine you are in Johannesburg and I am in Cape Town, a separation by road of some 1500km. I decide on the spur of the moment to visit you, instructing Gulliver -- my erstwhile young assistant -- to inform you that I am leaving at this very minute. For me, the trip is an excuse to "go for a burn" on my lovingly restored 20-year-old Moto Guzzi Le Mans. Mounting it, I set off and manage to average exactly 199km/h over the whole journey. Gulliver, fearful of losing his job, has neglected to tell me that the batteries in his cell phone are flat. Also, the local phones are down because the Telkom lines in the area have been the unfortunate victims of "alternative shopping", so for the same reason he can't even e-mail either. Being a resourceful if rather scatterbrained chap, he nips next door to the local Yakawhonsu dealer and buys the latest big-bore riceburner out of the money he has saved by skimping on his housekeeping budget (obviously I pay him too much). On this, he manages to set off at exactly the same time as I, in the hopes of getting to Jo'burg first to deliver the message. Of course he is not nearly such an experienced rider but -- having a typical adolescent's disregard for the normal fear of smearing oneself over the landscape, plus the advantage of a more powerful modern bike -- he averages precisely 200km/h.

Exactly half-way to Jo'burg, I pause for an instant in Blikkiesfontein to take a leak and refuel (these Guzzies are moereva light on juice). At this point, I give the pump jockey a big tip and ask him to let you know I am now in Blikkies. Now, he is seriously impressed by me, the Guzzi and the big tip, so he rushes in to phone. Unfortunately the tannie who has manned the local telephone exchange for the last twenty years is out having melktert and koeksusters with her friends in Gatsonderwater and no-one else knows how to drive this technological dinosaur. He has a flash of inspiration: his brother in-law, Frikkie "Slagyster" van der Vyfer, is the head of the local Hells Angels chapter. This luminary is renowned amongst the lunatic fringe as a bezerko rider who never refuses a challenge. He is also the only one from Blikkies who knows his way around Jo'burg, having got lost there so often while passing through on the way to the biker rallies. So the pump jockey bets his swaer that he can't deliver the message before I get to Joeys, and unbeknownst to me the dice is on. As I pull away, so does Slagyster. He doesn't have nearly as nice a bike as the Guzzi, but he has recognised me as being one of the DJs at the rallies. He also knows that if he loses the dice he will be too ashamed to ever enjoy a rally again in case he sees me there; his friends will see to that, ragging him unmercifully forever about losing a dice to an middle-aged DJ on a 20-year-old bike. To him, upholding his reputation as the fearless leader of the local Angels chapter is much more important than preserving his poor machine, so he abuses it mightily to stay ahead. He manages to match my first messenger's speed of exactly 200km/h. I, exhibiting my usual mechanical affinity, continue complacently to average my 199.

Now we must quickly do some basic maths. Since I was travelling at 199km/h, I managed to do the 750 km to Blikkies in 226 minutes, and of course the same from there to Jo'burg. Gulliver, doing 200km/h, would have passed through Blikkies only one minute ahead of my arrival there. Similarly, Slagyster is doing 200, so he gets to Jo'burg one minute ahead of me. Because Slagyster and I left Blikkies one minute after Gulliver passed through, and the two of them are doing the same speed, Slagyster also gets to your office one minute behind Gulliver. (We are assuming here that an "average" speed includes all pitstops, so they don't count.)

Unaware of this gruelling tableau unfolding on the roads, you are happily working away at your desk, solemnly scrutinising the latest Sky & Telescope tucked inside an old financial report. Gulliver, tired and fagged out after a long burn but totally hyped-up on adrenaline from the unaccustomed rush, bursts in to your secretary's office. He breathlessly delivers my message verbatim, as any good messenger should. She buzzes you to say I am leaving Cape town at that instant. "Ah, good," you say, assuming she must have received a phone call. A minute later, Slagyster arrives to say I am in Blikkies, which fact your now somewhat confused secretary efficiently conveys to you as well. "Something is wrong here," you think, "Assuming there were anyone left in the SADF who knows how to fly and service the thing, even our hottest airforce jet couldn't get from Cape Town to Blikkies in one minute. It would have to travel at 45000km/h to do that. In fact, even if it *could* do that speed, it would just melt from the friction!" And just one minute after that... I myself walk in, picking dead bugs off my visor and grinning broadly. I have apparently done Cape Town to Jo'burg in two minutes flat, without even the benefit of the Space Shuttle's ceramic tiles to fend off the heat. (So now you know the origins of the phrase "going for a burn".) This is clearly a record time, but then these old Guzzis are not just tough, they are also moereva fast, as we all know.

This story describes a situation that is actually possible (if little fanciful, given the prevalence of speed-cops and the state of my wallet). Let's relate the players in this flight of fantasy to what's going on with the quasars. In the story, you equate to "the observer"; your secretary is your "measuring equipment"; my two messengers are "photons of light"; I of course am "the jet of matter"; and Cape Town is "the quasar". As you can see, it is possible for perfectly valid information to be quite reasonably misinterpreted if taken purely at face value. Consider too that here I have described sending off only two messengers who -- by travelling only that little bit faster -- just manage to stay ahead of me. I could have despatched messengers at each point along my route as I got there; they would have arrived in sequence and -- given their times of arrival and their statements as to their points of origin -- you would get a consistent picture of my seemingly phenomenal speed. Obviously I chose numbers that were easy to work with and would give an impressive result, but the important issue here is not what order of magnitude our speeds were, but that there was a very small difference between my speed and that of my erstwhile messengers.

Let's now take the (thankfully) hypothetical case of a quasar only 100 light years away from Earth. This distance means that any event in the vicinity of the quasar can only be seen by us one hundred years later, since that's how long the light (travelling at the speed 'c') would take to get from it to us. Now, let's assume that at time 'T', a jet of plasma is ejected by the quasar in a direction almost exactly towards us. It achieves a speed of, say, 0.99c. Being highly energetic, it is very luminous. Nonetheless, the laws of physics still dictate that the light it emits can only travel at c. So, at time 'T + 50 years', the light emitted at the time the jet was ejected has travelled half way towards us (i.e. 50 light years), while the jet itself has travelled only 49,5 light years. Any light that the jet emits at this point must of course also travel at c, while the jet itself continues at 0,99c. At time 'T + 100' years, the light from the initial event reaches us; we see the jet being ejected from the quasar. At this point, the jet itself is still one light year away from us and the light it emitted at the halfway point is only 0,5 light years away from us. So six months later, at time 'T + 100,5 years', that light arrives and, voila!, we see the jet has apparently moved 50 light years distance in only six months. It appears that the jet must be travelling at 100 times the speed of light! At each instant during its travel towards us, the jet continues to emit light that manages to just pull away from it. Again, these photons will arrive in sequence and will present a consistent picture of the jet's phenomenal speed being far in excess of that of light. At time 'T + 101 years' the Earth, having been blasted by intense radiation for a year now, is finally engulfed by the plasma jet. Even those fortunate souls possessing space-faring Guzzi equivalents are in danger of annihilation. Clearly, it is just as well that in reality quasars are pretty much the most distant objects that we can see in the entire universe, because that gives the light a long time to pull away from the matter, leaving it far behind. So don't panic: death by quasar is not in our immediate future.

OK, now that you have digested these two illustrative accounts you will be wondering what astronomers have observed in reality. Before I actually get to that, I must point out a couple of other facts about what is practically possible for us to observe. Firstly, we see things "moving" in the sky because their position with respect to the background (their celestial co-ordinates) and other objects out there change with time. The very long baseline interferometers mentioned earlier allow very small angular displacements to be measured. Because the quasars are so far away, the ability to measure the angular progress of any jets which they might eject is a truly impressive achievement. The jets might be fast-moving and thus cover enormous distances in short order, but their distance from us is so great that the apparent angular separation between the jets and their parent bodies is infinitesimal. Secondly, if a quasar were to emit a jet of plasma directly towards us, we would not see it as a separate entity. This is primarily because the quasar itself is so much bigger and brighter, so the image of the jet would be swamped by that of the quasar itself. Possibly, after careful investigation of the composite image, we might notice some puzzling Doppler effects in the spectrum that could eventually be correctly interpreted by some genius out there (of which there are indeed a fair number). Thirdly and more importantly, objects travelling directly towards or away from us are not seen to move with respect to the background sky, i.e. they do not change their celestial co-ordinates with time. We do not therefore directly perceive their motion; it is only by secondary effects such as the Doppler shifts in their spectra that we can determine that they are in fact moving. And the information we get from that process may be difficult to interpret, but it does not lead to the same confusing conclusion as that highlighted in our earlier little stories. (An aside... Quasars are so far away that they appear to be receding from us at a truly great rate. As a result, the energetic ultraviolet radiation they actually emitted is so drastically Doppler red-shifted that they are seen by us in the infrared!)

With these concepts in mind, we can finally draw this explanation to a conclusion. You should hopefully understand from what I have said so far that, if a quasar were to eject a plasma jet at exactly 90 degrees to our line of sight, we would see it travelling at its actual speed. But if its motion were to be directed just a bit towards us, it would simultaneously get closer to us (i.e. have a "longitudinal" component to its velocity) and move across our field of view (i.e. have a "transverse" component to its velocity, which we directly discern as movement). As its direction of movement gets closer and closer to our line of sight, then the previously described illusion becomes more and more pronounced -- but the transverse component of its actual motion becomes smaller, cancelling this out to some extent. At very small angles, where we can only just separate the image of the jet from its parent quasar, the illusion is at its greatest but the transverse component is at its minimum. The net result is that the apparent multiplication of the object's speed is not as great as those described in the stories, where things were exaggerated for effect. However, it is still significant.

Right, so what is actually being observed in the real world? Amongst others, an astronomer by the name of T. Pearson became interested in a jet of material some 70000 light years in length that had escaped from the quasar known as 3C 273. He decided to regularly observe a very bright nodule within the jet. When he first observed it in 1977, it was separated from the quasar by a distance of 62 light years. When he next observed it three years later, he found to his great astonishment that it was now separated by 87 light years. In other words, between 1977 and 1980, it had apparently moved a distance of 25 light years, which would imply that it was travelling at just over eight times the speed of light. That's indeed rather impressive. [The determination of the actual speed of the nodule and its angle to our line of sight is, as they say, left as an exercise for the student... You can take that to mean that I don't happen to know.]

Well, I hope this has been both entertaining and, if you will forgive the pun, enlightening. It would be better to have suitable illustrations to assist in the explanation; perhaps someone would like to contribute such to the next edition of Canopus? Or -- better -- perhaps someone can take up the challenge of presenting this as a "mini Bateman lecture" at the next ASSA meeting, complete with suitable drawings unfolding on the whiteboard. (Eben/Danie/Evan/Tom/etc., are you listening?) May I suggest Jean Michel Jarre's "Chronologie" as suitable backing music to this epic extravaganza? Of course, I would also be more than happy to have any flaws in my understanding of this interesting phenomenon pointed out. And ecstatic if someone could explain it more simply. Lastly, just so that you can place this article in a temporal context, you may be interested to know that Stanley Kubrick died as I was writing it. (Not that I am suggesting that there is any connection, mind you.)

My best regards to all of you; I hope to see you soon...

Chris Stewart, Brussels,
March 1999

Grazing Occultations for Fun and Profit

By: Brian Fraser

If you want to do a little serious astronomy and get some enjoyment out of it at the same time, then there can hardly be anything more worthwhile doing than observing a grazing occultation of a star by the moon.

On September 2nd last year a group of us went out to the Benoni/Boksburg area to observe an occultation of a magnitude 5.9 star by the moon at about a quarter to midnight.

Tony Hilton and Melvyn Hannibal went to Bill Lockhart's house, which happened to be conveniently located in the path of the graze track. Bill has a lovely Meade LX200 telescope, computer controlled and housed in a very nice roll-off roof observatory which he built last year.

Danie Overbeek assisted by his son Andy, and Tim Cooper found a nice safe site in some school grounds not too far away.

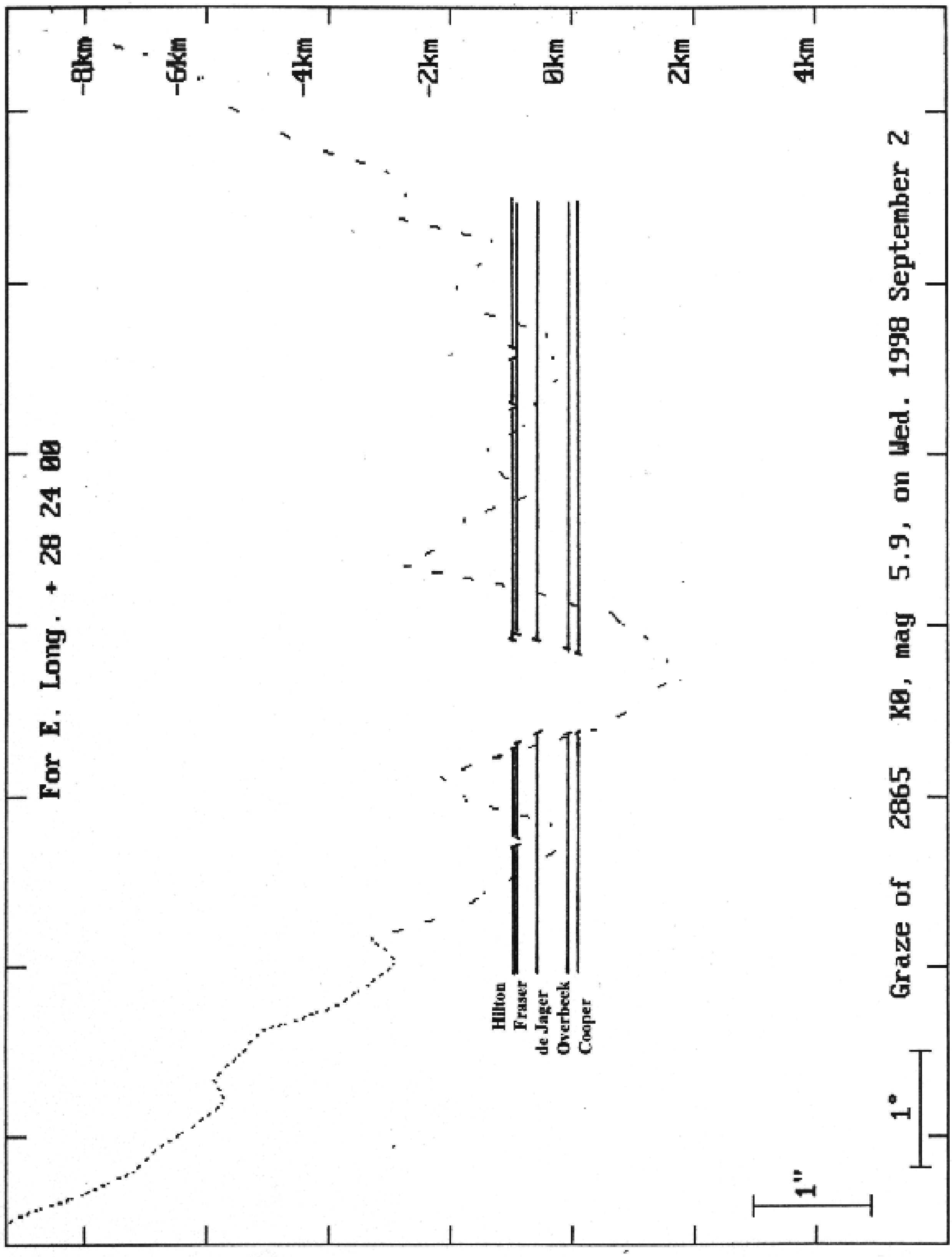
Brian and Val Fraser met Frans de Jager at a workmate's house in Boksburg and positioned themselves at suitable points in the area. Frans brought some friends all the way from Vanderbijlpark to observe the graze.

Although the star was quite bright and the weather conditions almost perfect, it turned out to be quite a difficult graze to see as the star skimmed over some sunlit peaks near the moon's terminator. At times it was impossible to tell the difference between the star and the sunlit peaks!

Fortunately, 5 observers obtained good timings and these are plotted on the accompanying chart. The dotted line is the moon's predicted position and profile. *(Over the page…apologies…the Editors.)*

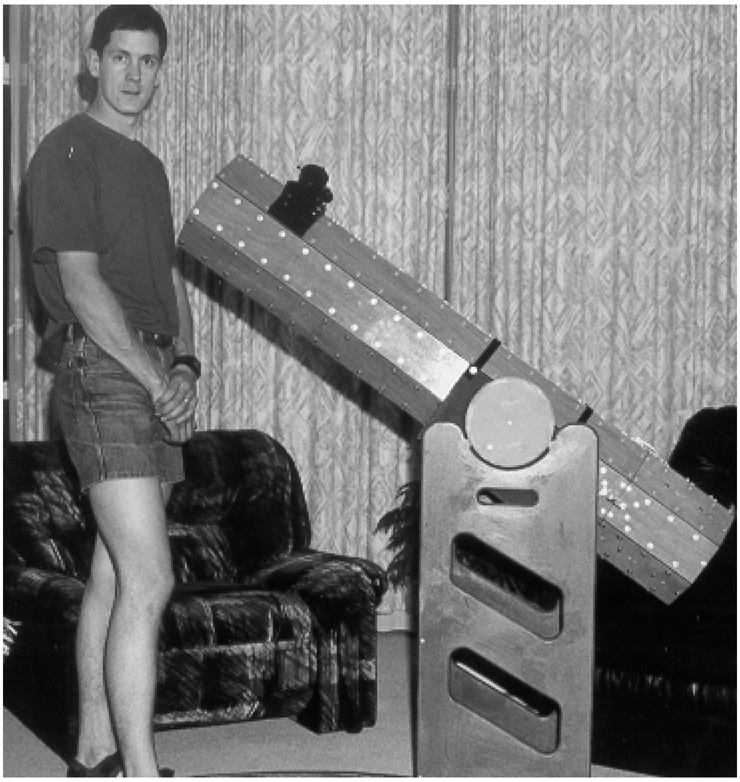
From the observers timings it can be seen that the predictions are in error by about 1/3 of a second. That is why we do these grazes. The results are sent to IOTA (International Occultation Timing Association) and to Tokyo, and are used to refine the position of the star, the moons profile and the lunar orbit. It is all jolly serious science. And fun too.

Plot of Grazing Occultation - 2nd September 1998



Telescope Making Class

Our new class got underway at Parktown Boys High school in the middle of January with about 12 "students" and is progressing very well. One of the students has almost completed his mirror and a couple of others are nearly there. Despite the fact that one guy almost set his school alight while melting resin to make a lap, John Scott has been his usual accommodating self and helped us tremendously.



Gerhard Koekemoer *(in picture with his home built 'scope*) and Rob Kelly are busy cutting gears and building motor drives for their Dobsonian telescopes, something that none of our members has ever attempted before.

We look forward to seeing the finished product. Plans for this motor drive can be obtained on the internet at Mel Bartel's home page.

Gerhard has helped us by having some copies of the handbook photocopied and scrounging some lenses from old photocopiers.

As some of the students finish their mirrors and start making the other bits and pieces for their telescopes we will have room for other students to join the class. So if you are interested in making a telescope, or perhaps feel motivated to finish that mirror you started 10 years ago, come and join us.

Close approach of Venus and Jupiter

On 23 February when Venus and Jupiter were closest together on line of sight, their separate apparent visual magnitudes were -4 and -2 respectively. What was their joint apparent magnitude at that time?

Assume their joint magnitude was ***x*** .

Then $$\frac{1}{2{,}512^{x}} = \frac{1}{2{,}512^{-4}} + \frac{1}{2{,}512^{-2}}$$

$$\therefore\ 2{,}512^{-x} = 2{,}512^{4} + 2{,}512^{2}$$

$$= 39{,}82 + 6{,}31 = 46{,}13.$$

$$\therefore\ -x\ell og\,2{,}512 = \ell og\,46{,}13$$

$$\therefore\ -x = \frac{\ell og\,46{,}13}{\ell og\,2{,}512} = \frac{1{,}66398}{0{,}4}$$

$$\therefore\ x = -4{,}16\ .$$

The joint visual magnitude of Venus and Jupiter, together, was -4,16. This was not much brighter than Venus alone. How much brighter?

It was $\left(\frac{1}{2{,}512^{-4{,}16}} \div \frac{1}{2{,}512^{-4}}\right)$ times brighter.

Let this = ***x*** ,

$$\therefore\ x = \left(2{,}512^{4.16} \div 2{,}512^{4}\right)$$

$$= 2{,}512^{(4{,}16-4)} = 2{,}512^{0{,}16}$$

$$\therefore\ \ell og x = \ell og\,2{,}512^{0{,}16}$$

$$= 0{,}16 \times \ell og\,2{,}512$$

$$= 0{,}16 \times 0{,}4 = 0{,}064$$

$$\therefore\ x = \mathrm{A}nti\ell og\,0{,}064 = 1{,}16\ .$$

The apparition was thus 1,16 times brighter than Venus, or 16% brighter.

In the Sky this Month

April 1999

dd hh		dd hh	
1 06	Jupiter in conj. with Sun	16 20	Mercury greatest elong. W(27)
1 08	Mercury stationary	17 05	Moon at perigee
3 08	Mars 3.3 S of Moon	18 20	Venus 6.7 N of Moon
4 19	Moon at apogee	19 02	Aldebaran 0.7 S of Moon Occn
9 03	LAST QUARTER	21 20	Venus 7.5 N of Aldebaran
10 09	Neptune 1.3 S of Moon	22 19	FIRST QUARTER
11 07	Uranus 1.1 S of Moon Occn.	24 18	Mars at opposition
14 03	Mercury 1.1 N of Moon Occn.	24 21	Regulus 0.4 S of Moon Occn.
15 08	Jupiter 3.2 N of Moon	27 11	Saturn in conj. with Sun
16 04	NEW MOON	29 21	Mars 3.9 S of Moon
16 18	Saturn 2.9 N of Moon	30 15	FULL MOON

May 1999

dd hh		dd hh	
1 07	Mercury 1.8 S of Jupiter	16 12	Aldebaran 0.8 S of Moon Occn
1 18	Mars nearest to Earth	18 15	Venus 5.8 N of Moon
2 03	Moon at apogee	22 03	Uranus stationary
6 19	Neptune stationary	22 03	Regulus 0.7 S of Moon Occn.
7 17	Neptune 0.0 S of Moon Occn.	22 05	FIRST QUARTER
8 16	Uranus 0.8 S of Moon Occn.	25 18	Mercury in superior conjn.
8 18	LAST QUARTER	26 11	Mars 5.0 S of Moon
13 05	Jupiter 3.6 N of Moon	28 02	Mercury greatest brilliancy
13 16	Mercury 0.7 N of Saturn	28 18	Mercury 6.5 N of Aldebaran
14 10	Saturn 3.0 N of Moon	29 08	Moon at apogee
14 12	Mercury 3.8 N of Moon	30 07	FULL MOON
15 12	NEW MOON	30 21	Pluto at opposition
15 14	Moon at perigee	30 22	Venus 4.2 S of Pollux

Telescope for sale:

Make: **Laser Optics**
Diameter: 4½"
Focal Length: 900mm

Accessories:
1 x Barlow lens
1 x 40mm Eyepiece
1 x 12,5mm Eyepiece
1 x 6mm Eyepiece

Contact Person: **Terry Mulvaney**
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