. . ROUNDUP . . ROUNDUP . .

Advertisements

This space is available free to members for advertisements (preferably, but not necessarily astronomical).

Record sundial?

I recently wrote, on behalf of the Astronomy Section, to the Editor of the Guinness Book of Records, pointing out that, while the 1995 Guinness Book of Records contains entries for the *most accurate time-keeping device* and the *largest sundial*, it does not record the *most accurate sundial*.

I suggested that he consider listing the Guernsey Liberation Monument, which is accurate to just five seconds. Its secret, of course, is that it is intended to record the time for only one significant day each year, and is built to an accuracy of 0°01. The slight effects of leap years have been allowed for in the design, and jacking points are provided to maintain its accuracy if settling should affect it.

I have received the following reply from Deputy Editor, Sarah Llewellyn-Jones:-

"I was very interested to read about this new sundial, and would be happy to retain the information that you've sent for possible future reference. As I am sure you can imagine, we are limited by the lack of space in The Guinness Book of Records, and it is considered that this limitation means that we will not be able to subdivide the category of most accurate time-keeping device any further. Naturally I will contact you should we reconsider in the future. ¤ ***DLC***

Astronomy Section Officers

Section Secretary:	Geoff Falla	724101
Honorary Treasurer:	Peter Langford	720649
Light Pollution Officer:	Ken Staples	54759

The next newsletter will be published early in January. The deadline for publication materials is 15th December.

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Sagittarius

The Newsletter of the Astronomy Section of La Société Guernesiaise

November/December 1995

Forthcoming events

The Birth of the Solar System
by Frank Dowding
Tuesday, 7th November
8.00 pm at the Observatory

Quiz and Supper Evening
Tuesday, 5th December
7.30 pm at the Observatory

and, of course:
Every Tuesday evening
from 7.30 pm at the Observatory
and observing on Fridays, if clear

In this issue

Robert H Goddard, Rocket Pioneer
by David Williams

Fast Moving Stars
by Mark Humphrys

Inside

Major articles in **bold**

Centre inserts

November/December star chart
and Moon phase calendars

The Birth of the Solar System

Frank Dowding will be the speaker at the next meeting, on **Tuesday, the 7th November at the Observatory.**

His talk is intended to give an understanding of a number of questions relating to the birth of our planetary system:-

Where did the basic materials for the Solar System come from?

Why do we have elements such as iron and carbon in a basically hydrogen and helium universe?

Why did the Solar System evolve in the first place, and why did the Sun and planets form into spheres?

Can we account for the inner planets being rocky, and the outer planets being gaseous?

And why is it that the Earth has an atmosphere which is breathable by humans?

Frank will answer these questions with the help of some slides and a short video sequence.

Quiz and Supper Evening

Our usual Quiz and supper evening will be held **at 7.30 pm on Tuesday, 5th December at the Observatory** (note the early start time). Roger Chandler will be the quiz-master this year, with the object of having some educational fun.

Supper as usual will be on a pot-luck basis. Please bring something to share with others, and which can be nibbled during the quiz. Guests are welcome.

Terraforming

On Tuesday, the 5th September, Christopher Le Conte spoke about terraforming – the process of changing a planet's climate to make it habitable.

Christopher started his talk by explaining that the term was coined in 1942 by a science fiction writer. He then described the range of techniques which could be used: chemical, genetic, brute force and technical. This last technique could include warming a planet by the use of mirrors, or developing Von Neumann machines, which, in addition to doing a job, re-create themselves!

Christopher then gave us what he called a "whistle-stop tour" of the Solar System, identifying the best candidates for terraforming. Many have advantages and disadvantages. For example, Venus is similar to the Earth, and has plenty of water, but the high temperature and pressure, and high sulphur content would make its atmosphere very difficult to modify. Titan, one of Saturn's moons would be a good candidate, but is very far away.

He provided a detailed comparison of Venus and Mars with the Earth, and suggested that carbon dioxide, ammonia or CFCs could be used to warm up Mars's atmosphere. He then listed the advantages and disadvantages of manned and unmanned flights, contrasting the flexibility of manned flights with the less energy required for unmanned flights.

Christopher outlined a possible schedule for terraforming a planet – taking some 2000 years! Finally, he dealt with some of the moral issues.

The talk stimulated much discussion about this unusual but fascinating subject.

Videos . . .

There had been good publicity, in newspapers, on television and radio, for the Video Evening and Star Night held on the 17th October at La Houguette School, so we expected a good public turnout. In the event, the weather was poor (it was actually raining just before the start), and we had just over 30 people, with good support from Section members.

The three videos shown proved very popular. The first was over half of *The Man Who Colours Stars*, a portrait of David Malin, with many examples of his astrophotographs and remarkable photographic techniques.

Second was *Christmas Star*, excellently edited from its full 50-minute length to 20 minutes by Sean Harvey. This was an analysis of theories about the Christmas Star, concluding that it might (or might not) have been a multiple conjunction of Jupiter and Saturn in 7 BC.

Finally, there was a short extract on Saturn from the Voyager spacecraft missions.

Incidentally, these and other videos are now available for rent to members (see announcement on page 17).

. . . and stars

The sky miraculously cleared (partially) at the end of the videos, and about half of the audience went to the Observatory to look at Saturn, the Andromeda Galaxy, the M15 globular cluster, and other objects.

The other half stayed at the School and watched a selection of colour slides of David Malin's photographs, projected onto the School's giant screen, accompanied by commentary written by David Malin himself.

Educational activities

On Monday, the 2nd October, David Le Conte gave a general talk on astronomy to the Castel Women's Institute, illustrated with colour slides. The talk netted a further £15 for Section funds.

On Tuesday, the 10th October the Observatory was featured on Channel Television News when David was interviewed about the possible discovery of a planet around another star (51 Pegasi) and the public event on the 17th.

On Monday, the 16th October 14 Ranger Guides from the 6th Guernsey (Vale) troop visited the Observatory for 1½ hours and were shown Saturn and other objects by Geoff and David. They also watched the *Christmas Star* video during a cloudy interlude.

On Tuesday, the 17th October, David gave a talk on the Solar System to pupils of La Houguette School.

Overseas members' news

David Williams, who is now our correspondent member in Ipswich, paid us a brief visit at the end of September. He brought a copy of the Orwell Astronomical Society newsletter. His long-running series on Famous Lives comes to an end in the next issue of Sagittarius. Hopefully he will continue to write for our newsletter.

We were also delighted to hear from **Mark Humphrys**, who is currently our correspondent in Kazakhstan! He is working in the Caspian Sea, but will leave in the winter, when the sea freezes over. He hopes to visit Guernsey at that time. In the meantime he sent the article on fast moving stars, which is published in this issue, starting on page 6.

Famous lives 11 – Robert Hutchings Goddard (1882 - 1945) by David Williams

Robert Goddard was born on the 5th October 1882 at Worcester, Massachusetts. He was a physicist by training, and a graduate of Worcester Polytechnic Institute. He carried out research for his doctoral degree at Clark University, Worcester. His early work, both experimental and theoretical into rocket mechanics, was also carried out at Clark University where he was Professor of Physics.

Rocket-powered flight is not new. The idea of flying by rocket has been in the imagination since early times, and the Chinese certainly knew about and experimented with rockets many centuries ago. It was this idea which gripped the imagination of the young Robert Goddard, and it was never to leave him as he was to devote his life's work to its development.

Rockets were not new; they had been used in various forms for some time – using solid fuels, but it was to fall to Goddard to develop a liquid fuel system, and so allow a quantum leap in rocket development to take place.

His first studies of the use of liquid-powered rockets were made in 1909. He applied for, and was granted, his first patent in July 1914. This was to be the first of over 200 patents granted to him during the next 36 years.

His research was to follow a militaristic line during World War I, for during this time he developed a system which allowed a light-weight rocket to be launched from a shoulder rocket launcher. He achieved this by altering the solid fuel composition.

It was this research which was to lead to the development of the bazooka in World War II.

However, not all his studies were for the military application of rockets, for he continued to make great strides in his work which resulted in several modifications to rocket designs. He received a boost to his work when, in 1916, he applied to the Smithsonian Institution for a grant and was awarded $5,000. This allowed him to continue his research into the area that truly excited him, that of high altitude rocket flying.

Originally, he attempted to develop a solid fuel motor, but gradually he came to realise that the way forward was to change from solid to liquid fuel propellants.

In September 1919 he was to publish what was to be his masterpiece. Under the auspices of the Smithsonian, his paper *A Method of Reaching Extreme Altitudes* was to contain his dreams and aspirations for the development of rockets.

He carried out his first experimental liquid fuel rocket test flight in 1926. It was a combination of liquid oxygen and gasoline. This first flight was held on the 16th March. The rocket achieved an altitude of 12 metres (41 feet), and landed 54 metres (184 feet) away from the launch site, a small but hugely significant flight. He was to continue working here for three more years, until, in 1930, with the support of the Guggenheim Foundation in the sum of $50,000, he moved to Roswell, New Mexico, where his research continued. »»

He continued not only to develop liquid fuel propellants, but to modify rocket designs as well, allowing them to become more stable and efficient by the use of gyroscopic stabilizers and by modifying fins to channel rocket exhausts.

Other advances achieved during this productive period include firing the first liquid fuel rocket faster than sound in 1935. He also developed the first step rockets, the precursor of the giant Saturn V Moon launcher. He also launched rockets that achieved altitudes in excess of one mile.

After his death in 1945, his notes revealed a man of immense foresight and vision. His writings outlined his ideas for rocket-powered flight to the Moon, of circum-lunar orbits to allow camera-bearing rockets the opportunity to photograph the far side of the Moon. He had also visualised ion and nuclear-powered rockets to allow humans to achieve inter-planetary exploration.

Sadly, this great man, the 'Father of modern rocketeers', never lived to see any of the great developments only he had visualised, for he died from throat cancer on the 10th August 1945, aged 62 years.

It is, however, a great testament to his scientific standing that, when, in 1919, he postulated in his paper that humans could go to the Moon by rocket, he was not ignored or laughed at by the scientific community. They realised the potential behind this great and thoughtful man's work.

When, in 1926, his first liquid fuel rocket made its first puny flight, it ranked in magnitude and importance to another puny flight which was also to change the course of human history, the first manned powered flight which had taken place only 23 years previously, at Kitty Hawk, on the 17th December 1903. ¤

David Williams

Reference:

Encyclopædia Britannica

Moon phase calendars

With this issue of Sagittarius we start a new series of inserts – charts of the Moon's phases, day by day for two months.

The computer program which I developed to prepare the charts uses an algorithm published recently in *Astronomy* to calculate the *Sun's selenographic colongitude*. This fancy term is a measure of the position of the morning terminator on the Moon.

I used this to give an approximation of the lunar phase for 9.00 pm GMT each day. Note that it may not coincide exactly with published phases shown in newspapers, as it is an approximation, and is for the evening, rather than midnight. ¤ ***DLC***

Variation on a theme

By Geoff Falla

Twinkle, twinkle little star,
How they wondered what you are;
Now we have no need to grope,
For there is –
the SPECTROSCOPE.

To catch a moving star – A short survey of fast moving stars by Mark Humphrys

When a star moves across the celestial sphere relative to the Sun the movement is called its ***proper motion*** (symbol μ). The motion is measured in seconds of arc per year ("/year). Most stars have proper motions of less than 0".1/year. However, there are around 300 stars which have a proper motion greater than 1"/year.

The history behind the discovery of proper motions goes back to 8th century China, when the monk I-Hsing discovered discrepancies between existing star coordinates and those determined using new instruments. Although the effects of precession and observational errors could account for some of the differences, it seems likely that some were due to the actual proper motions of the stars concerned.

In the 17th century Edmond Halley, studying the motions of Aldebaran, Arcturus and Sirius, determined that their motion was greater than could be accounted for by the effects of precessions and instrumental errors. Halley used measurements made by Hipparchus some 20 centuries previously, and determined that, for instance in the case of Arcturus, the star had moved nearly one degree across the sky in that time.

Thus the concept of proper motions came into being, and opened up a new area of astronomical research as more astronomers began to catalogue stars with determinable proper motions. It was also another nail in the coffin of the concept that the stars were fixed in space, centered on the Earth.

Between the 8th August 1989 and 15th August 1993 the satellite Hipparcos, launched by the European Space Agency, carried out a survey of over 100,000 stars. Its mission objective was to gather data so that the positions, distances, velocities through space and photometric values of the stars could be determined with a far greater accuracy than could be achieved from ground based observations. Despite the setback of not achieving its Clarke orbit due to booster failure, and the subsequent failure of one of its gyros due to the extreme radiation of the Van Allen belt, it remained operational for more than four years, longer than its designed life of 2½ years.

Also, in the process of acquiring positional data, Hipparcos also discovered several thousand new binary star systems, and measured the light variations of many hundreds of thousands of stars. The Hipparcos Star Catalogue will be ready in 1996, and will give positional data to an accuracy of ±0.002 arc-seconds, and photometric data to ±0.003 magnitudes.

This article will give an overview of some of the faster stars, as shown in Table 1, particularly those visible from the northern hemisphere. The finder charts will help to locate them in the sky if you do not have setting circles.

Barnard's Star

This is the second closest star to us, roughly 6 light-years away. It can be found in Ophiuchus, to the left of β Ophiuchi, near to the 5th magnitude »»

star 66 Ophiuchi (Figure 1). As the name suggests, its rapid movement across the sky was first determined by Edward Emerson Barnard in 1916. From two photographs taken 22 years apart, it was apparent that there was a considerable shift in its position, Figure 2 shows its path over the last hundred years. It will cover 1° of sky in about 351 years. Because it is travelling towards the Sun, and should make its closest approach in 11,800 AD, when it will be 3.8 light-years from us, its proper motion is also increasing, and should reach a maximum at about 10,000 AD, when the value will reach 25".6 per year!

Despite coming quite close to the Solar System it won't be much brighter, reaching only about 8.5 magnitude, as it is some 2,500 times fainter than the Sun and is only about 15% of the mass of the Sun.

Groombridge 1830

This star can be found about 8° northeast from ν Ursæ Majoris (Figure 3), lying between three faint galaxies: NGC 3930A/3930 and 3941. It is a sub-dwarf G8 yellow star, lying at a distance of 28 light-years. Its velocity through space is calculated at 216 miles per second, one of the fastest. The spectrum of the star indicates that it is metal deficient, suggesting that the star formed during the early stages of evolution of the Galaxy, compared with metal rich stars which formed much later and incorporated the remains of the materials left behind by the collapse of the Population II galactic halo stars.

There is also a companion to Groombridge 1830, lying about 1".7 away, at a PA of 166°.

Lalande 21185

Also in Ursa Major is Lalande 21185 (Figure 3), discovered by G Land in 1941. It lies about 4° northwest from ν Ursa Majoris. It is the fourth closest star to us, at about 8.2 light-years. It is a red dwarf with a mass of about 0.3 of the Sun's mass. There are perturbations in the star's motion, which indicates the presence of a companion, as yet undetected visually. Calculations show that the period is about 8 years, and that the mass is around one-hundredth of a solar mass, which gives rise to the possibility that it may be a massive planet orbiting the star.

61 Cygni

Next in the survey of fast stars is the famous double star 61 Cygni (Figure 4). Its two visible components have magnitudes of 5.3 and 5.9, the former being a K5 star while the latter is K7. Both have a distinct orange colour. The orbital period is around 650 years. Calculations of the orbits have shown that there is in fact a third component to the system. The companion, 61 Cygni C, is thought to have a mass of around 8 times that of Jupiter.

Wolf 359

This is the third nearest star to us (counting the Centauri trio as one star) lying about 7.7 light-years away from us (Figure 6). The star is very faint, with a visual magnitude of about 13.5 or so (Figure 7). According to Burnham's (Vol. 2, page 1071) it is about 1/63,000 as luminous as the Sun, and is one of the least luminous stars known so far. Calculations also show that the star has a diameter roughly that of Jupiter. »»

Omicron 2 Eridani

A triple star system in Eridanus (Figure 8), the primary (A) is an orange main sequence star shining at magnitude 4.48, while its companion (B) is a white dwarf of magnitude 9.7. The secondary has a faint 10.8 red dwarf orbiting it (C). The distance between A and B is reckoned to be around 400 AU (the average distance between Pluto and the Sun is 40 AU), with an orbital period of the order of 7,000 to 9,000 years. The distance between B and C is a mere 44 AU with an orbital period of 248 years. The star system is moving through space at about 62 miles per second.

Both A and C have densities of the same order as the Sun, but B is rather more exotic, having a calculated density some 65,000 times that of the Sun. A spoonful would weigh a ton or more !! This would create a surface gravity about 37,000 times that of the Earth. If it was possible to stand on the surface a 90 Kg adult would weigh around 3300 tons!

Mu Cassiopeiæ

Figure 9 shows the position of μ Cassiopeiæ to the southeast of Schedar, α Cassiopeiæ. The star is about 26 light-years from us, and moving through space at about 100 miles per second. It has a mass around 3/4 that of the Sun, and is classified as a sub-dwarf, with a luminosity of about 0.4 of the Sun's. It is also a binary, with a faint 8th magnitude red dwarf companion about 0''.8 away.

Luyten 726-8, UV Ceti System

This is an interesting binary system, consisting of two red dwarfs (Figures 10,11). The combined mass of the two stars is 0.08 that of the Sun, and thus each object has one of the smallest masses of star that has been detected. Of the pair it is the smaller companion which is the most interesting – it is a flare star, and has been seen to increase from magnitude 12.3 to 6.8 in 20 seconds, and then return to normal some three minutes later!

This binary system is travelling through the heavens at the same rate and direction as that of stars in the Hyades star cluster in Taurus, which is some 45° away – it may be that these stars are a distant outlier to the cluster.

Arcturus

This famous star is moving through space at around 90 miles per second, heading towards the constellation Virgo (Figure 12). It is around 25 times the diameter of the Sun, and is some 115 times more luminous. It is a K type star with a surface temperature of about 4,200 K, giving it a golden yellow colour.

Sirius

This is the brightest star in the sky, with a magnitude of -1.46. It is 8.7 light-years from us – the fifth nearest star system to us. A surface temperature of 10,000 K gives the star a brilliant white colour.

A companion to Sirius had been calculated from perturbations in the proper motion of the star in 1851, but it was not seen visually until 1862. The magnitude of the companion is 8.4, and is so close that it is usually swamped by the light of the main star. But it can be picked out in small telescopes when good seeing conditions prevail. This small companion is another white dwarf; its mass is near to that of the Sun, but it is only about 2% of its diameter, around 28,000 km across. (By comparison the Earth is only 12,800 km diameter.) »»

From this brief survey of fast moving stars it is apparent that the constellations as we know them today are very much a temporary feature, and future generations of astronomers will have different patterns in the sky to look for.

One last question: What is the Sun's proper motion? This can be calculated by examining the angle between the Sun's direction of travel and the direction of travel of stars within a 64 light-year radius. It turns out that the Sun is moving through space relative to these stars at about 12 miles per second. ¤

Mark Humphrys

Table 1: Stars of large proper motion

* - Described in main text. μ is proper motion.

Name	Constellation	μ "/year	Visual magnitude	RA (2000) h m s	Dec(2000) ° '	Dist. light-yr	Spectral class
* Barnard's Star	Ophiuchus	10.30	9.53	17 57 48	+ 04 34	6.0	M5
Kapteyn's Star	Pictor	8.72	8.84	05 09 42	- 45 00	13.0	M0
* Groombridge 1830	Ursa Major	7.05	6.45	11 52 58	+ 37 43	28.0	G8
Lacaille 9352	Piscis Aus.	6.90	7.34	23 05 52	- 35 51	11.7	M2
* 61 Cygni	Cygnus	5.22	4.84	21 06 53	+ 38 45	11.1	K5
* Lalande 21185	Ursa Major	4.77	7.49	11 03 20	+ 35 58	8.2	M2
* Wolf 359	Leo	4.70	13.53	10 56 30	+ 07 01	7.7	M6
ε Indi	Indus	4.70	4.69	22 03 21	- 56 47	11.2	K5
* o^2 Eridani	Eridanus	4.08	4.43	04 15 16	- 07 39	16.0	K1
* μ Cassiopeiæ	Cassiopeia	3.75	5.17	01 08 16	+ 54 55	26.0	G5
α^1 Centauri	Centaurus	3.68	0.00	14 39 36	- 60 50	4.3	G2
Lacaille 8760	Microscopium	3.46	6.68	21 17 15	- 38 52	12.5	?
* Luyten 726-8	Cetus	3.36	12.40	01 38 48	- 17 58	9.0	M6
81 Eridani	Eridanus	3.14	4.27	03 19 55	- 43 04	20.0	G5
* Arcturus	Boötes	2.28	- 0.04	14 15 39	+ 19 11	34.0	K2
* Sirius	Canis Major	1.33	- 1.46	06 45 06	- 16 43	8.6	A1

Notes: 1. The table was compiled from the following sources:-

Burnham's Celestial Handbook – all volumes

Handbook of Space Astronomy and Astrophysics, by M V Zombeck

The Astronomy Encyclopædia, edited by Patrick Moore

Project Dædalus, by the British Interplanetary Society

The Guinness Book of Astronomy, by Patrick Moore

2. The table is not complete; some stars with large proper motions are not included.

FIG. 1 – BARNARD'S STAR IN OPHIUCHUS

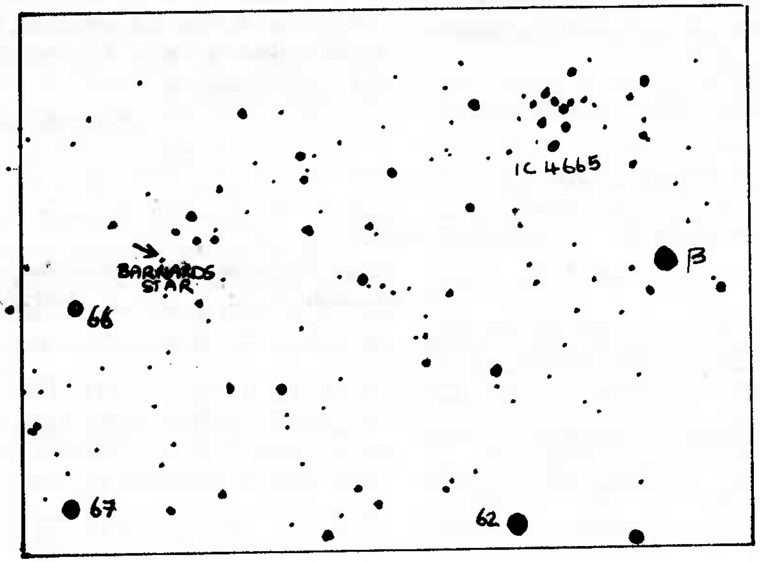
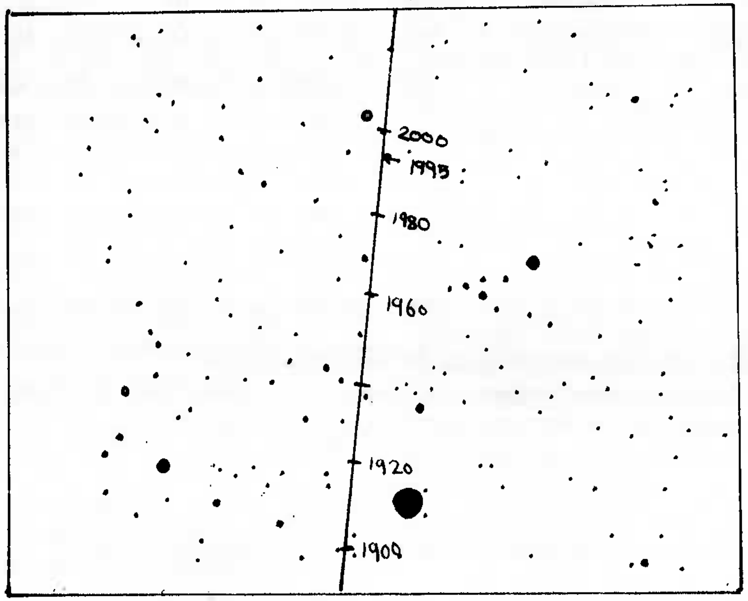


FIG 2. – THE PATH OF BARNARD'S STAR



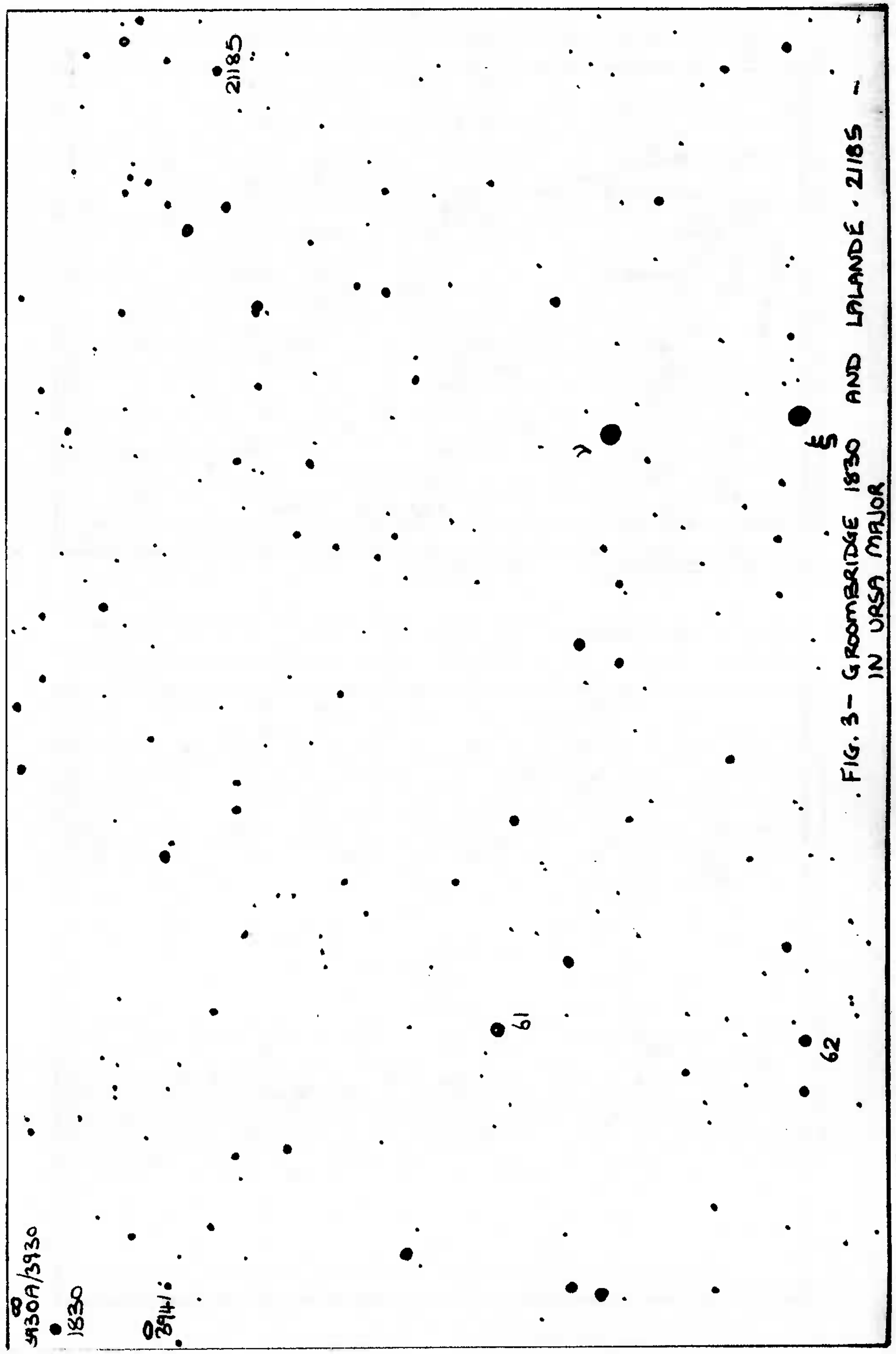


FIG. 3 – GROOMBRIDGE 1830 AND LALANDE 21185 IN URSA MAJOR

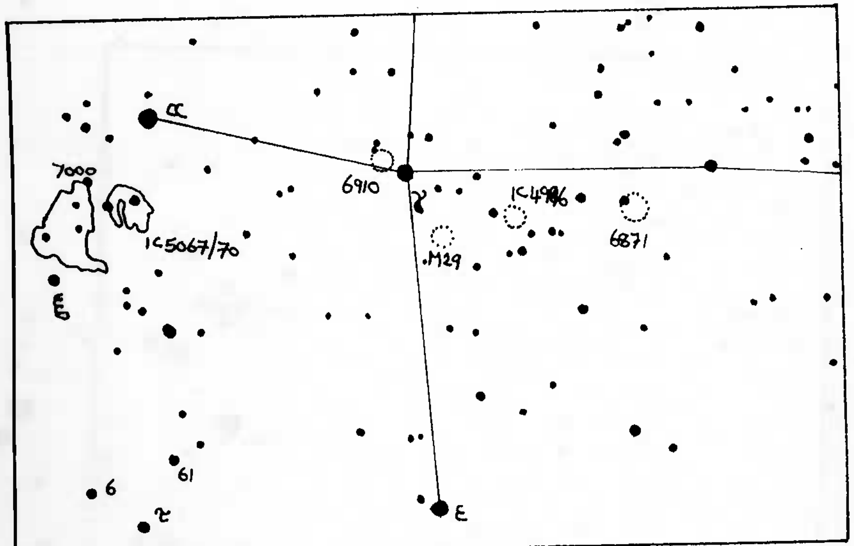
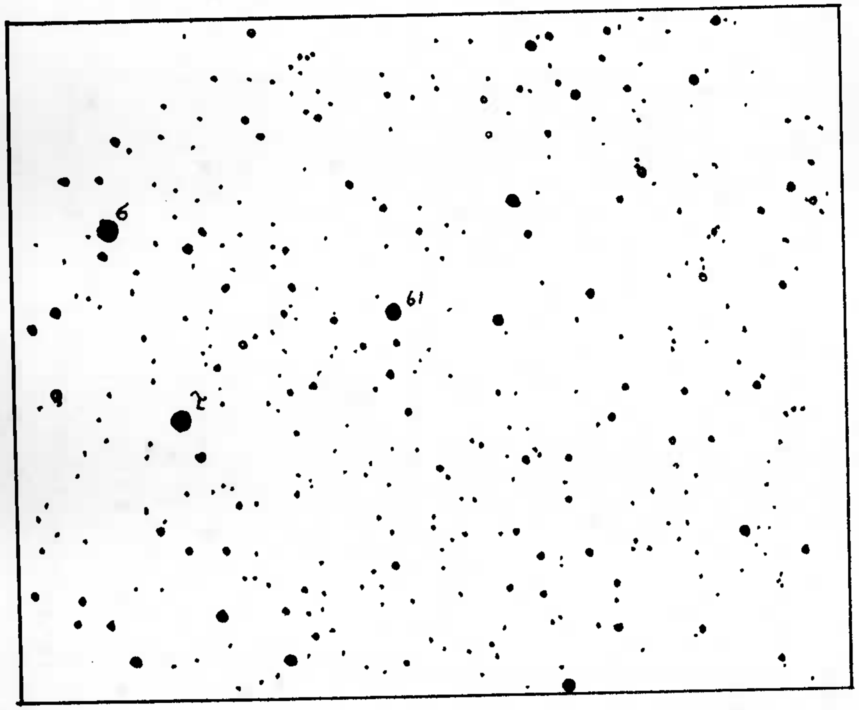


FIG. 4 – CYGNUS : 61 CYGNI

FIG. 5 – 61 CYGNI



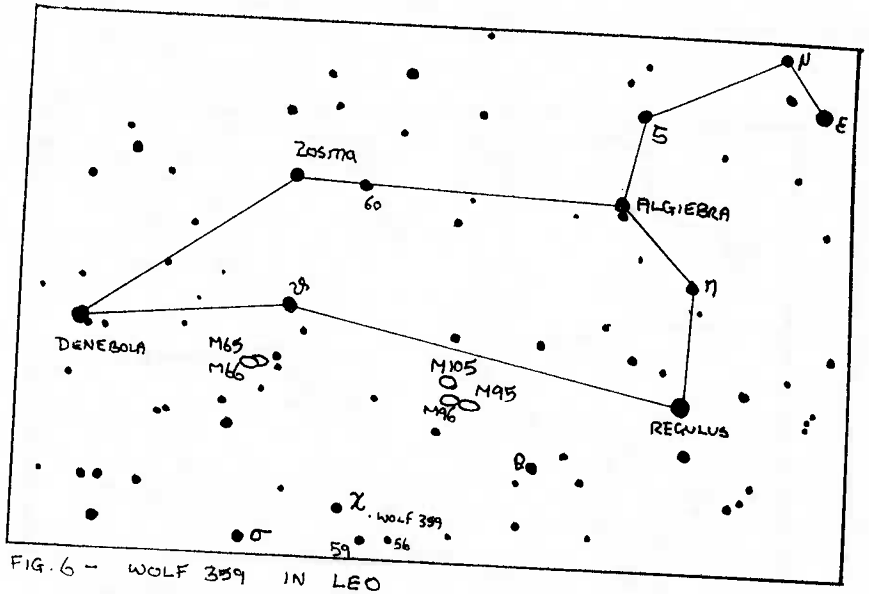
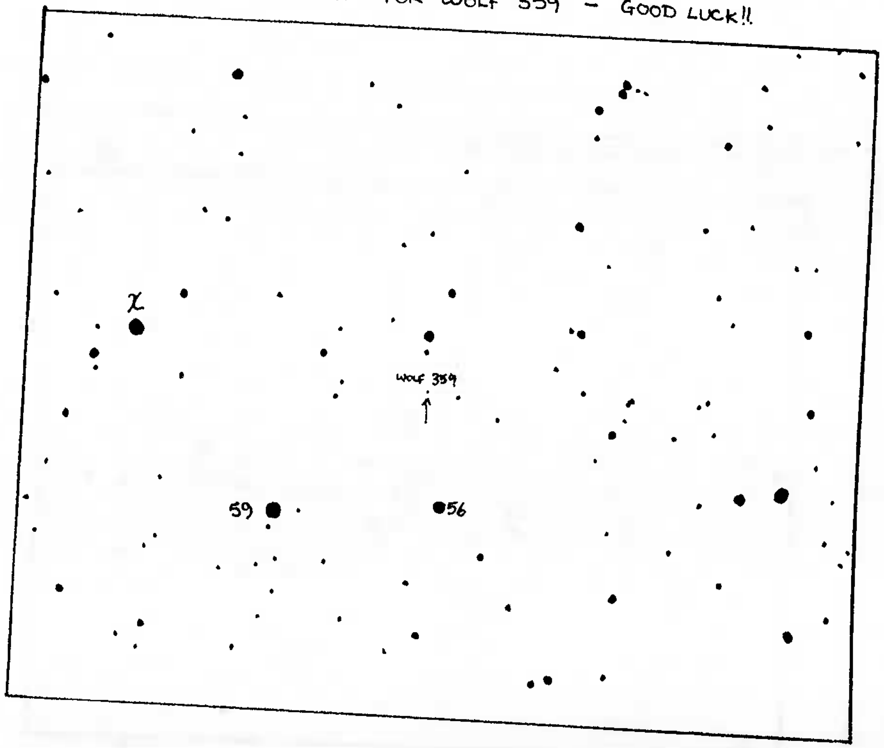


FIG. 6 – WOLF 359 IN LEO

FIG. 7 – FINDER CHART FOR WOLF 359 – GOOD LUCK!!



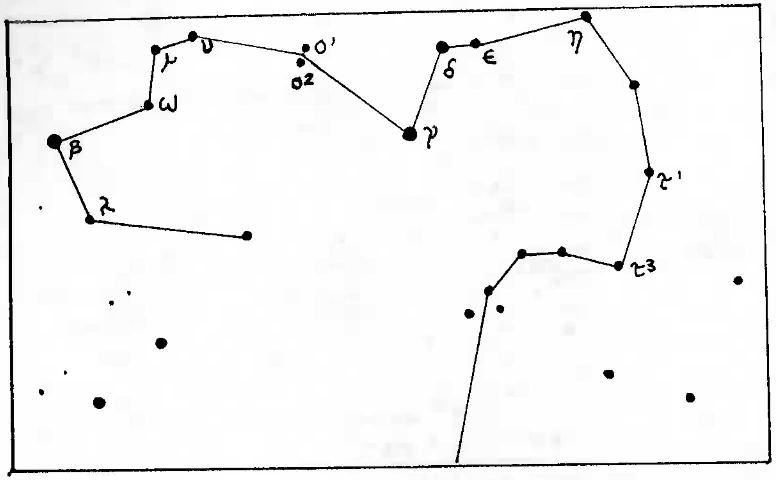
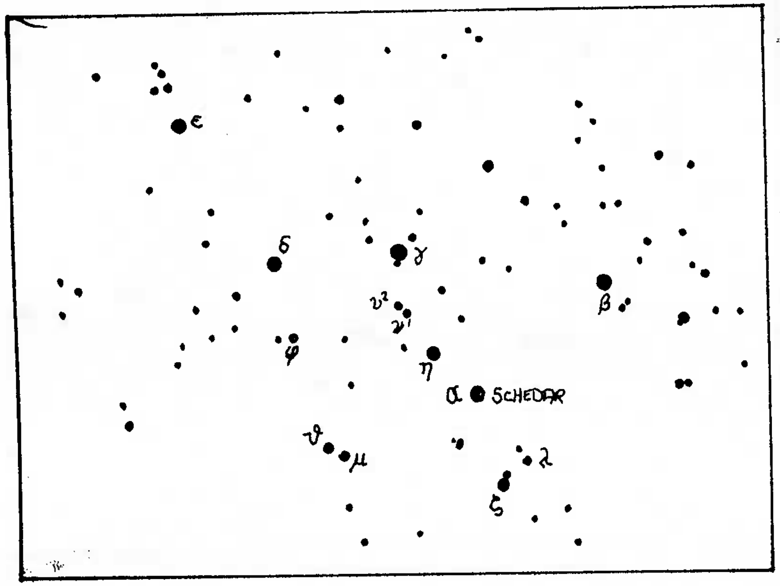


FIG. 8 - TRIPLE STAR SYSTEM, OMICRON 2, IN ERIDANUS

FIG. 9 - MU CASSIOPEIAE



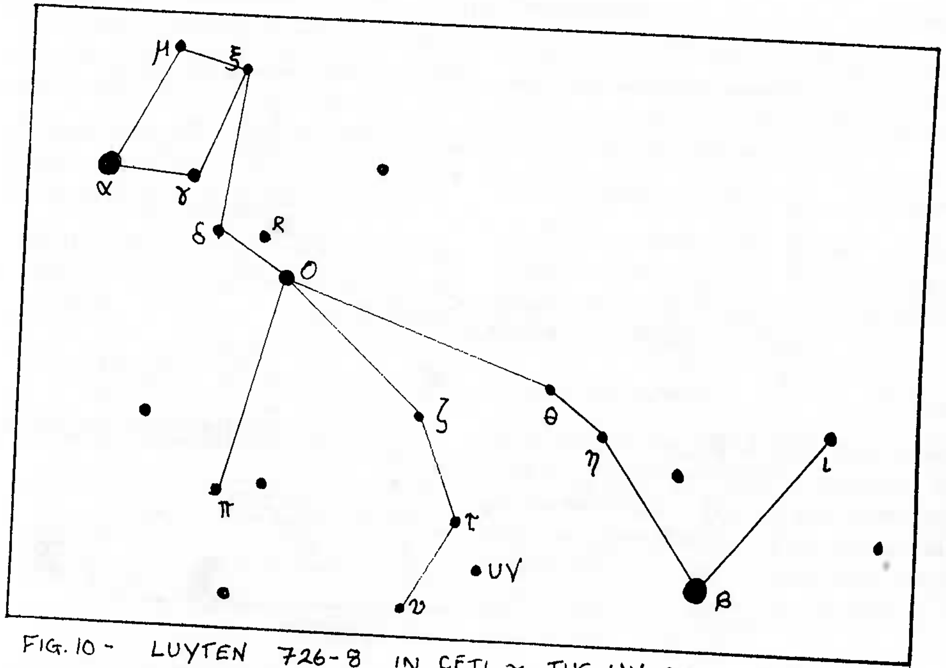
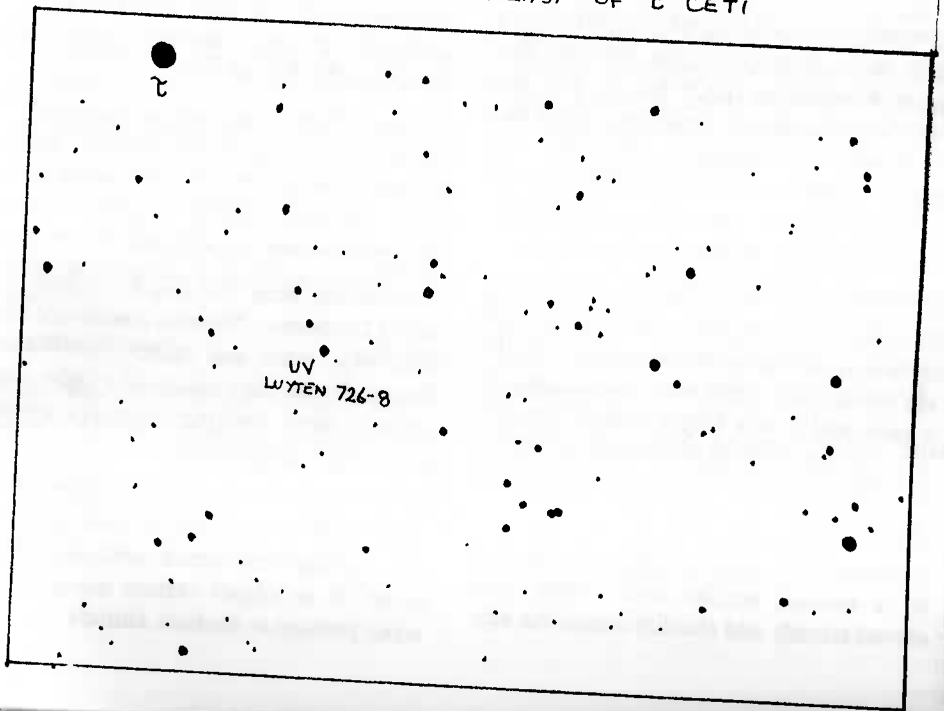


FIG. 10 - LUYTEN 726-8 IN CETI ~ THE UV CETI SYSTEM

FIG. 11 - LUYTEN 726-8 SOUTH EAST OF τ CETI



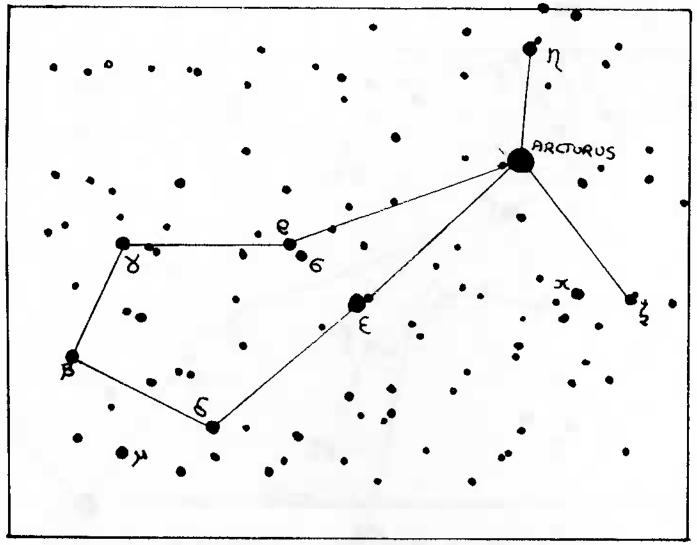


FIG. 12 ARCTURUS IN BOÖTES

St Martin's UFO report

I recently received a telephone call from a lady in St Martin's, saying that she had never believed in UFOs before, but that she did now. Briefly describing what had been seen the previous afternoon, the report sounded so interesting that I agreed to visit her the next day, when she described what happened in more detail.

Standing on the back doorstep and looking into the garden, at about 5.45 pm, she had suddenly noticed a strange object in the sky towards the south-east. The shape was square, and it was bright with a "crystal-like" surface, not bright enough to dazzle or affect her eyes, and it appeared to be pulsating.

A few seconds later the object was joined by a second, similar one. They both moved silently and steadily across the sky.

The second object then veered away to the left, on a different course, and a thin crescent Moon was noticed near it. This second object was then lost to sight, but suddenly it was noticed back again alongside the first object.

By now there was only a small area of light at the base of the objects as they moved steadily to the south-west, and they both became black squares before disappearing into the distance.

The objects were watched for between 10 and 12 minutes. Weather conditions were clear sky, warm and calm. The Weather Report for the day indicated a light north-easterly wind, backing overnight towards the north or north-west.

As for an explanation, if the sighting had been of just a single object moving steadily and silently, one could have thought in terms of an object carried along by the wind, perhaps at medium altitude. »»

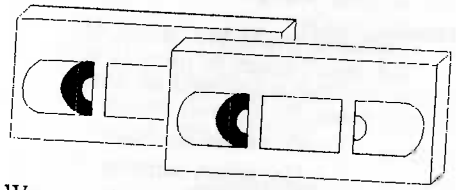
However, the description of the two objects, and in particular that one moved away on a different course for a while, seems to rule this out completely.

Can anyone suggest an explanation, or can we safely put this into the category of UFO reports which seem to be unexplained?

A report on the sighting (on August 30) has also been sent to the British UFO Research Association. ¤ ***Geoff Falla***

Kites? - ed.

Videos available



We now have a number of videos which Section members can borrow. A donation of £1 is requested, and the videos can normally be kept for a period of two weeks.

The following six titles are currently available.

The Man Who Colours Stars *50 mins*

The life and work of David Malin, the world's top astrophotographer. "The cosmos on camera as never before . . . filled with the most lavish pictures of deep space."

Christmas Star *50 mins*

What was the first star of Bethlehem – comet, meteor, planetary conjunction, or supernova? Astronomers offer their theories in this video, which is shot on location in the Holy Land, and interwoven with a wealth of cosmic animation.

The Universe *30 mins*

This is a NASA film, covering the entire universe, from the solar system, through the birth of stars, the Milky Way galaxy, pulsars, quasars and black holes.

The Voyager Missions *30 mins*

This video covers the journey of the Voyager spacecraft to Jupiter, Saturn, Uranus and Neptune, and the incredible images which they sent back.

The Dream is Alive *37 mins*

The video of the IMAX film, shot by the Space Shuttle astronauts, narrated by Walter Cronkite. It give you a window seat on the Shuttle, with spectacular images of the Earth, the astronauts' work and life aboard, and a repair of a satellite in space.

For All Mankind *77 mins*

The story of the manned flights to the Moon between 1968 and 1972 is told with NASA footage. The video combines the most dramatic moments from the nine Apollo missions into a single epic journey from lift-off to lunar landing. It includes the astronauts in their own words.

Some members also have videos of television programmes, which they would be prepared to share with other members.

Do you have any videos which you could make available? The videos can remain your property.

Please note that, because of the humid conditions in the Observatory, the videos cannot be kept there at the present time. Please contact David Le Conte (64847) if you want to borrow them. ¤

Pub talk - from leap years to leap seconds

Recently I was asked to explain how the leap year system worked, whether the year 2000 will be a leap year, and what time scales were used for space missions.

The enquirer, with whom I was unacquainted, seemed to know that leap years did not necessarily occur every four years, and he had heard of UTC, so I leapt into a detailed explanation. He then asked me to put it in writing, as the subject had been raised (presumably along with glasses) at his local pub, and he had undertaken to find out and report back the following Friday!

Astronomy Section members who do not frequent the same pub may be interested in my reply.

"The most authoritative reference to the leap year system of the Gregorian calendar is probably the Explanatory Supplement to the Astronomical Almanac, published by the U.S. Naval Observatory (1992), which says (page 580):-

> *"The Gregorian calendar today serves as an international standard for civil use. ... Years ... are divided into two classes: common years and leap years. A common year is 365 days in length; a leap year is 366 days, with an intercalary day, designated February 29, preceding March 1. Leap years are determined according to the following rule:*
>
> ***Every year that is exactly divisible by 4 is a leap year, except for years that are exactly divisible by 100; these centurial years are leap years only if they are exactly divisible by 400.***
>
> *As a result the year 2000 is a leap year, whereas 1900 and 2100 are not leap years. ...*
>
> *The Gregorian calendar is thus based on a cycle of 400 years, which comprises 146097 days. Since 146097 is exactly divisible by 7, the Gregorian civil calendar exactly repeats after 400 years."*

The Gregorian calendar is named after Pope Gregory XIII (1582). It replaced the Julian calendar, named after Julius Caesar.

The average length of the Gregorian calendar year is:

365 days 5 hours 49 mins 12 secs.

This is about 30 seconds longer than the Tropical Year, which is based on the seasons. The Gregorian calendar therefore accumulates an error of one day in about 2500 years.

There are several different time scales, but the most common one is Universal Time, or UT, which is a measure of the rotation of the Earth on its axis. It is virtually the same as Greenwich Mean Time (GMT). For precise scientific purposes International Atomic Time (TAI) is used; it is the standard time scale on which other time scales are based.

Coordinated Universal Time (UTC) is also used. It is an atomic time scale which is kept in close agreement with TAI. Because the Earth's rotation is not uniform, UTC is adjusted to agree closely with UT by the introduction of leap seconds about every 18 months.

Julian dates are used for many astronomical purposes, especially computing. This is a number which increments by one each day. However, »»

it is counted from noon, rather than from midnight. Fractions of a day are represented by decimal numbers. So at noon on the 1995 August 22, for example, the Julian date was 2449952.0, whereas at 9.00 pm on that date it was 2449952.375. ¤

David Le Conte

I would love to have been a fly on the pub wall that Friday (or even a fly in the beer glass)!

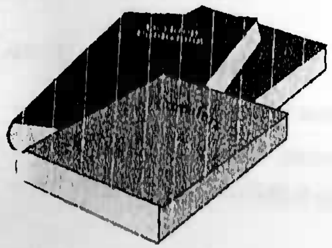
Book Review

Time and Space

by John and Mary Gribbon

published by Dorling Kindersley, 1994

Price £9.99



This is a superb book. Published in the *Eyewitness Science* series by Dorling Kindersley, it fully meets the Company's goal of encouraging children to observe and question the world around them. Its presentation is in a format which would appeal to bright secondary school children, and certainly this adult has found it an absorbing book to read through, dip into, and use as a reference.

As with most Dorling Kindersley books, it is lavishly illustrated, with much of the text in the form of expanded captions. Each double-page spread covers a single topic, with catchy titles like: *Timescales of history; Putting the Universe in order; The marriage of space and time; Beyond common sense;* and *God's dice.*

The book starts by describing the uni-directional flow of time, how time was interpreted by ancient peoples, and the development of measurement and mapping. It goes on to discuss the discoveries of Newton and Einstein, the finite and limiting speed of light, two theories of time, and non-Euclidean geometry. Relativity is dealt with very clearly, with ample illustrations of shrinking trains and slowing clocks.

Black holes, and the possibility of using them as a short-cut through space-time, including time travel, are addressed. The book concludes with a description of "strings" and theories of matter, and the birth of space and time.

This is a thin, but comprehensive book, ideal for anyone wanting to know the basics of modern thinking about space-time, without having to wade through miles of text. ¤

David Le Conte

Did you know?

If the Earth was reduced to the size of a black hole, what would its diameter be: 1 mm, 1 cm, 1 km, 10 km, or 1000 km? (*See bottom of page for the answer.*)

Daniel's published again

An article in the October issue of *Astronomy Now* was illustrated with a superb photograph of the Andromeda Galaxy, taken by Daniel Cave with the Observatory's 8-inch Schmidt camera.

Black Hole: 1 cm! – Peter Langford