. . ROUNDUP . . ROUNDUP . .

Advertisements

Do you have anything for sale, or do you want anything (preferably, but not necessarily astronomical)? Advertise here - no charge.

They've arrived!

The two mirrors for the solar telescope, which have been on order for a year, have finally arrived. They are six-inch mirrors, one flat and the other concave with a focal length of 75 feet. They will be used to create a heliostat system to cast an image of the Sun on the interior wall of the main observatory building.

Their arrival after all this time was something of a surprise, as, despite several reminders to the manufacturer, there was no sign of them.

The solar telescope will hopefully be set up in the next few weeks. ¤

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 May. The deadline for publication materials is 15th April.

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Sagittarius

The Newsletter of the Astronomy Section of La Société Guernesiaise

March/April 1995

Forthcoming events

La Société Guernesiaise Annual General Meeting
Wednesday, 8th March
7.30 pm at St Martin's Country Hotel

The Celestial Sphere
by David Le Conte
Tuesday, 14th March
8.00 pm at the Observatory

Star Nights and Telescope Surgery
Tuesday, 4th to Friday 7th April
8.00 pm at the Observatory

Inside

Major articles in **bold**

Centre insert

March/April star chart

A reminder:

Have you paid your subs?

Annual General Meeting

The Annual General Meeting of La Société Guernesiaise will be held at **7.30 pm on Wednesday, the 8th March at St Martin's Country Hotel.** This is the chance to hear what other Sections are doing, as well as reviewing our own progress during the past year.

The Celestial Sphere

At 8.00 pm on Tuesday, the 14th March, David Le Conte will talk about the celestial sphere. The night sky is a wealth of movement, and the celestial sphere is a convenient concept for determining and analysing the effects of such motions.

Now we have a telescope accurately aligned with the celestial sphere, it is an opportune time to learn more about the use of its setting circles. If you have wondered what is meant by such terms as Right Ascension, Declination, Hour Angle, and Sidereal Time, then this is your chance.

The talk will be illustrated with slides and computer programs.

Star Nights and Telescope Surgery

Public evenings will be held each night from Tuesday, the 4th to Friday, the 7th April, starting at 8.00 pm. These are usually popular events, and members are asked to assist with running them. Help is needed, not only with operating telescopes and pointing out constellations, but also with selling publications, coffee, etc.

We also invite anyone with a telescope to bring it along, especially if they are having problems with it.

Darken our lightness

That was the subject of Ken Staples' talk about light pollution on the 24th January. Ken pointed out that the main sources of light pollution in Guernsey were greenhouses, street lamps, sports floodlighting and "mood" floodlighting (such as buildings). Slides of Los Angeles in 1908, 1958 and 1988, dramatically showed the growth in lighting.

Ken said that about 60 million units of electricity are used annually in Guernsey for lighting, and that if everyone changed to energy efficient fittings, about 12 million units less would be used, at a saving of £1.2 million. 150-watt greenhouse lights could be replaced by 100-watt lamps, and simply putting meat tin reflectors over each light could reduce the energy consumption while giving more light. Bright outdoor lights produce dark shadows, in which criminals can hide.

Ken showed examples of good outdoor lighting — on streets, housing estates and car parks — as well as poor examples. He emphasised that, while Guernsey has a severe light pollution problem, the way forward was gentle persuasion, rather than legislation. He suggested that all Section members can help just by talking about light pollution when they have the opportunity.

Chasing solar eclipses

On the 14th February, Alderney resident and Section member Michael Maunder presented a fascinating lecture at Candie Gardens Frossard Lecture Theatre on the subject *Chasing Solar Eclipses*, as part of La Société's Winter Lecture Programme. Michael is an internationally renowned »»

photographer of eclipses, and a leading member of the British Astronomical Association.

He illustrated his lecture with an extensive and varied collection of slides, showing experience from some of his earlier expeditions, up to more recent journeys to view solar eclipses in Hawaii and Arizona. His multiple exposure photograph of the 1994 eclipse in Arizona has appeared in several Astronomy magazines, but appeared first in our own July/August issue of *Sagittarius*, as part of an article describing his experiences in Arizona.

The slides he showed us were outstanding, and in some night sky photographs we were envious of the incredibly dark and clear skies which we so seldom see. We are very grateful to him for the visit, on which he was accompanied by his wife, Wendy. They were also able to make a first visit to the Observatory during their stay, although it was not suitable weather to use the telescope — at one point there was a heavy hail-storm!

Michael runs a photographic business in the UK, and a list of products, including film and processing materials, which can be supplied is available to Section members at the Observatory. Having seen what can be achieved with eclipse photography, we look forward to our own local eclipse experience. In August 1999 there will be a total eclipse in Alderney, while in Guernsey it will not be quite total. The eclipse track will be through the Land's End area of Cornwall to the Channel Islands and into Northern Europe, and, as mentioned at our Annual Business Meeting, plans for this event are now underway. ¤

GF

Annual Business Meeting

On Tuesday, the 31st January nine members met to review last year's events and to discuss the Section's business for 1995.

Officers

Geoff Falla, Peter Langford, Ken Staples and David Le Conte were re-elected Secretary, Treasurer, Light Pollution Officer, and Editor, respectively. We still need an Education Officer. In the meantime, David agreed to continue to liaise on education matters.

Finances

Peter reported a healthy financial situation, with the May 1994 solar eclipse being the major fund-raising event of the past year, and the CCD being the major purchase. There was some discussion about sponsorship as a means of fund-raising, and the possibility of publishing articles in the news media. There was also some discussion about book purchases, it being agreed that it would be useful to acquire observing aids, such as *Uranometria* and *Burnham's Celestial Handbook*, as well as a book on beginner's astronomy.

Solar telescope

Regretfully, Geoff had to report that it seemed doubtful that the mirrors for the solar telescope would ever be delivered. A final try is to be made to get the supplier to produce them. It was agreed that the project was still a most desirable one and that other mirror suppliers should be tried.

Workshop

After a long discussion, it was agreed that Rex Huddle and Lawrence Guilbert would prepare plans for a workshop area to be built just north of the C14 building. »»

Equipment

There was much discussion about the C14 telescope and the Section's telescope needs. It was suggested that it be would be useful to aim for a refractor and a large modern reflector, such as a 16-inch Meade, perhaps by the year 1999. Although clearly requiring considerable resources, this seems a worthwhile goal, and we would be interested in hearing what other members think.

We also agreed to purchase a dehumidifier to reduce the dampness experienced during the winter months, which could affect our instruments and library.

Liberation Day event

It was decided that Geoff Falla, Roger Chandler, Peter Langford and David Le Conte would form a working group to plan the Liberation Day event - our major public and fund-raising event for this year - which will take place on the Albert Pier on the 9th May. Various suggestions were made, and it is hoped that all members will contribute ideas and time to this exciting project.

Solar eclipse 1999

Geoff Falla indicated that he is prepared to make provisional bookings for any member to stay at the Belle Vue Hotel in Alderney. This will be a good spot from which to see the total solar eclipse on the 11 August 1999. **Would any member (and family) who is interested in this offer please contact Geoff, preferably before March 25th, as he will be visiting Alderney at the end of the month.**

Geoff also suggested that we approach the Post Office about the possibility of issuing a couple of special Alderney eclipse stamps in 1999.

Observing projects

Finally, we briefly discussed the desirability of undertaking serious observing projects, in association with BAA sections. There is a number of specialist sections in the BAA, and as we are now members of the Association we should be taking advantage of the benefits of membership. We can get a lot of information from the BAA sections, and, through them, can feed our observations to the national and international scientific community. Further details are available at the Observatory. ◘

Turtles too!

It is not just humans that are affected by light pollution. I have heard that there is concern about its effect on birds. And consider this extract from an article about pollution in the Mediterranean. The writer is talking about loggerhead turtles who lay their eggs on the sandy, but brightly lit beaches of Laganá Bay on the Greek island of Zákinthos.

"When baby turtles hatch out in the sand, they turn to the nearest light and head for it. For millions of years that light was always the moon and stars reflected on the sea. Now it is often the Four Brothers' disco or Bob and Wendy's Bar, and many turtles expire during their futile journey or are picked off by birds the following day as they stumble throught the dunes."

- *Fred Pearce, "Dead in the Water" New Scientist, 4 February 1995*

Did you know that?

Christmas Day always falls on the same day of the week as May 1st.

Famous Lives - 7 Edmund Halley (1656-1742)

Halley is, I suspect, best known for calculating accurately the orbit of the famous comet that bears his name (and last seen so poorly in 1986), and as being the supporter of Isaac Newton in assisting him in the publication of Newton's epoch-making *Principia*.

However, Halley achieved much in his long life, both in the fields of astronomy and mathematics, and more generally in establishing scientific principles and laying the foundations of modern scientific thought.

Edmund Halley was born on 8 November 1656, and attended St Paul's School, London (still a fine school today), and later Queen's College, Oxford. It was while he was an undergraduate at Oxford that he was introduced to Sir John Flamsteed. As a result of the introduction he visited Flamsteed at the Royal Greenwich Observatory. As a consequence of this visit his interest in astronomy developed.

Flamsteed had used optical observations to compute a catalogue of northern hemisphere stars, and this study prompted Halley to attempt a similar project in the southern hemisphere. With financial support from his father and the King, Halley set sail in November 1676 for St Helena, then the southern-most territory of the Empire, to conduct his survey. Although the voyage was not without mishap, it was a success, and Halley returned some two years later, having catalogued the celestial longitude and latitude of some 341 stars and observed a transit of Mercury.

He published a star catalogue as a result of his work, in 1678, the first of its kind to show southern hemisphere stars based upon optical observations. It established his fame and reputation as an astronomer. Later in 1678, he was elected a Fellow of the Royal Society and granted the MA degree from Oxford, as he had left the University before taking this degree in 1676.

In 1684 he visited Sir Isaac Newton at Cambridge. This visit was the first of many, and over a period of time he became Newton's supporter and guide and offered invaluable advice with his work. Halley's faith in Newton was great, for it was he who provided the finances, the press, proof-read the draft, acted as editor, and wrote the preface to Newton's *Principia*. He did this, as the Royal Society had said: *"Mr Halley undertakes the business of looking after it and printing it at his own charge."*

Aside from his astronomical work, he produced, in 1686, maps displaying the prevailing winds around the world's oceans, and in so doing produced the first ever meteorological map. He also led the first ever sea voyage devoted to scientific study, between 1698-1700. During this voyage he studied variation in compass readings, and established accurate longitude and latitude in the South Atlantic. In 1701 he published the first ever magnetic charts of the Atlantic and Pacific areas. A combination of these charts, plus other navigational charts which he produced, were used by mariners for many years. »»

In 1704 he was appointed Savilian Professor of Geometry at his old university of Oxford. Sadly, Flamsteed appears to have objected to his appointment. While at Oxford he continued his mapping studies, and published many charts.

However, it was his work published in 1705, *A Synopsis of the Astronomy of Comets*, in which he stated, amongst other things, that the comets of 1531, 1607 and 1662 were one and the same. He predicted its return in 1758 (some 16 years after his death). It duly appeared, and bears his name to this day. He also demonstrated a method for observing the transits of Venus, and, in 1718, showed that stars actually moved through space.

In 1720 he succeeded Flamsteed as Astronomer Royal, and held the post until his death.

Edmund Halley was one of the outstanding scientists of his era. He was concerned to show that science had practical applications for people, and that ordinary people could benefit from scientific study. It is said that he had a great ability to distil complicated thoughts and ideas into everyday language, and so make it accessible to even the non-scientific mind, and there were plenty of those (there still are, of course!).

Halley's contributions to astronomy, mathematics, navigation and meteorological mapping, combined with his establishing of general scientific principles, leading to the foundation of modern scientific thought, places him at the forefront of that list of outstanding scientists through the ages, and certainly places him as one of the leading figures of 17th century science.

This distinguished man of science died on the 14th January 1742, aged 85 years, appropriately at Greenwich. ¤

David Williams

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Night-rise

"Night falls, or has fallen. Why is it that night falls, instead of rising like the dawn? Yet, if you look east, at sunset, you can see night rising, not falling - darkness lifting into the sky, up from the horizon, like a black sun behind cloud cover. Like smoke from an unseen fire, a line of fire just below the horizon, like bush-fire, or a burning city. Maybe night falls because it's heavy - a thick curtain pulled up over the eyes - a wool blanket. I wish I could see in the dark better than I do."

Margaret Atwood - The Handmaid's Tale

Spendthrift

The sun we wakened to today
will spill till disk its photon flow;
entropy's debt all stars must pay,
The sun we wakened to today
is not exempt; time will not stay
or ever backwards go - and so
the sun we wakened to today
will spill till dusk its photon flow.

K V Bailey

Landmarks in Space Research - Part 2 - by Geoff Falla

Following the Soviet launch of Sputnik 1 on 4th October 1957 and Sputnik 2 on 3rd November, and the failure of the Vanguard rocket launch on 6th December, the United States reverted to the proven success of the Army's Juno rocket and team led by Wernher Von Braun.

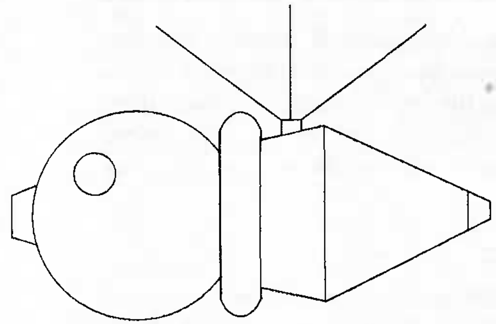
On 31st January 1958 the USA successfully launched its first satellite, Explorer 1, from Cape Canaveral, Florida. The satellite was instrumented by Dr James A Van Allen, and made the discovery that the Earth is surrounded by a ring of charged particles trapped in the magnetic field, the ring now known as the Van Allen Belt.

The National Aeronautics and Space Administration (NASA) was officially inaugurated on the 1st October 1958.

The year 1959 saw the first lunar flights by automatic space probes. The Soviet Union's Luna 1 was launched on the 2nd January, and passed the Moon at a distance of some 3000 miles, continuing on into an orbit around the Sun. Luna 2, the first man-made object to reach the Moon's surface, landed a few days after launch, on the 12th September, while the first ever pictures of the far side of the Moon were relayed by television from Luna 3 as it circumnavigated the Moon a few weeks later. The launch of the Luna 3 mission by the Soviet Union on the 4th October 1959 came exactly two years after the orbiting of Sputnik 1.

The age of communications by satellite commenced in 1960, when the United States launched Echo 1, the first experimental passive communications satellite. Inflated in orbit to a diameter of 100 feet and using aluminised Mylar plastic material, the satellite reflected radio signals over a range of several thousand miles.

The launch into orbit of Sputnik 5 on the 19th August 1960 with two dogs, and their successful recovery, was a prelude to the fist manned orbital flight.



Vostok 1

A single orbit by an automated Vostok spacecraft on the 25th March 1961 was followed on the 12th April by the historic manned spaceflight by Soviet Lt Yuri Gagarin in Vostok 1, completing one orbit in 108 minutes before returning safely to Earth.

The United States, at this time, was still not in a position to match the space achievements of the Soviet Union, but on the 5th May 1961 achieved a sub-orbital flight of 15 minutes in a Mercury spacecraft piloted by Commander Alan Shepard. It was not until the following year that Lt Col John Glenn became the first American to orbit the Earth, on the 20th February 1962. »»

In July 1962 the USA launched the first commercial communications satellite, Telstar. Planetary exploration also got underway in 1962 with the United States launch of a Mariner space probe, achieving a fly-by of Venus and sampling the planet's intense atmospheric pressure and temperature. In 1965 a similar Mariner probe to Mars obtained the first close-up photographs of the planet.

The Soviet Union achieved another first in March 1965, with a spacewalk by Lt Col Alexei Leonov, an operation which has since become a regular feature in the repair and maintenance of spacecraft in orbit.

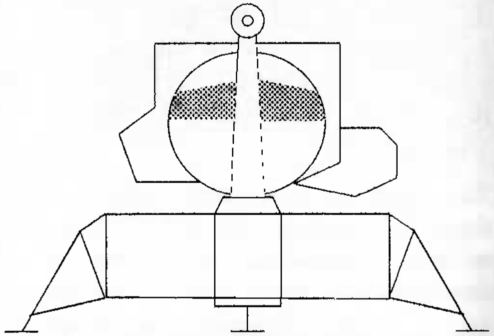
In 1966 Luna 9 became the first space probe to soft-land on the Moon, on the 3rd February, with touchdown in the Ocean of Storms. The United States selected the same landing area for its successful Surveyor 1 landing a few weeks later, followed in August by Lunar Orbiter 1 photographing potential landing sites for its manned Apollo flights which were under development.

The United States was now in a position to challenge the supremacy of the Soviet Union in space achievements. The giant Saturn rocket had been developed for use in the Apollo project, and in October 1968 Apollo 7, the first manned mission of the Apollo programme, achieved an extended flight of 163 Earth orbits, a distance much further than the equivalent of a return flight to the Moon.

The first manned flight to the Moon was achieved with Apollo 8 in December 1968. The flight was not planned as a landing, but completed ten orbits of the Moon before returning to Earth.

Two further test flights of the complete spacecraft in Earth and lunar orbit were completed before it was decided that all was ready for the first manned landing.

Apollo 11 was launched on the 16th July 1969, and landed on the Moon four days later. Neil Armstrong and Col Edwin Aldrin became the first astronauts to set foot on the lunar surface, remaining outside the Lunar Module "Eagle" for over two hours, setting up scientific instruments and collecting rock and soil samples. The third crew member, Lt Col Michael Collins, remained in lunar orbit in the Command Module.



Lunar Landing Module

Two hours before the departure of the lunar vehicle, a Soviet automatic probe, Luna 15 manoeuvred into lunar orbit, but crashed in the area of the Sea of Crises. It was considered probable that Luna 15 was intended to soft-land, as had already been achieved with Luna 9, and that it would then have collected soil samples and returned to Earth. If this had been achieved it would have competed with the publicity of Apollo 11's success.

The Soviet Union continued to specialise in the development of automatic »»

spacecraft. Venera 7 descended through the atmosphere of Venus in August 1970, while in September of the same year Luna 16, equipped with a drilling device, recovered soil samples from the lunar surface, and returned them to Earth. Two months later Luna 17 delivered the first remote controlled Rover vehicle to the Moon, travelling over the surface for a distance of about six miles, collecting soil samples and taking photographs. The first manned Space Station, Salyut 1, was launched in April 1971.

Up to this time the Soviet Union had achieved many firsts in space research, but the United States had won the race to the Moon with manned flight. The Apollo programme of lunar exploration was to continue for a further three years, with a total of six flights before the end of 1972. ¤

Geoff Falla

Letter to the Editor

Dear Mr Le Conte

Thank you for sending me a copy of your newsletter and 1995 Programme. I shall look forward to seeing you in August. (*He is giving the Astronomy Section a talk on sundials - Ed.*)

I have been very impressed with the two issues of the newsletter you sent me - much more professional than the one produced by my local society in Aylesbury.

However, as an avid follower of solar eclipses, I must take issue with the caption to the photo on page 3 (*Jan/Feb 1995 issue - Ed.*) The reason the photo shows a small corona is because it was clearly taken with a very fast shutter speed, so only the inner corona and (probably) the chromosphere is shown. In fact, the many long exposure photos I've seen from the South American eclipse show the long coronal streamers that are typical of this stage of the sunspot cycle.

I must admit that my own eclipse expeditions have met with only partial success so far. I went to Finland in 1990, but the Sun was totally obscured by fog (although Venus was visible during totality - it was interesting to hear that Mike Maunder was able to detect the phase of Venus with the naked eye during the South American eclipse).

I next went to Mexico in 1991 - fortunately, the skies were perfectly clear, so I was able to enjoy 6½ minutes totality, although the Sun was practically overhead, which made photography difficult. Later that evening, I saw Mercury for the first time; and later still, Scorpius (my Zodiac sign) in its entirety - one of the few constellations that looks like what it's meant to be!

Last May, I went to Morocco with the intention of seeing the annular eclipse at sunset - unfortunately, the clouds rolled in soon after first contact, so again I was thwarted.

I hope to be in India in October, when I also hope to seize the opportunity to visit the ancient observatory at Jaipur, which should also satisfy my interest in sundials!

Yours sincerely,

Richard C Mallett

CCD News

CCD Video prints of the Moon

The CCD (Charge Coupled Device) is an electronic "chip" which has revolutionised the technology of electronic imaging, particularly video cameras. There are numerous features of this device which set it apart from older technology, two of which are extremely useful in astronomical imaging applications.

Firstly, the device is small and light, making it very easy to insert into an optical system; secondly, it has the capacity to accumulate an image over as long a period as it is exposed to the light - thus making faint objects readily visible.

There is, however, one interesting quirk of the device: the process of reading the image off the chip actually erases the image as well. This means that if the image is not bright enough you have to start the imaging process again. It is, of course, possible to add a number of identical dim images together using computing techniques, assuming there is sufficient image signal compared to any background noise levels.

The CCD system purchased by the Astronomy Section is designed to acquire an image over any time which we set. Because of limitations in the hardware of our system we are not able to produce a real-time film, as one could with a video camera. To do this we need to scan and process the image at least 50 times a second to create a natural moving picture effect. Even if the hardware was sophisticated enough to do this, it would not be much use to us, as the CCD is not sensitive enough to register any astronomical targets, apart from a number of exceptionally bright ones.

The obvious target for real-time video images is the Moon, particularly at around first and third quarter, where lunar detail on the terminator is at a maximum. With a 6-inch refractor and a modern CCD camera the potential for stunning video images has fuelled my enthusiasm to try it for some time.

Several weeks ago I had the opportunity to borrow a miniature colour video camera. The actual camera head is about the size of a little finger, and produces a very high quality full colour image. By making an adaptor and attaching the camera behind the eyepiece, I was able to use eyepiece projection to form an image on the CCD chip. Using my 6-inch Vixen refractor, I tried various eyepieces at various camera-to-eyepiece distances to maximise the image quality and magnification. The best results were obtained using a 13 mm super wide-angle Mirador Plössl.

The actual set-up was a little cumbersome as it required numerous pieces of equipment. Firstly, the video camera is attached (via a 3-metre cable) to a video processor unit, which produces a composite video signal. This signal cannot be interpreted directly by a television, but most domestic video recorders are able to accept a direct video input. I therefore had to connect this signal into my video recorder, which in turn was connected to my television; all of which were outside accumulating dew! (just as well it didn't rain!!). In the end all the effort was justified by seeing the high-power image of the lunar surface directly on the television screen as if you are orbiting the Moon from several hundred miles up.

Of course, one of the advantages of having the video recorder in the set-up was that it enabled me to video the whole thing and thus provide an excellent record of the results. Furthermore, by using another piece of equipment known as a video printer, I was able, at a later date, to produce "photographic" prints from selected images on the original video recording.

One of these prints is reproduced here: a heavily cratered area of the Moon which includes the giant crater Clavius with its five smaller craters within it (bottom left), and the famous crater Tycho with its central peak (upper centre). ¤

John Taylor

The Liberation Monument - Part 3 - by David Le Conte

Last time we looked at how the obelisk shadow will change over the next 20 years. However, some of the monuments in Guernsey are already 150 years old, and we can well expect that the Liberation Monument might last that long, or longer.

I therefore calculated the shadow length and azimuth for the 9th May each year for the next 500 years or so, and the results are shown on the next page.

It must be noted that these long-term predictions are based on the method of calculating the Sun's coordinates assuming an elliptical orbit for the Earth, without taking into account the perturbations caused by the gravitational attractions of the Moon and planets. Higher accuracy predictions may possibly show additional long-term effects.

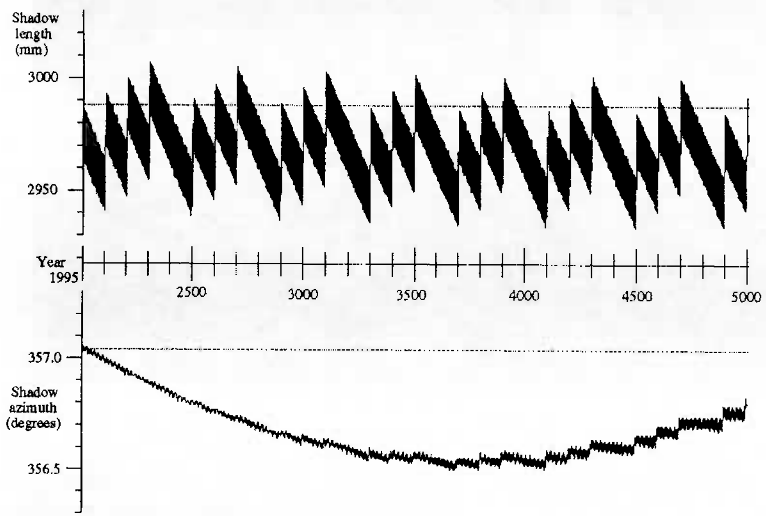
This exercise in long-term prediction shows that the 9th May Sun is currently at a low altitude, compared, for example, with the next 500 years. The average shadow length will therefore be a little less than in 1995. The azimuth will also, on average, be less than in 1995.

For academic, rather than practical interest, calculations have also been made of the shadow length and azimuth over a period of 4,000 years, to the year 5005 AD, and the results are shown below. It can be seen that, in addition to a 4-year cycle, there is a 100-year cycle, and a 400-year cycle. There is, however, very little long-term trend. This is a graphical demonstration of the Gregorian calendar.

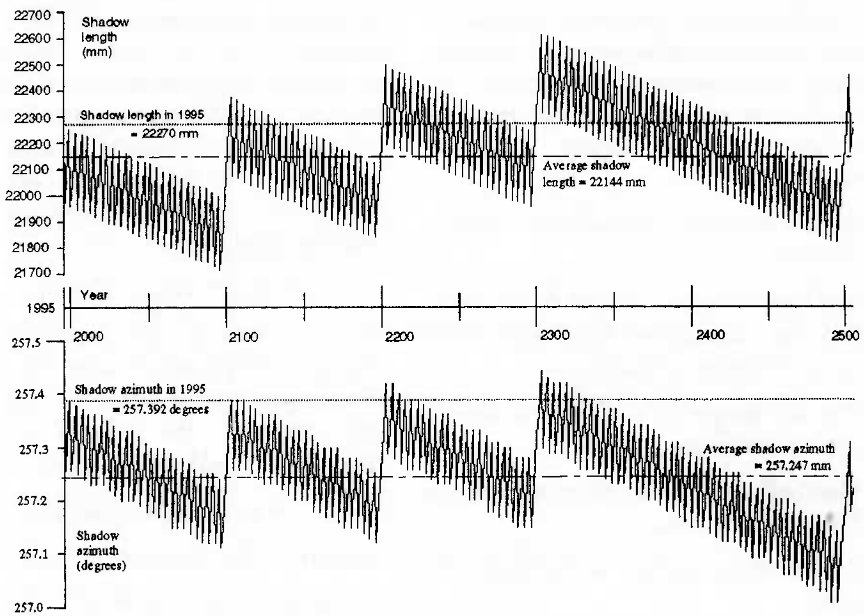
The Gregorian calendar gives an average year of 365.2425 days, compared with the tropical year of 365.24218 days. Thus, the difference is 0.00032 days, or one day in 3,125 years. This is reflected in the long-term trend shown by the shadow length.

The shapes of the azimuth graphs for 1200 UT are unexpected. Their shapes may be the result of artifacts of the calculation process, especially near azimuth = 360°.

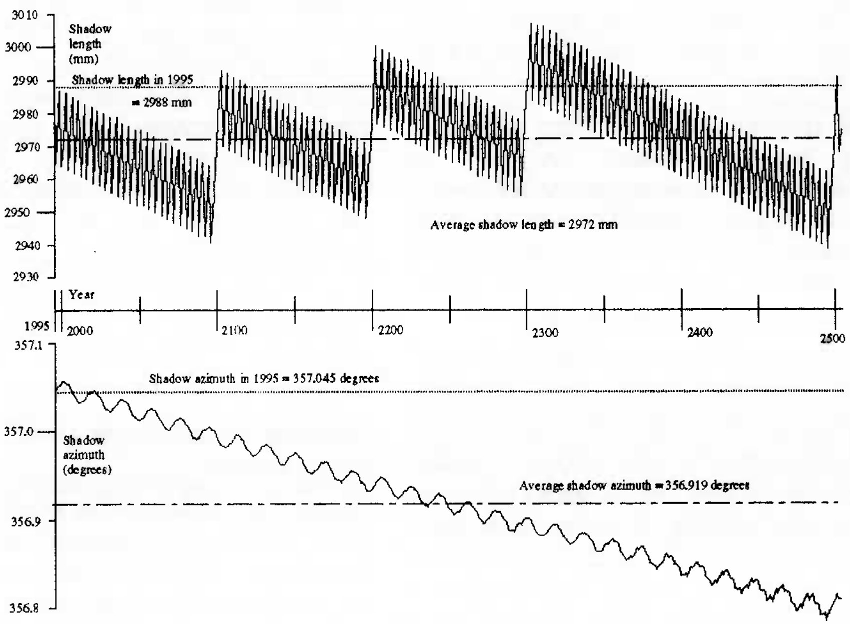
Shadow length and azimuth for gnomon 4.75 metres high, at 1200 UT, May 09, 1995 - 5005



Shadow length and azimuth for gnomon 4.75 metres high, at 0600 UT, May 09, 1995 - 2505



Shadow length and azimuth for gnomon 4.75 metres high, at 1200 UT, May 09, 1995 - 2505



Shadow length effects

The mathematical calculations of shadow length represent an ideal situation, which is unlikely to be attainable in practice. In particular, several effects could result in the shadow being shorter than the predicted ideal.

There are three effects tending to shorten the shadow:-

- The light from the top half of the Sun's disk (the calculations have been made using the centre of the Sun),
- The diffuseness of the shadow due to atmospheric haze,
- The long-term effects, due mainly to the Gregorian calendar,

and one effect tending to lengthen the shadow:-

- The need for the top of the obelisk to have a bulk, rather than a point, in order to cast an umbral shadow at the correct distance.

The magnitudes of these effects (other than the long-term effect) can only be determined by experiment. At the time of writing, some experiments have been carried out, but the severe weather in recent months has meant that the full set of experiments has not been possible.

A full-scale model of the top metre of the obelisk has been constructed, and tried out at the flattest area we could find — the bowling green at Beau Sejour. Further experiments were carried out on top of the New Jetty building. However, these are so far inclusive, and it has therefore been decided to make provision for adjustments by increasing the height of the obelisk slightly.

The penumbral edge of the shadow

A further uncertainty in the shadow direction is caused by the "fuzziness" of the shadow edge, caused by the fact that the Sun is not a point source of light but has a diameter of about half a degree. The lateral spread of the penumbral edge of the shadow on a surface perpendicular to the direction of the Sun's rays is:-

$$2L \tan(0°.267) = 0°.00943L,$$

where L is the distance from the shading object to the shadow receiving surface. For a surface at an angle (90°-*alt*) to the ray direction, the penumbral spread (fuzziness), F, will be given by:-

$$F = 0.00934\, L / \sin(alt)$$

as shown in the figure on the next page.

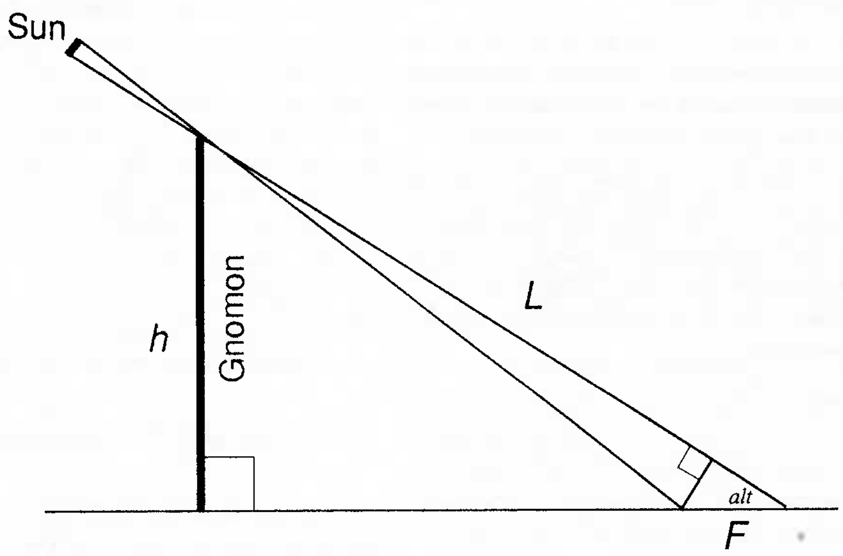
L is approximately equal to $1000h/\sin(alt)$, where h is the height of the gnomon in metres. Therefore:-

$$F = 9.34\, h / \sin^2(alt) \quad \text{millimetres.}$$

The value of F was calculated for various times. It varies from 62 mm at midday to over one metre before 7.00 am BST! However, the observed penumbral spread will probably be less than that, as the illuminance near the penumbral edge may be too small; ie the further from the umbral edge and the closer to the penumbral edge, the less clear the penumbral shadow will be.

Accuracy needed in the construction of the monument

During the conduct of the experiments to check the accuracy of the predictions, it soon became apparent that the full-scale monument would need to be built to close tolerances in order to avoid discernible errors in the position of the shadow. The differences recorded between the »»



Penumbral spread of shadow.

predicted and measured shadow lengths and directions could be accounted for by inaccuracies in the equipment used for the experiment, and the methods used for that error analysis can be applied to the determination of the construction accuracy.

The possible construction inaccuracies are:-

- Time marks inaccurately placed.
- Inaccurate height of obelisk.
- Obelisk not vertical.
- Base platform or seating not level.
- North direction inaccurately determined.
- Shadow path inaccurately manufactured.

The following analysis briefly considers the effect of each of these in turn.

Height of obelisk

An obelisk height one millimetre different from the specified height, i.e. 1/5000 or 0.02% error, will cause an error of 0.02% in shadow length. Shadow directions will be unaffected.

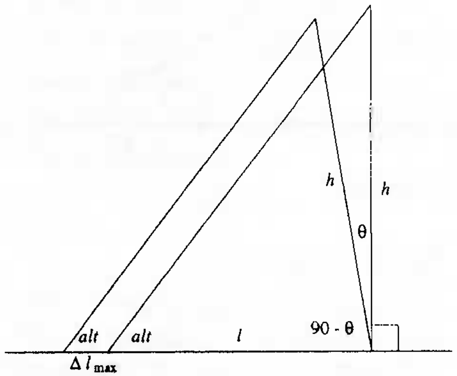
To match the accuracy in the Sun altitude predictions, the obelisk should be within 6 mm of the intended height. The maximum error in shadow length will then be 46 mm at 0540 UT, or 3 seconds in time.

However, the error in shadow length at midday will be almost 4 mm. Although the shadow will still be pointing in the right direction in both cases, an error in shadow length of this magnitude will be noticeable, and, it would be better to aim for a more precise tolerance in the height of the obelisk. An accuracy approaching one millimetre is therefore suggested.

Vertical accuracy

If the obelisk is tilted from the vertical so that the top of the gnomon is not directly above its base, there will be errors in both shadow length and shadow direction.

The effect on shadow length can be analysed by considering first a tilt angle of $\theta°$ in the direction of the shadow, ie in the shadow-Sun plane (see Figure 15). In this situation the error in the shadow length is maximum.



Effect of tilt of gnomon, in the plane of the tilt.

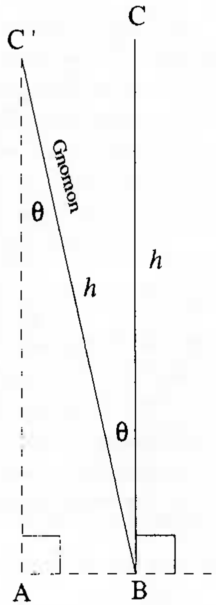
The general equation for the effect of gnomon tilt on shadow length is:-

$$\Delta l = \frac{1000\,h\,\{\cos(alt - \theta\cos(az_{tilt} - az)) - \cos(alt)\}}{\sin(alt)}$$

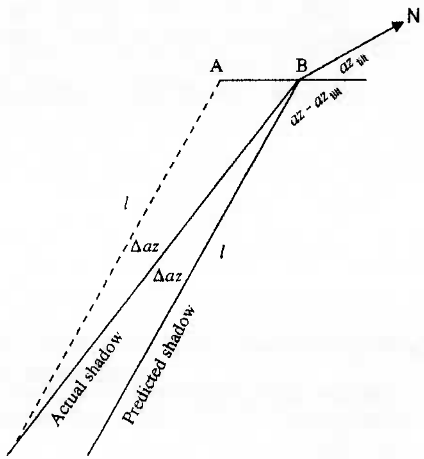
The effect of an obelisk tilt on the shadow direction is shown in the two figures in the next column. A is the point directly below the top C' of the tilted gnomon, B is the gnomon base, and C is the top of the gnomon when upright.

The error in azimuth is given by:-

$$\Delta az = \sin^{-1}\left\{\sin\theta \sin(180 + az_{tilt} - az)\tan(alt)\right\}$$



Above and below:
Effect of tilt of gnomon on the shadow direction.



Analysis suggests that an accuracy of at least one arc-minute should be aimed for, and preferably 0°.01 (0.6 arc-minutes).

Base platform and seating

If the base platform or the seating are not level, the effect will be similar to an error in height of the obelisk, as discussed above. The magnitude of error at each part of the monument will depend upon the effective height of the obelisk at that point (ie the vertical difference between the top of the obelisk and the platform or seating). As with the desirable obelisk height tolerance, the accuracy of the height of the platform and seating, with respect to the top of the obelisk, should preferably be one millimetre.

Determination of the direction of True North

An error of 0°.01 in determining the direction of True North will have the effect of skewing all azimuths, and therefore time marks, by that amount. The maximum time error of 1.3 seconds will occur at midday. The seat position due west (at 0710 UT) will be displaced north or south by 2 mm. To meet a 15-second accuracy, the north direction must be determined to within 0°.1125, or better than 7 arc-minutes. An accuracy of at least one arc-minute is suggested.

Several possible ways to find True North to this sort of accuracy have been suggested:-

1. An accurate compass bearing can be taken, and due allowance made for magnetic variation. Extrapolation from data given on Admiralty charts does not give sufficient accuracy. More accurate extrapolation can be made from the magnetic field model by the Ministry of Defence Hydrographic Office in Taunton. The model is recalculated by the British Geological Survey every five years, the next one being due in 1995, and a check should be made with that source for the latest data.

2. The second method involves taking a bearing related to the Universal Transverse Mercator Grid shown on the Ordnance Survey maps of the Island, and then making an allowance for the difference between Grid North and True North. It is understood that the Grid used on the Guernsey maps is not a simple extension of the Grid used on United Kingdom Ordnance Survey maps.

3. The third method of finding True North is that used generally by astronomers for aligning telescopes with the North Celestial Pole. The method, for equatorial telescopes, is described, for example in *Norton's 2000.0*. Some modern telescopes provide for accurate polar alignment through computerised methods.

4. An accurate prediction could be made of the time at which the Sun is due south on a given day, taking into account the Equation of Time. A bearing could be taken of the Sun at that time, or the position of the shadow of a suitably sized, vertical gnomon could be marked.

5. O. Neugebauer has suggested a possible method by which the Great Pyramid of Giza may have been accurately orientated to the cardinal directions. This involves observations of the shadow of a small pyramid, and its reorientation on a trial and error basis until it is correctly aligned. It seems doubtful that this would give the accuracy required for the Liberation Monument, but the method could be analysed and a minimum pyramid size determined for the required accuracy to be established. ¤

David Le Conte

A visit to . . . the Deutsches Museum, Munich

By prior arrangement through a mutual friend, I was met by Dr Gudrun Wolfschmidt, the astronomer responsible for setting up the major new exhibition on astronomy at Munich's huge museum of technology.

In a whirlwind tour I was shown all the best exhibits - an impressive selection with the emphasis naturally on German science. Of particular significance were the two rooms devoted to instrument makers Brander (1713-1783) and Fraunhofer (1787-1826). The star exhibit here was the 24-cm Fraunhofer refractor used by Galle at the Berlin Observatory to discover Neptune on the 23 September 1846.

Among the many examples of instruments on display were telescopes by Marius, a contemporary of Galileo, and by Scheiner (1573-1650), the inventor of the equatorial mount.

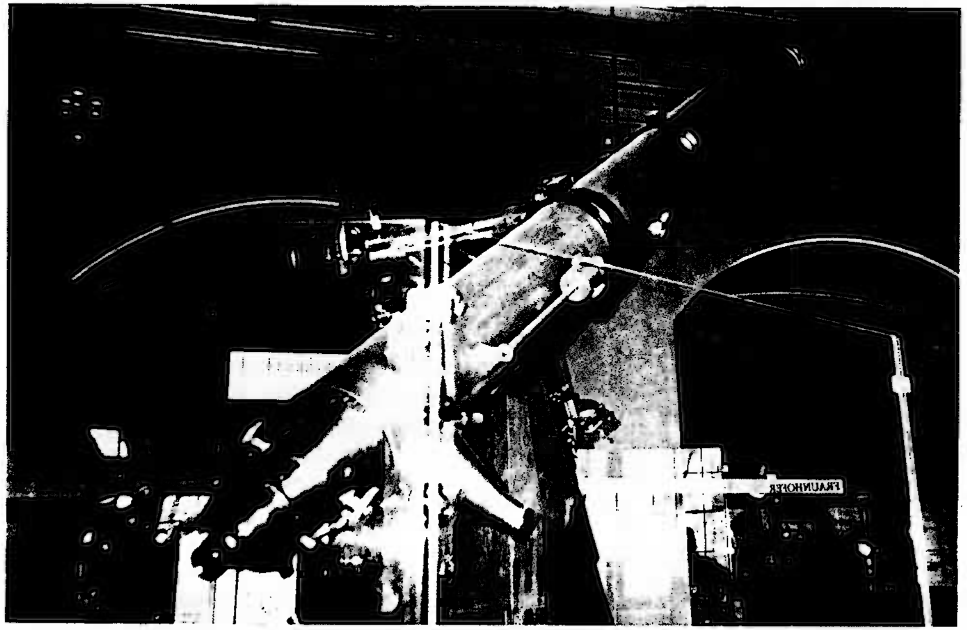
Another important exhibit is the working end of the original 6-metre horn radio reflector, with which Penzias and Wilson discovered the 3K background radiation (the "Echo of the Big Bang") at Bell Labs in the USA in the early 1960s.

Other exhibits interpret astronomical concepts in an interactive way. Captions are in English as well as German. The exhibition covers several rooms, and there is a separate section on optics which includes many telescopes.

The Museum includes a planetarium with a modern Zeiss projector, and an IMAX theatre. There is also an excellent shop.

The astronomy exhibition is undoubtedly one of the best I have seen, and well worth a visit to Munich if you have the chance. ¤

David Le Conte



The Fraunhofer 24-cm refractor, with which Neptune was discovered in 1846.

Sundials again

Several issues ago I listed the known sundials in Guernsey. Several additions have since come to light, and below is the complete list to date. I am grateful to Roger Chandler and Richard Mallett for some of the additions.

1. Mass dial on St Saviour's Church - reportedly the only mass dial in the Channel Islands. (There is also a sundial on a gravestone.)
2. Salle Paroissiale, St Pierre du Bois.
3. Forest School (1829).
4. St Andrew's Church of Scotland, The Grange, St Peter Port.
5. St Martin's Church.
6. Castel Church.
7. Saxon's Holt, Petit Bot Valley (1969).
8. Moulin de Haut, Rue Paintain, Talbot Valley, Castel.

I am going to the British Sundial Society Conference in April. If you are aware of any further old or interesting modern sundials please let me know. It could well be that there are more sundials on old houses, churches, or public buildings.

Incidentally, Geoff Falla reports an unusual sundial in the forecourt of Alderney Airport. ¤

David Le Conte

Did you know that?

"*Orientation* is derived from the direction towards the Sun rising. Churches in England point towards the place of sunrising on the festival of the Patron Saint. Therefore the Churches of St John the Baptist face very nearly northeast."

- J Norman Lockyer

Educational activities

School children see the Moon . . .

On Wednesday the 11th January about 40 children from La Houguette School visited the Observatory to look at the Moon. They were accompanied by several teachers and parents. They came in three groups, each for half an hour. The sky was rather cloudy, but each child was able to catch a thrilling telescopic glimpse of the gibbous Moon, with the help of Geoff Falla and David Le Conte. ¤

. . . and the Liberation Monument

On Wednesday, the 25th January David Le Conte spoke to the 80 children of St Sampson's Infants School about the Liberation Monument. The children are pursuing a project called "Celebration", centred around the Liberation, and have visited the site of the Monument twice. David showed them overhead transparencies of the Monument design, the night-time observations to determine true north, and the experiments carried out at the Observatory.

The children were particularly interested in two computer programs demonstrating the movement of the shadow during May 9th and over the whole year. They also had fun casting a shadow using a model and a torch.

Beavers to be observers?

On Thursday, the 9th March, from 6.30 pm to 7.30 pm, nine Beavers (young boy scouts), their leaders and parents will visit the Observatory to look at the Moon and other objects. If it is cloudy then slides will be shown. Come along if you can.

We are also expecting students from Blanchelande College in the next few weeks. ¤