Tailpiece

On the 7th May 1997, just two days before Liberation Day, the Civic Trust Award triangular plaque won by the Liberation Monument was formally presented by the Director of the Civic Trust, Michael Gwilliam, to Conseiller Roger Berry, President of the States of Guernsey Board of Administration, as the Board is the current "owner" of the Monument.

La Société Guernesiaise was represented by former President Griff Caldwell. The Astronomy Section was represented by Secretary Geoff Falla, and the Certificate to the Section for its mathematical and experimental work was received by David Le Conte. The Certificate will be displayed at La Société's Headquarters at Candie Gardens, probably in the Frossard Lecture Theatre.

The entry for the Award was actually made by Section Member David, in his position with the Board of Administration, and with the encouragement of the Island Development Committee (who administer the Award scheme in Guernsey), and the Liberation Day Committee. David is also responsible for the upkeep and maintenance of the Monument. ☆

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The next newsletter will be published early in (month). The deadline for publication copy is the 15th (month).

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Sagittarius

The Newsletter of the Astronomy Section of La Société Guernesiaise

July/August 1997

Forthcoming events

The Search for Molecules in Interstellar Space
Chris Mahy
Tuesday, 22nd July
8.00 pm at the Observatory

Observatory Day
Saturday, 26th July
9.00 am at the Observatory

Barbecue and Perseid Meteor Count
Monday, 11th August
7.30 pm at the Observatory

and meetings every Tuesday night and Friday night (when clear) at the Observatory

In this issue

Meteor showers
The Earth's magnetic field
The Moon
Calendars

Inside

Centre inserts

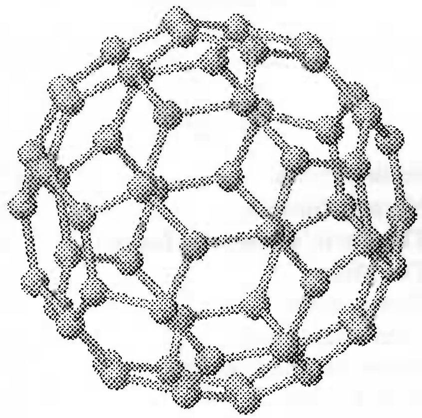
Star chart
Moon phases
Sunset, twilight and sunrise times

Interstellar molecules

On Tuesday, the 22nd July, at 8.00 pm at the Observatory, Chris Mahy will talk on The Search for Molecules in Interstellar Space. Chris recently completed a degree at the University of Sussex.

It was there that Professor Sir Harold Kroto carried out his pioneering research into the existence of very long carbon chain molecules in interstellar space, which led to the discovery of C60 Buckminsterfullerene, and the 1996 Nobel Prize for Chemistry.

C60 has the highly stable structure of a football, and has been the subject of much study. Chris will undoubtedly tell us about its discovery, the implications for our knowledge of the interstellar medium, and present research into the subject. ☆



Observatory Day

Once again, the most exciting day of the year – for some! **Starting at 9.00 am on Saturday, 26th July**, we will be carrying out our annual jobs at the Observatory. There is much to be done, so come along either for the whole day, or for as much time as you can spare. ☆

Barbecue and meteor count

Members' families and friends are welcome to this event – the more the merrier! **Starting at 7.30 pm on Monday, 11th August at the Observatory**, we will be holding the **annual barbecue**. As usual, the fire will be provided. Please bring your own food, which you can cook yourself. While we have a few utensils at the Observatory, it is wise to bring some. Any side dishes are usually shared.

The **Perseid meteor shower count** will start after the barbecue, when it gets dark. All members and friends are invited to join in for an hour or so. Even if you cannot come to the barbecue, you are invited to join the meteor count.

There will be a first-quarter Moon, but this should not interfere too much with observation of the meteors. We normally expect to see 50 or 60 meteors an hour. The Perseids are often bright meteors, travelling fast, so it can sometimes be quite a show!

Debbie Quertier has written an article about meteors, including the Perseids, in this issue of Sagittarius.

Watching meteors, especially on a summer's evening, can be one of the most pleasant and rewarding experiences in astronomy, involving no more effort than relaxing in a garden chair. (We only have one of those, so you could bring your own, if you wish.)

The "rain date" for these events is the following day, Tuesday, 12th August. If you are in doubt about the weather conditions on the 11th, please telephone Geoff Falla (724101) after 6.00 pm, or the Observatory (64252) after 7.00 pm. ☆

Calendar talk

On the 20th May David Le Conte spoke about calendars. He started by posing the question, "What has this subject to do with astronomy". He continued to explain that calendars had an astronomical basis, and that they were an attempt to record the passage of the seasons by relation to the Sun, and, in some cases, to the Moon.

The difficulty was that neither the length of the day, nor the lunar month bore a direct relationship to the solar year. Various cultures had attempted to deal with this problem in different ways. Even the calendar we now use has several imperfections, and from time to time there have been attempts at reforming it.

David has written a two-part article based on his talk, and the first one appears in this issue, on page 11. ☆

UFOs – real or unreal?

Geoff Falla spoke on the subject of *UFO reality? – the filmed evidence*, on the 24th June. This was the 50th anniversary of the first sighting of an Unidentified Flying Object.

Geoff showed videos of a number of observations of strange incidents. The subject is a controversial one, and so it proved on this evening. Strong views were expressed, both by those who believed some UFOs are the crafts of intelligent beings from outside the Earth, and those who believed that all the observations have a natural or man-made cause.

It seems clear that people either believe in UFOs or they don't, and both need firm evidence, which is unlikely, to convince them of the correctness of the other's view. ☆

Telescope donated . . .

We are delighted to announce that Dr Lawrence Pilkington has kindly donated the 14-inch Celestron telescope to the Astronomy Section.

The telescope has been used by the Section since 1993, on loan from Dr Pilkington. As members will be aware, it has been very well used by members, both for general observing and for serious work, including photography and electronic imaging. And, of course, we built the present building specially to house it.

We are, therefore, most grateful to Dr Pilkington for agreeing to give it to the Section. This will give us the security of knowing that it will continue to be available to us, and that we can develop it as necessary.

. . . and refurbished

In the few weeks since the telescope became the Section's property, we have undertaken a major refurbishment programme. This involved stripping it down completely, including the removal of the corrector plate and main mirror. All the optics were thoroughly cleaned.

This cleaning work had to be carried out very carefully and correctly to avoid damaging the optics. We took advice from the telescope manufacturer's manual, and from the UK Celestron distributor, David Hinds. The corrector plate gasket and shims were replaced. The mechanical parts were completely overhauled, and various electrical and electronic faults were repaired. Finally, the telescope tube was restored its original orange colour.

Most of the work was carried out by Daniel Cave, with involvement by John Taylor and David Le Conte. ☆

Meteor showers – by Debby Quertier

Several years ago I heard part of a local radio talk about the Perseid meteor shower (probably given by a member of this Section). It prompted me to go and buy a book on astronomy (which only briefly mentioned them), and go and sit at L'Ancresse from sundown onwards, in the expectation of seeing many meteors. I saw none, gave up and went home, but was rewarded when I went into the garden much later and saw quite a lot of meteors.

Lawrence's talk last July taught us a lot about meteors, and I find it an interesting subject about which I have tried to learn more. Lawrence has also suggested that we should observe other showers, especially the Leonids. Looking at back issues at astronomy magazines, the November issues have articles *"Will the Leonids roar?"*. Let's hope they do in 1999, and provide an unbeatable firework display for the end of the Millenium.

The meteor showers start with a comet and the dust trail it leaves behind. The particles in the tail continue to orbit the Sun long after the comet has gone, and the meteor shower is produced when the Earth crosses this stream of meteoroids. There are parts of the stream where the meteoroids are more clumpy, and a meteor storm, such as the hoped-for Leonids, may occur. The radiant is the area in the sky where the meteors appear to come from, the shower being named after the constellation, or part of it, that is is in.

This August will be the annual barbecue and Perseid meteor count. This shower is no doubt the best known, and of course summer nights are far more comfortable for staying out late and observing. Several other showers are active at the time of the Perseids – these are the South Delta Aquarids, North Delta Aquarids, Alpha Capricornids, South Iota Aquarids, North Iota Aquarids, Kappa Cygnids, Upsilon Pegasids, and the Alpha Ursa Majorids. I knew of about a dozen showers, but have been surprised to learn that there are about five times that amount. A few of these can rival the Perseids for a good display (Leonids, Geminids, Quadrantids), whilst some are daylight ones, and others have a low hourly rate (*ZHR*).

Different showers do have their own characteristics. Some showers display very fast meteors (Leonids, Perseids), whilst the Geminids produce relatively slow ones. Should you see a "shooting star" travelling "slowly" across the sky, possibly visible for up to 30 seconds, or fluctuating in brightness, you may well be seeing a piece of space junk re-entering the atmosphere. This is not that common, but a regular observer will probably see it happen at some point.

The Quadrantids can produce a ZHR of up to 200, but as the period of maximum activity is only a few hours long, and can occur in daylight, this shower is not usually a spectacular one. The Orionids' maximum is on 21st October, and about three days after this fireballs are more common. To date I have only seen one fireball, which I estimated at about magnitude -5.5 to -6. I would happily stay out late on a cold October night if I could see more of the same.

Meteor shower viewing requires no equipment, but you can tune an FM radio to a distant station you would not normally hear, and listen to enhancements in the ➡ signal as you pick up the meteors. There are more elaborate methods of radio observation about which I know nothing.

Meteor showers

Shower	Maximum	ZHR	Parent comet
Quadrantids	3rd January	110	
Lyrids	22nd April	12	Thatcher
Eta Aquarids	4th May	20	Halley
Delta Aquarids	28th July		
Perseids	12th August	68	Swift-Tuttle
Draconids	10th October	Varies	Giacobini-Zinner
Orionids	21st October	30	Halley
Taurids	4th November	12	Encke
Leonids	17th November	Varies	Tempel-Tuttle
Andromedids	20th November	Low	Biela
Geminids	14th December	58	
Ursids	22nd December	12	Tuttle

In the box is a list of the main showers, with their date of maximum activity, ZHR and parent comet, where known.

There is not a great deal of reading matter on this subject (at least I have not found much), but there is one very good book by Cambridge University Press called "*Observing Comets, Asteroids, Meteors and the Zodiacal Light*" by Stephen J Edburg and David H Levy. I got a copy from the Library, but the book is still available at £20.95. I am going to make an effort to view the major showers, but as the best time to view is the early hours of the morning I do not know how successful I will be. ☆

Debby Quertier

Editor's note: *Members can obtain the book mentioned by Debby, and any other book published by Cambridge University Press, at a discount of 10%. Please contact me for details.*

Note on ZHR

In her article Debby mentioned the *ZHR* as the indication of the amount of activity of a meteor shower. *ZHR* is an abbreviation for *zenithal hourly rate*. The Collins Dictionary of Astronomy defines this as:-

The probable number of meteors observed per hour from a meteor shower that has its radiant in the observer's zenith. Shower rates vary as the zenith distance of the radiant changes. To obtain the normalized ZHR, the observed rate must be multiplied by a factor, F, which varies for different values, A, of radiant altitude.

A	90°	52	35	27	8.6	2.6
F	1	1.25	1.67	2	5	10

The Earth's magnetic field – The Magnetosphere
by David Williams

The Earth has an extensive magnetic field which extends outwards into space for a considerable distance. As far as is known, the Earth is the only one of the inner planets to possess such a strong *magnetosphere*. Scientists believe this magnetosphere is a result of the dense magnetic materials comprising the Earth's core.

The magnetosphere was not known about until fairly recently. Indeed, the year 1958 is significant in its discovery, when data from an early research satellite was sent back to Earth.

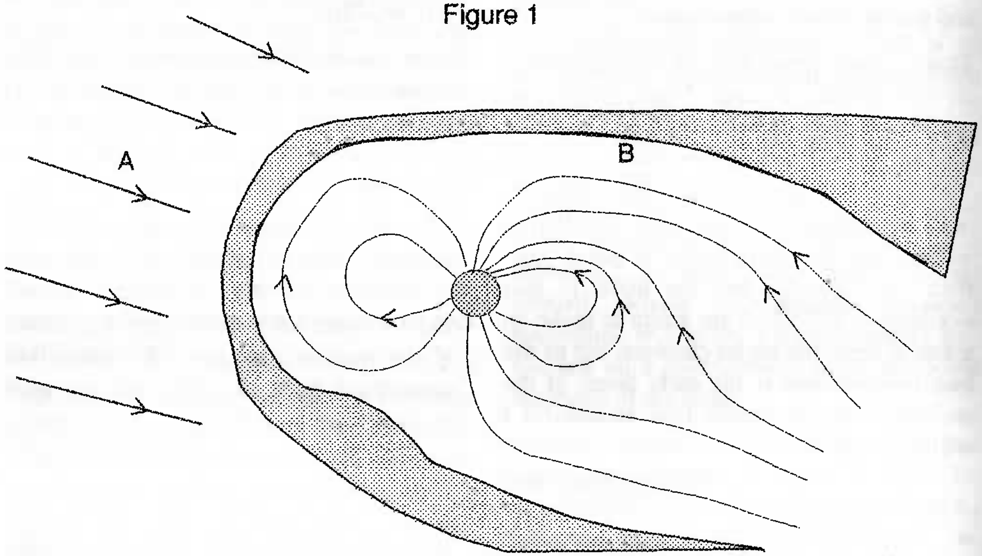
As you can see from Figure 1, the magnetosphere is rather egg-shaped, with magnetic lines of force radiating out and around the Earth. It also resembles a comet, in that, like a comet, its tail is always pointing away from the Sun.

The area facing the Sun extends for approximately 64,000 km from the Earth's surface, whereas the tail extends into space for a much greater distance.

A shows the direction of the solar wind, and as it meets the Earth's magnetic field it causes a shock wave to be formed, and the shaded area signifies the turbulence that results. This area of turbulence has a very definite boundary, B, which is termed the ***magnetopause***.

Although the diagram shows the magnetosphere as surrounding the Earth, in effect the true magnetosphere is only to be found on the sun-ward side of the Earth. It is here that we find the greatest activity, where the solar wind particles collide with the Earth's magnetic field. The further away from the Earth you travel, the weaker the shock waves are, and the more ➠

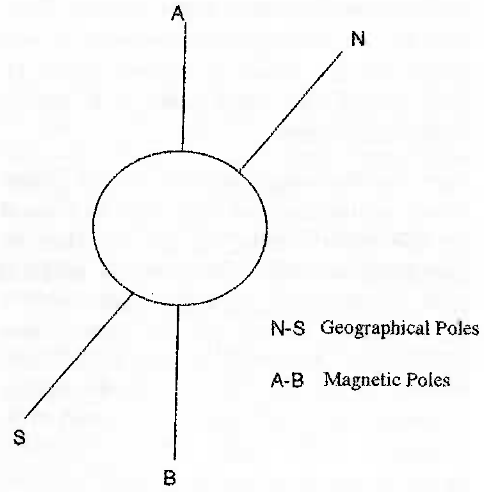
Figure 1



diminished the effect of the magnetosphere.

Figure 2

Magnetic and geographical poles



When you look at the magnetosphere in more detail you find that it is divided, as previously mentioned, into several distinct regions (see Figure 3): the ***Inner Area*** (**1**), the ***Slot*** (**2**), and the ***Outer Area*** (**3**).

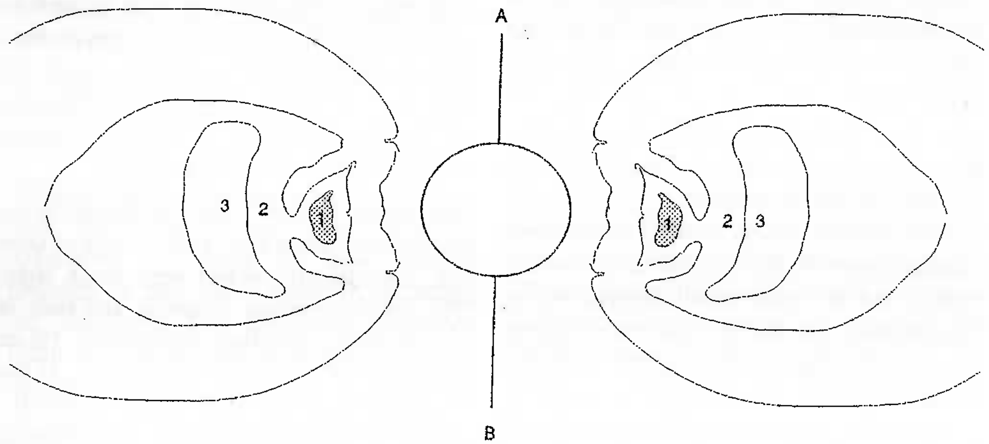
The Inner Area consists mainly of high-energy protons, and extends for approximately 4,800 km. This has been found to be a rather stable area.

This area of inner stability is separated from the very volatile outer area of highly charged electrons by an area called the Slot. It contains less active particles, and so acts as a buffer zone, at an altitude of approximately 13,000 km.

This outer area is affected greatly by solar activity, and it is responsible for much of the observed atmospheric magnetic displays we call *aurorœ*. This area extends to 16,000 km, after which the intensity of activity begins to fall off. ☆

David Williams

Figure 3



The Moon – by Geoff Falla

We are all familiar with the Moon – perhaps too familiar, as we seem to bypass it for much of the time in our quest to observe the planets, and the much more distant stars and other objects in deep space. The Moon is a very easy object to observe, even with a small telescope, while a powerful telescope with several hundred times magnification will seem almost to put us into lunar orbit, so that the Moon's impressive landscape of giant craters and mountains can be seen in some remarkable detail.

The Moon is much smaller than the Earth, the diameter being about a quarter at just over 2,000 miles, and this is reflected in the total mass comparison. It would take about 80 Moons to equal the mass of the Earth. The Moon is, however, quite a large satellite when we look elsewhere in the Solar System. Most of the planets have moons, the gas giant planets Jupiter and Saturn having a large number – increased as a result of space probe discoveries. Jupiter in particular has four major moons comparable in size to our own Moon, but the parent planet is truly huge in comparison.

Our own Earth-Moon system has at times been described as almost a double planet, as the Moon does not simply revolve around the Earth but around a common centre of gravity, located, not at the Earth's centre, but at a point some distance below the surface. The Moon's gravitational pull is one-sixth that of the Earth, although some variations have been discovered by lunar orbiter craft as a result of *mascons* – mass concentrations apparently below certain lunar maria areas.

We know that the Moon always keeps the same face turned towards the Earth. This is because the Moon turns once on its axis in the same time that it takes to make one orbit around the Earth, at just over 27 days, and known as a sidereal month. If the Moon did not rotate we would indeed be able to see the other side as it moved around in its orbit.

The slightly longer synodic month (lunar month or lunation) of 29.5 days is a result of the Earth's orbit, in that it takes an additional two days for the Moon to be at the same phase as seen from Earth.

Although it is generally true that we are unable to see the far side of the Moon, variations in orbital speed, as a result of its elliptical orbit and varying distance produces a rocking motion to east and west, bringing otherwise hidden areas to the edge of visibility. Likewise, the inclination of the Moon's orbit and axial tilt allows some visibility over the north and south polar areas. The overall result is somewhat surprising – the effect of what is know as *libration* is that considerably more than half of the Moon's surface, some 59 percent, can be seen from Earth. This led to the discovery of at least one major feature on the far side of the Moon.

The Moon always looks very bright to us, particularly when it is Full – but it does not, surprisingly, reflect very much light. The Moon's surface material and rock is mostly grey, reflecting only around 7% of the sunlight falling on its surface. If the Moon had a cloud-covered surface like the planet Venus, it would be ten times brighter and would make observing other objects in the sky that much more difficult – ➠

"light pollution" would be up there in space, and there would be nothing we could do about it.

Because each part of the Moon's surface has two weeks of continuous daylight, followed by two weeks of darkness, temperature extremes are created, ranging from boiling point, 100°Celsius, down to around minus 155°Celsius.

The Moon has only a weak, localised magnetic field at present, although the field strength seems to have been appreciable during the Moon's early history.

How old is the Moon, in fact, and how did it form? Research and studies of lunar rock returned to Earth from space flights have established that the Moon seems to be about the same age as the Earth – 4,600 million years.

The Moon could have formed in one of several ways.

It could have been born out of the same cloud of material that formed the Earth, attracting material from its surroundings by gravity. It could have been formed elsewhere in in the Solar System entirely, displaced by gravitational forces, and subsequently "captured" by Earth.

Another theory of the Moon's formation is that it was ejected from the Earth by natural forces while still in its early molten state.

Although this last theory seems to have been ruled out because the Moon is considered too large to have formed naturally in this way, research, including the similarity, but differences, between Earth and Moon material indicates a more dramatic answer.

The favoured theory now seems to be that the Earth was struck by a large object – perhaps as large as Mars, and that the impact ejected material both from the object and from the Earth to combine, forming the Moon by accretion. The process would have formed a molten body with a thin crust, and the residue of material would then have bombarded the lunar surface, producing the now familiar craters and lava plains. The Moon's crust is relatively thin on the Earth-facing side of the Moon, appearing to explain why the past outflow of lava forming the dark *maria* areas are so much a feature of the near side, and are indeed virtually absent on the far side of the Moon.

There is some debate regarding lunar craters, whether the majority were produced by volcanic activity or by meteor impacts. The fact that the smaller craters always disrupt the walls of the larger craters has been held as evidence of formation by meteor impacts, as the larger residue material would have been attracted first on a reducing scale. The same could be said, however, in the case of reducing volcanic activity as the Moon's interior cooled.

There are several reasons to support the idea that many of the craters may have been formed by volcanic activity. Firstly, it has been found that the overall distribution of lunar craters is in a non-random pattern. Some craters are found in lines or as crater chains as a result of faults in the lunar surface. Small craters are to be found on many of the mountain peaks, which can hardly have occurred by chance impacts. Such volcanoes, in the centre of larger craters, would represent the last stages of volcanic activity on the Moon.

Much knowledge about the geological structure and composition of the lunar ➠

surface and interior has been obtained as a result of space probes and the manned Apollo landings. Over 2,000 rock samples were returned to Earth from these flights between 1969 and 1972. Seismometers and other scientific instruments were also left on the Moon's surface to record geological activity and other information.

The Moon's surface, known as the *regolith*, consists of a layer of material pulverised by meteor bombardment, and producing a soil which varies from one to 20 metres deep. The solidified lava flows of the lunar maria areas have a composition similar to volcanic basalts.

The highland areas of the Moon are composed of a paler rock than the dark lunar "*seas*", and reveal a more ancient surface of anorthosite rock rich in calcium and aluminium. Some of the rock from these areas has also been found to contain rare elements, including uranium and thorium.

Recently reported discoveries of a valuable fuel source – helium 3 – in the lunar soil, and the surprising announcement that there is evidence of water in the form of ice at the Moon's South Pole brings forward the prospects for a lunar base, and mining for future generations of astronauts. ☆

Geoff Falla

Editor's notes:

1. It has now been reported that the previous reports of ice on the Moon were mistaken.

2. It is of interest to note that the libration of the Moon was used to good effect by Guernsey-born astronomer Warren De La Rue to create three-dimensional views of the Moon in the late 1850s.

Do you know?

1. Who originally devised the system of magnitudes?
2. Shining at an absolute magnitude of more than -7, which star has the greatest absolute magnitude?
3. What is the apparent magnitude of the sun?
4. What is the absolute magnitude of the Sun?
5. At what distance is absolute magnitude measured?
6. What is the spectral class of the Sun?
7. What is the name of the diagram that plots stars according to luminosity and spectral type (temperature)?
8. In what year was Uranus discovered?
9. Who discovered Pluto?
10. How many light-years are there in a parsec?
11. What is the speed of light?
12. Name the astronomer who first measured the speed of light in 1675.
13. Who discovered pulsars in 1967?

The above questions were set by Debby Quertier.

Members should know the answers, because all these questions were posed during the Quiz Evening last December!

So, how good is your memory? ***Answers on page 19.***

From time to time we will include questions from the quiz. The next issue of Sagittarius will include an astronomical crossword by Peter Langford. ☆

Calendars, Part 1 – by David Le Conte

What date is it?

That depends on the calendar used:-

Gregorian calendar:	1997 May 20
Julian calendar:	1997 May 7
Jewish calendar:	5757 Iyyar 13
Islamic Calendar:	1418 Muharam 13
Persian Calendar:	1376 Ordibehesht 30
Chinese Calendar:	Shengxiao (Ox) Xin-You 14
French Rev Calendar:	205, Décade I
Mayan Calendar:	Long count 12.19.4.3.4 tzolkin = 2 Kan; haab = 2 Zip
Ethiopic Calendar:	1990 Genbot 13
Coptic Calendar:	1713 Bashans 12
Julian Day:	2450589
Modified Julian Date:	50589
Day number:	140
Julian Day at 8.00 pm BST:	2450589.292

First, let us note the difference between *calendars* and *time-keeping*. The *calendar* deals with with intervals of at least one day, while *time-keeping* deals with intervals less than a day. Calendars are based on astronomical movements, but they are primarily for social rather than scientific purposes. They are intended to satisfy the needs of society, for example in matters such as: agriculture, hunting, migration, religious and civil events. However, it has also been said that they do provide a link between man and the cosmos.

There are about 40 calendars now in use, and there are many historical ones. In this article we will consider six principal calendars still in use, relating them to their historical background and astronomical foundation. These six calendars are:-

Gregorian calendar
Hebrew Calendar
Islamic Calendar
Indian Calendar
Chinese Calendar
Julian Day Numbers

We shall also consider two ancient calendars: Egyptian and Mayan.

The astronomical basis of calendars

The principal astronomical cycles are:-

Day	Based on the rotation of the Earth on its axis
Year	Based on the revolution of the Earth around the Sun
Month	Based on the revolution of the Moon around the Earth

The complexity arises because the revolution cycles (year and month) are not integral numbers of days, and because none of the cycles is constant. We have first to note the definitions of: *Solar Day*, *Synodic Month*, and *Tropical Year*.

The *Solar Day* is the interval between successive returns of the *Mean Sun* (an artificial Sun which moves with uniform motion) to the same meridian. It is slightly (about 4 minutes) longer than the time taken for the Earth to rotate 360° on its axis with respect to the stars (the *sidereal day*).

The *Tropical Year* is the mean interval between the Vernal Equinoxes. It relates to the seasons, and is therefore the most important type of year for calendar purposes. It varies sightly, but is currently 365.2422 days. ➠

The *Synodic Month* is the mean interval between conjunctions of the Moon and the Sun, and relates to the phases of the Moon. It is 29d 12h 44m 03s (29.5305879 days). Again, it is longer than the simple orbital period of the Moon on its axis, which is about 27.32 days.

Therefore, it can be seen that the year is not an integral number of days; nor is it an integral number of months, in astronomical terms.

Attempts to arrive at a solution to these problems have resulted in three distinct types of calendar (see box).

Solar calendar	Based on the tropical year. (Eg Gregorian Calendar.)
Lunar calendar	Based on lunar phase cycle. (Eg Islamic Calendar.)
Luni-solar calendar	Based on lunar phase cycle, but uses intercalary months every few years to bring it back into phase with the tropical year. (Eg Hebrew and Chinese Calendars.)

In a purely lunar calendar, 12 lunar months are about 11 days shorter than the tropical year. Therefore, in the luni-solar calendar an extra month is inserted periodically (an intercalary month). For example, if an extra month is added in seven years out of every 19, then the average calendar year is only about six minutes longer than the tropical year. This was the basis of several Babylonian calendars and of their Greek derivatives. The Jewish calendar is a close relative.

The Old Roman Calendar

Romulus was responsible for the introduction of the old Roman calendar. Its epoch (starting point) was the Foundation of Rome in 753 BC. Years were denoted "AUC" (*anno urbis conditæ* or *ab urbe condita*). Therefore 753 BC was equivalent to 1 AUC. The year had 304 days divided into 10 months, starting in March. (Hence we have: *Sept*ember, *Oct*ober, *Nov*ember, and *Dec*ember as the *7th, 8th, 9th* and *10th* months.) The months were divided into three parts: *Kalends, Nones*, and *Ides*.

Nuna Pompilius, who reigned from 39 to 82 AUC (ie 715-672 BC) added two months, February and January to the start of year. The year then had 355 days. In 302 AUC (452 BC) February and January were reversed to take up their present positions.

The months alternated 30 and 29 days, with one extra day added at the end of the year. Every second year an extra month (called *Mercedinus* from the latin word for wages) was added. This had alternately 22 and 23 days. But now the year was one day too long, on average. Therefore, further slight adjustments were made.

The Julian Calendar

By the reign of Julius Caesar (102-44 BC) the Roman calendar had reached a state of confusion, and the Greek astronomer Sosigenes advised Caesar in the redesign of the calendar.

The result was a major readjustment which took place in 708 AUC (46 BC). This year had two additional months of 33 and 34 days, inserted between November and ➠

December, and an intercalary month of 23 days. So the *Year of Confusion* lasted 455 days!

The new Julian calendar had 12 months, alternating 31 and 30 days, an exception being February, which had only 29 days in non-leap years. There was a leap year every four years, and the calendar year therefore averaged 365¼ days.

However, just two years after it came into effect Caesar died, and, unfortunately, the priests who were responsible for administering the calendar, apparently misunderstood the system. Instead of a leap year every four years, they had one every three years, and this went on for 36 years. Therefore by 9 BC three days had accumulated, and the Vernal Equinox had moved from 25 March to 22 March.

Changes to Julian Calendar by Augustus

Julius Caesar was succeeded by his grand-nephew, Caesar Augustus (63 BC - 14 AD). He restored the Julian Calendar by having 12 years with no leap years, and by 4 AD everything was all right again.

Well, it would have been all right except for Augustus's meddling. Julius Caesar had been born in the fifth month, *Quintilis*, and Augustus therefore renamed this month *July* in his honour.

The sixth month, *Sextilis*, was of special importance to Augustus, and he renamed it *August*. However, August had only 30 days, and, to give it the same number as July, which had 31 days, he transferred one day from February. February thus had only 28 days in non-leap years.

But then July, August, and September all had 31 days, so, to restore some semblance of the alternating sequence, Augustus moved one day from September to October, and another from November to December.

The Gregorian Calendar

The date of Easter is the Sunday after the first ecclesiastical Full Moon that falls on or next after 21 March. The ecclesiastical Full Moon is not the same as the astronomical Full Moon, as it is based on tables that do not take into account the complexity of the lunar motion.

By the 16th century the Vernal Equinox had shifted by ten days, and the astronomical Full Moons were occurring four days before ecclesiastical Full Moons, on which the date of Easter was based.

This is the reason why Pope Gregory XIII (AD 1502-1585) decided to reform the calendar.

The Pope was advised by Ghiraldi and Clavius. The objective was to restore the days which had been lost since the Council of Nicea, in AD 325. That Council had met to resolve, *inter alia*, the date of Easter. By that year 4 days had been lost from the original Julian Calendar, and the Vernal Equinox had moved from 25th March to 21st March.

The question has been raised as to whether the calendar should not have reflected the position of the Equinoxes at the time of the birth of Christ, rather than the date of the Council of Nicea. The difference would have been one day.

Because the calendar year was 365.25 days, rather than the tropical year of 365.2422 days, the annual mean error of the Julian Calendar was 11m 14s. Therefore, the accumulated error from AD 325 to AD 1582 (1257 years) was 9d 19h 20m 18s. It was therefore necessary to correct the calendar by 10 days. ➠

Thus, by a Papal Bull issued by Pope Gregory XIII, the 5th October 1582 became 15th October 1582.

The calendar was also redefined so that a leap year was skipped every 100 years, except for every 400 years.

The rule for the Gregorian Calendar is:-

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.

Therefore, 1800 and 1900 were not leap years, but 2000 will be a leap year.

The Gregorian calendar cycle is 400 years. (400 years equal 146,097 days. This is exactly divisible by 7, and therefore the calendar exactly repeats after 400 years.)

In the Julian calendar 400 years was 146,100 days, an average of 365.2500 days per year. The Gregorian calendar has an average of 365.2425 days per year. This is close, but not exactly equal to the tropical year of 365.2422 days. By changing from the Julian to the Gregorian calendar the mean length of the calendar year was reduced from 365d 6h 0m 0s to 365d 5h 49m 12s, and the mean error in the solar year reduced from 11m 14 s (one day per 128 years) to just 26s (one day per 3323 years).

This long-term error in the Gregorian calendar can be seen as a trend line in the 3000-year plot of the shadow of the Liberation Monument. (See next page.)

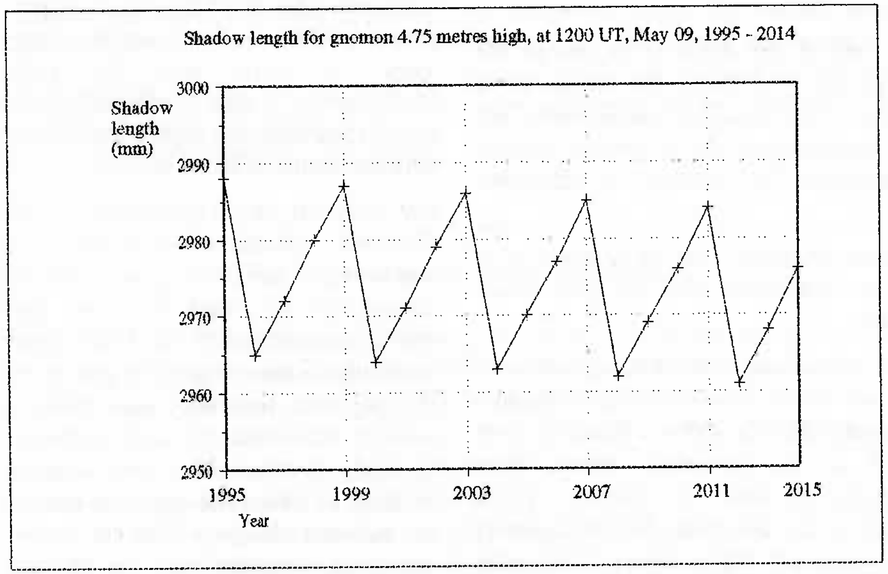
The Gregorian calendar in England

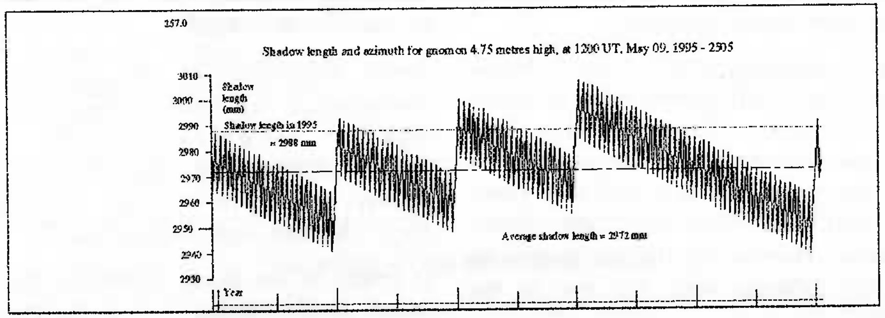
Of course, the Papal Bull had no effect in Protestant Countries, such as England. Indeed, in 1570, just 12 years previously, a similar Bull by Pope Pius V had excommunicated Queen Elizabeth I, and released her Catholic subjects from their loyalty to her! Pope Gregory had also encouraged Elizabeth's enemy, Mary, Queen of Scots. So, it was not surprising that England was loath to accept the new Papal calendar.

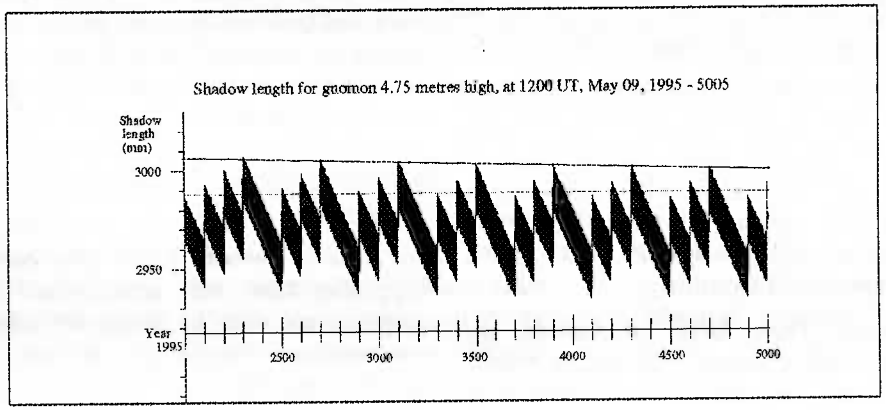
Nevertheless, Queen Elizabeth did attempt to have the calendar introduced, against the wishes of her bishops. The Archbishop of Canterbury wrote to the Queen giving worthy excuses, designed to delay any decision. He said that before the bishops could agree with the introduction of the new calendar, it would be necessary to consult widely, with the Church in England as well as with other churches. It was also stated that if England agreed to the change then it would, in effect, be submitting to the authority of the Pope.

Scotland did accept the Gregorian calendar in 1600, by the *Act of the Estates*. The fact that much of the world used the new calendar, while England (and Guernsey, of course) used the old one, must have led to confusion. Indeed, it became common to refer to dates between 1 January and 24 March in terms of both systems, as there was ambiguity about the start of the new year.

So by 1750 it was decided that the Gregorian calendar should, after all, be accepted. *The Calendar (New Style) Act, 1750* (Act 24, George II, Chapter 23) introduced the calendar into Britain and the British Colonies (including the USA) in 1752. In Guernsey, the Act (*Regulating the Commencement of the Year, and for correcting the Calendar now in use*) was registered in the Royal Court on 28 December 1751. By that time the Julian calendar was 11, rather than 10 days adrift of its position at the time of the Council ➡







Plots of the shadow lengths of the Guernsey Liberation Monument. The top diagram shows the effect of leap years for 20 years (the year 2000 AD is a leap year). The middle diagram shows the effect of leap years for 500 years (leap years are omitted in the years 2100, 2200 and 2300, but 2400 is a leap year). The bottom diagram shows the long-term trend (solid line) caused by the loss of about one day because of the Gregorian calendar.

of Nicea.

The effect of the Act was to change the start of the year from 25 March to 1 January (1751 therefore having only 282 days), and dropping eleven days by making 3 September 1752 become 14 September 1752.

The new calendar was designated *New Style*, as opposed to the *Old Style* Julian Calendar.

It was pointed out that if the new calendar had not been introduced, the gradual movement of the Vernal Equinox with respect to the calendar would have eventually resulted in Easter (which depends on the date of the Vernal Equinox) being celebrated at Christmas! This would clearly have been a nonsense.

Other countries accepted the new calendar over the years, with Greece being the latest one, in 1923. (However, they also modified their version of the calendar to make the years 2900 and 3300 leap years, but 2800 and 3200 not leap years. Therefore, Greece may in due course be one day different from the rest of the world!)

"Give us back our eleven days!"

It is often said that people in England rioted when the calendar changed from the Old Style to the New Style, crying "*Give us back our eleven days!*" The reason frequently given is that they were concerned that their lives were being shortened by 11 days.

However, Peter Jarvis of Oxford has suggested that people were not so stupid, and that the real reason was that agricultural rents and tithes were calculated on an annual basis, but fell due on the four quarter days (Midsummer, Michaelmas, Christmas Day and Lady Day). Therefore people paid the landlords and the clergy an extra 11 days' rent for nothing. Undoubtedly, if such a proposal was made today, then we could expect demonstrations perhaps similar to those in 1752.

Unfortunately, this explanation also seems incorrect. Examination of the Act, as registered in the Royal Court (which was copied out by hand from the printed version transmitted by the Privy Council), shows that it went to great lengths to ensure that payments were only made for services actually received. And, indeed, the quarterly payment days were changed by 11 days to reflect the days lost because of the calendar change. Thus the Lady Day payments, normally due on 25 March, became due on 5 April.

Owen Gingerich of the Center for Astrophysics, Cambridge, Massachusetts, says that: *"The Bill met with a mixture of militant Protestantism and resentment of change, and "Give us back our Eleven Days" became a campaign slogan."*

It seems to me likely, therefore, that the more simple explanation is that people were highly sceptical about such a radical change to their lives, and rallied against it, using the phrase as a slogan. They may, of course, also have been unsure of the exact terms of the Act (and perhaps those leading the opposition may have encouraged such uncertainty).

As a civil servant I see this process happening time and again when new proposals are made by States of Guernsey committees. People use all sorts of spurious arguments in support of their opposition to carefully formulated proposals. ☆

David Le Conte

This article was based on a talk given by David on 20 May 1997.

In Part 2 in the next issue we will consider a few other calendars, including some no longer in use, but nonetheless of historical importance.

In the three boxes on this and the next page are some notes about the origin of the names of the months and the days of the week, and the evolution of *New Year's Day*

The origin of the names of the months

January	*Janus*, two-faced Roman god, concerned with beginnings.
February	*Februare* - to purify. *Februa* - Festival of purification.
March	*Martius*, from Mars, the Roman god of War.
April	Possibly from *aperire*, to open. Or *Aphrodite*, Greek god of love.
May	*Maia*, the daughter of Atlas, and mother of Mercury.
June	*Juno*, chief Roman goddess.
July	*Julius* Caesar. Formerly *Quintilis*, the fifth month.
August	Caesar *Augustus*. Formerly *Sextilis*, the sixth month.
September	Seventh month.
October	Eigth month.
November	Ninth month.
December	Twelth month.

The origin of the days of the week

The *week* of 7 days most likely has a mystical basis, rather than an astronomical basis. However, it has been noted that the lunar quarters approximate 7 days, and that the number 7 is related to the number of "wandering stars" (Sun, Moon, and the five naked-eye "planets": Saturn, Jupiter, Mars, Venus, and Mercury). The French names are indeed related to these.

	English meaning	French	"Planet"
Sunday	*Sun*		*Sun*
Monday	*Moon*	Lundi	*Moon*
Tuesday	*Tiw*, northern god of War = Mars	Mardi	*Mars*
Wednesday	*Woden*, Anglo-Saxon god of war	Mercredi	*Mercury*
Thursday	*Thor*, Scandinavian god of thunder	Jeudi	*Jupiter*
Friday	Scandinavian, Anglo-Saxon god of love	Vendredi	*Venus*
Saturday	*Saturn*		*Saturn*

New Year's Day

By the 6th century it was felt better to base the starting point of the calendar on the Nativity, rather than on the foundation of Rome. Dionysius Exiguus concluded that Christ was born in the year 753 AUC, and that this year should become 1 AD (*Anno Domini*). Now, however, it is believed that Christ was born in the year 4 BC.

The 25th December was accepted as the date of the birth of Christ because it was nine months after Lady Day, the 25th March, the day of the Annunciation, which itself coincided with the Vernal Equinox. The 1st January was accepted as the start of the year, rather than 25th December, because it was the Feast of Circumcision. Circumcision took place on the 8th day, including the day of birth. Therefore 1 January could be regarded as the date of Christ's "birth" in the Church.

New Year's Day only became standardised on 1 January in the 16th century, with the introduction of the Gregorian calendar. Even then it did not apply everywhere. For example, England (and Guernsey) used 1 January as the start of the year only from the 18th century. Before then, New Year's Day was 25 March.

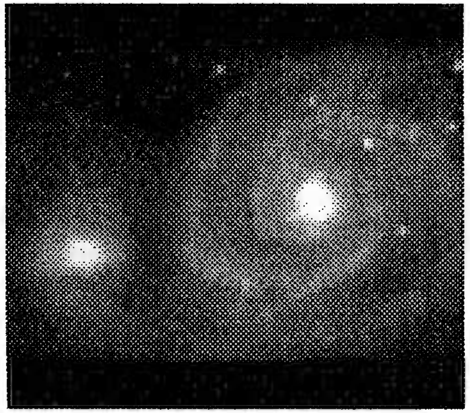
The mistake in the date of Christ's birth results in some peculiar consequences.

The epoch of our calendar should really be 1 January 3 BC. This would mean that the new Millenium starts on 1 January 1998. And the 2000th anniversary of Christ's birth is 25 December 1997!

There has, of course, been some debate about when we should celebrate the new Millenium. In the Gregorian calendar the epoch is 1 January 1 AD, and this is the date that the year 1 AD (if it had existed) would have started. Therefore, 2000 AD will start on 1 January 2000 AD. Thus, the present Millenium ends on 31 December 2000, and the New Millenium starts on 1 January 2001.

Picture pages on the Web

Daniel Cave has done a lot of work on our Web pages, especially the *Gallery*. There are 16 beautiful images, most of them in colour, and most of them taken by Daniel with our new colour filter system for the CCD camera. Here is one example.



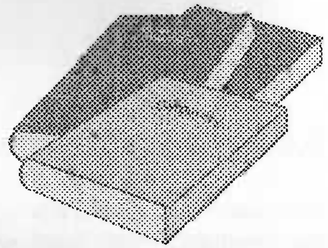
The Whirlpool Galaxy, M51, appears on our web page.

Daniel has, unfortunately for the Section, left Guernsey, but will continue developing the site. However, we are running out of space. Does anyone have a few kilobytes they could spare? ✫

Book Review

The Great Astronomical Revolution

by Patrick Moore



published by Albion Publishing, 1994

Along with many others who attended Patrick Moore's entertaining talk in January, I bought the above book, which has been most enjoyable to read.

The book deals with the contributions to astronomy of five men – Copernicus, Brahe, Kepler, Galileo and Newton – and show how, over about 150 years, they overturned the long-held beliefs that the Earth was the centre of the Universe, and all the bodies revolved around it.

The book does not just deal with their discoveries, it paints a picture of what life was like for these men. The idea that we were part of a heliocentric system went against the teachings of the Church, and to go openly against this was dangerous indeed. It must have been thrilling for them, as they made their observations and began to realise that the established beliefs were wrong – but frustrating that they could not shout it from the roof-tops for fear of repercussions. Indeed, it is only a few years ago that Galileo was formally cleared of heresy by the Vatican.

After the book deals with Newton's contributions (who led a peaceful existence, compared with his predecessors) it comes up to date with a summary of the Space Age. Most people with an interest in astronomy are familiar with the names of these men, and have some idea of what they did. This book widens that knowledge, as we learn about their lives and the valuable contributions they made to the progress of astronomy in (sometimes very) difficult times. ✫

Debby Quertier

Answers to *Do you know?* (page 10)

1. *Hipparchus* devised the system of magnitudes in the 2nd century BC.
2. *Deneb* has the greatest absolute magnitude.
3. The apparent magnitude of the Sun is -*26.7*.
4. The absolute magnitude of the Sun is *4.3*.
5. Absolute magnitude if measured at a distance of *10 parsecs*.
6. The sun's spectral class is *G2*.
7. The *Hertzprung-Russell diagram* plots stars according to luminosity and spectral type.
8. Uranus was discovered in *1781*.
9. *Clyde Tombaugh* discovered Pluto.
10. There are *3.26* light-years in a parsec.
11. The speed of light is 186,000 miles per second (300,000 km per second).
12. *Ole Römer* discovered the speed of light in 1675.
13. *Jocelyn Bell* (now Jocelyn Bell-Burnell) discovered pulsars on the Cambridge team led by Professor A Hewish. ✫