TAILPIECE

Advertisements

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

Public talks

Ken Staples has been broadcasting on the BBC Radio Guernsey Pat Lihou morning show, on the last Friday of each of the past few months. He has been describing what listeners can expect to see in the night sky during the coming month. Try to tune into him.

On the 28th June David Le Conte gave a talk at the weekly *Meeting Point*, a lunchtime series at the Town Church. His talk appears in this issue of Sagittarius, starting on page 13.

On the 2nd July David spoke to the St Peter Port Women's Institute, and showed slides of a variety of astronomical objects.

On the 19th July guest speaker Richard Mallett did an impromptu talk about sun dogs on Pat Lihou's show on Radio Guernsey. Listeners had observed sun dogs and were curious about them.

On the 9th August David was interviewed on Radio Guernsey News about the discovery of fossilised micro-organisms in a meteorite from Mars, and the total eclipse of the Sun to take place on 11 August 1999.

Articles needed

We need articles for the next series of newsletters. Come on, budding authors!

No sponsor has been found for this issue.

If you know of a potential sponsor please let us know so that they can be contacted.

The cost is £25.

Sagittarius OnLine is the Astronomy Section's home page on the World Wide Web. It includes the on-line version of the newsletter, with some of the articles that have appeared in previous issues. It can be found at:

http://www-dept.cs.ucl.ac.uk/students/d.cave/a_sect.htm

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 November. The deadline for publication copy is the 15th October.

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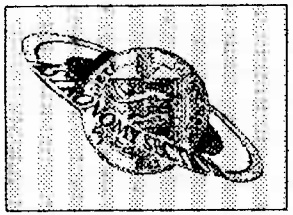
Sagittarius

The Newsletter of the Astronomy Section of La Société Guernesiaise

September/October 1996



Forthcoming events

Is anyone out there?
by Antony Saunders
Tuesday, 27 August
8.00 pm at the Observatory

National Astronomy Week
The Solar System
Tuesday, 24th September
8.00 pm at La Houguette School

Total lunar eclipse
Friday, 27th September
2.12 am - 5.36 am
at the Observatory

Observatory Open Day
Saturday, 12th October
10.00 am to 10.00 pm
including:
Partial solar eclipse
1.59 pm - 4.31 pm

In this issue

Eclipses
The Big Bang

Inside

Major articles are in **bold**

Centre inserts

September/October star chart
Moon phase calendar

Is anyone out there?

At 8.00 am on Tuesday next, the 27th August, Antony Saunders will be talking about **the possibility of life elsewhere in the universe.**

His talk will concentrate on the criteria for the existence of life on another planet, and whether such life would follow the same path as mankind.

With the recent announcement of the discovery of micro-organisms in a meteorite from Mars, this is a highly topical subject. ☆

Observatory Open Day

The Section's main event of the year takes place **on Saturday, the 12th October. This is the Open Day, when the Observatory will be open to the public from 10.00 am to 10.00 pm.**

The highlight of the day will undoubtedly be the afternoon's **partial eclipse of the Sun**. This lasts from **1.59 pm to 4.31 pm.** We now have, of course, our new solar telescope, which will come into its own as a method of observing the eclipse. We will also be using the projection method, and a solar filter on the 11-inch telescope. And don't forget that you can get your special eclipse viewers from the Section for just £1.50.

In the evening we will be inviting the public to observe a number of objects, especially Saturn.

This is our major fund-raising event of the year. We will need several members to assist with this special day – to talk to and help the visiting public, to serve refreshments, etc. Please come along. And pray for fine weather! ☆

National Astronomy Week

The Astronomy Section will be taking part in National Astronomy Week, which this year particularly commemorates the 150th anniversary of the discovery of Neptune in 1846. In fact, later in the year we will be having a talk from Frank Dowding on this very subject.

There are two main events during the week. **At 7.30 am on Tuesday, the 24th September at La Houguette School** there will be a public slide-show and video evening. The subject, with the discovery of Neptune particularly in mind, will be the Solar System. Following the slides there will be the opportunity for people to use the observatory telescopes, weather permitting. Saturn will be in a favourable position for observation, and the rings, now that they are no longer edge-on, should be well visible.

The second event will require much stamina from members, as it will take place in the early morning hours. The **total eclipse of the Moon starts at 2.12 am on Friday, the 27th September** (ie Thursday night). Totality lasts from 3.19 am until 4.29 am, and the eclipse ends at 5.36 am. As usual, we will be observing from the Observatory.

Full details of the eclipse appear on page 4.

Barbecue and meteors

About 15 members and friends enjoyed the barbecue on 11 August, despite indifferent weather. Clouds cleared for the meteors, but relatively few were seen. Counts on that and the next night gave rates of only about 20 per hour – about a third of that expected. The best one was not a Perseid – it was going in the opposite direction! ☆

Meteoroids, meteors and meteorites

On the 2nd July Lawrence Guilbert spoke about "the three Ms". He explained that the word "meteor" came from the Greek, meaning "that which is created in the atmosphere". At the end of the 18th century it was realised that meteors were small bodies burning up in the atmosphere.

After describing how to observe them, Lawrence spoke of their cometary origin. They appear 80-100 km above the Earth. What we see is an incandescence produced by ionisation. On average, 5-6 per hour are seen in the evening, increasing to 12-16 in the morning.

It has been estimated that, every day, throughout the Earth, there are 75 million meteors with magnitude brighter than 5! Bright meteors (> magnitude -3) are called fireballs. On average, one out of 2000 meteors is brighter than magnitude -8. Exploding fireballs are called bolides. At the opposite extreme, micro-meteoroids are too small to become incandescent, and float gently down to Earth.

The larger objects hit the Earth as meteorites. It is estimated that there are about 40,000 meteorites per year, most of which fall into the sea. About ten are recovered annually. The first meteorite was recorded in 1492, and by 1803 it was accepted that meteorites had an extra-terrestrial origin.

Lawrence then described the different types of meteorite: stony and iron, and their subgroups.

By the end of the evening, we were all far more knowledgeable about the subject, which had been well researched and presented by Lawrence. ☆

Indian observatories

On the 23rd July Richard Mallett paid us a welcome return visit. He started his talk by showing slides of the total solar eclipse which he observed from Fatehpur Sikri in India in 1995. It was a spectacular eclipse seen from a spectacular setting.

Richard then described in detail three of the ancient stone observatories which he had visited on the same trip.

Delhi Observatory was built from 1719 to 1724 by the Maharajah Jai Singh, who reformed the Indian calendar and determined the angle of the ecliptic. It includes a number of instruments, the largest being an equatorial dial standing 70 feet high.

The Jaipur Observatory was built in 1727, and restored in 1901. Richard explained how each of the many instruments was used. He completed his talk with a description of the Varanasi Observatory. ☆

Observatory Day

Our annual work-in day at the Observatory, arranged this year for Saturday, 20th July, turned out to be one of the hottest days of the year. Although really too warm for outdoor work, several Section members braved the heat, and a very useful amount of work was done.

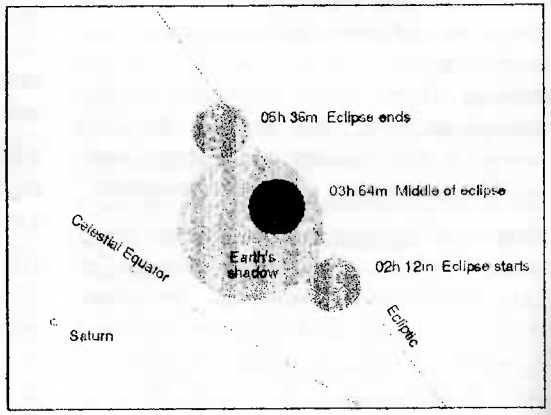
This included repair of the Observatory steps, cleaning and tidying of the buildings, trimming back the hedge, and grass cutting. An area to be used for the solar telescope tripod was cleared, and the stock of spare timber lengths was sorted and covered.

Thanks to those who were able to help, including Roger Chandler, Debbie Quertier and Gerald Robilliard. ☆ ***GF***

Total eclipse of the Moon, morning of 1996 Sep 27

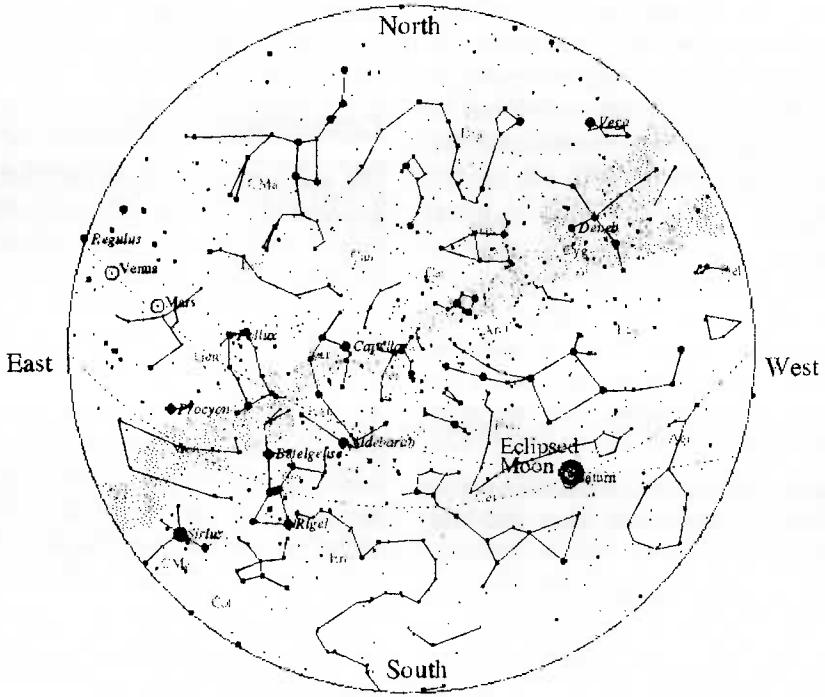
In the early morning hours of Friday the 27th September the second total lunar eclipse of the year will occur.

The Moon will enter the umbra of the Earth's shadow at 02h 12m BST, and will be totally eclipsed by 03h 19m. Mid-eclipse is at 03h 54m. Totality ends at 04h 29m, and at 05h 36m the Moon will be completely free of the umbra.



The circumstances of the eclipse. (Note the position of Saturn)

Astronomy Section members are invited to observe the eclipse from the Observatory. Despite the very unsocial time of the eclipse, if the weather conditions are good, it should be well worth staying up for. ***DLC***



The night sky at the time of total eclipse.

Did you know?

What is the difference between a meteor, a meteoroid, and a meteorite? When is a meteor a fireball? When is a meteoroid an asteroid? What is a minor planet? And what is a micrometeoroid?

A *meteor* is a light phenomenon – a streak across the sky, which is visible and can be recorded photographically or by radar. It is commonly called a *shooting star*. A *meteor* is caused by a *meteoroid*, which is defined by the International Astronomical Union (IAU) as:-

"*A solid object moving in interplanetary space, of a size considerably smaller than an asteroid and considerably larger than an atom or molecule.*"

A meteor is actually the result of ionisation of the atmosphere, the air glowing rather like a neon tube as the meteor passes through it at a speed of about 50 miles per second. So, although you can't see the meteoroid, you can see the meteor.

A *meteorite* is a meteoroid, or part of a meteoroid, which reaches the Earth's surface.

A *fireball* is a very bright meteor, sometimes defined as brighter than -3.

An *asteroid* is a large body, which can be seen as a star-like image in a telescope. A *minor planet* is a synonym for asteroid, and is the IAU's preferred term.

Martin Beech and Duncan Steel have proposed[1] that the upper limit for a meteoroid (and the lower limit for asteroid) be set at 10 metres, and the lower limit be 100 μm. Below that size, particles would termed *dust*. ☆ ***DLC***

Reference

1. *Q.J.R.astr.Soc.* **36**, 281-284

Meteorites in Guernsey?

Recently, a member of the public brought to me an unusual looking stone, and asked whether it might be a meteorite. It had been sitting in his garden for some years, and he was thinking of throwing it out, but did not wish to do so before checking if it was a visitor from space.

The stone was about the size of a hand, and appeared to have a basically spherical structure, with a worn crust. There was a darkening reddish colour on the interior, which could have been iron, a constituent of many meteorites.

I have seen many meteorites, including pieces of the famous Barwell meteorite, the largest recorded one in Britain, which fell on Christmas Eve, 1965. The Smithsonian Institution, where I used to work, has the largest collection in the world, and I was involved in the acquisition of a piece of the Barwell meteorite for the Institution.

However, I am not a geologist, and, although I thought the stone found in Guernsey was unlikely to be a meteorite, I felt it best to get it checked out by an expert. I therefore asked Alan Howell, Natural History Officer at the Guernsey Museum, and a geologist by training, to look at the stone, Here is his report.

"*The specimen is unfortunately not a meteorite but a highly mineralised and weathered rock from the St Peter Port Gabbro complex. An initial cursory examination (with a hand lens) led me to think that this was a 'clot' of metallic sulphides from that rock group. However, after further examination under the microscope, the specimen appears to consist of altered and mineralised gabbro which is in part sphaeroidally weathered.*»

The common name for this is onion-skin weathering and the reason for that is fairly apparent. The rock itself has the usual green colour associated with dominant amphibole mineral, originally hornblende.

This has, however, been substantially altered in part to minerals like actinolite and serpentine and the whole has been invaded by the pale green zeolitic mineral prehnite. There are traces of the gold coloured iron sulphide pyrite and weathering of this has resulted in the rusty stains on some surfaces.

The pale lath shaped crystals apparent on the outer weathered surfaces are plagioclase feldspars and their size and texture leads me to suspect that this rock originally came from a smaller intrusion within the gabbro complex, perhaps a dyke of equivalent scale to the dolerites seen in many parts of the island."

So, now you know! I still have the rock if anyone is interested in seeing it.

This raises the question of whether there are any meteorites in Guernsey. I have not heard of any falling here, and I understand that the Museum does not have any. I have a small, bought sample, but does anyone know of any meteorites of a good size? ☆

David Le Conte

Did you know?

Which planet is most often the closest one to the Earth? The answer, which may surprise you, appears upside-down below.

Thanks to Peter Langford for this one. ☆

The surprising answer is Mercury! Think about it. (Or refer to *Sky and Telescope* January 1996).

Solar eclipses 1 – 3000AD

In the May/June 1994 issue of Sagittarius I listed all the solar eclipses visible from Guernsey between 1940 and 2040. In expectation of the 1999 total eclipse, which will be visible from Alderney, I have been researching the last time a total eclipse of the Sun was visible from the Bailiwick Guernsey. Using the Mücke and Meeus *Canon of Solar Eclipses* to identify roughly those which might have been visible, and then a computer program *Solar* to check them, I had gone back as far as the year 1500 AD without finding one total eclipse.

There was an annular eclipse in 1847, but that was clouded out (see page 19 for newspaper reports of the time).

I was resigned to continuing to plod back through Mücke and Meeus until I found a total eclipse. But then to the rescue came a new book called *UK Solar Eclipses from Year 1* by Sheridan Williams. This describes every total and annular solar eclipse visible from the British Isles for the years 1 AD to 3000 AD, and provides maps of every eclipse track, including the English Channel. I have extracted the data relevant to the Channel Islands, and listed the total eclipses and annular eclipses.

Incidentally, the book also lists the partial eclipses for the years 1900 to 2051, and it is possible to infer many of the partial eclipses for other years by checking eclipses which were total and annular as seen from the UK.

The answer to my question is surprising. The last total solar eclipse visible from the Channel Islands was over 1000 years ago, in 968 AD! The Sun was rising, and totality at Guernsey, on the edge of the path of totality, lasted just a few seconds. Alderney was outside the path of totality.

The eclipse before that one was in 565 AD. This time the Sun was setting, and again Guernsey was on the edge of the path of totality, with just a few seconds in which to see the total eclipse. Alderney was again outside the path, but Jersey was close to the centre, and would have experienced a total eclipse of about a minute.

Both the eclipse of 565 and that of 968 occurred in the winter, with the Sun at an altitude of only a few degrees above the horizon. There is, therefore, a good chance that the eclipse was obscured by cloud on both occasions. Even if it was clear, the fact that the Sun was just setting in one case, and just rising in the other case, could mean that the eclipses may have passed unnoticed. On the other hand, sunset and sunrise are the only times when the Sun is regularly observed with the naked eye, the atmosphere providing the necessary attenuation, and so it is possible that there were watchers at the time.

The last good total solar eclipse visible from the Bailiwick of Guernsey was in the year 28 AD, nearly 2000 years ago! The date was in July, and the time was close to sunset. There was also a total eclipse just a few years earlier, in 19 AD, but the centre of the track (where the eclipse lasted over 4 minutes) lay well to north of the Bailiwick.

The next total eclipse occurs in 2081. Guernsey is on the edge of the path of totality. However, Guernsey is well placed for the eclipse of 2090, although the Sun will be low as the eclipse takes place just before sunset.

Altogether, over the 3000 years 10 total eclipses are visible from the Channel Islands, an average of one every 300 years. There are also 13 annular eclipses.

Total solar eclipses visible from the Channel Islands, 1 AD to 3000 AD

y	m	d
0019	Jun	21
0028	Jul	10
0565	Feb	16
0968	Dec	22
1999	Aug	11
2081	Sep	03
2090	Sep	23
2142	May	25
2189	Nov	08
2726	Jul	21

Annular solar eclipses visible from the Channel Islands, 1 AD to 3000 AD

y	m	d
0004	Apr	08
0105	Oct	25
0207	May	14
0464	Jul	20
0536	Sep	01
0698	Dec	08
0852	Mar	24
0891	Aug	08
1310	Jan	31
1847	Oct	09
2220	Sep	27
2650	Aug	19
2777	Oct	23

☆ ***David Le Conte***

References

UK Solar Eclipses from Year 1 by Sheridan Williams, Clock Tower Press, 1996.

Canon of Solar Eclipses -2003 to +2526 by H Mücke and J Meeus.

What are the chances of the weather permitting observation of these exlipses? See page 19 for an 1847 account!

Observing Programme – September/October 1996

The Autumn sky in this Section between Right Ascension 21.00 and 01.00 hours includes a selection of object types, with galaxies, globular and open star clusters, planetary nebulæ and double stars.

The most well known object is the spiral galaxy *M31* in Andromeda, the nearest of its type to our own galaxy, and the most distant object visible to the naked eye. At a distance of just over two million light-years the galaxy is at a magnitude of around 3.4. It is accompanied by a small elliptical galaxy *M32*, and is perhaps best viewed at very low magnification or with binoculars.

The constellation Pegasus contains *M15*, one of the brightest of the globular star clusters, at magnitude 6. The cluster is very condensed, and should be easily seen with a small telescope.

Cassiopeia has a rich open cluster of stars, designated *NGC 7789*. It was discovered towards the end of the 18th century by Caroline Herschel, sister and assistant to the astronomer William Herschel.

The constellation Cepheus, east of Cassiopeia, contains a red variable star named *Herschel's Garnet Star*, varying in magnitude between 3.4 and 5.1 over a 730-day period. Cepheus also has the nearest star cluster to the North Celestial Pole, the open star cluster *NGC 188*. Another open cluster can be found in the northern part of Cygnus, *M39* at magnitude 4.6.

The constellation Aquarius has several objects of particular interest, including the bright globular star cluster *M2*, at magnitude 6.5, and two planetary nebulæ. One of these is the *Saturn Nebula*, *NGC 7009* at around magnitude 8, while the other, named the *Helix Nebula*, *NGC 7293* is much fainter at magnitude 13. However, it is notable as having the largest apparent diameter, at about 12 arc-minutes, for an object of this type, and is regarded as probably the closest of the planetary nebulæ. ☆

Geoff Falla

The table of objects for September and October is on page 9, the star chart is on pages 10 and 11, and the observing log is on page 12. These centre pages can be removed for convenience.

Visitors galore

Tuesday nights have seen a steady flow of visitors to the Observatory. Most nights, weather permitting, there have been a dozen or more visitors, and on one night about 25 turned up.

A member of an astronomy club near Düsseldorf in Germany visited us on two clear nights, and was able to use the C14 telescope to take some photographs. A piggyback picture of the summer triangle was graced by a superbly bright Perseid meteor. He has promised to send us a copy if it comes out.

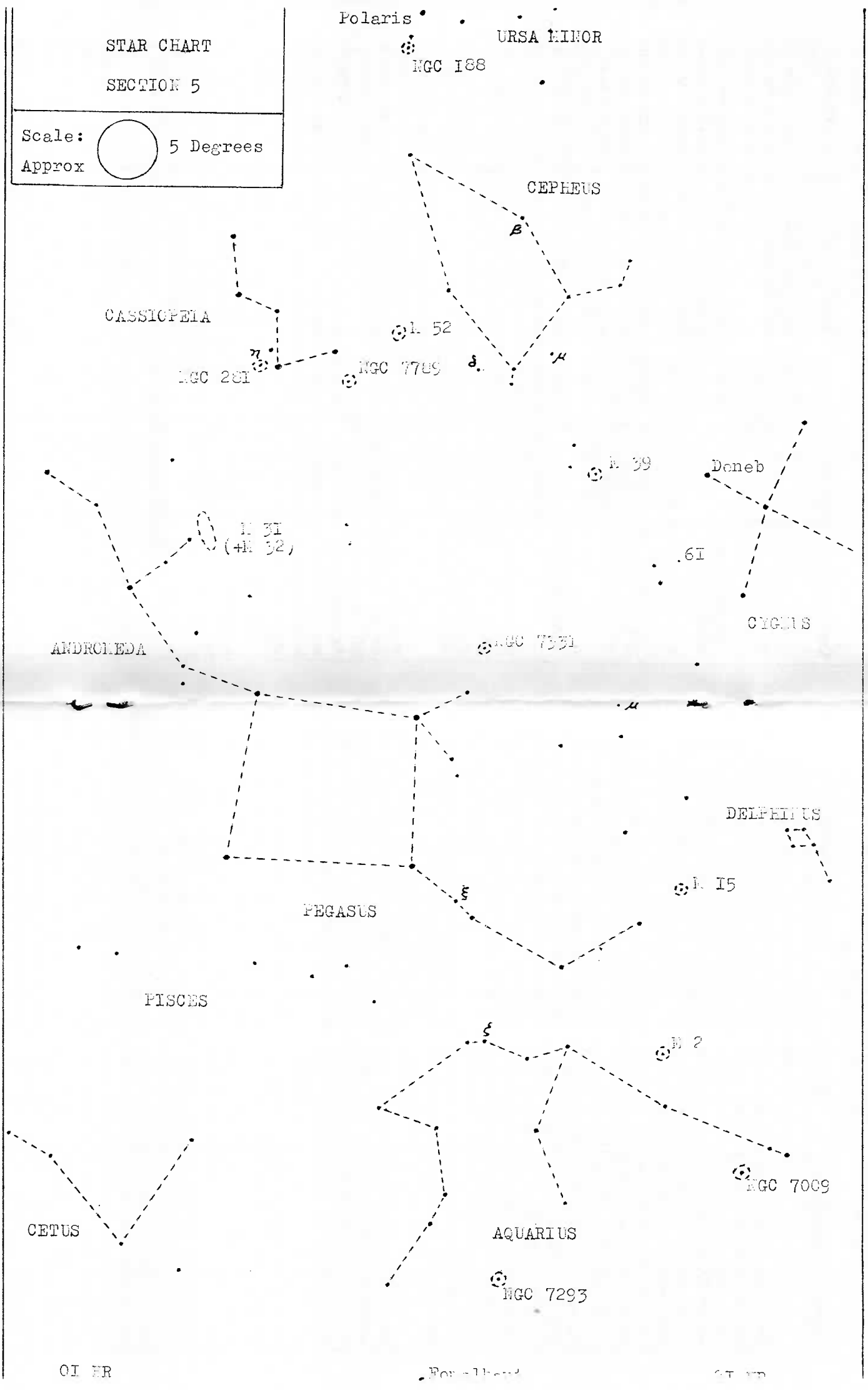
At the time of writing, we are expecting a group of Canadian visitors. ☆

Comet Hale-Bopp

The comet has been regularly observed over the past month. It is now easily visible in binoculars, and members should have no problem keeping track of it over the next few months. ☆

STAR CHART - SECTION 5

Constellation	Object	Type (○○ = Should be visible with binoculars)		Coordinates RA h m	Coordinates Dec degs
ANDROMEDA	M 31	Spiral galaxy	○○	00 43	+41.3
	M 32	Elliptical galaxy		00 43	+40.9
	NGC 7662	Planetary nebula		23 26	+42.6
PEGASUS	M 15	Globular cluster	○○	21 30	+12.2
	Xi ξ	Double star		22 47	+12.3
	NGC 7331	Spiral galaxy		22 37	+34.4
CASSIOPEIA	Eta η	Double star (*Achird*)		00 49	+57.8
	NGC 281	Diffuse nebula		00 53	+56.6
	NGC 7789	Open cluster		23 57	+56.5
	M 52	Open cluster	○○	23 24	+61.6
CEPHEUS	Beta β	Double star		21 29	+ 70.6
	Delta δ	Double star		22 29	+ 58.4
	Mu μ	Variable star (*Herschel's Garnet Star*)		22 44	+ 58.8
	NGC 188	Open cluster		00 44	+ 85.3
CYGNUS	61	Double star		21 06	+ 38.8
	M 39	Open cluster	○○	21 32	+ 48.4
	Mu μ	Double star		21 44	+ 28.8
AQUARIUS	M 2	Globular cluster	○○	21 34	- 00.8
	NGC 7009	Planetary nebula (*The Saturn Nebula*)		21 04	- 11.4
	NGC 7293	Planetary nebula (*The Helix Nebula*)		22 30	- 20.8
	Zeta ζ	Double star		22 29	00.0


STAR CHART
SECTION 5
Scale:
Approx
5 Degrees
Polaris
URSA MINOR
NGC 188
CEPHEUS
β
CASSIOPEIA
M 52
η
NGC 281
NGC 7789
δ
μ
M 39
Deneb
M 31
(+M 32)
61
CYGNUS
ANDROMEDA
NGC 7331
DELPHINUS
M 15
ξ
PEGASUS
PISCES
M 2
NGC 7009
CETUS
AQUARIUS
NGC 7293

STAR CHART - SECTION 5 OBSERVATION LOG

Date	Constellation	Object	Observation notes, etc

The Big Bang - A Day without a Yesterday?
by David Le Conte

The beginning of Haydn's Oratorio "*The Creation*" contains a chorus: "*Und Gott sprach: Es werde Licht! Und es war Licht.*" ("And God said: Let there be light! And there was light.") The sudden crescendo at the second word *Licht* depicts in a beautiful way one concept of the Creation of the Universe, based on the Book of Genesis.

Haydn wrote his Oratorio in the 18th century. A century earlier, Archbishop Usher had calculated from evidence in the Bible that the Creation of the Universe had occurred in the year 4004 BC, about 6,000 years ago. His calculations were based on the assumption that human existence, starting with Adam and Eve, coincided with the Creation.

Geological evidence, however, has shown that the age of the Earth itself is almost a million times older than that. If you stretch out your arm so that the distance from the tip of your nose to the tip of your finger represents the age of the Earth, then a single stroke of a nail file will wipe out all human existence.

The prevalent theory of the creation of the Earth as a planet is that it was formed, along with the eight other planets which the solar system contains, from a spinning disc-shaped cloud of gas and dust surrounding the newly-born Sun, an average star. We know, from studies of thousands of other stars, that our Sun is in a stable state, with a lifetime of about 10,000 million years. It is about half way through its life, and in another 5,000 million years it will swell up to become briefly a red giant star, probably swallowing up the Earth, and then it will fade to a comparatively dead white dwarf star, unable to support life in the solar system.

That sounds a grim prospect, but we do know that the Sun is one of a 100,000 million stars in our galaxy, the Milky Way, and that there are perhaps 100,000 million galaxies in the Universe. That amounts to an awful lot of stars. I have heard Professor Sir Hermann Bondi point out with an element of understatement: "*When an astronomer says lots, he means lots!*"

There is evidence of spinning discs around other young stars, some of which may well give birth to planets like our own Earth, with the possibility that life perhaps exists in a myriad of forms elsewhere in the Universe. Indeed, within the last few months the existence has been inferred of no less than seven planets orbiting around other stars.

So we believe we know how the Sun and other stars developed from huge gaseous clouds, and how the Earth was formed. But how and when was the Universe itself created?

There is increasing evidence that the Universe is about three times as old as the Earth, and that, at its creation nothing, not even time, existed.

The concept of a Universe with a definite beginning created from nothing, was eloquently put by that wise mother in the Second Book of Maccabees, who saw her seven sons tortured and killed. To her last son she said: "*I beg you, child, look at the sky and the earth; see all that is in them and realize that God made them out of nothing.*" »»

In the 5th century AD, St Augustine postulated that the Universe came into existence, not in time, but with time – not at some point in time, but at the beginning of time itself.

The father of the current theory of the origin of the Universe was Georges Lemaître, who sounds as if he could have been a Guernseyman, but who, in fact, was a Belgian, an ordained priest who had a PhD in mathematics, was a physicist and a Cambridge University astronomer. In 1927 he proposed a theory of an expanding, material Universe with a specific beginning which coincided with the Creation of time, and he called it "*A day without a yesterday*". Cosmological evidence now points strongly to the Universe having been created some 12,000 million years ago in a huge explosion of energy which created both time and matter. We now call it *The Big Bang*.

As a priest, Lemaître was no doubt attracted by the theological relevance of a theory which envisaged a sudden creation of the Universe. But Einstein himself told Lemaître that, although his theory was mathematically sound, he believed that the Universe was not expanding, but was unchanging, and had always been the same.

The term *Big Bang* was actually coined in the 1950s by Fred Hoyle, a supporter of the *Steady State* theory of the Universe. He and others thought that matter was continually being created, and he used the term *Big Bang* as a pejorative phrase to describe the competing theory of a Universe which had a specific beginning, and which was evolving and changing. The idea of a Universe which had always been unchanging – a continual creation – seemed to many to be a much more satisfying theory than one in which the Universe apparently came into being out of nothing – a singular Creation.

However, the idea that the Universe has always existed and always will has a basic flaw, and that is called *the Second Law of Thermodynamics*. This law implies that the Universe is *running down* – using up its energy, and irreversibly moving towards what is called a state of maximum *entropy*.

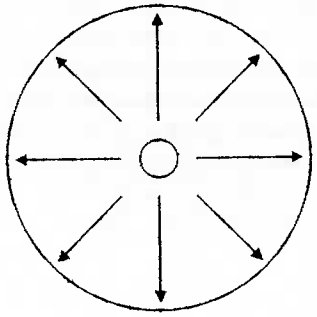
The concept of an evolutionary Universe was brought home to Einstein by a discussion with the American astronomer Edwin Hubble in 1930. Hubble's observations of galaxies – those giant islands of thousands of millions of stars – showed that they were all moving away from each other, and that the further ones were receding more rapidly than the nearer ones. There is, therefore, a direct relation between the recession velocity of the galaxies and their distance, the value of this relationship being called the *Hubble Constant*. This "expansion" of the Universe could be interpreted as having resulted from a giant explosion, thousands of millions of years ago – the *Big Bang* – and the Hubble Constant is itself an indication of the age of the Universe.

One of the crucial pieces of evidence for the Big Bang theory was the discovery in 1965 of a persistent, extremely faint radio noise, in the microwave part of the spectrum. Penzias and Wilson, at the Bell Laboratories in New Jersey, used a giant horn-shaped antenna which, no matter which way it was pointed, produced a faint hum. At first they thought it was caused by pigeon droppings, but even when these were cleaned out the noise persisted uniformly in every direction in the Universe. The radiation which causes this noise corresponds to a temperature just 3 degrees above absolute zero, the point »»

at which molecules of matter cease to move. It is interpreted as being the residual heat from the Big Bang – a lingering echo of the Creation.

More recently, in 1992, the Cosmic Background Explorer satellite detected tiny temperature ripples in this background radiation, amounting to only 30 millionths of a degree, and representing the pattern of gravitational force in the very early Universe. It was likened, rather fancifully, to seeing the face of God.

Cosmologists believe that they now know, not only how the Universe has evolved during its 12,000 million years of life, but even what happened in the first second of its Creation. In the first tiny fraction of a second the particles of the Universe were confined to a minute point, and were in chaotic motion. A huge release of energy in that first second rapidly *inflated* the Universe to about the size of a tennis ball.

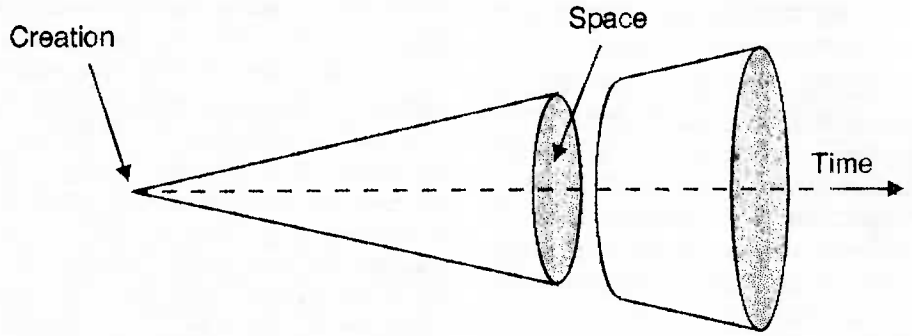


From then on the Universe expanded with the force of an explosion, and is still doing so. After 300,000 years, the first atomic matter was born, and radiation, which up till then had been absorbed, was suddenly released. The Universe became transparent, flooded with illumination – "*And there was light!*" After another 1,000 million years the now familiar galaxies started to form.

I must make it clear that the Universe was not, at the moment of its Creation, composed of empty space into which matter expanded. Rather, space itself was created at the time of the Big Bang, and the moment of Creation is what physicists call a *singularity*, when the laws of physics as we know them did not apply. The Universe, then, was not a point surrounded by emptiness – it was a point located in nothing, not even space. Rather, all of space was located within the point. And matter in the Universe is not expanding into space – it is space itself which is expanding.

Time also did not exist at the singularity, so there was no "yesterday" before the first day of the Universe. It is meaningless to talk about what happened "before" the Big Bang, because there was no "before". This is a difficult concept. The writer Fay Weldon has said: "*Who cares about half a second after the Big Bang; what about the half a second before?*" But space and time are not a fundamental background within which the Universe was created – they are a part of the Universe, and simply did not exist without it. "Nothing" is a totally different concept from empty space. Stephen Hawking has suggested that it is similar to asking the question: "What lies beyond the North Pole?" The answer is "nothing", not because what lies beyond the North Pole is emptiness – the concept is simply meaningless.

A useful way to visualise this creation of space-time is to take the example of a cone. The apex of the cone is the moment of Creation, its axis represents time since the Creation, and the surface areas of circular cross-sections through the cone, at right angles to the axis, represent the volume of space at particular instants in time. »»



The cone does not exist in space-time, all space-time is contained within it. So outside the cone is no space and no time, and to talk about what happened "before" the point (apex) of the cone is meaningless.

So the Universe, including time and space, apparently came into existence spontaneously from a state of "nothingness".

A fundamental characteristic of nature, as currently understood by the laws of physics represented by modern quantum theory, is that matter is dominated by something called the *uncertainty principle*. This allows spontaneous fluctuations which cannot be predicted, as they have no apparent cause. As we delve deeper and deeper into matter, to the smallest quantities of space, there comes a tiny point, called the *Planck scale*, within which we have no means of determining the state of matter. This Planck scale is associated with a basic period of uncertainty, called the *Planck Time*. The moment of the Creation of the Universe was followed by such a moment of uncertainty – a tiny fraction of a second, before which it is impossible for us to know what happened.

Nevertheless, this theory, or model of the Creation, has been very successful in explaining the *abundances* – that is the relative quantities – of the chemical elements in the Universe. It is, indeed, our most successful scientific theory to date.

I mentioned that the value of the Hubble Constant is a measure of the age of the Universe. So astronomers have expended a lot of effort in determining its value accurately. Get it wrong and you can have the anomalous situation of stars which appear to be older than the Universe itself. The Hubble Space Telescope, named after Edwin Hubble, is giving us, not only remarkably detailed pictures of the remotest objects, but is also providing new information about the Universe, including the Hubble Constant, for example by looking at distant stars, called Cepheid variables, which vary in magnitude with a period dependent upon their intrinsic brightness. Within the last few months there has been an emerging consensus on the Hubble Constant and the age of the Universe at somewhere between 9 and 14 billion years old. (Therefore we can assume an age of about 12 billion years.) »»

But astronomers do not use just visible light to view the stars. The entire electromagnetic spectrum, including infra-red, radio waves, X-rays and gamma rays, is used. We cannot perceive these radiations with our senses; we need special instruments. And we see different things in each part of the spectrum. For example, infra-red penetrates the obscuring screen of dust which permeates some of the most interesting parts of our Galaxy, such as the birthplaces of stars and the centre of the Galaxy. X-rays provide clues about the existence of black holes, the extremely dense remnants of very massive stars. Black holes themselves may be singularities.

One of the most exciting objects which we occasionally see is a supernova – a massive dying star suddenly exploding and becoming brightly visible in a matter of seconds, spewing its material into surrounding space. We now know that such stars have a very short life-time, and are the birthplace of all the heavy elements – that is those heavier than the original hydrogen and helium which dominated the early life of the Universe. These are the elements of which our Earth and everything in it and on it are made, including every living thing. The material of all our bodies came from such stars. Paraphrasing Prospero, we could say: "*We are such stuff as stars are made of*".

But it appears that there is also much of the Universe that we cannot see at all. Evidence from the movement of galaxies indicates that as much as 90 percent of their material seems to be contained in a mysterious outer halo of invisible matter, which we call *dark matter*. We do not, as yet, know what this dark matter is – whether it is gas, dust, distant planets, faint "brown dwarf" stars, black holes, light but numerous neutrinos from the early days of the Big bang, exotic particles, or a combination of some or all of these.

The amount of such dark matter is important for the future of the Universe. Just as the value of the Hubble Constant (which tells us the expansion rate and therefore how old the Universe is) is important, so is the value of the total mass of the Universe. Because if its mass density is greater than a critical value, the Universe will not continue expanding for ever. The gravitational pull of the material in the Universe will gradually slow down the expansion to a point where it starts to fall back in upon itself, perhaps resulting in a *Big Crunch* – another singularity.

One theory says that a new Universe could then be created in a new Big Bang, and this could go on and on, so that you could have a Universe which oscillates in and out of existence.

A further theory states that it is conceivable that there are parallel universes co-existing, with Big Bangs constantly taking place, spawning many expanding universe bubbles, like those in a kettle of boiling water. So, not only are we perhaps not alone in the Universe, possibly our Universe is not alone!

One of the curious features of our Universe is that the fundamental constants of physics are finely balanced. The slightest changes in them would make the mechanism which produced the stars and our planet unworkable. For example, the evolution of the Universe would have been quite different if the gravitational constant or the electron charge were slightly different from their observed values. And if the Earth had no Moon then the orientation of the »»

Earth's axis would have been unstable. The consequences would have been that mankind would simply not have existed to observe those physical constants, the Moon or the Universe itself. This concept is referred to as the *anthropic principle*, and it can be developed to argue that the Universe is like it is because we exist to observe it. If it was not, then we would not exist.

These sometimes bizarre sounding theories are the consequence of our studies of the mathematics and physics of the Universe we know. The job of scientists working in this field is to attempt to deduce the nature of the Creation of the Universe and its history since the Creation; that is: how it was created. Whilst astronomy and theology have enjoyed a close and beneficial relationship for thousands of years, astronomers must leave it to theologians to try and explain why the Universe was created.

Albert Einstein, the scientist, once said that "*the most incomprehensible thing about the Universe is that it is comprehensible.*" In contrast, the philosopher J B S Haldane said that "*the Universe is not only queerer than we suppose, but queerer than we can suppose.*"

I do not think science can either prove or disprove the existence of God. But I believe that the idea of a Big Bang creation of the Universe is not incompatible with the concept of God. Although the Universe may have been spontaneously created out of nothing, there is some underlying reality in the form of the basic laws of physics which determined that a form of existence called the Universe *could* come into being, and that *nothing* was replaced by *something*.

I know that I exist, as a mere observer of the cosmological scene. I am content with being enthralled by the beauty of the Universe which has been revealed by our telescopes, our data gathering, and our theorising. I have lived through a most exciting time in astronomy. Over the last few decades there have been remarkable revelations – about unconceived objects, about details of the remotest regions of space – and our understanding of the mechanism of the Universe has made great strides. Who knows what the next few decades will bring. I believe we are on the verge of yet more exciting discoveries, leading to a thorough understanding of our Universe home.

But will our understanding of the Creation increase proportionately? I have some doubts. What I have described today is only the currently generally accepted model – one which fits the observations. As with any scientific theory, it is not necessarily the same as reality. We may simply be wrong. New observations and discoveries are being made all the time, and it may well be found necessary to amend or replace the model with one which explains a new view of the Universe.

In the meantime, I will stay with the Big Bang theory, and know that, because the Universe was created the way it was, for whatever reason or for none, although there may not have been a yesterday there will certainly be a tomorrow.

David Le Conte

(This article was derived from a talk with the same title, given by the author at *Meeting Point*, The Town Church, St Peter Port, on Friday, 28th June 1996).

A bibliography follows: »»

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The dog-star rages

Upon reading my piece in the last issue about dog-days, my wife quoted the following extract from the poem *Epistle to Dr Arbuthnot* by Alexander Pope (1688-1744):

Shut, shut the door, good John!
fatigued I said,
Tie up the knocker,
say I'm sick, I'm dead
The dog-star rages! ☆

DLC

From The Guernsey Star

Monday, October 11,1847

"The Eclipse. — In consequence of a thick stream of clouds from the southward having prevailed during the whole of Saturday morning, the phenomenon of the sun's eclipse, which then took place, was rendered completely invisible in this island.

The only indication of its occurrence which was observable, was an unusual degree of darkness during its progress."

and . . .

Wednesday, October 13,1847

"London. — On Saturday morning a considerable portion of the inhabitants of the metropolis were anxiously looking out for the long-expected eclipse, but they were doomed to be disappointed, in consequence of the extremely clouded state of the atmosphere. On all the bridges numbers of persons were assembled with smoked and coloured glasses, but they were unable to see anything; on the contrary, they were exposed to a pitiless rain. Hawkers were seen at most open spots exposing for sale pieces of smoked glass, but they were met with a very sorry market.

Paris. — But little could be seen of the eclipse which took place at Paris on Saturday morning, the sky being cloudy until about ten minutes after eight, at which period the most interesting moment was over. The moon had then gone beyond half the sun, and the latter body had the appearance of a crescent. The whole terminated at two minutes to nine, but the end could not be very clearly seen, a number of clouds remaining the whole time flying about." ☆ ***DLC***