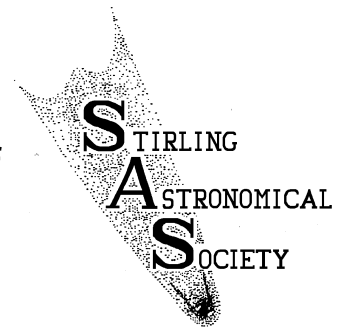


Newsletter of



Vol. 17 No. 4 October 2002

COSMIC RAYS AND THEIR DISCOVERY

Cosmic rays were confirmed ninety years ago by Victor Hess with a balloon flight high up over eastern Saxony, Germany. Radioactivity attracted a lot of attention and research in the years after its discovery in 1896. With the invention of "electrometers" for detecting radiation from radioactive sources, a mystery became apparent. Electrometers still detected some radiation when there was no radioactive material anywhere near to account for it. It seemed to be everywhere - even on ships on the oceans, far from any radioactive rocks. Even stranger, however much scientists shielded their electrometers, some of the radiation always penetrated it and was detected. Radiation from known radioactive materials could not penetrate the shielding, so there must be an unknown source of a mysterious radiation of immense penetrating power - but what was it, and where was its source?

In 1910 a Jesuit priest, Father Theodor Wulf, measured the mysterious radiation at ground level in Paris and again at the top of the Eiffel Tower, and found that it was stronger at the top of the Tower. He surmised that the radiation might have an extra-terrestrial origin and he suggested going up in a balloon to a much greater height to test this, but didn't want to go up himself. The challenge was taken up by Victor Hess, an Austrian. To confirm that the mysterious radiation came from outer space he decided to go as high in a balloon as was possible with the technology of the day and take measurements.

At dawn on 7 August 1912 Hess, together with an experienced balloonist and a meteorological observer, set out from the town of Aussig, just south of the Austro-Hungarian border with Germany, on what would prove to be an historic balloon flight. They were in a small basket beneath the balloon, with only a small bench to sit on and surrounded by assorted instruments and 800 kg of ballast in 52 sacks. The sacks of ballast were hung so that they could each be easily released by cutting a string. After releasing ten sacks of ballast the balloon rose to 1500 m and crossed the German border. By 08.30 am, after cutting adrift twenty more sacks, the balloon had risen to 3000 m and at 09.15 am it was up to 4000 m over the town of Elstra.

The temperature was well below zero and taking the necessary measurements was exhausting in the rarefied air, even with the help of oxygen which had been brought. By 11.30 am and eight further sacks lighter, the balloon reached 5000 m (16,400 ft). Hess, even with the help of oxygen, was only able to complete two of the three intended measurements at that height. Although they could have gone still higher, with several sacks of ballast left, Hess had had enough, and they released gas to come down and land about 50 km east of Berlin around midday. They collected the equipment from the balloon and returned to Vienna by the overnight train.

The scientific results from this pioneering balloon flight solved the mystery. Hess confirmed with precise measurements that the radiation increases with altitude. At 4000 m it was half as strong again as at ground level; at 5000 m more than twice as strong. The conclusion was that the radiation must be coming from outer space and is being partially absorbed by the atmosphere as it passes through it. Hess had proved the existence of cosmic radiation, but there was still no indication of what it was.

Soon scientists were trying to capture cosmic rays high up on mountains to find their composition. Cosmic rays have been revealed to be extremely energetic atomic nuclei which continually bombard the outer atmosphere. When these hit the atmosphere they generate showers of subatomic particles, most of which are absorbed by the air before reaching ground level. Cosmic rays can have energies extending far beyond what can be achieved in Earth-bound particle accelerators. The highest energy particles are very rare, with only a few arriving in an area of ten square km in ten years. The origin of these remains a mystery.

Cosmic radiation passing through the atmosphere has revealed exotic forms of matter never seen on Earth. Among these is the positron, or anti-electron. This was the first detected example of anti-matter previously predicted by Paul Dirac. The study of cosmic rays and the subatomic particles they generate stimulated efforts to reproduce these in the laboratory, and this has led to the development of high energy particle accelerators, and indeed to modern particle physics.

Victor Hess was awarded a Nobel Prize in 1936 for his pioneering work, at the same time as Carl Anderson for his discovery of the positron. Hess is generally recognised as the discoverer of cosmic radiation. Theodor Wulf on the other hand, whose Eiffel Tower investigation started it all but who did not follow it up, has only a footnote in the halls of scientific fame.

Derek Allen

A LATERAL LOOK AT LIFE, THE UNIVERSE AND THE LOTTERY.

Life seems a very unlikely phenomenon in a Universe with only a handful of different elements. Only one of these elements, carbon, has the ability to make the vast range of stable molecules necessary for the complexities of life. Only one type of life is known, and that is DNA-based life. It is humbling to realise we have the same genetic machinery as the grass in our lawns.

Exactly how the very complex molecular machinery of our DNA ancestor got started is still a mystery, but it would not have happened without carbon's unique properties. Carbon itself would not have formed in stars if the force of gravity was just a little weaker and atomic nuclear properties were not just right. Actually, physicists can list about five arbitrary natural constants, any of which could have been slightly greater or smaller and made life as we know it impossible. Life is far from an inevitable consequence of the Big Bang, any more than winning the lottery is an inevitable consequence of buying a lottery ticket. Now we are here, we can trace backwards to deduce our origins and it really does seem we are the winners of some gigantic cosmic lottery.

It is those perfectly tuned arbitrary natural constants that are the big puzzle. They could have been any value after the Big Bang, not all perfectly tuned to evolve life. They are like the numbers in a lottery draw. How did we get the right ones? To say "if we hadn't we wouldn't be here" is true but not an explanation. The obvious explanation seems to be that the game has been played a great many times. This means we will probably find evidence that many universes exist in time and space exhibiting many variations of the natural "constants". In fact recently measurements on light from a very distant quasar seem to indicate that one of the natural constants, the "fine structure constant" has changed over billions of years.

Chris Davis

FACTS AND FIGURES - THE COOLEST STAR

The coolest true stars are thought to have surface temperatures around 2,600° K. One example of such a star is Gliese 105C, imaged by the Hubble Space Telescope in 1995. The main factor determining a star's surface temperature is its mass. Theory puts the lower mass limit for a star at 8% the Sun's mass. Below this limit, it is impossible for the centre of a clump of gas, contracting under gravity, to heat up sufficiently for spontaneous nuclear fusion to start and become self-sustaining. Potential stars that fail because their mass is below this limit are called brown dwarfs. Gliese 105C appears to be a true low-mass star, and not a brown dwarf. Its mass is put at 8-9% of the Sun's. Gliese 105C is the binary companion of larger star, Gliese 105A also known as HD 16160, which is 25,000 times brighter. They are 27 light-years away in the constellation Cetus.

MAKING THE NOISIEST PLACE IN SPACE QUIETER

Where is the noisiest place in space? As far as astronauts are concerned, it is the International Space Station. The permanent level of noise in it is as high as 72 decibels - the equivalent of standing near a busy motorway, or in a crowded swimming pool. This is not very good for the astronauts on board as they orbit 385 km above the Earth. Besides the problem of simply trying to get to sleep, there is a risk as an astronaut cannot always hear clearly what a colleague is shouting, and may misunderstand important instructions. NASA has also found that some astronauts suffer from temporary deafness after a tour of duty on the Space Station.

Where then does all the noise come from? Most of it originates from equipment which is actually required to keep the astronauts alive. Fresh air has to be kept circulating so that they can breathe normally. Down on Earth air is circulated naturally by convection currents, but in zero gravity hot air doesn't rise and so there is no convection. Air circulation pumps are therefore needed. In addition the air has to be constantly purified to remove carbon dioxide, to supply oxygen and to control humidity, and this all needs pumps, motors and other equipment. Getting rid of the excess heat generated by the astronauts' bodies and by electrical and electronic equipment is also necessary to control the temperature inside the Space Station. This is done with coolers which use water and other liquids to carry heat from the Space Station's interior to its outside surface, where the heat is radiated away into space. The operation of all this equipment generates an assorted accumulation of noises which, in the confined space and hull of the Space Station, are not damped or dissipated very well. The worst area for noise is the Space Station's Russian-built service module where two of the three permanent astronauts on board have to sleep. The third sleeps in the relatively quiet American module, where the noise level is nearer the 60 dB limit set by the US Navy for its ships.

The noise problem was in fact recognised when the Space Station was being designed. The choice, however, was either to spend a lot more time making sure everything was designed and made to be totally quiet, or to omit this in order to save time. As the International Space Station programme already had many other problems and delays, the latter course was chosen, with the intention of trying to reduce noise after the Space Station had been assembled in orbit. The aim now is to reduce the noise level to 60 dB throughout the Space Station. Acoustic dampers are being designed and made for each pump and motor in the Russian module. These will be sent up to the Space Station to be fitted by the astronauts on board, who will no doubt be grateful for the relief they will bring.

Derek Allen

METEOR CRATER - U.K. STYLE

Where did the meteor (or asteroid?) impact occur which wiped out the dinosaurs? Mexico (Chicxulub) has held centre-stage for a decade, but evidence is building up that there may have been a shower of incoming fragments, and that one at least of these came much closer to home.

Recently published results from researchers at BP reveal a buried crater from 65 million years ago in the North Sea, just 130 km off the mouth of the Humber. The crater is 3 km in diameter and is surrounded by at least ten ring fractures stretching 20 km across. It is not visible on the surface of the sea bed as it is buried under 1000 m or so of marine deposits. The data was originally collected during a 3-D seismic survey in 1992 in the course of underwater oil and gas exploration. Further detailed examination will be required to confirm the feature as an impact structure. Meanwhile it is being called the "Silver Pit Crater" after a nearby channel in the sea floor.

Calculations suggest that the impacting nucleus was about 120 m across, weighed two million tonnes, and that it collided with the Earth at a speed of 30 km/sec (68,000 mph). The crater's survival is remarkable since the sea level has fluctuated in the intervening millennia. For some of this time much of the North Sea was above sea level as low lying land and subject to erosion by the icefields of the ice ages which ended about 10,000 BC.

Ken Mackay.

NO DARK MATTER IN THE UNIVERSE AFTER ALL?

A fundamental question in astronomy and cosmology is : *How much matter is there in the Universe?* There are two ways in which astronomers try to find an answer. Simplistically, the most obvious one is to add together the masses of everything that can be seen or detected. They can also measure the movements of all these objects and apply the laws of physics to calculate how much mass is needed to generate the gravity that must control these movements. It is a big headache for astronomers that these two methods give significantly different answers. There is not nearly enough mass to generate the gravity needed to hold star systems together as they revolve around their centres. It occurs in nearly all large star systems, from dwarf galaxies through normal galaxies, and also in galaxy groups and superclusters of galaxies. The magnitude of the discrepancy ranges from factors of a few times to factors of hundreds of times.

The conclusion has been that there must be a lot more undetected mass in the Universe - the so-called "dark matter". Cosmologists have also found that the presence of dark matter would help in explaining how galaxies were first formed after the Big Bang. But where and what is this dark matter? Some of the undetected mass is of course ordinary matter that gives off too little radiation to be detected, such as planets, dwarf stars and warm gas. Astronomers call this "dim matter" to distinguish it from the unknown dark matter. Dim matter could account for up to ten times the matter we can see, but even so it only accounts for a small fraction of the total missing mass. As yet there has been no generally accepted explanation of what the missing dark matter actually is - it remains a mystery. It has been estimated that the missing dark matter must amount to about 90% of the total matter in the Universe, to explain the movements of stars and galaxies. Practically nothing is known about it, except that it must be there, somewhere. *Or must it?*

Instead of pursuing the idea of dark matter, some astronomers and physicists, notably Mordehai Milgrom, think that its elusiveness suggests that it may be the wrong approach to the problem. If there is no missing matter, how else could the situation possibly be explained? Perhaps the problem lies not with missing mass but with the laws of physics. For any orbiting system, the relation between mass, velocity and orbital size or distance is governed by a combination of Newton's law of gravity and Newton's second law of motion (relating force to acceleration). On a large enough size scale, might this need some modification? An analogy would be Einstein's modifications to Newton's laws. The special theory of relativity modified Newton's second law for velocities approaching the speed of light, and the general theory altered the law of gravity for very intense gravitational fields.

A general characteristic of vast orbiting systems is that the governing force of gravity, which diminishes with the square of the distance, is extremely small, and so the centripetal acceleration inwards of orbiting bodies is also extremely small, many orders of magnitude smaller than anything we know. For example, the centripetal acceleration of the Solar System towards the centre of the Galaxy to keep it in orbit around the Galaxy is *one hundred billionth* of the centripetal acceleration of the Space Shuttle towards the centre of the Earth when in orbit around the Earth. In 1983 Milgrom postulated that Newton's second law needs to be modified when dealing with these minute accelerations, and he has come up with the idea of MOND, standing for MODified Newtonian Dynamics, which does this in a way which seems to solve the problem, or at least much of it.

MOND introduces a new very small constant a_0 , an acceleration. When the actual acceleration is much larger than a_0 , Newton's second law applies as usual and force is proportional to acceleration. But when the actual acceleration is less than a_0 , force becomes proportional to the *square* of acceleration. The effect of MOND only kicks in for the very small accelerations which we never experience, but which control the movement of stars and galaxies. The force needed to impart a given acceleration is smaller than with Newton's normal second law. To account for the observed accelerations in galaxies, MOND implies a smaller gravitational force is needed, and hence less mass to produce it. In this way it eliminates the need to invoke dark matter.

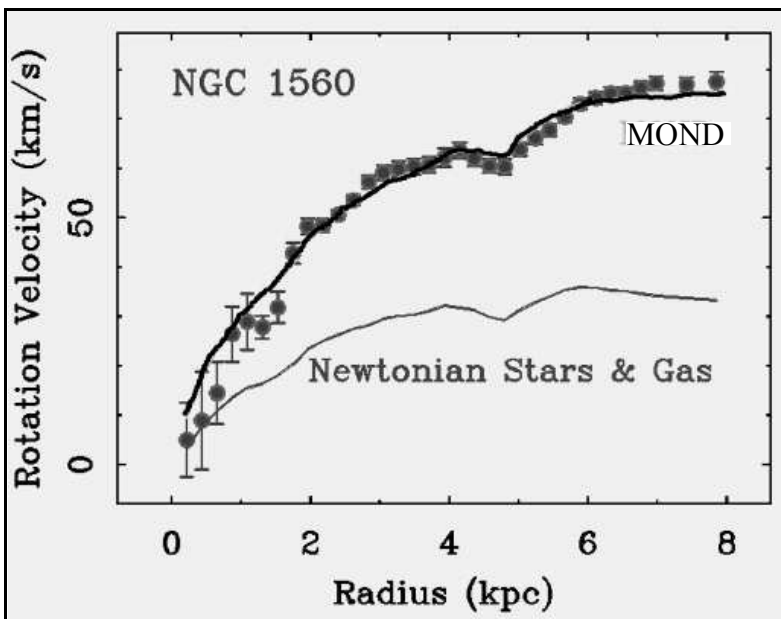
On the fringes of a galaxy, the acceleration produced by its gravity decreases with distance and eventually falls below a_0 . Just where this occurs depends on the value of a_0 and on the mass; the

larger the mass, the further out the effects of MOND set in. For the value of a_0 which is required by the observed motions, and for a galaxy of typical mass, the transition occurs several tens of thousands of light-years out from its centre. For the mass of a typical cluster of galaxies it occurs a few million light-years out from the centre of the cluster.

There are many observations now which fit the MOND hypothesis. For example, the rotation curves of over a hundred galaxies agree with MOND on the basis of the observed stars and gas and do not then need any dark matter to explain them. One of these is shown in the diagram. Although MOND is having considerable success, it has by no means been thoroughly tested and validated yet as a reliable theory. It is at present just an empirical relationship. It cannot be tested in the laboratory as the background accelerations caused by the Earth's gravity, its rotation, and its movements around the Sun for example, would swamp the detection of any MOND effect. The acceleration of bodies orbiting the Sun doesn't fall below a_0 until a distance of about 10,000 times the Earth's distance from the Sun is reached, outside the Solar System and at present inaccessible.

The value of a_0 which fits in with a whole range of galactic observations is an acceleration of about one angstrom per second per second (an angstrom is 10^{-10} m and is usually used as a unit to measure the wavelength of light). Could it be a new universal constant like Planck's constant or the velocity of light? It will be interesting to see how the two ideas of dark matter and modified Newtonian dynamics develop and compete to explain the dynamics of galaxies and to see what the eventual outcome will be. Watch this space!

*Rotation curve for the dwarf galaxy
NGC1560*



The large dots are data from 21 cm observations. The lower line is the rotation predicted by applying Newton to the observed stars and gas, and is much less than the observed rotation. The upper line shows the rotation to be expected by applying MOND to the observed stars and gas, and coincides very well with the observed data, including the kink. Invoking dark matter does not properly explain the kink because it would not be distributed in the same way as the luminous mass.

MOND for the mathematically inclined

Newton relates force to the mass being accelerated by:

$$F = M \cdot a$$

With MOND, this is replaced by:

$$F = M \cdot a \cdot \{1 - \exp(-a/a_0)\}$$

[exp(x) means e^x; a₀ is the MOND acceleration constant]

When $a \gg a_0$, $\{1 - \exp(-a/a_0)\} \rightarrow 1$, and so:

$$F = M \cdot a$$

This is the normal Newtonian regime.

When $a \ll a_0$, $\{1 - \exp(-a/a_0)\} \rightarrow a/a_0$, and so:

$$F = M \cdot a^2 / a_0$$

This is the MOND regime, where force becomes proportional to the square of the acceleration.

Derek Allen

IS THERE STILL WATER ON MARS?

There is a lot of evidence of the past existence of liquid water on the surface of Mars, perhaps billions of years ago before it evaporated into space as Mars lost much of its original atmosphere. But now measurements made by the Mars Odyssey probe indicate that some of this water may still be around, in the form of dirty ice contained in at least the top metre layer below the surface of Mars. The measurements made have been of neutron and gamma-ray emissions from the surface layers of Mars which occur when cosmic rays collide with hydrogen nuclei. It is thought that this hydrogen is most likely in the form of water molecules. The apparent icy layer comes to within 30 cm of the surface near the southern pole, which shows its widest distribution so far. There also seems to be water ice around the northern pole, but the presence of carbon dioxide ice there has made measurements more difficult. The amount of water ice found up to now, if confirmed, is enough to "fill two Lake Michigans". This concentration of water ice would indicate that in some areas Mars has a porous, rocky subsurface, and this means that there could be a lot more ice around.

DHA

SOME OF US LOOKED A BIT YOUNGER THEN !



This old photo of SAS members has just come to light. A bit of research has revealed that it was taken by Ken Mackay during an SAS visit to the Royal Observatory Edinburgh on 15 June 1990. A little bit more research, and we found the event recorded in *Mercury* Vol.5 No.2 Sept/Oct 1990, page 2, as follows:

About 20 Members visited the Royal Observatory in Edinburgh on Friday evening, 15th June. We were welcomed by Mr Chris Davis, (no relation to the Mercury Contributor) who gave us a well presented talk on the aims and objects of ROE, and especially its interest in the telescopes set up on the summit of Mauna Kea, a mountain roughly the height of the Matterhorn, but located in Hawaii. Photographic plates from the Schmidt telescope at Siding Springs, Australia, were displayed for us to examine, and the visit ended with a tour of the Library.

DHA

Book Review

THE NORTHERN LIGHTS by Lucy Jago (Penguin, 2002; pp308; £6.99)

I hadn't heard of Kristian Birkeland (1867 - 1917) before, in spite of having read fairly extensively about aurorae. Lucy Jago's book has brought home to me how much of our current understanding we owe to Birkeland and his team of aurora-watchers, a century ago. He was Professor of Physics in the University of Christiania (Oslo), when he set up his first expedition to study aurorae, geomagnetism and cloud formation. At that time there was considerable doubt about where in the atmosphere aurorae were located. During the summer of 1899, Birkeland had an observation-base constructed on the summit of Halde, a 1000 m mountain at 70° N between Tromsø and Hammerfest. He and four colleagues planned to spend the winter months, mid-October to mid-March, manning the observatory round the clock, recording wind-speed, barometric pressure, temperature, hygrometer readings, as well as magnetometer and electrometer readings. They were in total darkness from 24 November until 17 January; in January, too, they experienced a prolonged and ferocious storm which lasted 21 days without a break.

The expedition returned on 15 March. One observer had had to be invalided out with severe frost-bite. Another observer and a friend were killed by an avalanche on the way down. But the expedition had yielded positive results. There was a connection between aurora sightings, magnetic disturbances and electric currents in the atmosphere. Sunspot groups crossing the solar meridian resulted in aurorae about three days later. Aurorae tended to recur at 27 day intervals, corresponding to one rotation of the Sun. Cathode rays (electrons) from the Sun were channelled by the magnetic field of the Earth into the Arctic oval. The results were published (in French) in 1901, but were disregarded by the general scientific world. Lord Kelvin, from his position as the arbiter of science fashion, commented that "any connection between magnetic storms and sunspots was unreal - and mere coincidence".

A second more ambitious expedition took place the following winter, using four observatories - in Iceland, Spitsbergen and Novaya Zemlya, as well as Halde. Birkeland was bitten by a rabid dog on the journey to Novaya Zemlya, and had to hand over direction of the observatory while undergoing the protracted counter-measures. He survived, and the expedition succeeded. The two volumes of the Report were published (in English this time), in 1908 and 1913, and covered 27 auroral histories.

Birkeland was full of ideas. To display artificial aurorae in the laboratory, he devised a glass-windowed vacuum enclosure in which he located a source of electrons (representing the sun) and a large, phosphor-coated brass sphere (a "terrella") containing an electromagnet. With this he was also able to demonstrate several electromagnetic phenomena such as :

Solar corona, sunspots, their motion towards the equator as the magnetism is increased, auroral displays on Earth/planet, planet formation as "atomic dust" is made to clump by magnetism, simulation of Saturn's rings, comet tails, Zodiacal light, and rocket propulsion in space.

His extensive knowledge of high voltage physics led him to design improved circuit-breakers for the developing Norwegian hydro-electric generation system. He patented an electromagnetic "cannon", which seemed to find a use in outer space as part of the "Star Wars Initiative". He developed an electrostatic process for fixing nitrogen, which could be used in the production of artificial fertiliser.

Fate was unkind to him. After a lifetime of struggling against the odds, he died before his 50th birthday, alone, in Japan, through an overdose (possibly accidental) of sedative. His final thesis, unread by any eyes but his own, was lost when the ship carrying it back to Norway sank in a storm. Who knows what conclusions he was counting on imparting to the world of geomagnetism ?

Ken Mackay

THE NIGHT SKY : October, November, December 2002

SUN	October		November			December	
	4	18	1	15	29	13	27
(approx) Rises	06.23	06.52	07.21	07.50	08.17	08.37	08.46
(approx Sets)	17.43	17.08	16.35	16.08	15.48	15.36	15.46

MOON	October				November			
Phase	NM	FQ	FM	LQ	NM	FQ	FM	LQ
Date	6	13	21	29	4	11	20	27
Rises	05.42	15.16	17.09	22.28	06.15	14.14	15.58	23.07
Sets	17.50	21.47	06.31	14.53	16.21	22.04	08.06	13.38

	December			
Phase	NM	FQ	FM	LQ
Date	4	11	19	27
Rises	08.26	13.02	14.55	00.00
Sets	15.27	23.37	08.22	12.22

PLANETS

			Magnitude
MERCURY	<i>October</i>	10th: Few degrees E of Mars in Virgo. Morning twilight object low ESE horizon 2nd and 3rd week only, then unsuitable for observation.	-1.0
	<i>November</i>	Unsuitable for observation.	
	<i>December</i>	Unsuitable for observation for three weeks, then in last week low SW horizon at evening civil twilight for short time.	-0.5 - +0.2
VENUS	<i>October</i>	Unsuitable for observation throughout month since declination is -23° .	
	<i>November</i>	Bright morning object before dawn from 2nd week, SE sky.	-4.4
	<i>December</i>	Bright morning object SE sky for several hours before sunrise.	-4.7
MARS	<i>October</i>	Before dawn low ESE, moving from Leo into Virgo.	+1.8
	<i>November</i>	Morning object ESE sky, moving eastwards in Virgo	+1.8
	<i>December</i>	Early morning object for several hours SE sky.	+1.8
JUPITER	<i>October</i>	Morning object. By end of month visible from midnight, SE sky.	-2.0
	<i>November</i>	Visible from before midnight. Moving from Cancer into Leo, SE sky.	-2.2
	<i>December</i>	Visible from late evening E sky through to morning object S sky. Retrograde moving from Leo into Cancer.	-2.4
SATURN	<i>October</i>	Morning object. On 11th, stationary in Orion 15° North of Betelgeuse.	-0.1
	<i>November</i>	Visible most of night, but rings not at their best until early 2003.	-0.3
	<i>December</i>	Visible throughout hours of darkness, retrograde in Taurus.	-0.5

CONSTELLATIONS (near meridian at 22.00)

<i>1st October</i>	Ursa Major (below pole), Cepheus, Cassiopeia, Cygnus, Lacerta, Andromeda, Pegasus, Capricornus, Aquarius.
<i>1st November</i>	Ursa Major (below pole), Cepheus, Cassiopeia, Andromeda, Pisces and Cetus.
<i>1st December</i>	Ursa Major (below pole), Ursa Minor (below pole), Cassiopeia, Andromeda, Perseus, Triangulum, Aries, Taurus, Cetus.

CONJUNCTIONS

(with the moon unless otherwise stated and based on observing at 51°N)

October

<i>Date</i>	<i>Time</i>	
2	09.00	Jupiter 4° S
5	04.00	Mars 4° S
5	12.00	Mercury 5° S
6	19.00	Mercury at stationary point
8	15.00	Venus 9° S
10	19.00	Venus at stationary point
13	07.00	Mercury at greatest elongation (W 18°)
20	14.00	Neptune at stationary point
26	09.00	Saturn 3° S
30	00.00	Jupiter 4° S
31	12.00	Venus in inferior conjunction

November

<i>Date</i>	<i>Time</i>	
2	20.00	Mars 3° S
4	06.00	Uranus at stationary point
4	08.00	Venus 6° S Mercury
4	10.00	Venus 8° S
4	10.00	Mercury 2° S
14	05.00	Mercury in superior conjunction
21	07.00	Venus at stationary point
22	12.00	Saturn 3° S,
26	10	Jupiter 4° S

December

<i>Date</i>	<i>Time</i>	
1	11.00	Mars 2°N
1	15.00	Venus 2°S,
4	12.00	Jupiter at stationary point, 5th (4.00) Mercury 0.6°S,
5	04.00	Mercury 0.6°S
9	17.00	Pluto in conjunction
17	17.00	Saturn at opposition
19	15.00	Saturn 3° S
23	14.00	Jupiter 4° S
26	05.00	Mercury at greatest elongation (E20°)
30	01.00	Mars 1° S

Compiled by Hamish MacPhee

METEORS

November Leonids, possible display early morning on 18th, but moon liable to cause interference.

December Geminids should occur on 13th and 14th. However, conditions are unfavourable before 02.00 as bright gibbous moon still visible until then.

AN ALPHABETICAL INDEXER

We first published a back index of *Mercury* with the October 2001 issue, Vol. 16 No. 4. We intend to up-date this once a year, in January, with the contents of the previous year's Volume.

We are grateful to Chris Davis for some hard work on his computer which has produced an Alphabetical Indexer for use with the chronological index. Information is available on floppy disk, or alternatively Chris may be able to provide a printout if you do not have access to a computer. Chris has made the following comments about what he has achieved.

The Indexer is generated from the comprehensive chronological index of back issues up to October 2001, which I have up-dated to Vol. 17 No. 2, April 2002. I have also added a "Keywords" column which gives complete control of what appears in the alphabetical index.

Using the title words (starting with a capital) as keywords, the program produces an index of nearly a thousand entries. Subsequent rationalisation has nearly halved this, hopefully without removing all the words which make an index interesting to browse.

Going back to issue Vol. 16 No. 1, I have added cross-referencing using words from within the articles, not just the titles. I have paused the process with the index at over 400 entries and nine pages of print, pending the views of Members on where it should go from here.

A sample extract from the index of keywords is shown below.

Please can we have some feedback!

DHA

MERCURY - INDEX OF KEYWORDS

Indexed to :- Vol.17 No.2 Apr 2002

WORD	VOL	YR	AUTHOR	-TITLE-
-- A --				
Adaptive Optics :-	:- v16.1	01*	DA	Un-Twinkling a Star
	:- v16.4	01	AM	Adaptive Optics
Aknowledgement	v17.2	02	DA	Editorial
Alan	v05.4	91	AS1	Letter from Alan
Amateur	v13.2	98	JM	Amateur Rocketry
Analemma	v06.1	91		Ever heard of Analemma?
Anglo-Saxons	v05.4	91	MH	Seen by the Anglo-Saxons
Annual General :-	:- v03.1	88		AGM 1988
	:- v04.1	89		AGM 1989
Apollo	v16.4	01	DA	Apollo Moon Landings - Fact or Fiction?
Asteroid :-	:- v16.1	01*	DA	The Eros Asteroid
	:- v17.2	02	DA	An even bigger Rock
Asteroid Monitoring	v16.2	01*	DA	We're Helping to Stop the End of the World!
Astro	v11.2	96*	DS	Astro Computing
Astro-Limericks	v08.2	94*	VR	Astro-Limericks
Astronomers	v05.4	91	HS	Astronomers Royal
Astronomical	v06.4	92	HS	Astronomical Time-Keeping
Astronomy :-	:- v01.4	86	RS	History of Western Astronomy
	:- v01.5	86	RS	History of Western Astronomy - Part 2

STIRLING ASTRONOMICAL SOCIETY MEETINGS, 2002 - 2003

2002

- 11 October Lecture **Dr David Bacon**
 Seeing the invisible cosmic web
There are good reasons to believe that galaxies are found in a huge, 3D web of material filling the universe. We can see the galaxies, but we can't see most of the mysterious material in the web; we call it 'dark matter'. In the last few years, we have been able to begin detecting and mapping the web of dark matter itself. We can do this because the gravity of any part of the web stretches and squashes our image of objects behind it. We chart the distortions in our images, and can therefore map the web. In this talk the way this is done is described, what is known so far, and what is hoped to be achieved in observing the dark matter in the next five years.
- 25 October Members' evening
8 November Annual General meeting
29 November Members' evening
13 December Lecture **Dr Will Sutherland**
 (Title to be confirmed)
20 December Members' evening - form of Christmas meeting not yet decided

2003

- 10 January Lecture **Dr Marek Kukula**
 (Title to be confirmed)
31 January Members' evening
21 February Lecture (Speaker and title to be confirmed)
28 February Members' evening
14 March Lecture **Dr Ian Bond**
 Microlensing searches for extra solar Planets
28 March Members' evening
11 April Lecture (Speaker and title to be confirmed)
25 April Members' evening
9 May Lecture **Dr Ross McLure**
 (Title to be confirmed)
30 May Last members' evening

All lectures (except on 21 February 2003) are on the second Friday of the month at The Smith, Dumbarton Road, Stirling, from 7.30 to 9.30 pm.

All members' evenings (except on 20 December 2002) are on the last Friday of the month at the Mayfield Centre, St. Ninians, Stirling from 7.30 to 9.30 pm.

HMacP

Stirling Astronomical Society

OFFICERS AND COMMITTEE FOR 2002

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FACTS AND FIGURES

THE COLDEST PLACE KNOWN IN THE SOLAR SYSTEM

The lowest temperature ever recorded at the surface of a body in the solar system is the surface temperature of Neptune's moon Triton, which Voyager 2 measured as - 235 °C, only - 38 degrees above absolute zero. Temperatures on Pluto are almost certainly very similar, though only ground-based estimates are available. They put the bright areas on Pluto at about - 233 °C, with its darker areas around 20 degrees warmer. Pluto and Triton seem to be very similar - more alike than any other pair of bodies in the solar system. The surface temperature of a moon or planet depends on several factors: its distance from the Sun, whether it has an internal source of heat, and the effects of any atmosphere. Triton and Pluto both receive very small amounts of heat from the Sun, have no internal heat, and are cooled further by the evaporation of ices from their surfaces.

STAR OF GREATEST PROPER MOTION

E. E. Barnard discovered the star that still holds the record for the greatest proper motion in 1916, and it is known informally as Barnard's star in recognition. Its proper motion is 10.31 arcseconds per year. A star's proper motion is its real motion through space across our line of sight as projected onto the sky. It depends on the star's real velocity in the direction at right angles to the line joining it and the Sun, and also on its distance: even if a star is moving rapidly, its travel will not be apparent if it is at a very great distance. Barnard's star is one of the closest to the Sun - the next nearest after Proxima Centauri and the binary pair Alpha Centauri A and B. Barnard's star is also moving towards the Sun at 0.036 light years per century. In about 9,000 years, it will be the nearest star in place of Proxima Centauri.

CLOSEST APPROACH OF A COMET TO EARTH

The closest recorded encounter of a comet with Earth was that of Comet Lexell in 1770. Its least distance from Earth was 0.015 astronomical units or 2.244 million km on 1st July 1770. This is about six times the distance of the Moon. When at its closest, the apparent size of the coma was nearly five times the diameter of the full Moon. The comet was discovered by Charles Messier on 14th June 1770, but it was subsequently named after A. J. Lexell who studied the orbit of the comet and published his results in 1772 and 1779. He found that the comet had been projected into its Earth-approaching orbit by a close encounter with Jupiter 1767. Another even closer approach to Jupiter in 1779 once again perturbed the comet's orbit drastically, and it has been unobservable from Earth since then.

EDITORIAL

Please send your contribution to (or first discuss it with) one of us:

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Copy can be in clear handwriting, typescript, e-mail, or on floppy disk, preferably in rich text (*.rtf*) format, in that ascending order of preference for the work involved in editing. Contributions should usually be not more than about 750 words in length, or 1000 at the most. Please have material ready by the end of November for the next issue of *Mercury* due out the beginning of January 2003.

Let's have one or two new contributors next time!