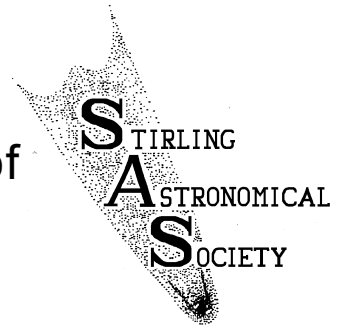


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## LISTENING IN TO THE SOUND OF THE SUN

The Sun is by far the noisiest place in the Solar System. We can't hear it directly of course, because sound waves are pressure waves which need a physical medium to travel through, and cannot jump the vacuum of the intervening space between the Sun and us. The cause of the sound waves is deep down in the Sun's core in which the Sun's energy is generated by the conversion of hydrogen nuclei into helium nuclei. The mass of helium produced is slightly less than the mass of the hydrogen converted, the difference appearing as energy according to Einstein's  $E=mc^2$ . The energy is in the form of heat and the core is maintained at the temperature of 15 million °C needed for the conversion by a balance of the heat generated with the rate at which it is radiated and convected out to the Sun's surface and then radiated away.

The Sun is all gas and the energy from the core heats large pockets of gas which therefore expand and begin to rise upwards towards the Sun's surface by convection. As they rise towards the surface the pressure becomes less intense, the hot gas pockets expand further and their motions accelerate. However, it is a very long way up to the surface, over 500,000 km, and by the time they reach it the gas pockets can be travelling at speeds of up to 100 km/sec. These continual streams of hot gas pockets bursting out make the Sun's surface froth violently as they spread out over thousands of kilometres, often at supersonic speeds. This violent frothing is responsible for the granulated appearance of the Sun's surface and it also generates intense sonic pressure waves, some of which propagate back into the Sun's interior.

In ways similar to those in which seismic waves from earthquakes are used to explore the interior of the Earth, these sound waves can be used to obtain information about the interior of the Sun. Some waves travel a few thousand kilometres inside the Sun before resurfacing, while others go right through the core and emerge on the other side. Sound waves move differently depending on what they pass through, and they can be used to probe what is going on inside the Sun at different depths. Because the waves get carried along by the gas they are passing through, their speed with the gas flow is higher than their speed against the gas flow. Thus differences in wave speeds can be used to deduce the speeds and directions of gas flows inside the Sun. Sound waves also travel more slowly in helium than in hydrogen and this has been used to measure the composition of the Sun in terms of its hydrogen and helium. Because the Sun was formed out of hydrogen and the rate at which hydrogen is being converted to helium in the core is known, this enables the Sun's age to be found - it is 4.7 billion years old.

Sound waves only take a matter of a few hours to go through the Sun from one side to the other, so information obtained from using them is right up to date. Before the discovery of how to use sound waves, the only way of investigating the Sun's interior was by using the electromagnetic (light) radiation originating in the core. However, the photons involved are trapped in the Sun's interior and take millions of years to find their way to the surface, so their information content can only tell us what the Sun was like a long time ago.

Since we cannot directly listen to the Sun from Earth, how can the Sun's sound waves be used to tell us about the Sun? What astronomers in fact study are ripples on the surface of the Sun caused by sonic disturbances. The light reaching Earth from these ripples can tell us their speeds and directions, by the Döppler effect, and also their frequencies, i.e. the musical "notes" of the sound. This enables individual sound waves to be identified and tracked out of the general cacophony.

Sound waves enable astronomers to explore what is going on beneath the Sun's surface. An example of this is the way a puzzle about the Sun's spin has been solved. The Sun spins in the same direction as the planets, as they were all originally formed out of the same spinning cloud of gas and dust. However, different points on the Sun's surface do not all rotate at the same rate. A complete revolution of a point on the Sun's equator takes about 24 days, whereas points nearer the poles rotate progressively more slowly, so that very near the poles a revolution takes about 34 days. The puzzle was to know whether this behaviour is just a surface phenomenon, or whether it continues down inside the Sun, maybe right to the centre. This has been solved by studying the way sound waves travel around the Sun's interior. The answer is that the differences in rotation rates persist down to a depth of 200,000 km and then suddenly disappear, so that deeper than this the spin is the same everywhere, like for a solid ball.

Finding this out has also shed possible light on the cause of the eleven year cycle of maximum sun spots on the surface, which eject large amount of ionised gas into space at high speeds. When some of these ions and their associated magnetic fields reach the Earth, two days or so after their ejection, they generate electricity surges which can cause havoc to satellites and power grids. At the spin discontinuity 200,000 km below the Sun's surface there is a layer of gas which is stretched and sheared between the differently moving adjacent layers. This is thought to make magnetic fields in this layer progressively stronger and stronger as the lines of magnetic force are stretched and wound around the inside of the Sun at the discontinuity. Regularly, after eleven years on average, the magnetic fields reach a critical strength at which they force the surrounding gas away and they start rising towards the surface. When these super-strong magnetic fields break through the surface they create large holes in it, which we see as dark Sun spots, and which in turn trigger the violent ejections of gas.

Research is continuing to see whether these super-strong magnetic fields can be detected and tracked (by their effect on sound waves) before they burst out as sun spots, thus giving more advanced notice of the potential problems they can cause here on Earth. In the future it may also become possible to "listen in" to other stars - something undreamed of when the Sun's sound waves were first discovered only forty years ago.

*Derek Allen*

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## **SOME OTHER FACTS ABOUT THE SUN**

The Sun is a very average star as far as its mass, size and make-up is concerned. It is a star of spectral type G2. Its mass is 2,000,000,000,000,000,000,000,000,000 ( $2 \times 10^{30}$ ) kg, or more than 330,000 times the mass of the Earth. Its diameter, 1,400,000 km, is about a hundred times that of the Earth. Ninety nine percent of the Sun is hydrogen and helium. All the other elements add up to the remaining 1%. The Sun's effective surface temperature is 5,785 °C. The visible light we receive from the Sun is emitted by the surface photosphere, hundreds of kilometres thick, which also emits as much radiation again in the ultraviolet and infrared parts of the spectrum. High above the photosphere, beyond the chromosphere, is a region of rarefied gas known as the corona which eventually merges into the interplanetary medium. The corona reaches temperatures of up to 1,000,000 °C, nearly 200 times hotter than the photosphere.

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## ASTROPHOTOGRAPHY WITH A DIGITAL CAMERA

### Part 2: Your first observing session

*(Part 1 appeared in the last issue of Mercury)*

#### *Preparing to take the photographs*

- **Be familiar with the camera**

As you probably found out when you originally got your telescope, the first thing that happens when you buy a new item of astronomical equipment is that it rains for the next several nights! The same thing will happen when you get your camera and adapter, so make use of the inevitable non-observing evenings by having a good read through the manual for your camera and trying it out just taking photographs around the house, of your friends, pets or whatever. Become familiar with the controls on the camera before you take it outside and try to use it in the dark. Also, this is a good time to practise attaching the adapter to the camera thread. The rubber eyecup folds down and the eyepiece can then be threaded into the filter thread on the camera lens.

It's easy to get into the situation where you are trying to hold three things with only two hands. You want to avoid this, so practise in the light to be sure you can do it without dropping anything or scratching the lens - again before you try it in darkness. It helps if you develop a routine so that you know in advance which hand will be holding which piece of equipment and in what order. In particular, take care with the lens cap on the camera - it is spring-loaded, and in the dark it is all too easy for it to spring out of your fingers and bounce off the camera lens or eyepiece. Once again, practising in daylight and taking things slowly should avoid any problems.

#### *Your first photographing session*

- **Setting up the telescope**

OK. Tonight the clouds have cleared and the Moon is up. Let's take some pictures.

For your first photography session, start by setting the telescope up as usual. Instead of your usual eyepiece, fit the adapter eyepiece instead. Before attempting any photographs, spend half an hour or so observing the Moon as you would with a regular eyepiece. This will let you get used to the eyepiece and get a feel for how it focuses.

- **Focusing**

To set the focus correctly, all that you need to do is to look into the eyepiece and focus as for normal viewing. When the telescope is focused correctly for you to view with your eye, the image seen in the eyepiece will appear to be located at infinity (that is to say, the image appears to be a very long distance away, and your eye is relaxed as if looking at a distant object). If the camera is also set to focus at infinity, it too will see a sharp image when connected to the eyepiece.

The word "afocal" in the afocal projection method refers to the fact that, when focused in this way, the exact distance between eyepiece and camera is not too critical. This makes it easy to connect the camera to the eyepiece and obtain a good image.

If you look carefully, you will find that you can move the focuser a millimetre or two and still see a sharp image with your eye - this is because your eye "accommodates" or changes focus to allow it to view nearby objects as well as distant ones. You will probably be aware of the lens in your eye refocusing as you move the focuser, giving a range of positions in which you can see a sharp image in the eyepiece. This is one of the things you will need to experiment with; try different positions within this range until you find the focus position that works best when you attach the camera.

When you are ready to start taking photographs, centre the Moon in the eyepiece, set the focus to a comfortable position and lock the focuser.

- **Fit camera into focuser**

You're now ready for the camera to take the place of your eye. Take the adapter out of the focuser, fold down the rubber eyecup and screw it onto the camera. Now fit the camera and eyepiece combination back into the focuser. You'll find this a lot easier if you have previously practised in daylight!



*Camera and adapter fitted to telescope*



*Ready to take pictures...*

Once everything is set, switch on the camera. You should see the Moon appear in the camera's display panel. You're nearly ready to take your first pictures, but first there are a few settings to take care of on the camera...

- **Turn off the flash !**



One of the first things you must do is to switch off the flash on the camera. By definition your astrophotographs will be taken in the dark and you don't want your night vision ruined by getting a blast from the camera's flashgun !

Press the flash button on the back of the camera until the "no flash" symbol appears in the display.

- **Leave camera on autofocus**

For the Moon, you can leave the camera set to autofocus for your first pictures. Later on, and for photographing planets and other objects, you will need to experiment with manual focusing, but for now the Moon is bright enough that the camera's automatic focusing will cope.

- **Set camera to aperture priority mode**

The default full automatic mode on the camera is not really suitable for astrophotography, so you need to pick one of the modes that gives you a little more control. Just as with your telescope, aperture is important. To collect the most light you'll want to ensure that the camera's lens is set to its maximum aperture. Press the 'Mode' button (next to the shutter release) and rotate the control wheel until an 'A' appears in the camera's display. Now release the 'Mode' button and turn the control wheel again to change the aperture. The aperture in use is indicated by the 'F'

number in the display; a lower number indicates a wider aperture, so rotate the control to get the lowest 'F' number.

- **Avoid camera shake by using the self-timer**

As you will have noticed, the image in the display jumps about quite a lot as you operate the controls on the camera - the small movements caused by pushing the buttons translate into large image movements.



Clearly, we don't want the camera to shake just as you press the shutter release, and this can be avoided by using the self-timer, which gives a ten-second delay before the shutter fires. Press the 'MF' button three times until the self-timer icon appears in the top left-hand corner of the display.

- **Zoom in and take pictures**

Great - you are now ready to take your first picture! Centre the Moon in the display and zoom in to get the image composed in the way you want it. It's best to have the lens in the middle of the zoom range, which is indicated in the display by the macro symbol turning yellow.

Now press the shutter release half-way down until the camera focuses on the Moon. Press fully to take the shot. You will see a ten-second countdown which allows any vibrations caused by pressing the shutter button to settle before the picture is taken.

You may need to experiment a bit with focus and exposure settings, but by the end of the session you should have your first pictures of the Moon.

*Alan Cayless*

*NEXT ISSUE:* Part 3: Refining your technique

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### ***EDITORIAL***

Our thanks to contributors. Members, please think about items or articles for the next issue. Items describing events or the activities of the Society, individual members or groups of members are especially welcome.

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

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Copy can be in clear handwriting, typescript, e-mail attachment, or on floppy disk, in that ascending order of preference for 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 2004.

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## NOW IT IS EUROPE'S TURN TO GO TO THE MOON

The Russians were the first to the Moon in 1959 when their unmanned Luna 2 probe crashed onto its surface. This was of course followed by the American series of manned Apollo missions which finished with Apollo 17 in 1972. Much later came the American unmanned Clementine in 1994 and Lunar Prospector in 1998. The astronauts on the Apollo missions collected lunar soil and rocks from their landing sites for scientific analysis. Clementine was a Department of Defense project not primarily concerned with collecting scientific data, but it did carry ultraviolet and infrared instruments into lunar orbit. Lunar Prospector looked for evidence of water at the polar icecaps, and also for information relating to the feasibility of a future manned lunar base.

Now it is Europe's turn with the European Space Agency's SMART-1 Moon-orbiting unmanned spacecraft (the name stands for Small Mission for Advanced Research and Technology). The spacecraft has a launch weight of about 350 kg with a payload of about 15 kg. It was due to be launched on 28 August this year mounted on an Ariane-5 rocket by the European Space Agency, together with two commercial satellites, from Europe's spaceport in Kourou, French Guiana. At the time of writing the launch has been delayed but it should eventually be on its way when this issue of *Mercury* appears. [*Later: It is!*]

An important objective of the mission is to demonstrate and test a new type of engine based on Solar Electric Propulsion (SEP), an idea originated by the Russians in the 1970s. The power source is a 1850 watt array of solar panels which charge a lithium ion battery, which in turn powers a xenon ion engine. In eclipse, on the dark side of the Earth or Moon, the electric propulsion is turned off to reduce the required power consumption to about 270 watts over an eclipse length of two hours. The engine uses Hall-effect thrusters which are small ceramic chambers ringed with magnets. Attached to one side of each chamber is a cathode to create electrons. Trapped inside the chamber by a magnetic field, the electrons collide with a supply of xenon gas to create xenon ions. These ions are accelerated out of the chamber by an electric field as a high velocity ion beam which provides thrust to push the spacecraft forwards. The actual "fuel" carried by the spacecraft is just 75 kg of xenon, and all the energy needed comes from the Sun. Although the thrust is quite small, the engine can operate continuously (except when in the dark), as contrasted with a chemically fuelled engine which provided much larger thrust but only for very short periods.

After the spacecraft is released into Earth orbit from the Ariane-5 rocket, its ion engine will thrust continuously until the perigee (point nearest Earth) of the spacecraft's orbit is over 20,000 km. The Earth escape phase will then begin by expanding the orbit apogee (point furthest from Earth) and eventually phasing it with the Moon. Breaking free from Earth will take about six months and the whole journey into lunar orbit between 15 and 17 months. During this prolonged period the spacecraft will be exposed to severe radiation, and special protection against this has had to be provided. Moon capture is possible under specific conditions, and the initial lunar orbit is intended to be over the Moon's poles, between 300 and 10,000 km in altitude. The initial perilune will be placed close to the Moon's south pole. In time the eccentricity of the orbit will be decreased to raise the perilune and decrease the apolune. In lunar orbit the spacecraft will operate almost completely autonomously. It will point itself most of the time with one axis in the nadir direction for surface observation and surface science investigations, which are the two main objectives of the mission. The pointing accuracy will be to within half a degree. At regular intervals (every few days) the spacecraft will re-orient to point a high-gain antenna towards Earth for high speed science and technical data transfer

. The spacecraft, which will spend six months in lunar orbit, is designed for a total lifetime of two years and at least 500 eclipse periods. The on-board resources, however, could accommodate

an extension of six months. If resources permit, an escape from lunar orbit will finally be attempted.

The lunar landscape will be recorded in great detail by a miniature digital camera taking high resolution images at various light wavelengths. By studying parts of the surface from different angles and under different lighting conditions, these images are expected to provide clues as to how the lunar surface evolved. Variations in surface temperature, cracks in the surface, meteor damage and other interesting surface features will also be investigated. An infrared spectrometer will gather data on the composition of surface rocks and dust to enable the distribution of minerals on the Moon to be better understood. An X-ray spectrometer will be used to provide detailed information on the relative abundance of surface elements such as aluminium, iron and magnesium. The success of this aspect of the mission should enable us to understand much better how the Moon originated and evolved.

This is the first spacecraft to leave Earth to be powered by SEP. Although only capable of a very gentle thrust, it is acting as a prototype for the future development and eventual breakthrough of using this means of powering spacecraft capable of travelling great distances without the need for huge fuel loads. With SMART-1, the European Space Agency is making an important contribution to our understanding of the Moon and to the future of space exploration.

*Derek Allen*

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## **STELLAR SPIN**

Stars, especially main sequence types, are often referred to as 'balls of gas' which are regarded as approximately spherical. In the proto-star phase of development they acquire a spin, or rotation about a diameter, and it is this spin which keeps a star as a unit. Every time a gravitational collapse occurs, the unit gets smaller and spins faster as angular momentum is conserved, thus binding the unit more closely together.

Whether a star is really spherical however cannot be determined by visual observation, as its disc cannot be seen through a telescope. Thus it has not been possible to examine separately the light from different points across a star's disc. The Sun is an exception, as study of sun spots shows that they are moving because of the rotation of the Sun, and of course it is possible to examine light from different points on the Sun.

Rotation of a spherical star will tend to squash its polar spinning diameter and stretch its equator. Recent developments in astronomical interferometry have made it possible to take the measurements needed to calculate the spin of some stars. It is recorded in *Physics World*, July 2003, that the most unsymmetrical star ever seen has recently been discovered. This is Alchernar, with an equatorial radius at least 50% greater than its polar radius. This discovery was made with a Very Large Telescope Interferometer in Chile, and is said to be the result of 'flat out' spinning. It is thought that this may make astrophysicists think again about how large stars are held together.

Jacqueline Mitten, in her *Penguin Dictionary of Astronomy*, provides the following information. Achernar (or alpha Eridani or Eri) is the brightest star in the constellation Eridanus. The name is of Arabic origin, meaning 'the end of the river', and the star marks the southern extremity of the constellation at a declination of  $-57^{\circ}$ . It is a B star of magnitude 0.5.

*Harry Stout*

*Editorial Note:* What is 'flat out' spinning? Presumably the spin at which the star's tendency to fly apart is just balanced by the star's gravity? Any faster spin and it would disintegrate. It would also be interesting to discuss how a star's spin helps to keep it together as a unit. Is this a possible topic for a Mayfield meeting?

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## MERCURY - THE INTRIGUING BUT NEGLECTED PLANET

Mercury, the planet closest to the Sun, is a strange world of extremes. It rotates on its axis once every 59 Earth days and orbits the Sun once every 88 Earth days. The length of its period of continuous daylight, from dawn to dusk, is the longest in the Solar System at 176 Earth days, which is *twice* as long as its year! The simple two-to-three ratio between its day (59 Earth days) and its year (88 Earth days) is striking. Mercury originally probably rotated much faster, but slowed down because of the dissipation of energy by tidal flexing until it became locked into this ratio by a process which is not yet properly understood. Mercury's orbit around the Sun is more eccentric than that of any other planet except Pluto, as its distance from the Sun varies between 47 million and 70 million km. As it approaches perihelion (the point in its orbit nearest the Sun), it moves around its orbit so fast that, from its surface, the Sun appears to slow down in its movement across the sky, stop altogether, and then actually go backwards! After perihelion the reverse happens as Mercury's orbital speed decreases. During its long period of daylight surface temperatures can reach 467°C, higher than that of any other planet, and above the melting point of lead metal. At night, because of its lack of insulating atmosphere, the temperature can plunge to about -183°C, low enough to freeze krypton gas solid.

Mercury, with a diameter of 3000 miles compared with Earth's 8000 miles, is the smallest planet except for Pluto. Its average density is only slightly less than that of Earth and, because of its smaller size and lower interior pressure, it is thought that Mercury must have a substantial iron core, accounting for 70% of its mass and 75% of its diameter. Its surface gravity is just less than 40% of the Earth's surface gravity. Mercury has a magnetic field a hundredth the strength of Earth's magnetic field, but the fact that there is one at all provides further evidence for Mercury having an iron core, some of which must be liquid. High daytime temperatures and its small mass mean that Mercury cannot retain any atmosphere. What little atmosphere exists is made up of atoms blasted off its surface by the solar wind, captured from the solar wind itself, or emanating from the radioactive decay of its rocks, and it has less than a million-billionths the pressure of Earth's atmosphere at sea level. This extremely tenuous atmosphere is composed chiefly of oxygen, sodium, and helium atoms, which quickly escape into space and are continuously replenished.

With no atmosphere, there has been no erosion by wind or water, and meteorites do not burn up before hitting the surface. Mercury's surface therefore very much resembles that of the Moon, scarred by thousands of impact craters resulting from collisions with meteorites. As well as areas of smooth terrain, it also has cliffs, some soaring up to a mile high, formed by ancient impacts. One of the largest features on Mercury is the Caloris Basin, about 1,300 km in diameter. It was formed by an asteroid impact early in the Solar System's history about 3.6 billion years ago, and this is also the probable cause of strange surface features on the opposite side of the planet. Over the following half-billion years, Mercury shrank in radius by from two to four kilometres as the planet cooled from its formation. The outer crust was compressed and grew strong enough to prevent the planet's magma from reaching the surface, effectively ending the Mercury's period of geological activity. Evidence of Mercury's active past is seen in the smooth lava plains in the Caloris basin.

Mercury, inside Earth's orbit, is never more than 28° away from the Sun as viewed from Earth. This is less than the angle made by the hands of a watch at one o'clock. Mercury's inner orbit also means that it exhibits phases, like the Moon. For these reasons normal telescopic observation of Mercury from Earth is difficult and is limited to periods of twilight before sunrise or after sunset, when it also has to be viewed through a very thick layer of the Earth's turbulent atmosphere. The best terrestrial telescopes can only distinguish features on Mercury which are at least two or three hundred kilometres across. This resolution compares unfavourably with that for the Moon

as seen by the naked eye. It might be thought that these problems could be overcome by using the Hubble Space Telescope. Unfortunately the Hubble cannot be used to study Mercury because of the risk of fierce radiation from the nearby Sun coming into its field of vision and damaging its sensitive optical instruments.

Because of these observational problems, investigation of Mercury by spacecraft probe would seem to have merited a high priority, but only one has in fact been sent so far. This was Mariner 10 in the mid 1970s, which flew by Mercury as part of a larger mission to explore the inner Solar System. Getting Mariner 10 to the vicinity of Mercury was not straightforward. Just letting the probe fall into the gravitational well of the Sun would not do it, and Mariner 10 had to go around Venus first to dissipate gravitational energy, in order to slow down into a suitable orbit around the Sun. This orbit provided three close fly-bys of Mercury, on 29 March and 21 September 1974, and 16 March 1975. They returned images of 40% of Mercury's surface and took other measurements which between them gave us almost all we now know about Mercury. Two thousand images of the surface were obtained with an effective resolution of about 1.5 km, comparable to photos of the Moon taken from Earth through a large telescope.

Radar investigation of Mercury from Earth in the 1990s astonishingly indicated the possible presence of water ice in about twenty apparently circular areas around its north and south poles. Any ice must of course be in permanent shade, that is in deep craters, otherwise it would rapidly sublime away into space because of the high daytime temperatures, lack of atmosphere and low gravity. Theoretical studies indicate that typical craters near the poles could have permanently shaded areas which never rise above about  $-170^{\circ}\text{C}$ , at which water ice would be stable and permanent. Impacting meteorites, and maybe comets, especially in the distant past, would have brought water to Mercury. Water could also have originated through out-gassing from the interior as Mercury cooled. Whether it is actually there, however, remains to be positively proved.

The heavily cratered surface of Mercury revealed by Mariner 10 seemed to be similar to that of the Moon, and this at first led to the impression that Mercury is very similar to the Moon in other respects as well. As a result Mercury has, since Mariner 10, been neglected in the space programme - there have been more than forty missions to the Moon, twenty to Venus, and fifteen to Mars, as well as others to Jupiter and Saturn, but no more so far to Mercury, although in the 1990s three Mercury missions were proposed but not proceeded with.

At last this situation is about to change. A second spacecraft probe to investigate Mercury, called Messenger, is scheduled for launch next year. More about this in the next issue of our own *Mercury!*

*Derek Allen*

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## **THE LARGEST STAR**

The largest star certainly belongs to the class of red supergiants, though the difficulty of measuring precise sizes means it is not possible to say for certain which is the largest star. Red supergiants have radii which are comparable with the orbits of Jupiter or Saturn - from 800 to 1,600 million kilometres, or between 1,200 and 2,400 times the size of the Sun. Alpha Herculis or Mu Cephei may be the largest. Red supergiants are stars in a late stage of evolution. When hydrogen fuelling the energy source at the star's centre begins to run out, changes in its interior take place which cause the star's outer layers to expand greatly to form a huge envelope of very tenuous but luminous gas around the central core of the star.

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## THE NIGHT SKY : October, November, December 2003

SUN	October		November		December	
	12	26	9	23	7	21
(approx) Rises	05.41	06.10	06.39	07.08	07.31	07.45
(approx) Sets	16.25	15.5	15.21	14.58	14.45	14.44

MOON	October				November				December				
	FQ	FM	LQ	NM	FQ	FM	LQ	NM	FQ	FM	LQ	NM	FQ
Phase	2	10	18	25	1	9	17	23	30	8	16	23	30
Date	2	10	18	25	1	9	17	23	30	8	16	23	30
Rises	14.04	16.32	20.28	05.27	13.56	15.09	22.18	06.05	12.31	13.51	22.51	08.14	11.02
Sets	19.43	05.10	14.10	15.43	21.33	06.46	13.13	14.16	22.07	07.08	11.41	13.55	23.00

### PLANETS

### Magnitude

<b>MERCURY</b>	<i>October</i>	Low eastern horizon beginning of morning civil twilight	-0.8 to -1.2
	<i>November</i>	Unsuitable for observation	
	<i>December</i>	Unsuitable for observation	
<b>VENUS</b>	<i>October</i>	Unavailable for observation	
	<i>November</i>	Possible viewing last week of month, very low SW sky after sunset	-3.9
	<i>December</i>	Bright early evening object, low SW sky	-4.0
<b>MARS</b>	<i>October</i>	Evening, low SW sky in Aquarius. By end of month not visible after midnight	-2.1 to -1.2
	<i>November</i>	Evening, SW sky	-1.2 to -0.4
	<i>December</i>	Evening SW sky, moving eastwards from Aquarius into Pisces	-1.0
<b>JUPITER</b>	<i>October</i>	Brilliant morning object in eastern sky	-1.8
	<i>November</i>	Brilliant morning object in eastern sky	-1.9
	<i>December</i>	Brilliant morning object, south-eastern sky in Leo	-2.1
<b>SATURN</b>	<i>October</i>	Visible all night in Gemini	0.0
	<i>November</i>	Visible all night SE sky in Gemini	-0.2
	<i>December</i>	Visible all night. Moving slowly retrograde in Gemini	-0.4

### CONSTELLATIONS (near meridian at 22.00)

<i>16 October</i>	Ursa Major (below pole), Cepheus, Cassiopeia, Andromeda, Pegasus, Pisces, Aqarius, Cetus
<i>16 November</i>	Ursa Minor (below pole), Cassiopeia, Andromeda, Perseus, Triangulum, Aries, Taurus, Cetus, Eridanus
<i>16 December</i>	Draco (below pole), Ursa Minor (Below pole), Camelopardus, Perseus, Auriga, Taurus, Orion, Eridanus, Lepdus

### METEORS

<i>November</i>	Leonids : Possible display early hours 17th. Suggest viewing from 22.00 on 16th through the night.
<i>December</i>	Geminids : Unfavourable for viewing since waning gibbous Moon is above horizon all night on 14th.

## CONJUNCTIONS (with the Moon unless otherwise stated and based on readings for 51°N)

### October

Day	Time	
6	15.00	Mars 1°N
17	13.00	Saturn 5°S
22	01.00	Jupiter 4°S
23	01.00	Neptune at stationary point
25	09.00	Mercury in superior conjunction
25	12.00	Mercury 1°S
25	23.00	Saturn at stationary point
26	19.00	Venus 0.09°N

### November

Day	Time	
3	10.00	Mars 3°N
8	12.00	Uranus at stationary point
13	19.00	Saturn 5°S
18	18.00	Jupiter 4°S
25	02.00	Mercury 0.3°N
25	17.00	Venus 2°N

### December

Day	Time	
1	18.00	Mars 4°N
9	05.00	Mercury at greatest elongation
10	22.00	Saturn 5°S
12	04.00	Pluto in conjunction
16	06.00	Jupiter 3°S
17	15.00	Mercury at stationary point
23	21.00	Mercury 5°N
25	16.00	Venus 3°N
27	00.00	Mercury in inferior conjunction
30	09.00	Mars 3°N
31	20.00	Saturn at opposition

*Compiled by Hamish MacPhee*

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## A REMOTE PLANET

While viewing Mars during its closest approach, I noticed that Skyglobe (a computer planetarium) showed that the distant planet Uranus was in the same area of sky as Mars and actually higher up than Mars.

I put a transparent plastic sheet over the Skyglobe screen and traced the main star patterns between Mars and Uranus with magic marker. The tracing was then clipped upside down onto white paper and taken to the telescope. At the time I thought this was quite clever, but it was getting late and I also thought I needed to turn the tracing over to get the telescopic view. This would have been right if I had a star diagonal, but I don't.

After spending a lot of time trying to pick out the star patterns through the neck-aching finder (no star diagonal), and then star hopping through the main telescope, I found nothing. The lower sky was a bit murky but I still thought Uranus ought to be visible if the telescope actually got to point at it. So I just started scanning around in the murk above and to the west of Mars, examining the sparse visible stars. Eventually I became increasingly convinced I was wasting my time. Then the magic moment came, as I saw a little pale green full stop-sized object. That was it, about one and a half billion miles away, the remotest planet we amateurs are ever likely to see as a discernable disc. Compared with Earth, it is a giant at roughly 30,000 miles in diameter, but cold and remote from the Sun.

As I gazed at it, I thought that if Uranus were to be put where our Moon is, the tables would turn: we would be a moon round Uranus! It would dominate our sky day and night, occupying seven degrees of the heavens, fifteen times as much as our Moon, and presenting a disc two hundred and twenty five times the size of the Moon's. With Uranus in the sky it would not get dark at night. Uranus's huge disc and high reflectivity would make its light equivalent to about two thousand full Moons. As it is, Uranus is difficult to make out but it is worth having a good look for it.

*Chris Davis*

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## STIRLING ASTRONOMICAL SOCIETY MEETINGS, 2003 - 2004

Lectures, with the exception of 16 April 2004, are on the second Friday of the month in the Smith Museum Lecture Room, Dumbarton Road, Stirling, from 7.30 pm to 9.30 pm. These meetings are free and anyone with an interest in astronomy is welcome to attend, whether a member of the Society or not.

Members' Evenings are informal meeting which, with exception of 19 December 2003, are held on the last Friday of the month at the Mayfield Community Centre, St. Ninians, Stirling, from 7.30 pm to 9.30 pm.

Information on the current series of meetings is given below and up to date notices of lectures are printed in the Stirling Observer.

10 October	Lecture: Stuart Forbes	Rocks from Space <i>Meteorites - what they are, where they come from, and what they tell us about the Solar System. The lecture will be followed by a "hands-on" session, in which a variety of meteorite samples will be shown.</i>
31 October	Members' Evening	
14 November	AGM: AGM business and two short talks	
29 November	Members' Evening	
12 December	Lecture: Dr Martin Hendry	<i>(Title to be confirmed)</i>
19 December	Christmas Meeting	<i>(Format to be confirmed)</i>
9 January	¶	
3 January	Members' Evening	
13 February	¶	
27 February	Members' Evening	
12 March	¶	
26 March	Members' Evening	
16 April	¶	
30 April	Members' Evening	
14 May	¶	
28 May	Last Members' Evening	

¶ *Speaker and title to be confirmed*

### Evening classes

Stirling Astronomical Society regularly runs a series of Evening Classes in Stirling. These are open to anyone over 11 years old with an interest in Astronomy. Topics vary in each course.

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### **Stirling Astronomical Society OFFICERS AND COMMITTEE FOR 2003**

<i>President</i>	Dr Harry Stout
<i>Chairman</i>	Douglas Cooper
<i>Secretary</i>	Hamish MacPhee
<i>Treasurer</i>	Dr Iain Smith
<i>Director of Observations</i>	Dr Ken Mackay
<i>Membership Secretary</i>	Albert MacKenzie
<i>Librarian</i>	Maurice Dixon
<i>Committee Members</i>	Terry Aitchison Dr Alan Cayless John Clynes

For information about Stirling Astronomical Society and its activities, please contact the Secretary :

*Hamish MacPhee, tel. 01786 462310*

Or visit the website:

[www.stirlingastronomicalsociety.org.uk](http://www.stirlingastronomicalsociety.org.uk)

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