# SKY-HIGH 2004

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*The annual guide to the wonders of the night sky visible from Ireland during the year ahead*

*12th year of publication*

*by Liam Smyth and John Flannery*

*monthly phenomena … the year in review … naked-eye comets in 2004 … space missions … detailed notes on celestial highlights … the June 8th transit of Venus … and lots more*

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GREETINGS to all fellow astronomers and welcome to the twelfth annual edition of *Sky-High*. Each year we lead with a general introduction to help set the scene for those new to the hobby. We ask the indulgence of established readers in this regard.

We have carried out an expansion of the content this year to provide more comprehensive notes on particular phenomena. This has allowed us to cater for the budding sky watcher taking their first steps in the hobby while giving a sufficient level of detail to satisfy the more serious amateur astronomer.

It is fair to say that those with even just a casual interest in the night sky should find a year of fascinating reading within the pages of *Sky-High 2004*. That is not to say we have covered all phenomena visible as this guide is generally pitched toward naked eye and binocular observers. A subscription to a monthly astronomy magazine though will keep you up-to-date on transient phenomena such as comets or novae, as well as supplying more detailed data on solar system objects.

As always, feel free to contact us through the IAS with your comments or for further information on any of the sights listed during the year — *Liam Smyth and John Flannery*

## At a glance — the highlights of 2004

| | *Event* | *Page* |
|---|---|---|
| Jan | Uranus is in the same binocular field as Venus mid-January while Neptune is similarly close to Venus later in the month | 8 |
| Mar 4 | Jupiter reaches opposition amongst the stars of Leo and is visible throughout the hours of darkness | 10 |
| Mar 25 | Mars extremely close to the Moon — it is actually occulted just after it has set 30 minutes past midnight of March 25/26 | 10 |
| Apr | Venus skims by the lovely Pleiades star cluster in the evening sky during the first week of April | 11 |
| Apr 19 | Partial eclipse of the Sun visible from the southern hemisphere | 25 |
| Apr 25 | Comet C/2002 T7 (LINEAR) at perihelion — predicted to be one of two bright naked-eye comets this year | 31 |
| May 4 | The first of two total eclipses of the Moon that will be seen from here this year | 29 |
| May 21 | Daylight occultation of Venus by the Moon | 12 |
| Jun 4 | Comet C/2001 Q4 NEAT at perihelion — could this be the comet of the year? | 31 |
| Jun 8 | A rare transit of Venus across the face of the Sun will be the key highlight for amateur astronomers this year | 20 |
| Jul | Mars glides through the Beehive cluster in early July — use binoculars to spy the scattered suns of the group | 14 |
| Aug 12 | Perseid meteor shower peaks — the Moon doesn't rise towards 'til dawn leading to ideal viewing conditions | 32 |
| Sept | Venus slips past the star-swarm of the Beehive star cluster during mid-month | 16 |
| Sept 29 | The near-Earth asteroid 4179 Toutatis sweeps past us at a distance just four times that of the Moon | 34 |
| Oct 13 | Perihelion for comet C/2003 K4 (LINEAR) — possibly the "best of the rest" for comet observers in 2004 | 31 |
| Oct 14 | Partial eclipse of the Sun visible from northeastern Asia, Hawaii, and Alaska | 25 |
| Oct 28 | Second total eclipse of the Moon for Ireland this year | 29 |
| Nov 5 | A dramatic pairing of Venus and Jupiter finds both within ½° of each other in the morning sky | 18 |
| Nov 17 | Will skies clear this time for the Leonid meteor shower? Rates have now more or less declined to near normal levels | 32 |
| Dec 13 | Moon-free skies will greet those willing to brave the winter chill to observe the Geminid meteor shower | 32 |

## Enjoy a Whirlpool ... and more ...

While our cousins across the Atlantic may occasionally practice outdoor hot-tub astronomy, our less than benign climate means "whirlpool" in this case refers to the Whirlpool Star Party — the annual autumnal gathering of amateur astronomers from Ireland and abroad in Birr, Co. Offaly, for a weekend of lectures and stargazing in the Midlands town. The event is hosted by Shannonside Astronomy club and attendees have previously been enthralled by talks from luminaries such as controversial cosmologist Halton "Chip" Arp and telescope guru John Dobson. The WSP, as it's known, is held close to the New Moon period in late-September. Check out the organisers website — gofree.indigo.ie/~sdbell — for more info.

Buttressing the other end of the Summer twilight period is the equally well-established Cosmos weekend hosted by Tullamore Astronomical Society. Again, the event is usually pencilled in for a dark of the Moon period in late March to cater for observers that hail from more light-polluted conurbations! While the profile may be slightly lower than the WSP, the standard of lectures is high and the whole weekend is marvellously laid back. Details for the 2004 event were not available at the time of going to press but peruse the TAS website — www.iol.ie/~seanmck/astro.htm — closer to the time.

A new event is the Connaught Star Party to be held by Galway Astronomy Club on Saturday, 24th January 2004. An interesting line-up of speakers is planned (with contributions from National University of Ireland, Galway) along with observing later that night. More information through the Galway club's website — homepage.tinet.ie/~galwayastronomyclub/

# Your night sky primer

As with any hobby, astronomy seems to have it's own set of terminology designed to confuse. However, with a little patience you'll soon pick up the jargon and be well on the way to knowing your way around the sky.

## The revolving heavens

We all know the Heavens don't revolve, it is the other way round, the Earth rotates on its axis. But it looks otherwise and it is easier to describe things as we see them for our immediate purpose. The fact that the Earth turns on its axis about every 24 hours causes the Sun to rise in the east and set in the west,and it is due south at noon. A similar situation applies to all the other heavenly bodies except that since they appear to move relative to the Sun they are not south every day at noon.

The stars appear to drift west in such a way that any particular star is due south four minutes earlier each day or night. If you multiply four minutes by 365 you get something close to 24 hours. So if a star is south at eight o'clock tonight, it will be south four minutes earlier tomorrow, and two hours earlier in a month. In six months it will be south at about eight in the morning. In a year it will be south at eight in the evening. It follows that we see different constellations in different seasons, but over a year, we see all we can see from Ireland.

## Star maps

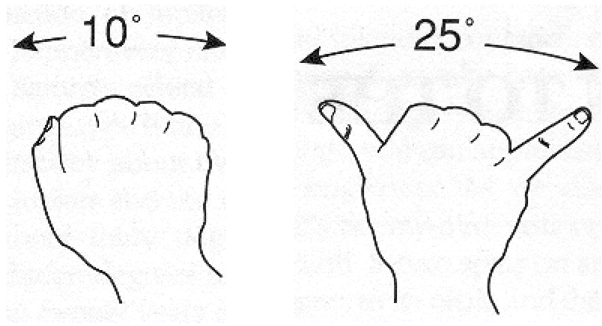
You will need at least one star map. This should be a set of monthly charts such as those in *The Times Night Sky 2004* (available for around seven Euro) or Phillips' Planisphere which is very useful. The latter comes in various sizes at equivalent cost. It allows you to show the constellations visible at any time in the year.

You could get away with using the monthly charts published in newspapers but there are a couple of drawbacks. Each chart is correct for only one time on a given night, say 10 p.m. If you are observing two hours later you would need the following month's chart. These charts also show the planets visible for a particular month, so they can be confusing unless you tippex them out. When learning the constellations check first from the monthly notes if there is a bright planet in the area.

For more detailed studies, especially with binoculars you will need a more detailed map showing all stars to at least sixth magnitude. A delightful pocket-sized book is *Stars* — part of the Collins Gem series that is available for about seven Euro in any bookstore. Don't let its diminutive appearance mislead you; it's packed with information and the core of the book features a set of constellation charts with many interesting celestial objects labelled.

## An idea of size or scale

If you have seen a picture of a total eclipse of the Sun you will have noticed that the black disk of the Moon just about covers the bright disk of The Sun. If you were to suspend a one Euro coin about 2½ metres in front of your eye, it would just about cover the Moon's disk.




A "handy" way to measure scale in the sky. Your little finger at arm's length covers ½°; i.e. the apparent width of the Full Moon.

A good demonstration of the illusion that the Moon looks big is that it would take ten Full Moon's side-by-side to span the gap between the two "pointer" stars in the Plough — a distance of just 5°!

The Sun is nearly 1·6 million km in diameter, The Moon is 3200 km and the one Euro coin is just over two centimetres in size. Yet they appear nearly equal. This is because they all seem to take up the same amount of the space in front of our eyes. We may say they have the same **angular diameter**. In this case it is about half a **degree** (½ °).

Degrees are further divided into 60 **arcminutes** (60') with each arcminute made up of 60 **arcseconds** (60"). The scale allows us to measure angles in the sky or apparent size of a celestial object . For example, the Full Moon measures an average of half a degree, or 30 arcminutes, in diameter.

Your closed fist held at arms length is about ten degrees (10°). Your stretched out hand, i.e. from the tip of your thumb to the tip of your little finger, is about twenty-five degrees. Four outstretched hands or about twice as many closed fists will take you from the horizon to zenith. If you know the Plough you will find that its overall length is rather more than one outstretched hand, it is almost 25 degrees.

Some familiarity with angular measure is necessary to find your way easily about the sky.

## Positioning in the sky

Starting at any landmark and going right around the horizon is three hundred and sixty degrees. The **azimuth** of an object is a measure of it's point relative to the horizon as measured from true north which starts at 0° with due East being 90° and so on. Going from a point on the horizon straight up to the point overhead — **the zenith** — is ninety degrees and a measure of **altitude**.

Astronomers use a kind of celestial longitude and latitude called **right ascension** and **declination** to accurately plot the position of an object on the **celestial sphere**.

Right ascension is expressed in hours (h), minutes (m) and seconds (s) running eastward from 0 to 24 hours right around the sky. The zero point of right ascension is taken as the vernal equinox — the point where the Sun crosses the celestial equator, moving from south to north, in its course around the sky.

An object's declination is written in terms of how many degrees, minutes, and seconds north (+) or south (-) of the celestial equator it is.

## Planetary data

The Earth is the third planet of the Solar System. Mercury and Venus are closest to the Sun while Mars, Jupiter, Saturn, Uranus, Neptune and Pluto are further out. The planets are always to be found in the **zodiac** — a band which cuts the sky in half that lies either side of the **ecliptic**. The ecliptic is the plane of the Earth's orbit projected on to the celestial sphere. Mercury and Venus seem to swing from one side of the Sun to the other but as viewed from Earth they never get further away than the positions known as **greatest elongation**. The other planets can be anywhere in the zodiacal band.

The moment when Mercury or Venus are directly between the Earth and the Sun is known as **inferior conjunction**. They are at **superior conjunction** when they pass behind the Sun. Obviously, the other planets outside our orbit can only pass through superior conjunction.

When outer planets are in **opposition** they are opposite the Sun to us and are on the celestial meridian at midnight. The **celestial meridian** is an imaginary line that starts at the north point of the horizon, rises directly through the **North Celestial Pole** (NCP) to the zenith and then continues on down to the southern point of the horizon. The NCP is less than one degree from Polaris, the Pole Star.

Venus and Mercury show phases like the Moon. Mars can look **gibbous**, i.e. not quite full. Jupiter can show very slightly less than full at **quadrature** in amateur telescopes.

The outer planets can exhibit a phenomenon known as **retrograding**. A consequence of them lying further from the Sun than us is that they orbit more slowly than the Earth. Therefore, at opposition, the Earth can overtake an outer planet causing its apparent movement against the stars to grind to a halt, move back to the right, halt, and then resume direct motion once again.

## A note on time

Times throughout *Sky-High 2004* are given in **Universal Time** (UT). This is the 24-hours system starting at mean midnight as measured at Greenwich. It is the same as Greenwich Mean Time (GMT). UT is the same as Irish civil time except when Summer Time is in use. To translate UT into Summer Time just add one hour.

We have added **sunrise and sunset times** along with **moonrise and set times** at the foot of each diary page. These times are quoted for Dublin but there is little difference countrywide. A "*p*" is used to denote moonrise occurs the *previous* evening while "*f*" indicates moonset is the *following* morning.

## Star magnitudes

The **magnitude** of a star refers to its brightness, not to its size. The scale of magnitudes is a logarithmic one. A difference of one magnitude is a difference of 2.512 times in brightness. A difference of five magnitudes is a difference of 100 times in brightness. The lower the magnitude number, the greater the brightness.

The stars in the Plough range from about magnitude 2 to magnitude 3½. The faintest stars you can see with the naked eye on a really dark moonless night, away from city lights, are magnitude 6 or 7. Binoculars show stars two to four magnitudes fainter, while the most powerful telescopes in the world are able to show magnitudes approaching +30. The apparent brightness of a star depends on its true brightness and its distance. The term magnitude if not qualified, refers to apparent brightness.

The term **absolute magnitude** is the magnitude a star would show if it lay at a standard distance of 10 **parsecs** (a *parsec* is the distance a star must lie to exhibit a *par*allax of one arc-*sec*ond; it is equivalent to about 3·26 light years.)

| | | | | | |
|---|---|---|---|---|---|
| α | alpha | ι | iota | ρ | rho |
| β | beta | κ | kappa | σ | sigma |
| γ | gamma | λ | lambda | τ | tau |
| δ | delta | μ | mu | υ | upsilon |
| ε | epsilon | ν | nu | φ | phi |
| ζ | zeta | ξ | xi | χ | chi |
| η | eta | ο | omicron | ψ | psi |
| θ | theta | π | pi | ω | omega |

*The Greek alphabet is used to identify the brightest stars in each constellation. The labelling sequence doesn't necessarily start with alpha being the brightest — in fact, 34 of the 88 constellations have at least one star more brilliant .*

## The scale of space

While kilometres may be a convenient unit to measure distance on Earth, not so in space.

Astronomers therefore use a more manageable metre-stick within the solar system known as the **astronomical unit** (a.u.). One astronomical unit is simply the mean Earth-Sun distance which is roughly 149, 597, 870.691 kilometres — mind you, it would still take over 177 years continuous driving (within the national road speed limit!) to reach the Sun!

The void between the planets may be measured in tens of millions of kilometres but to bridge the gap to even the nearest star requires kilometre-long leaps of mind-boggling proportions so we use the **light-year**. A light-year is simply the distance travelled by a ray of light in a year. We know light itself has a finite speed of approximately 300, 000 km/s so a light year can then be calculated as 300, 000 * 60 seconds in a minute * 60 minutes in an hour * 24 hours in a day * 365.25 days in a year to give a rough result of 9·46 *trillion* km!

By the way, a light-year is a measure of *distance*, not of *time*. However, looking at the night sky we genuinely are looking back in time and see celestial bodies as they were because of how long even light needs to cross the huge distances.

Once you get beyond the stars and into the realm of galaxies even the light-year becomes unwieldy when talking in large numbers. The term **mega-parsec** (1000 *parsecs*) is freely banded about by cosmologists though they are even reduced to describing distances to objects at the edge of the observable Universe in terms of their **recessional velocity**, or **red shift**, of which the quantity $z$ is used in equations.

All in all, space is a very big place indeed but within the pages of *Sky-High* we hope we can get you started on a voyage through the wonders of the Universe that will last a lifetime.

# Looking back — the past year reviewed

TRAGEDY. IT WAS A WORD that dominated the headlines last February after the destruction of the US space shuttle *Columbia* during re-entry on February 1st following a successful 16-day science mission.

The loss of *Columbia* and her seven crew was the second major disaster to hit the US space shuttle fleet since the first maiden flight of the space orbiter in April 1981. The spacecraft was just 15 minutes away from landing when the left wing apparently broke apart 60km above the Earth. Multiple on-board sensors in the area of the left wing stopped working or showed temperature rises beginning as ground-based observers began to see material apparently breaking off from the fiery trail of the vehicle.

In the early days following the tragedy, much was mentioned about a piece of insulating foam from the external tank striking *Columbia* on take-off.

Tests in July simulating the high-speed impact of a piece of debris on an orbiter wing showed *Columbia* was doomed from virtually the start of the mission. The *Columbia* Accident Investigation Board subsequently released a report that was critical of Nasa's management structure and margins for safety. Their recommendations are currently being vigorously implemented by Nasa prior to return to service of the shuttle fleet which is now expected to happen after the summer of 2004.

Professional astronomy in Australia suffered a cruel blow in mid-January when firestorms that swept through Canberra destroyed Mount Stromlo Observatory, Australia's oldest research observatory.

All six telescopes, a major equipment workshop, several houses and an administration building were completely gutted. The fires also incinerated a key piece of equipment that had been built for the Gemini North telescope in Hawaii.

The Australian government has committed to rebuilding the observatory and restoring the country's pre-eminence in the international astronomical community

## Space exploration

A number of setbacks, the successful launches of new space observatories, and the dispatch of a flotilla of craft to Mars characterised the year.

Two tragic accidents befell the Brazilian and Russian space programmes. Brazil's *VLS-1* rocket was undergoing preparations for a launch from the country's Alcantara launch facility when it suddenly exploded without warning. The explosion destroyed the rocket and the two small satellites it planned to launch. A total of 21 people, including a mix of military and civilian technicians, were killed in what was one of the world's worst space industry disasters.

Meanwhile, in October 2002, a *Soyuz-U* rocket failed shortly after launch at the Plesetsk cosmodrome killing one and injuring others, while the scientific payload with many foreign experiments was destroyed.

Scientists were horrified to see Europe's new *Ariane 5-ESCA* rocket fail just three minutes into its maiden flight on December 11th, 2003. The launcher blew up when it started to veer off course, dumping two satellites worth more than 600m euros in the Atlantic Ocean. Space officials subsequently postponed the planned January 2003 launch of the *Rosetta* comet lander due to concerns at the failure of the new *Ariane 5* configuration

*A picture of Columbia's crew on the shuttle flight deck. The print was found on a roll of film recovered from the debris of the orbiter.*

Elsewhere, we give a little more background to the various Mars-bound spacecraft that left Earth during the Summer of 2003. The planet, and the missions, diverted attention somewhat from other space launches during the year.

ESA's *International Gamma-Ray Astrophysics Laboratory* (*InteGRAL*) was lofted into orbit by a Russian *Proton* rocket in October 2002. The spacecraft will allow astronomers to study objects emitting the most powerful electromagnetic radiation into space in unprecedented detail.

The *Space InfraRed Telescope Facility* (*SIRTF*) finally reached orbit following launch by a *Delta-2* rocket on August 25th, 2003. The spacecraft will utilise a one-metre class telescope to observe the sky in infrared wavelengths and will trail the Earth in its orbit to avoid heat radiating from our own planet contaminating the observations. Mission objectives include detailed study of cold circumstellar dust clouds; a search for the enigmatic brown dwarfs; extension of *IRAS* studies of forming stars to lower temperatures and luminosities; identification and study of powerful infrared galaxies; and, infrared measurements of all presently catalogued quasars.

Finally, on January 22nd last, NASA's Deep Space Network received possibly the last communication ever from it's long-enduring probe *Pioneer 10*

Attempts to contact the spacecraft in February were unsuccessful and no further ones will be made. At the time the message was received, *Pioneer 10* was 12·16 billion kilometres from Earth. The signal, travelling at the speed of light, took 11 hours and 20 minutes to arrive.

## The solar system

Moons, moons, and more moons. No wonder Daniel Fischer, on his *Cosmic Mirror* website, threw up his hands in exasperation at attempts in keeping track of the planet satellite counter ticking upwards week after week.

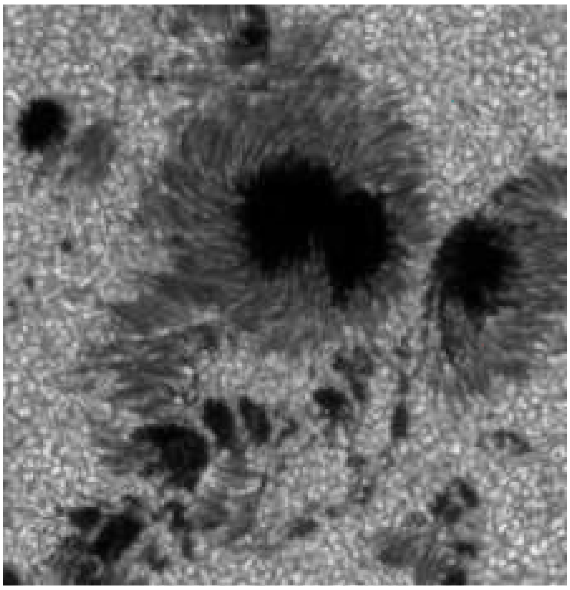
In early January, a team of astronomers discovered three previously unknown moons of Neptune boosting the number of known satellites of the planet to eleven. The new satellites are between 30 and 40 kilometres in size. Astronomers using telescopes on Mauna Kea in Hawaii meanwhile pushed the tally of known moons of Jupiter to 60. They are mostly small irregularly shaped objects that are probably captured asteroids.

A near-Earth asteroid called 2003 $QQ_{47}$ made the news when astronomers predicted that it could strike the Earth in 2014. There now have been 51 observations made of its orbit and the chance of it hitting the Earth has receded. The space rock is estimated to be 1·2 km across. If it had struck Earth, it would have caused widespread destruction across an entire continent.

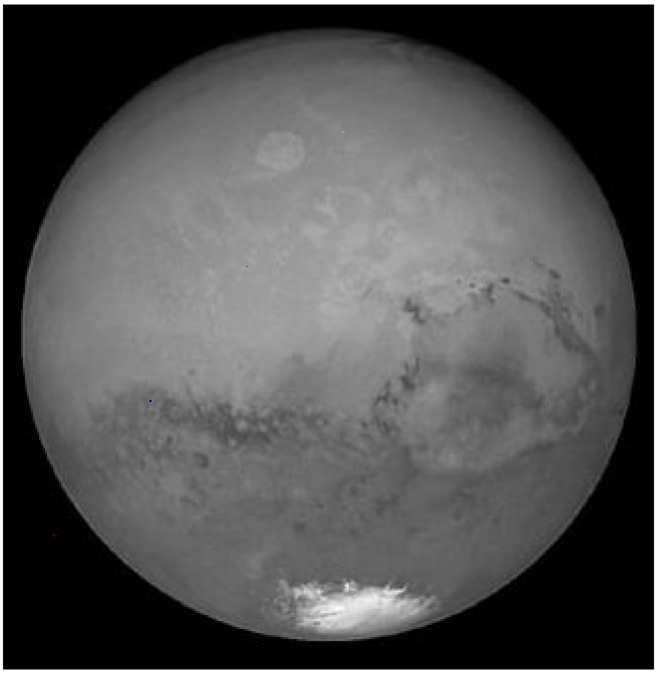
Another body, 2002 $AA_{29}$, happens to share almost the same orbit as the Earth as it goes around the Sun, getting closer and further as it interacts with our planet's gravity. There is no possibility that it can ever hit our planet, though, as interference from the Earth's gravity keeps it at bay — causing it to trace out a strange horseshoe shape as it goes around the Sun.

At the beginning of the year, astronomers discovered a new object which shares a very similar orbit with Neptune. Part of a classification of objects called Trojans, 2001 $QR_{322}$ is 230 km across and requires 166 years to orbit the Sun. Although clusters of Trojans have been found following Jupiter's orbit, none have ever been found to share an orbit with any other giant planet; although, they've been predicted for years.

Data from the Mars Global Surveyor spacecraft seemed to rule out the presence of a global ocean on the planet in the distant past.The evidence has come from the spacecraft's



*Astronomers used new techniques to capture sunspots — dark blemishes on the solar surface — in unprecedented detail in 2004*



*Our best ever view of Mars from Earth was taken by the Hubble Space Telescope on August 27, 2003 — the day the Red Planet was at it's closest to Earth anytime in recorded history.*

thermal emission spectrometer which found no detectable carbonate signature in surface materials during its six-year Mars mapping mission.

Some trace amounts were found in the surface dust but this probably did not come from marine deposits derived from ancient martian oceans, but from the atmosphere interacting directly with dust. Tiny amounts of water in Mars' atmosphere can interact with the ubiquitous dust to form the small amounts of carbonate that we see.

It now looks like cold, frozen, icy Mars has always been that way, as opposed to a warm, humid, ocean-bearing Mars sometime in the past.

There are now four bodies known in the outer solar system that approach or reach half the diameter of the planet Pluto. The latest to be added to the list is 2002 $LM_{60}$ with a particularly well established diameter of 1250 km. This object (which the discoverers want to name Quaoar) is actually more normal than Pluto, with an almost circular orbit at 42 AU and a lower inclination of 7°.

NASA has finally authorized the New Horizons Pluto-Kuiper Belt mission to go forward with spacecraft and ground system construction. New Horizons is proceeding toward a January 2006 launch, with an arrival at Pluto and its moon, Charon, as early as the summer of 2015.

The 415-kilogram spacecraft will characterize the global geology and geomorphology of Pluto and Charon, map the surface compositions and temperatures of these worlds, and study Pluto's unique atmosphere in detail. It will then visit one or more icy, primordial bodies in the Kuiper Belt, beyond the orbits of Neptune and Pluto, where it will make similar investigations. The spacecraft carries seven separate sensor packages to carry out these studies.

However, the US Congress recently billed a motion to slash $55m from the mission budget. Whether the spacecraft finally flies is still debatable based on this recent news.

## Cosmology

Proof that we haven't yet fully completed a census of the Sun's neighbourhood came early this year when astronomers discovered one of the closest stars to our Sun.

The new star was found because its relatively swift motion across the sky was picked up by automated sky surveys. It ranks as the third closest star system and the fifth closest star to our Sun. The star currently goes by the designation SO 025300.5 +165258 and is a faint red dwarf only 7·5 light years away.

Observations made with *Hubble* indicated that the first stars formed as little as 200 million years after the Big Bang — much earlier than previously thought.

The evidence came from data showing large amounts of iron present in very distant, ancient quasars. This iron must have been made in the massive explosions that ended the lives of the first generation of stars in the cosmos.It also suggests that the raw materials for life were present from a very early stage in the history of the cosmos.

Early in the year, scientists also discovered that one of the brightest gamma ray bursts on record was also a supernova. It was the first direct evidence linking these two types of explosions, both triggered by the death of a massive star.

The burst was initially detected on March 29, 2003, in the constellation Leo by Nasa's *HETE* satellite. For more than 30 seconds, the burst outshone the entire universe in gamma rays. Two hours later, the explosion's optical afterglow remained a trillion times more luminous than the Sun. Although the fireball was about two billion light-years away, it was nevertheless bright enough to be detected by small telescopes on Earth.

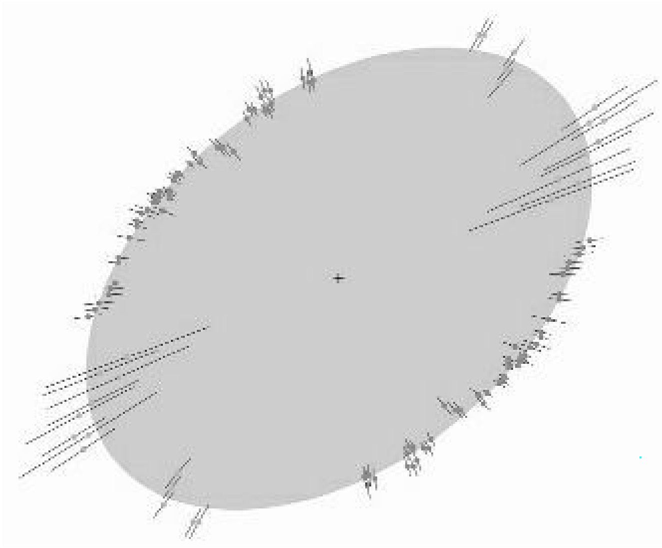
Astronomers with the European Southern Observatory discovered that the star Archenar is extremely flat. All rotating objects in space are flattened due to their rotation but Achernar is 50% wider at its equator than at its poles. However, its shape doesn't fit current astrophysics models. The star should be losing mass into space at the rate it's rotating.

The *Hubble Space Telescope* was recently used to identify the oldest extrasolar planet ever discovered. The 2·.5 Jupiter mass planet was originally discovered around a pulsar in the globular cluster M4 way back in 1988. By using *Hubble*, astronomers were better able to explain how the planet ended up around a pulsar. This discovery could reshape the current models of planetary development, which predict that stars needed to go through at least one complete cycle to create the heavier elements planets require.

A new companion to the Andromeda galaxy (M31) was discovered in September. It turns out that a collection of stars orbiting M31 are actually the remnants of another galaxy being torn apart and consumed. Researchers only realized it was a separate galaxy after charting the velocities of several of its stars. Astronomers failed to detect it before now because much of the galaxy is located in front of Andromeda's bright galactic disk.

## The amateur scene

May was a banner month for amateur astronomers with a transit of Mercury across the Sun, a total lunar eclipse, and an annular solar eclipse, all scheduled in that order. In between dodging clouds, many Irish amateur astronomers got their first glimpse of a planet transiting the solar disk in a dress-rehersal for the long awaited June 2004 Venus transit.



*A simulated profile of the star Achernar — the flattest star known?*

Yet again, the weather played havoc with our attempts to view another astronomical event when the total lunar eclipse was washed out. However, sketchy reports suggested that at least one or two people got a brief glimpse of the partial phases through gaps in the clouds. One Irish amateur was successful when a business trip to Luxembourg coincided with a clear spell and the eclipse was seen in the brightening dawn sky.

With the path of annularity for the May 31st annular solar eclipse sweeping across northern Scotland, a number of Irish eclipse chasers took the opportunity to head to Alba to catch the event. However, the low altitude of the Sun at the time of annularity contrived with dense fog to defeat the efforts of most. From Durness though, a small group of intrepid observers managed to see the lovely sight of the "Ring of Fire" just after sunrise over the North Sea.

The year though belonged to Mars and it's closest approach to Earth at any time in recorded history. Needless to say, many overlooked the simple fact that Mars regularly is well placed for amateur astronomers at opposition time though not as good as this. Although the planet was low, some stunning views through large instruments were had and the interest in the event was enormous. The current apparition continues for the astronomy community well into the first month of 2004.

On the night of closest approach (August 27th), many budding sky watchers were startled by the sudden appearance of a fireball bright enough to illuminate the surrounding landscape. The bolide streaked across the country from the northeast to southwest and brought a flood of reports from all over Ireland. Kerry though yielded the most interesting data with many people reporting a loud explosion and, in some instances, cases of houses being shook. It is almost certain a case of a meteorite fall though at time of writing further analysis is needed to delineate a search area.

All in all, it's been a busy year in astronomy and space and through these pages, 2004 looks to be equally exciting.

# January 2004

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 |

○ 7d 15h 40m ◑ 15d 04h 46m ● 21d 21h 05m ◐ 29d 06h 03m

Venus is dazzling in the evening sky with Mars a red spark among the stars of Pisces. Jupiter and Saturn shine bright throughout the hours of darkness while Mercury can be seen in the dawn the entire month.

The Quadrantid meteor shower is badly affected by moonlight though some of the brighter shower members may *schuss* across the sky before dawn on the 4th. The minor planet 1 Ceres is at opposition on the 9th (page 34).

Venus continues its very favourable evening apparition from late-2003 and remains a brilliant lamp hung above the southwestern skyline. Through a telescope the phase is distinctly gibbous, becoming just marginally a little less plump by the end of the month.

The magnitude -4·0 planet passes close in the sky to two distant solar system members this month when it drifts by Neptune on New Year's Day and Uranus on the 15th.

Binoculars will enable you spot Neptune as a magnitude 8·0 bluish “star” on the evening of the 1st in Capricornus when it lies within 3° of much brighter Venus. The charts here for both it, and the Venus-Uranus appulse, should help you track down both far-flung worlds.

It’s the turn of Uranus to pair up with Venus on the evening of the 15th when it is lies within 3° of the veiled planet. Uranus is borderline naked-eye visibility at magnitude 5·9 but to achieve that feat you would need good skies with the planet much higher in the night.

Is it really four months since the close opposition of Mars to Earth garnered all the attention? The planet still continues to intrigue for telescope users though the disk shrinks to a challenging 6·87 arcseconds by the end of the month (it opens January at 8·46 arcseconds in diameter).

Similarly, the brightness tails off a notch from magnitude 0·2 to 0·7 by month’s end — though it easily outshines the dim suns making up the constellation Pisces in the southern sky where it lies these evenings as soon as darkness falls.

A 10cm telescope will still show surface detail and in particular, the north polar cap which has grown over the last few months following winter solstice in the Martian northern hemisphere on 2003 September 29. The planet was at eastern quadrature on December 30th and so looks gibbous.

Saturn reached perihelic opposition on the last day of 2003 when it lay 1204 million km from Earth — it won’t be this close again until 2032. It rises just after sunset on the 1st and shines with a slightly yellowish-tint in the feet of Gemini. This has been one of the best apparitions of Saturn for some time with the magnitude -0·4 planet high for observers when on the meridian later in the night.

The southern aspect of its ring system are tipped 25½° Earthward at present and are a beautiful sight in any scope.

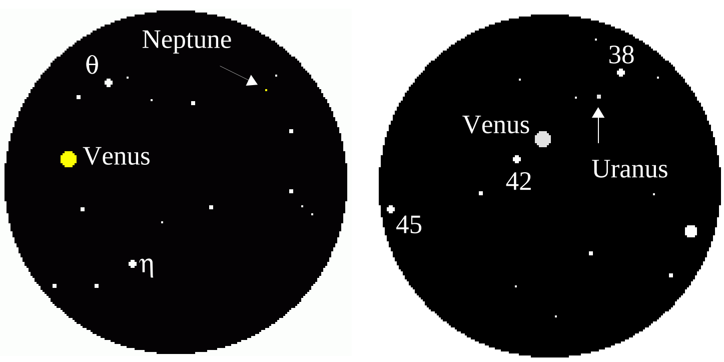
Saturn’s largest moon Titan orbits in just under 16 days and is about five ring diameters east or west of the planet when at elongation. Look for it in large binoculars as an 8th magnitude speck west of the planet on the evening of the 1st.

Fat Jupiter heaves itself over the horizon a little before 23h on the 1st and two hours earlier by the end of January. It begins the month within ½° of the 4th magnitude star σ Leonis and is at its stationary point on the 4th when it begins to retrograde and creep slowly westward. The planet moves 10° west among the stars of Leo between now and May 5th.

Mercury, in the morning sky, climbs rapidly above the southeastern skyline after the first few days of the month. You should have no problem spotting the magnitude 0·5 point of light before sunrise. Mercury brightens to magnitude -0·2 after greatest western elongation (23° 55’) on the 17th but begins the retreat back in to the solar glare at the same time. It remains on view very low down for the rest of the month though.

The Moon pairs off with the five classical planets at some point during the month. Saturn lies 4° below the almost full Moon on the evening of the 6th while the waning gibbous phase approaches Jupiter on the evening of January 11/12 with the duo closest on the morning of the 12th. Look for the thin crescent in the dawn on the 19th with Mercury two-and-a-half binocular field widths to its left (12°).

Before the end of the month, our companion traveller in space has cycled its phases through New and is a slender curl 3½° to the lower right of Venus after dusk on the 24th. The final encounter is with Mars when the Red Planet lies 5° above the Moon during the late evening of the 27th.




These charts show a 5° binocular field on the nights of January 1st when Venus lies near Neptune in Capricornus (left), and January 15th when Venus is close to Uranus in Aquarius (right). The stellar limit is to magnitude 7·5.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Jan 1st | *s.r.* 08h39m | *s.s.* 16h18m | Jan 15th | *s.r.* 08h32m | *s.s.* 16h37m | Jan 30th | *s.r.* 08h13m | *s.s.* 17h05m |
| Jan 1st | *m.r.* 12h49m | *m.s.*f03h37m | Jan 15th | *m.r.* 00h51m | *m.s.* 11h44m | Jan 30th | *m.r.* 11h21m | *m.s.*f03h49m |

# February 2004

| S | M | T | W | T | F | S |
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| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | | | | | | |

○ 6d 08h 47m ◑ 13d 13h 40m ● 20d 09h 18m ◐ 28d 03h 24m

Venus, Mars, Jupiter and Saturn are all to be found in the evening sky throughout February. A sweep across the heavens the latter half of the month finds all four ecliptic hugging planets simultaneously above the horizon. The moment is a fine opportunity for those with even just a casual interest in the sky to be inspired.

Mercury is too close to the Sun to be observed. Uranus and Neptune both pass through superior conjunction.

Venus bursts into view as the evening star as twilight fades and holds a commanding place high above the south-western horizon. It brightens a tenth of a magnitude by the end of the month to -4·2 while the disk seen in a small telescope narrows to 66% illuminated in the same period. The best time for telescope users to observe Venus is actually in a twilit sky (or even in full daylight). Then, the planet's brilliance is less glaring against the paler background. Venus sets nearly four hours after the Sun throughout February.

A little known fact is that its piercing light is sufficient to cast shadows from a dark site. Find a place far from the artificially induced pall hanging over our towns during a period when the Moon is absent. The most ideal location is where you can only see the narrow portion of sky that includes Venus because you want to shield yourself from as many other light sources as possible.

A perfect spot is a forest clearing with Venus visible through a gap in the canopy. Hold your hand in front of a piece of white card or shirt and you should see a faint shadow cast. It's a fascinating demonstration of the burka-clad world's radiance.

The rapid motion of Mars carries it over the border of Pisces into Aries at the beginning of the month and nearly three-quarters of the way across the Ram by the end of February. It continues to fade though remains prominent in the evening in a bright-star poor region of the sky, sliding from magnitude 0·7 to 1·0 by the 29th.

A telescope of at least 15cm aperture is probably now necessary to make out any sort of detail on the disk which shrinks to less than six-arcseconds after mid-month.

For many, this marks the end of the great apparition over the past half-year but patient observers will tease out some of the more prominent features. Delicate strands of cirrus cloud and bright frost patches may be seen too as the Martian atmosphere clears following the dust storms that frequently whip up during perihelic oppositions.

Saturn, still bright at magnitude -0·2, is high in the eastern sky in Gemini as soon as darkness falls and slowly closes to within 1° of the magnitude 2·9 star μ Geminorum by the end of the month. Look for Titan at eastern elongation on the 10th at 19h.

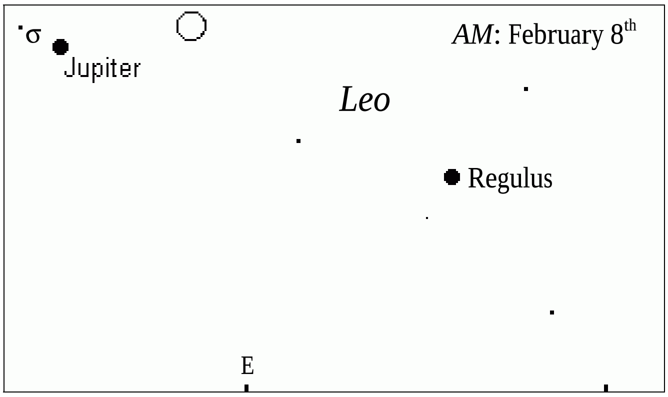
Jupiter continues its stately progress through Leo and is now just over a month from opposition. The magnitude -2·5 planet rises a little after 20h on the 1st and two hours earlier by the end of the period. A small telescope will reveal the two main equatorial belts while higher magnification brings out more detail in its turbulent atmosphere.

Binoculars are sufficient to show the motions of the four Galilean satellites — Io, Europa, Ganymede and Callisto — about their parent from night to night. They will appear as tiny pinpoints of light close in to Jupiter. In fact, the four would be visible to the naked-eye but for the glare from the primary. The quartet line-up in their order of increasing distance from the planet late-evening on the 9th when they are pearls-on-a-string to Jupiter's east.

Mercury is just a little too low to be visible this month as it is quickly swamped by the brightening dawn. Neptune and Uranus are both in conjunction with the Sun; the former on the 2nd (it is, in fact, occulted by the Sun's disk) while Uranus passes through conjunction point on February 22.

The lovely sweep of planets mentioned in the highlights at the top of the page is more than just an attractive sight, it's also an opportunity to closely study their contrasting colours. Venus shines with a sharp white light while the ochre hue of Mars is a result of its rust-red surface material. Saturn often seems to have a slightly yellowish tint when set against regal Jupiter's soft cream glow. What colours do you see?

The Moon is a lovely sight when a slender 34-hour old crescent on the evening of the 21st. Venus lies 4° to its upper right on the 23rd while Mars can be found 3° above the Moon two nights later on the 25th. The Moon is paired with Saturn on the 3rd and the 29th. On the morning of the 8th the waning gibbous Moon is 5½° from Jupiter.




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Feb 1st | *s.r.* 08h09m | *s.s.* 17h08m | Feb 15th | *s.r.* 07h43m | *s.s.* 17h36m | Feb 29th | *s.r.* 07h14m | *s.s.* 18h01m |
| Feb 1st | *m.r.* 12h06m | *m.s.*f06h08m | Feb 15th | *m.r.* 04h30m | *m.s.* 11h20m | Feb 29th | *m.r.* 10h37m | *m.s.*f04h57m |

# March 2004

*Summertime begins on March 28 — set clocks forward one hour*

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| 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 28 | 29 | 30 | 31 | | | |

○ 6d 23h 14m ◑ 13d 21h 01m ● 20d 22h 41m ◐ 28d 23h 48m

Jupiter is at opposition in Leo and visible right throughout the night. Venus, Mars, and Saturn all remain evening sky objects. Mars is occulted by the Moon on the night of March 25/26 (actually, just after midnight the 26th) but the planet has set from here by the time the event gets underway. Mercury rises out of the evening twilight and is visible the second half of the month.

Fleet-footed Mercury rises sharply out of the evening twilight glow the second half of March and can be found as a bright "star" low in the western sky after sunset for the remainder of the month. The altitude increases rapidly and it stands 11° above the skyline on the day of greatest eastern elongation on March 29.

The brightness diminishes as the planet nears elongation — a consequence of the narrowing phase of illumination. Through a small telescope on the 29th the disk of the planet appears 40% lit.

Venus is at greatest eastern elongation (46° 00') on the 29th and stands high in the western sky. It sets nearly five hours after the Sun and is unmistakable at magnitude -4·3. At greatest elongation this month, the disk is a lovely illuminated half-phase and measures 23 arcseconds diameter. The latter week too it is rapidly closing in on the beautiful Pleiades star cluster in Taurus which it will lie close to, and pass, in April.

Mars continues to slowly fade as threads its way from Aries into Taurus during the month. It begins March at magnitude 1·1 and ends within 8° of the magnitude 0·9 star Aldebaran when it is the dimmer of the two at magnitude 1·4. Use the occasion to compare the colours of the duo. Aldebaran is an orange-coloured giant 65 light years distant and is not actually a member of the Hyades star cluster in which it appears to lie — it's only half the cluster's distance.

We just about miss an occultation of Mars by the Moon on the night of March 25/26. The Moon is just a couple of days shy of First Quarter and slowly creeps towards Mars during the hours after dark on the evening of the 25th.

The occultation itself will take place just after midnight though both Mars and the Moon are very low on the horizon at the time. The pair will have just set at the time Mars is covered by the leading edge of the Moon.

Still, it's rare there are such opportunities to see a planet so close to the Moon's limb and it is well worth observing for curiosity value.

Jupiter is at opposition on March 4th when it can be seen throughout the night as a brilliant magnitude -2.5 object within 1° of the magnitude 4·6 star χ Leonis. The equatorial diameter of the planet , 662 million km distant, is 44·55 arcseconds on opposition day.

Telescopic observers in Ireland will lament the missed chance to see a rare triple shadow transit of the Jovian moons on March 28th — the event takes place after sunrise on that day for us. We must wait until the early morning of 2013 October 12 for the next favourable opportunity from here when the umbrae of Io, Europa, and Callisto simultaneously glide across Jupiter's cloudtops.

Not as rare are shadow transits of two of the Galilean moons and some favourable dates this month to catch the phenomenon are on the evening of the 8th when the shadows of Europa and Io are projected on Jupiter's face from 20h 20m UT to 21h 18m UT, with the same moons involved for the event on the 15th when the shadows of both can be seen between 22h 14m UT and 23h 54m UT. An even more interesting double transit is that during the early hours of the 30th when the shadows of Io and Europa closely follow each other across the disk. Turn your scope Jupiter-ward between 2h 17m UT and 3h 41m UT.

An 80mm telescope at high power is about the minimum size needed to see the various transit phenomena while a 150mm or larger instrument is sufficient to show Jupiter's four largest moons as tiny disks with some subtle colour differences between them also evident.

Saturn is at eastern quadrature on March 27 (elongation east of the Sun is 90°) when the shadow of the globe is cast farthest to the side on the rings giving an even more three-dimensional appearance to the view than usual. The planet is stationary on March 7 when it's prograde, or eastward, motion among the stars resumes.

The Ringed Planet can be found tonight just 1° east of the magnitude 2·9 star μ Geminorum and travels 21° eastward through Gemini between now and November 8.

Pluto reaches its stationary point on March 24 when the planet begins to retrograde; a loop that carries it 2 ¾° westward among the stars of Serpens between now and August 31. Pluto is currently a magnitude 13·9 mote in a moderate sized telescope and is 4685 million km distant.

Mercury lies 5½° to the right of the 45-hour old slender crescent of the Moon on the evening of the 22nd. Two days later, on the 24th, the Evening Star of Venus is 3½° above lovely luna. High in the southwest as soon as darkness falls on the 28th you will find Saturn 3° to the lower left of the Moon while Jupiter pairs off with the Moon on the 6th when it can be found 3° to its right.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mar 1st | *s.r.* 07h13m | *s.s.* 18h03m | Mar 15th | *s.r.* 06h40m | *s.s.* 18h29m | Mar 30th | *s.r.* 06h04m | *s.s.* 18h56m |
| Mar 1st | *m.r.* 11h21m | *m.s.* f05h46m | Mar 15th | *m.r.* 04h45m | *m.s.* 11h08m | Mar 30th | *m.r.* 11h09m | *m.s.*f04h52m |

# April 2004

*Summertime in effect this month — add one hour to event times*

| S | M | T | W | T | F | S |
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| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | |

○ 5d 11h 03m ◑ 12d 03h 46m ● 19d 13h 21m ◐ 27d 17h 32m

**Venus** dallies close to the Pleiades star cluster the first few days of April and appears to chase **Mars** across the sky during the month. **Saturn** can be found within Gemini in the southwestern sky after dark while **Jupiter**, in Leo, approaches the meridian at nightfall. **Mercury** is an evening sky object the first ten days of the month. Favourable conditions the night of April 21/22 will let you spot some members of the **Lyrid** meteor shower.

The not too frequent opportunity to see the five classical naked-eye planets simultaneously above the horizon remains for the first ten days of this month. The next instance this will occur is during a period from mid-December 2004 to mid-January 2005 in the morning sky. You then must wait until 2016 to see such a sight again.

**Mercury** is waning in brightness as the month opens while a small telescope at medium magnification will show the phase as a diminutive crescent. It is also dropping back towards the solar glare and will be lost to view after the first third of April.

**Venus** opens the month in close proximity to the beautiful Pleiades, or Seven Sisters, star cluster — probably one of the most famous stellar associations in the whole sky. Binoculars will enhance an already beautiful scene with many other fainter Pleiads sprinkled across the field of view.

Most people can see six of the seven "sisters" from a suburban site while it's possible to see ten or more members of the cluster with a little patience and transparent skies from a dark location.

On the 14th, Venus engages the reddish star Aldebaran in Taurus in the first of three *conjunctions in right ascension* to occur this year (see also the notes for June and July). The last time this happened was in 1817. The separation during this first pass between the pair will be just under 10°.

Venus swells in size during the month from 24 arcseconds to 36 arcseconds while the phase in a small telescope narrows from half to 28% illuminated by the end of April.

The planet chases, but doesn't quite catch, **Mars** during most of April — the duo are closest in angular distance on the 25th when just 5½° separates both. Thereafter, Venus rounds the curve of its orbit and we see it begin the retreat sunward.

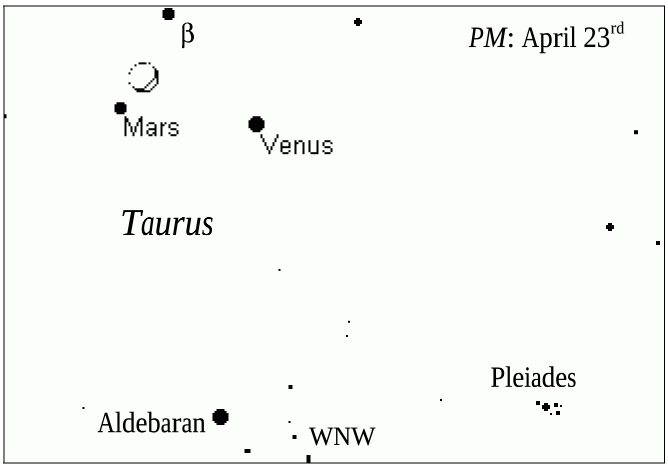
The contrast in brightness is dramatic with magnitude 1·3 Mars a whopping 160 times dimmer than -4·3 Venus. The Red Planet is not quite anonymous among the stars of Taurus but is a pale imitation of its opposition on August 27 last when it was 48 times brighter than present.

**Saturn** can be found high in the southwest among the stars of Gemini as soon as darkness falls. The planet remains bright at magnitude 0·1 though the rings begin to close up ever so slightly after being at their maximum extent open for the year during March.

**Jupiter**, in Leo, is approaching the meridian as darkness falls these evenings and loses a tenth of a magnitude — from -2·4 to -2·3 — by the end of the month as the gap between us and the planet begins to open. In terms of the geometry of the solar system, the Earth is now past Jupiter's opposition point when the Sun, ourselves, and Jupiter were in a straight line. Now, we're on that arc of our orbit that is carrying us away from the distant giant. Actually, a very good visual demonstration of this is to point your web browser to the heavens-above.com website where you can run a Java applet that gives a birds-eye view of the solar system. The software allows you step through the motions of the planets month-by-month and is quite intuitive.

As twilight draws to a close these evenings we can sometimes see a pale cone of light tapering up from the western horizon. This is the **zodiacal light**, a disc of dust particles in the inner solar system (and the plane of the solar system) reflecting and scattering sunlight. Late-February through to early-April are the most favourable times of year to see it in the evening sky from our latitudes. A moonless night far from sources of light pollution is also a prerequisite.

The lovely grouping of the **Moon, Venus and Mars** on the 23rd is shown in the diagram below but look out too for the pairing of Luna with the two naked-eye gas planets. Jupiter is 2½° to the lower right of the Moon in the southeastern sky when dusk falls on the 2nd while it is high in the south and 5° lower left of the Moon on the 29th — the gap actually narrows somewhat as the night progresses. The night after the link-up of the Moon with Venus and Mars, Saturn can be found 5° to the left of the Moon on the 24th.




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Apr 1st | *s.r.* 05h59m | *s.s.* 19h00m | Apr 15th | *s.r.* 05h26m | *s.s.* 19h25m | Apr 30th | *s.r.* 04h54m | *s.s.* 19h52m |
| Apr 1st | *m.r.* 13h45m | *m.s.*f05h29m | Apr 15th | *m.r.* 04h44m | *m.s.* 14h31m | Apr 30th | *m.r.* 14h03m | *m.s.*f04h00m |

# May 2004

*Summertime in effect this month — add one hour to event times*

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| 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | 31 | | | | | |

○ 4d 20h 33m ◑ 11d 11h 04m ● 19d 04h 52m ◐ 27d 07h 57m

The **Moon** rises in **eclipse** on the 4th with the rest of the drama played out in the deepening twilight (see page 29). **Venus** remains prominent in our evening skies accompanied by Mars and Saturn. A **daylight occultation** of Venus is visible from here on the 21st. Mars plays catch up with Saturn and the two close to within 2° of each other towards the end of the month. **Jupiter** can be found in Leo and remains on view for the majority of the night.

At the beginning of the month, **Venus** can be found lingering briefly near the star β Tauri which marks the tip of the northern horn of the Bull. It reachest greatest brilliancy on the 2nd (magnitude -4·5) when it dominates the western sky after sunset. The phase is narrowing to a thin crescent while also swelling in size and even a pair of 7x or 10x binoculars is sufficient to show the diminutive sliver at the moment. The best time to look is when the glare from the planet is subdued by the hues of twilight and before the sky gets fully dark.

A **daylight occultation** of Venus occurs from here on the 21st and exact circumstances (for Dublin) are given in the occultations section on page 28. Special care is needed when observing a daytime occultation of a planet lest you let the Sun accidentally drift into the field of view of your telescope. Venus is 27° east of the Sun on the day in question.

The planet narrows the gap to less than 6° between itself and Mars on May 1st before reaching the apex of its path in the sky this apparition. It now begins to turn back Sunward and inferior conjunction on June 8th when it will transit the Sun's disk.

**Mars** crosses from Taurus into Gemini the second week of June. It lies close to the splashy open star cluster M35 around the 9th though twilit skies will mean the stellar grouping is all but invisible.

The rapid motion of magnitude 1·7 Mars means it catches up with Saturn (magnitude 0·1) on the evening of the 24th when both are just over 1½° apart low in the north-western sky. Venus (magnitude -4·3) is a dazzling beacon 15° to their lower right. The trio all lie in a nearly straight line 15° long on the 13th, reading — in increasing altitude above the skyline — Venus, Mars, and Saturn.

The southern aspect of **Saturn's** rings are still tipped over 25° Earthward throughout the month and the view is to be marvelled at time and time again in any telescope. The planet sets 4½ hours after the Sun at the beginning of the month and 2 hours earlier by the end of May.

You'd be forgiven for overlooking **Jupiter** with all the other drama being played out in the dusk this month.The giant planet is stationary on the 5th when it ceases to retrograde and it's direct, or eastward, motion amongst the stars of Leo resumes.

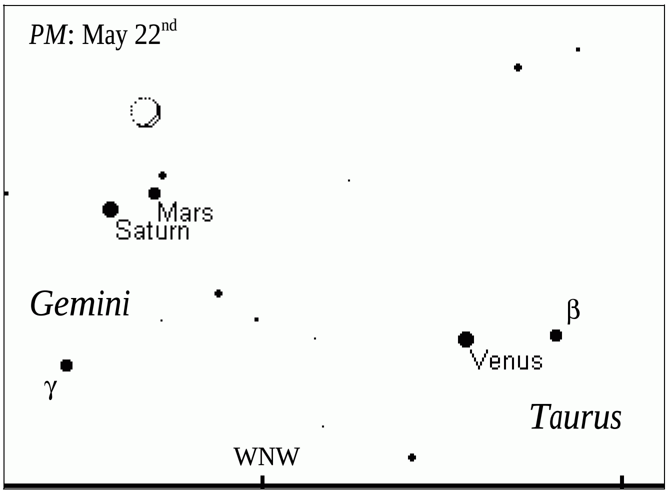
The magnitude -2·0 planet remains above the horizon until the early hours of the morning. The angular diameter of the disk shrinks from 40·5" to 36·9" by the end of May.

A good astronomical handbook such as Guy Ottewell's *Astronomical Calendar* will provide much detail on interesting satellite phenomena involving the four Galilean moons. The guide is available through the website of *Sky and Telescope* magazine for around $25 and is usually published a couple of months prior to the year it covers. We cannot praise it highly enough for it's production, usefulness and level of detail on what's on view for the year ahead.

**Mercury** is too close to the solar glare to be seen this month. **Neptune** begins to retrograde on the 17th and travels 2¾° westward amongst the stars of Capricornus between now and October 24th. The planet can be glimpsed in steadily held binoculars as a bluish magnitude 7·9 "star" .

The Moon is 3½° to the upper left of Venus on the 21st and makes for a lovely grouping with Mars and Saturn on the following evening when it is just over three days past New. Look for any earthshine dimly outlining the rest of the lunar disk not in sunlight. You will find Jupiter 4° to the lower right of the Moon on the 27th as soon as darkness falls.

You might notice a preponderance of artificial satellites slowly threading their way across the sky each night over the next few months. There's a good reason for this. The Sun never dips far below the horizon during the Summer period so the Earth's shadow cast in space is low in the sky. During the Winter, when the shadow is higher, most satellites tend to be eclipsed by the Earth's umbra for an observer on the ground, leading to fewer of these space-birds being seen.




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| May 1st | *s.r.* 04h52m | *s.s.* 19h53m | May 15th | *s.r.* 04h26m | *s.s.* 20h17m | May 30th | *s.r.* 04h07m | *s.s.* 20h39m |
| May 1st | *m.r.* 15h26m | *m.s.*f04h11m | May 15th | *m.r.* 03h26m | *m.s.* 16h13m | May 30th | *m.r.* 15h47m | *m.s.*f02h40m |

# June 2004

*Summertime in effect this month — add one hour to event times*

| S | M | T | W | T | F | S |
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| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | | | |

○ 3d 04h 20m ◑ 9d 20h 02m ● 17d 20h 27m ◐ 25d 19h 08m

Comet C/2001 Q4 (NEAT) becomes circumpolar from our latitude though the jury is still out as to how bright it will be this month. The transit of Venus across the Sun on June 8th will dominate the science headlines though. Mars and Saturn are slowly slipping into the solar glare though Mars will keep pace ahead of the Sun and remain on view a little longer. Jupiter now seems to hold a lonely station in the late evening. Mercury is not visible.

The rare transit of Venus across the face of the Sun on June 8th will be the highlight of the year for many. Our article on page 20 gives a detailed account of the history of transits and how to observe this one. The astronomical version of Murphy's Law — the more important the astronomical event, the more likely it will be clouded out — means many Irish amateurs will almost certainly plan a holiday to somewhere with a better guarantee of clear skies for the transit!

Following passage through solar conjunction it reappears in the morning sky the last week of the month and rises ahead of the Sun. The second conjunction in right ascension of Venus and Aldebaran is on the 28th when the pair are just over 1½° apart.

Again, a further opportunity falls around this time to spot the phase in binoculars — but make sure you keep the Sun outside your field of view! The thin crescent is 48·52" in angular size on the day of the conjunction with Aldebaran.

For the naked eye observer, you might like to follow how long you can keep the planet in view up to — and after — sunrise. Venus is normally visible in daylight provided you know where to look so use this opportunity when it precedes the Sun above the skyline to achieve the feat.

Both Mars and Saturn are slowly slipping towards the solar glare but the more rapid eastward motion of the Red Planet means its elongation from the Sun only diminishes ever so slowly during June, letting it linger above the horizon a little longer.

The two planets are 4¼° apart on the first day of the month but the gap opens quickly thereafter. Saturn is probably lost to view for most by the second half of the period.

Jupiter's eastward motion carries it to within 1° of χ Leonis by the end of the month when the planet is setting 2½ hours after the Sun. It hovers around magnitude -2 throughout June and far outshines any star in the part of the sky where it currently lies. A small telescope will reveal the dark slashes of the two main equatorial bands while a more serious instrument will let you study the various cloud phenomena of its turbulent atmosphere.

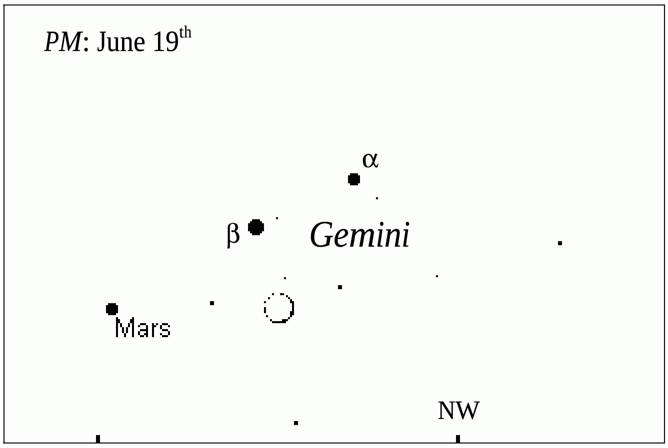
Pluto (magnitude 13·8) is at opposition on the 11th when it is 1½° southeast of the magnitude 4·3 star ν Serpentis. A moderate sized telescope is the least that is required to glimpse this diminutive little world that currently lies 4458 million km (just over 4 light-*hours*) distant.

Uranus begins to retrograde on the 11th and travels 4° westward amongst the stars of Aquarius between now and November 12th. The planet can be glimpsed as a magnitude 5·8 greenish-blue "star" in steadily held binoculars. It is above the theoretical naked-eye limit but is low in the sky as seen from Ireland. On a very clear night in August 2003, I managed to repeat from here my previous sighting of the planet with the unaided eye which was achieved from Zimbabwe in 2001 when Uranus was much higher in the sky.

The Full Moon of the 3rd is the closest of the year with a perigee of 357, 249 km with the disk measuring 33' 40". Make a point of watching moonrise the previous evening (and this) when the effect of the famed Moon illusion will make it look huge! June's Full Moon skims low above the horizon during the night and looks a lovely golden or deep-yellow colour. It's also how we got the term "honeymoon".

Two *appulses* of the Moon and a planet occur during the month with Mars first to be paired off with our companion satellite on the 19th. Look for it 6½° to the left of the almost two-day old crescent Moon. Jupiter meanwhile lies 3¼° to the lower left of the Moon in the western sky on the 23rd.

The night-long twilight at this time of year lends itself to occasional displays of noctilucent cloud. These are clouds that form at altitudes of about 80km and as such are the highest occuring clouds ever seen. They are visible long after sunset when their great height allows them to remain lit by the Sun. Lower down tropospheric clouds can often be seen in silhouette against them. NLCs are usually bluish or silvery in hue and can appear as a fine tenuous veil or exhibit a herringbone-like structure.




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Jun 1st | *s.r.* 04h05m | *s.s.* 20h42m | Jun 15th | *s.r.* 03h57m | *s.s.* 20h54m | Jun 30th | *s.r.* 04h01m | *s.s.* 20h55m |
| Jun 1st | *m.r.* 18h52m | *m.s.*f03h14m | Jun 15th | *m.r.* 02h20m | *m.s.* 19h03m | Jun 30th | *m.r.* 19h27m | *m.s.*f02h14m |

# July 2004

*Summertime in effect this month*
*— add one hour to event times*

| S | M | T | W | T | F | S |
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| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 |

○ 2d 11h 09m ◑ 9d 07h 34m ● 17d 11h 24m ◐ 25d 03h 37m ○ 31d 18h 05m

Venus returns to the morning sky during the middle of July when it can be found in Taurus adding to the spectacle of the constellation's two prominent naked eye clusters rising ahead of the dawn. Saturn too becomes a morning sight when it may be seen the last few days of the month. Mars and Mercury are both a difficult observation. Jupiter claims the late evening as its own.

A close pairing of Mars and Mercury on the 10th will be a very difficult observation from our latitude with both just 2° above the north-northwestern skyline 45 minutes after sunset. An unobscured horizon, careful timing, coupled with a little patience and luck in searching, might enable you snare the two planets within 10 arc-minutes of each other. Mars is now magnitude 1·8 — about as dim as it ever gets — while Mercury shines at magnitude -1·2 as it heads towards greatest eastern elongation on the 27th. Use binoculars to try and spot the duo in the deepening twilight.

Fleet-footed Mercury high tails it back into the solar glare following the July 10th viewing opportunity while Mars can also effectively be considered lost to view after the first half of the month. The Red Planet actually glides through the centre of the Beehive star cluster in Cancer during the first week of July but the chances of spying any of the stellar pinpoints in the twilight is remote.

Jupiter is sole host to the evening and continues its slow stately progress eastwards amongst the stars of Leo, ending the month within 1° of magnitude 4·05 σ. The planet sets 2½ hours after the Sun at the beginning of the month and 90 minutes after by the end of July.

It seems as if we've picked satellite phenomena we *won't* see from here in 2004, but an item of interest for observers Stateside is a double transit of two of the Jovian moons when Io and Callisto almost simultaneously cross the disk.

Io transits at 2h 11m to be followed by Callisto just a minute later. It promises to be a lovely sight at high power in a telescope. Jupiter has long set from Ireland by the time the event gets under way.

Saturn passes through solar conjunction on the 8th and then moves into the morning sky where it will be spotted the last few days of the month rising ahead of the Sun as a magnitude 0·1 object still in Gemini.

Most will wait 'til later in the year before once again commencing observation of the planet when it is accessible at a more respectable hour of the night. However, a small band of dedicated Saturn-watchers willing to study the planet in the wee hours have often been the first to alert the worldwide community of unusual activity in the planet's atmosphere.

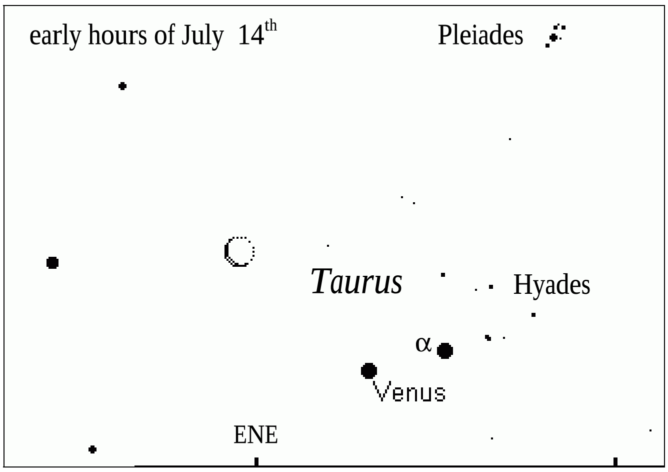
Venus climbs above the east-northeastern horizon ahead of the Sun the first week of July and passes it's third and final conjunction with Aldebaran on the 5th when the pair are at their closest of the three events (1·1°). The magnitude -4·5 planet reaches greatest brilliancy on the 15th when the 37·5 arcsecond diameter disk will appear 27% sunlit in a small telescope.

The sight of the planet rising mid-month close to the Hyades star cluster with the lovely Pleiades shimmering higher in the dawn will be breathtaking. Towards the end of the month, the track of the dazzling veiled world carries it below Alheka, or ζ Tauri — the star that marks the tip of the southern horn of the Bull.

Venus is 7° to the lower right of the waning crescent Moon just three days before New on the morning of the 14th. Jupiter and the Moon are quite low above the western horizon on the evening of the 21st when the giant planet can be found 3½° to the lower right of the Moon. It should be a wonderful sight for strollers on a late Summer evening.

Small telescopes equipped with a medium power eyepiece will let you see two minor planets in the same field when 4 Vesta (magnitude 7·0) and 9 Metis (magnitude 10·5) lie just 4 arc-minutes apart on the 15th. The pair can be found 3½° west of ι Ceti on that date.

The Earth is at aphelion on July 4th at 6h when we are 152 million km from our parent star. The Sun slides slightly less than twice its own width per day along the ecliptic though this isn't a constant rate because of our own varying speed as we orbit the Sun. It shifts 1.02° per day near perihelion in January and about 0.95° per day in July when we are at aphelion.




Jul 1st *s.r.* 04h02m *s.s.* 20h55m Jul 15th *s.r.* 04h16m *s.s.* 20h45m Jul 30th *s.r.* 04h38m *s.s.* 20h23m
Jul 1st *m.r.* 20h51m *m.s.*f03h09m Jul 15th *m.r.* 01h43m *m.s.* 20h11m Jul 30th *m.r.* 20h27m *m.s.*f03h29m

# August 2004

*Summertime in effect this month — add one hour to event times*

| S | M | T | W | T | F | S |
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| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | | | | |

◑ 7d 22h 01m ● 16d 01h 24m ◐ 23d 10h 12m ○ 30d 02h 22m

Conditions are good for observation of the **Perseid meteor shower** on the night of August 11/12 with a slim chance of a brief outburst approaching storm proportions (see page 32). **Jupiter** finally slips into the solar glare while **Mars** and **Mercury** are both unobservable. **Venus** continues to appear earlier and earlier before the dawn and closes dramatically on **Saturn**, lower down, during the month. **Uranus** and **Neptune** are both at opposition.

The planetary action begins to shift to the morning sky for the next few months but you might just about catch **Jupiter** the first half of August when it briefly lingers above the western skyline after sunset. Although it slips below the horizon around an hour after the Sun at this time, we are seeing it as twilight still paints the sky making the observation more difficult.

Both **Mercury** and **Mars** are too close to the Sun in the evening sky to be seen at all during the month.

**Venus** dominates the dawn and rises 3¼ hours ahead of the Sun at the beginning of the month and by just over four hours on the 31st. Through a small telescope on the 19th you will see the magnitude -4·3 planet appear like a tiny half-Moon when the disk is 50% illuminated and 23·26 arcseconds in diameter. The date is just two days after its greatest western elongation on August 17th.

The planet really has put on a mavellous performance all year with an excellent evening sky apparation the first five months of 2004, followed by the long anticipated transit across the disk of the Sun on June 8th.

The more rapid motion of Venus on the celestial sphere causes it to close the gap on **Saturn**. The pair are just over 25° apart on the 1st but close dramatically to a minimum separation of a little less than 2° by the end of August.

Saturn's rings continue to close up ever so slightly but they are still magnificently presented in a small telescope. In fact, sturdily mounted large binoculars (say, 20x60mm) can just about reveal the ring system separate from the globe during moments of steady seeing.

The panorama is especially breathtaking during the period between the mornings of the 11th through to the 14th when the waning crescent **Moon** adds to the scene.

Venus lies 6½° to the lower right of the 24-day old Moon on the morning of the 12th while one day later, on the 13th, Saturn is 3½° to the lower right of the noticeably slimmer crescent.

**Uranus** (magnitude 6·0) is at opposition on the 27th when it can be found 4° southeast of θ Aquarii. The planet lies 2849 million km from us at present.

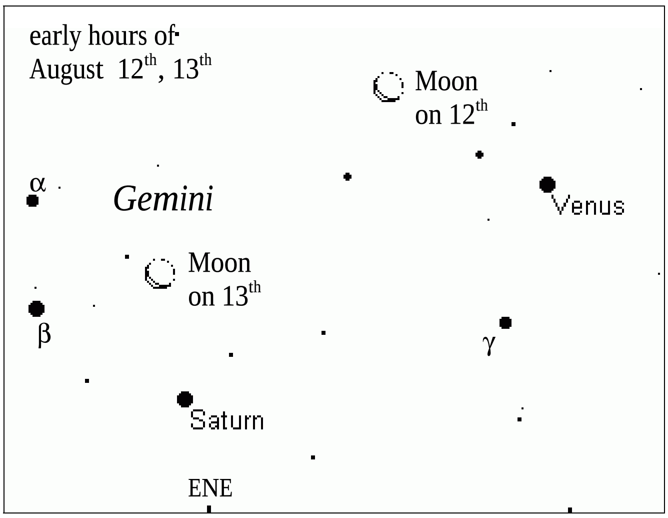
Even more distant **Neptune** (magnitude 7·6) reaches its opposition point ½° north of θ Capricorni on the 5th. Our gaze crosses 4347 million km when we spy this far flung world in binoculars or a small telescope tonight.

August is a fine opportunity to admire the sweep of our galaxy across the heavens as it meanders across the sky through Aquila, Cygnus, passing close to the zenith, then into Cassiopeia, Perseus and Auriga. The richness of the *naked eye* Milky Way in the Cassiopeia and Perseus region draws the attention again and again as the eye learns to distinguish subtleties in the levels of brightness along its length when sky conditions are very good.

Naked-eye studies of the Milky Way were an important branch of astronomy during the latter years of the 19th century. An appeal by F.W.A. Argelander to amateur astronomers to undertake naked eye observations of phenomena such as meteors, the zodiacal light, variable stars and the Milky Way led to a number of projects concerned with mapping the naked eye Milky Way.

One such program was that completed by Otto Boeddicker, a German astronomer who was an assistant to the Fourth Earl of Rosse at Birr Castle between 1880 and 1916 (when he had to return to Germany because of war in Europe). Boeddicker made exquisite renditions of the naked eye Milky Way down to declination –10° over a period of six years and the chart was published by lithography in *The Milky Way* (London, 1892).

Modern astrophotography has all but made naked eye studies of our Galaxy defunct but it is a worthwhile and stimulating project for amateurs to undertake to enhance their observing skills and become aware of deep-sky objects that *are* visible to the unaided eye.

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|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug 1st | *s.r.* 04h41m | *s.s.* 20h20m | | Aug 15th | *s.r.* 05h05m | *s.s.* 19h53m | | Aug 30th | *s.r.* 05h31m | *s.s.* 19h19m | |
| Aug 1st | *m.r.*p21h00m | *m.s.* 04h58m | | Aug 15th | *m.r.* 03h45m | *m.s.* 20h16m | | Aug 30th | *m.r.*p19h41m | *m.s.* 05h30m | |

# September 2004

*Summertime in effect this month — add one hour to event times*

| S | M | T | W | T | F | S |
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| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 | | |

◑ 6d 15h 11m ● 14d 14h 29m ◐ 21d 15h 54m ○ 28d 13h 09m

Jupiter and Mars are both too close to the Sun to be seen this month but the early morning skies is where we find an intricate planetary dance. The separation between Venus and Saturn widens with the veiled planet close to the Beehive star cluster in Cancer mid-month. Mercury's morning apparition sees it briefly pair with the star Regulus in Leo. A close-flyby of the near-Earth asteroid 4179 Toutatis occurs on September 29th (see page 34).

With Mars in conjunction with the Sun on the 15th, and Jupiter soon after on the 22nd, the naked-eye luminaries have all finally departed from the evening period. Both planets are morning sky objects following conjunction but are still too close to the Sun to be seen just yet.

Venus and Saturn on the other hand continue to entrance with their close pairing carried over from last month. Their 2° separation at the start of September begins to grow with each passing day as Venus moves rapidly eastward against the stars. The Moon passes through the area on the 10th — when Saturn is 4° to its right — and the 11th when it is 5½° to the left of Venus.

Venus glides south of the Beehive star cluster in Cancer mid-month which makes for a dramatic sight through binoculars. With the group featuring in various planetary encounters during the year maybe we can be forgiven for reproducing here for our newer readers some of the material we wrote about the cluster in the 2003 edition of *Sky-High*?

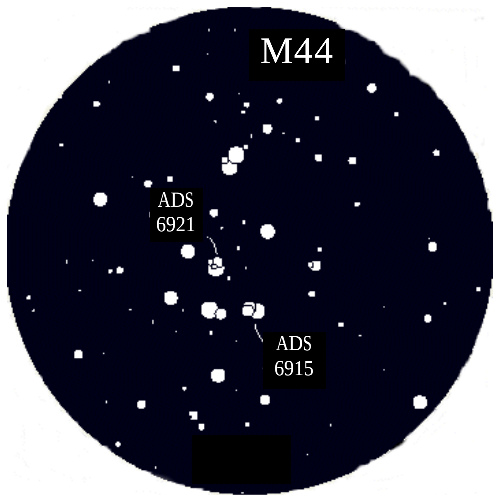
The planet ends the month 4° from the first magnitude star Regulus in Leo when the magnitude -4·1 world is a fat 70% sunlit gibbous phase in a small telescope.

Saturn (magnitude 0·2) is rather more unhurried as it slowly threads its way towards the Gemini-Cancer boundary. Its largest satellite Titan is at eastern elongation on the 5th and western elongation on the 13th and 29th when steadily held binoculars will reveal the magnitude 8·5 world.

The Ringed Planet seems to gain an extra distant "moon" on the morning of the 14th when a magnitude 7·4 star lies six arcminutes away. Catalogued as TYC 1374-1571-1, a search for any information on the star on the 'net amazingly produced a link — to one of the online star registries where it was listed as a wedding gift! As astronomers we cannot condone the practice of selling star names (the stars are free to everyone!) but there are times when the poignancy touches.

Mercury leaps briefly out of the solar glare when it appears in the dawn during the middle of the first week of September. Look for it within four arcminutes of the first magnitude star Regulus on the morning of the 10th or use the Moon (1½ days from New) as a guide to Mercury on the 13th when the magnitude -0·7 planet lies 3° to its right.

One of the most celebrated objects in the sky is the naked-eye star cluster Praesepe (the "manger"), or M44, the Beehive cluster in Cancer, the Crab. The cluster has been known since ancient times and the first recorded mention is



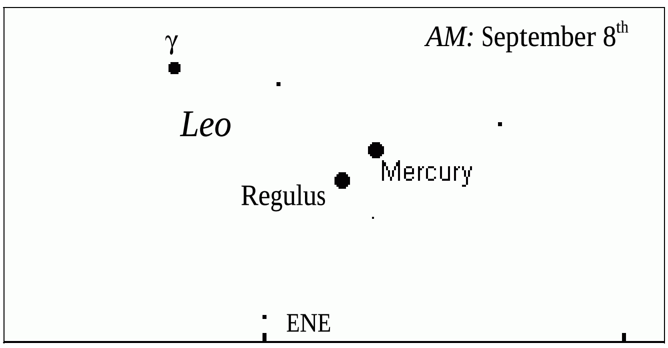

in the weather and sky lore poem *Phaenomena* written by the Greek author Aratus in 260 BC.

Binoculars are the ideal instrument to examine this sprawling cluster and resolve the stars swarming around an imaginary celestial honey pot. The apparent size of the whole group is three Moon-diameters and it's a real gem.

Two binocular double stars reside within its boundaries – ADS 6915 (Burnham 584) and ADS 6921. Both lie towards the southern edge of the cluster as part of a sort of tipped-over "house"-shaped asterism that reminds you of a miniature Cepheus.

ADS 6915 is a triplet of suns of around seventh magnitude at the "roof" of the "house" with the star right at the apex of the triangular arrangement being brightest. ADS 6921 is a quadruple system but only the two more luminous members will be seen in binoculars.

Measurements by the astrometric satellite *Hipparcos* place M44 at a distance of 577 light years with the cluster's age estimated to be about 400 million years.




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sep 1st | *s.r.* 05h34m | *s.s.* 19h15m | Sep 15th | *s.r.* 05h58m | *s.s.* 18h41m | Sep 30th | *s.r.* 06h24m | *s.s.* 18h05m |
| Sep 1st | *m.r.*p20h04m | *m.s.* 08h21m | Sep 15th | *m.r.* 06h45m | *m.s.* 19h10m | Sep 30th | *m.r.*p18h31m | *m.s.* 08h38m |

# October 2004

*Summertime in effect this month — add one hour to event times (up to the 31st)*

| S | M | T | W | T | F | S |
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| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | | | | | | |

◑ 6d 10h 12m ● 14d 02h 48m ◐ 20d 21h 59m ○ 28d 03h 07m

A **total eclipse of the Moon** is visible from here during the early hours of the 28th (i.e. on the night of October 27/28) — see page 29 for more details. **Saturn** is well placed for viewing for the major part of the night while the other naked eye planets — bar Mercury — are morning sky objects. **Venus** rapidly closely the gap between itself and **Jupiter** during the month. **Mars** might be seen very low in the dawn towards the latter half of October.

**Saturn** rises before midnight at the beginning of October and progressively earlier throughout the month. It can be found close to the border of Gemini and Cancer. Saturn is at western quadrature on the 20th when the shadow of the globe on the rings enhances the three-dimensional effect you get when viewing the planet. The sight is magical.

Just after Saturn-rise on the 22rd, look through binoculars or a small telescope and you will see the magnitude 8·5 moon Titan a little over an hour past eastern elongation when it can be found four ring-widths distant from the primary. December's release of the *Huygens* probe (part of the *Cassini* mission) that will descend through the atmosphere of Titan may finally answer many of the mysteries as to what lies beneath the moon's opaque cloud layer.

**Jupiter** returns to view this month when the magnitude -1·7 planet can be spotted low in the eastern sky after the first week. The gas giant is virtually on the far side of the Sun to us following conjunction on September 22nd and is 200% *dimmer* than when it was at opposition on March 4th.

There's a good reason for this; it's now over twice as far away from us (9·4440 astronomical units distant) than in March when the gap was *only* 4·4257 AU.

The planet spends a few days after mid-month near the magnitude 3·89 star η Virginis and is closest on the 18th with a minimum separation of a ¼°.

Although it's still very low, you might just spot magnitude 1·7 **Mars** barely above the skyline during the last week of the month. It's 12½° to the lower left of Jupiter at this time.

**Venus** is a brilliant magnitude -4·1 spark in the early hours and sweeps past the first magnitude star Regulus in Leo over the mornings of the 3rd and 4th. The planet is ½° from Regulus on the 3rd and ¾° past the star by the 4th.

It's rapid motion on the celestial sphere also carries it just south of the magnitude 4·05 star σ Leonis on the mornings of the 19th and 20th. It crosses over the border into Virgo the at the beginning of the final week of the month, all the time reducing the distance between itself and Jupiter.

Venus is 4¼° to the Moon's upper right on the morning of the 11th and is a wonderful sight to greet the dawn. Saturn rises paired with the Moon after midnight of October 6/7 with the two lying 5° apart — a gap that lessens to 4° as morning twilight begins.

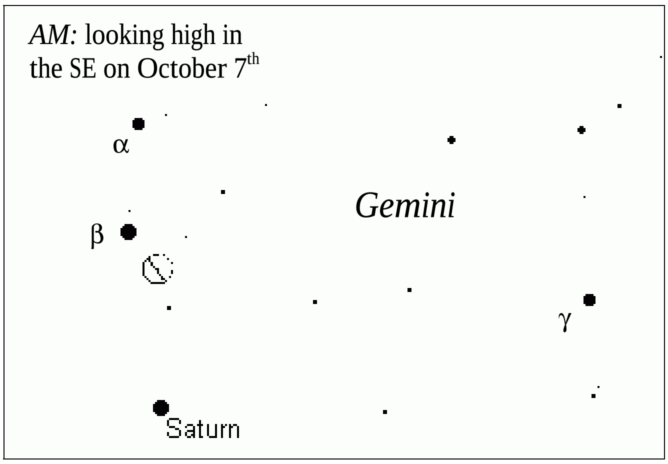
Scan slightly right of the east point on the horizon with binoculars thirty minutes before sunrise on the morning of the 13th and you might just about spot an *old* Moon a little over twenty hours from New. The wafer-thin sliver of a crescent is just 3° up at the time so an unobstructed skyline is required to catch a glimpse of the sight. Jupiter is 4° to the Moon's upper right that morning so it will aid in locating the curl. The previous morning, Jupiter is 5° to the day-younger Moon's lower left.

A brief autumnal shower may paint the sky with a beautiful ephemeral rainbow, causing us to gaze with wonder at one of nature's marvels. The result of the simple interaction of sunlight and water in droplet form, a rainbow has many facets few are aware of.

You may be have previously noticed how the sky inside a bow can occasionally appear brighter than outside. This is due to the preferential scattering of light within the water droplets back towards the red end of the spectrum.

If a secondary bow accompanies the primary then the colours are reversed and the scattering is towards the outside of the bow. This can lead to what looks like a dark band of sky between both bows dubbed Alexander's dark band after the Greek philosopher who drew attention to the phenomenon 2,000 years ago.

The classic book on the subject is *Rainbows, Haloes and Glories* by Robert Greenler while Marcel Minnaret's *Light and Colour in the Outdoors* is very detailed. A more recent tome, *Colour and Light in Nature* by David Lynch and William Livingston, is a very good introduction to this fascinating branch of naked eye sky phenomena.

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|---|---|---|---|---|---|---|---|---|---|---|---|
| Oct 1st | *s.r.* | 06h26m | *s.s.* | 18h02m | Oct 15th | *s.r.* | 06h51m | *s.s.* | 17h30m | Oct 30th | *s.r.* 07h19m | 
| Oct 1st | *m.r.* | p18h42m | *m.s.* | 09h58m | Oct 15th | *m.r.* | 08h36m | *m.s.* | 17h52m | Oct 30th | *m.r.* p17h17m |

| | | |
|---|---|---|
| Oct 30th | *s.s.* | 16h58m |
| Oct 30th | *m.s.* | 10h15m |

# November 2004

| S | M | T | W | T | F | S |
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| 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 28 | 29 | 30 | | | | |

◑ 6d 10h 12m ● 12d 14h 27m ◐ 19d 05h 50m ○ 26d 20h 07m

**Saturn** is visible throughout the greater portion of the night during November. **Venus** continues its rapid motion across the celestial sphere and is dramatically paired off with **Jupiter** on the morning of the 5th. The morning star also closes the gap between itself and Mars during the month. Mars crosses from Virgo into Libra this month though is still low in the eastern sky before dawn. The **Leonid meteor shower** peaks on the 17th (see page 32).

**Saturn** (magnitude 0·1) reaches its stationary point on the 8th and begins to retrograde, travelling 7° westward amongst the stars between now and March 22nd, 2005. The planet remains in Gemini after having approached close to — but not quite crossing — the Gemini-Cancer boundary before turning on its retrograde loop.

The southern aspect of the rings are tipped 21¾° Earthward early in the month — their least for 2004, but still wide open. Other good opportunities to view the planet's largest moon Titan at greatest eastern elongation fall on the evenings of November 8th and 24th.

A **dramatic pairing** in the early morning sky on the 5th finds Venus (magnitude -4·0) and Jupiter (magnitude -1·7) just about ½° apart in the southeast. Much dimmer Mars (magnitude 1·7) can be found 17° to their lower left and within 3° of Spica.

Distant **Jupiter** grows a little in a telescope to show a disk 33 arcseconds in size by the end of the month while the brightness racks up a notch too to top magnitude -1·8. The planet lies within 1½° of the famed double star γ Virginis (Porrima) during mid-month.

**Venus** continues its rapid progress through Virgo during November and in a telescope the disk shrinks in size while the phase thickens to a fat gibbous.

The magnitude -4·0 planet is within a ¼° of the magnitude 3·89 star η Virginis on the morning of the 2nd, even closer to θ Virginis on the 13th, and ends the month having narrowed the gap to Mars to just 3½°.

Venus is rising 3½ hours before the Sun at the beginning of the month and by slightly less than three hours on the 30th.

Magnitude 1·7 **Mars** can also be found within the boundaries of the celestial virgin though it crosses into Libra during the 22nd. On that date too, it can be found close to the magnitude 4·51 star λ Virginis.

The planet is still a poor show in a telescope with the angular size of the disk a paltry 4 arcseconds and less for most of the year.

Mars does have "off-years" however between oppositions when the Earth needs to catch up with the planet again. Its twice-as-long "year" compared to ours means the two worlds only come into favourable alignment every twenty-four months or so.

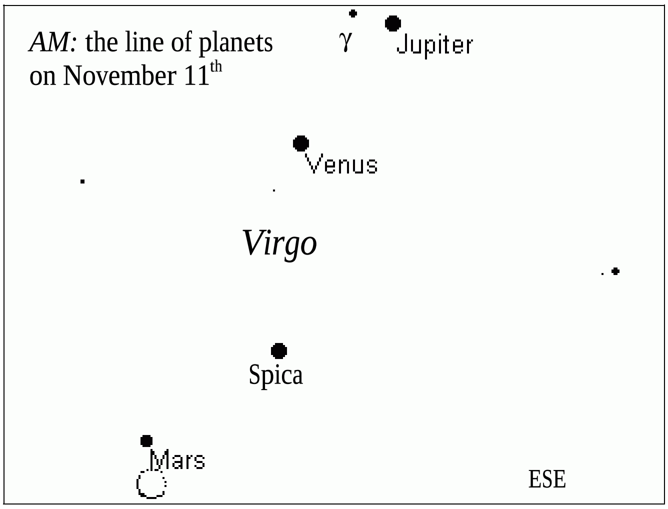
Saturn is paired up twice with the Moon during November. On the 3rd it can be found 4° to the lower right of the waning gibbous Moon. On the last day of the month (30th) it is a little more distant — lying 5° to the lower right of the waning gibbous phase.

On the 9th our companion world is four days before New and 4° to the upper right of Jupiter with Venus 4½° to Jove's lower left. It will be a beautiful sight to see the three celestial bodies strung out in so close a line along the ecliptic. A thin crescent hangs close to Mars low in the pre-dawn sky on the 11th. The Red Planet is 1¼° above the Moon just thirty one hours from New.

Maximum light for the long period variable ο Ceti may have fallen at an unfavourable time this year for us but therein lies a curious tale of murder and intrigue.The star, also named Mira ("the wonderful"), is due south during late evening in November.

The variations of the star were first noticed by David Fabricius in 1596 who initially believed it to be a nova but work by the Dutch astronomer Jan Fokkens soon showed the periodic nature of Mira. Fabricus was pastor of a small village in northern Germany, a role that would seem to be a secure and peaceful existence.

But such was not the case. In 1617, a goose belonging to him was stolen and on the following Sunday he hinted, from the pulpit, at the identity of the person who took it. This alarmed the thief who killed Fabricius to prevent further disclosures.




*AM:* the line of planets on November 11th

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Nov 1st | *s.r.* 07h23m | *s.s.* 16h54m | Nov 15th | *s.r.* 07h49m | *s.s.* 16h30m | Nov 30th | *s.r.* 08h15m | *s.s.* 16h12m |
| Nov 1st | *m.r.*p18h06m | *m.s.* 12h35m | Nov 15th | *m.r.* 12h05m | *m.s.* 18h13m | Nov 30th | *m.r.*p17h32m | *m.s.* 12h03m |

# December 2004

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 | 31 | |

◑ 5d 00h 53m ● 12d 01h 29m ◐ 18d 16h 40m ○ 26d 15h 06m

Marvel at the sweep of all five naked eye planets simultaneously above the horizon from mid-month. Saturn is nearing it's January 2005 opposition date and so is on view virtually all night. The soft cream glow of Jupiter alters the pattern of Virgo while Venus still remains prominent in the dawn. Mercury appears above the horizon for the second half of the month while Mars becomes better placed to follow it's wanderings (see Dec 31st note below).

The appearance of Mercury above the southeastern skyline in the second half of the month means that all five naked-eye planets will be simultaneously on view for the rest of December. They will also be in order of their normal increasing distance from the Sun in the solar system though the symmetry is ruined slightly when Venus slips past Mercury late-month and both swap position in the sequence. The sight continues into mid-January 2005 and will not repeat again until 2016. It's a rare opportunity to marvel at how all five hug the imaginary ecliptic line in the sky.

First on view in the night though is Saturn, rising at 7:30pm on the 1st and by two hours earlier at the end of the month when it is two weeks away from its 2005 January 13 opposition date. The planet breaches the negative magnitude barrier too as the gap between us and Saturn narrows -- starting December at magnitude -0·1 and ending two-tenths of a magnitude brighter.

The rings are opening up ever so slightly too and the southern aspect is currently tipped 22¼° Earthward. The real highlight for most will be the expections surrounding the *Huygens* spacecraft due to enter Titan's atmosphere in mid-January 2005. Our space exploration highlights on page 22 gives a bit more background to this exciting mission.

Jupiter, still in Virgo, brightens to magnitude -2 by the end of December while the disk continues to marginally increase in size to end the month 36 arcseconds in angular diameter. The globe will look slight gibbous in a telescope as it nears western quadrature (in January 2005).

On the morning of the 12th you'll find all four Galilean moons — Io, Europa, Ganymede, and Callisto — all briefly lined up in order of increasing distance to the west of the planet. The latter three will be tightly bunched together.

Magnitude -4 Venus remains the brilliant Morning Star and swiftly leaves Libra, crossing Scorpius to end the year in Ophiuchus. What's that? Ophichus isn't a zodiacal constellation. Well ... okay, we'll leave that topic for another edition of *Sky-High*. There's too much drama in the late-December morning sky to debate here the -ology versus -onomy!

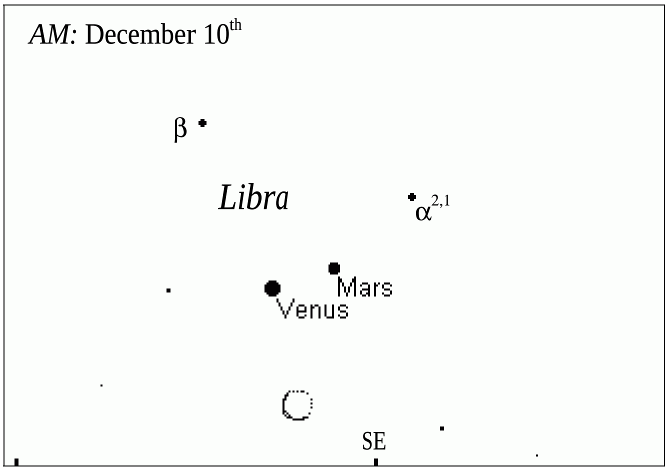
Part of that drama is Venus overtaking Mars on the 6th when the two are 1¼° apart — they actually make a very nice compact isoceles triangle with the wide binocular double star $\alpha^{2,1}$ Librae. The Red Planet actually makes its own personal date with the magnitude 2·75 star on the morning of the 4th when it lies a ¼° from it.

Some other close encounters between Mars and distant suns are on the 22nd when it is 18 arcminutes north of magnitude 4·74 $\kappa$ Librae and the 26th when it passes less than 10 arcminutes from magnitude 5·03 $\lambda$ Librae. But wait 'til you see what it does on the morning of the 31st when it threads itself through the gap between $\omega^1$ and $\omega^2$ Scorpii! Both stars are around fourth magnitude — don't miss it!

Mercury rises out of the solar glare mid-month and appears to climb to meet Venus, reaching a minimum separation the last few days of 2004 when the duo are within 1¼° of each other. Mercury actually appears to loop over the top of Venus and continues the sweeping curve into early 2005 — a dramatic example of the complex dance of the planets.

Jupiter is 1¼° to the lower left of the Moon on the morning of the 7th — the planet is actually occulted for observers in the eastern United States. The waning crescent, 2 days from New, then stands 5° below Venus and Mars on the morning of the 10th. The Moon is just a day past Full when it accompanies Saturn hour-by-hour across the sky during the night of December 27/28.

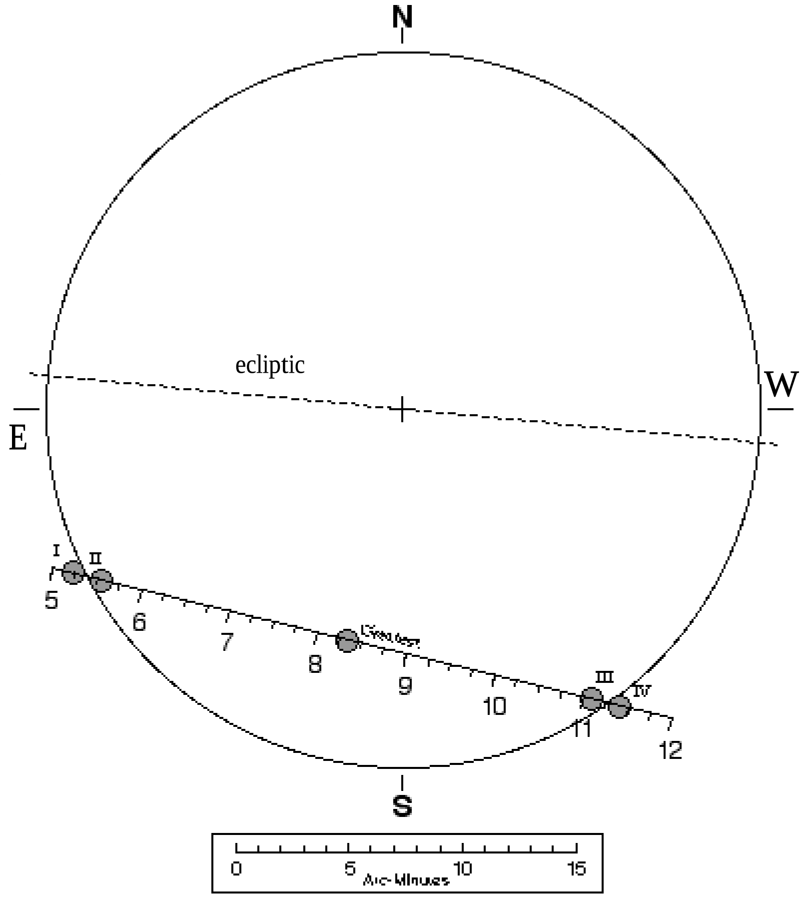
The May notes mentioned the Earth's shadow and you don't need the occasion of a lunar eclipse to see it. Just after sunset you'll often see the shadow projected onto the atmosphere as a greyish band above the eastern horizon. The effect is readily visible along with the phenomenon sometimes dubbed The Belt of Venus —where the leading edge of the shadow is tinged a pinkish hue as the upper part of the atmosphere continues to be painted with the tones of sunset for a short time after the Sun itself has dipped below the horizon.




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dec 1st | s.r. 08h16m | s.s. 16h12m | Dec 15th | s.r. 08h33m | s.s. 16h07m | Dec 30th | s.r. 08h40m | s.s. 16h15m |
| Dec 1st | m.r.p18h35m | m.s. 12h34m | Dec 15th | m.r. 12h04m | m.s. 20h10m | Dec 30th | m.r.p18h49m | m.s. 11h16m |

# *The 2004 June 8 transit of Venus*

*Permission to use the diagram in this article has kindly been granted by Fred Espenak (Nasa GSFC)*




| | | | |
|---|---|---|---|
| Contact I | 05:13:29 UT | Contact III | 11:06:33 UT |
| Contact II | 05:32:55 UT | Contact IV | 11:25:59 UT |

The point of *greatest transit* is reached at 08:19:44 UT

*"There will be no other transit of Venus till the twenty-first century of our era has dawned upon the Earth, and the June flowers are blooming in 2004. When the last transit occurred the intellectual world was awakening from the slumber of ages, and that wondrous scientific activity which has led to our present advanced knowledge was just beginning. What will be the state of science when the next transit season arrives God only knows."*

Those words, prophetically written in 1882 by William Harkness about the rarity of the phenomenon, are a sobering reminder that not one person remains alive today who has witnessed a passage of Venus across the face of the Sun.

## Historical interlude

The cosy cosmology of the Earth-centred Universe was to come under fire in the Middle Ages through the work of Copernicus, Brahe, Kepler and others. True, the Ptolemaic system sufficed for most to explain the motions of the planets but many inadequacies existed. None more so than the wandering of Mars across the celestial sphere but equally infuriating were the motions of Mercury and Venus. Neither could be followed throughout a complete cycle because they are just too close to the Sun to be seen for part of the time. The scenario regularly led astronomers to make a "best guess" to try force observed motions to fit prediction.

A brilliant and elegant answer to the conundrum was noticed by the German astronomer/mathematician Johannes Kepler who was Tycho Brahe's understudy. Following Brahe's death, Kepler inherited the Danish astronomer's notes and used them to formulate his three laws of planetary motion. Part of this work led Kepler to determine that there were rare occasions when Mercury or Venus could transit, or pass across, the face of the Sun when would see the planet in silhouette against the bright solar disk. Accurate measurements during such a transit would lead to much improved ephemerides for both Mercury and Venus.

Kepler predicted a transit of Mercury on 7 November 1631 but died the year prior to the event. However, the astronomer Pierre Gassendi did witness the transit from Paris; an observation that was a triumph for Kepler’s newly published *Rudolphine Tables* which brought unprecedented accuracy (for the time) to planetary ephemerides.

A transit of Venus was also predicted for 1631 but it was not visible from Europe. Kepler had written that over a century would pass before one of the innermost planets would again glide across the solar disk. However, a young English amateur astronomer, Jeremiah Horrocks, believed otherwise and calculated that a similar transit would occur in December 1639. As it happened, Horrocks, and a friend, William Crabtree, were the only ones privy to that particular passage of Venus across the Sun due to there being little time to alert the scientific community to the event.

## Measuring the Earth-Sun distance

One of the most crucial foundations to understanding our place in the Universe is the determination of the scale of space. The Earth-Sun distance is a measurement of great importance and gives us the linear scale of our solar system.

Early work by the Greek astronomer Aristarchus two thousand years ago helped set in motion the achievement of this goal when he managed to determine an initial value for the *solar parallax*. The quantity is the angular width of the Earth's equatorial radius as seen from the centre of the Sun (when the Earth is at 1 AU). If this angle is known and the radius of the Earth can be measured, then the distance to the Sun can be simply calculated.

Using other methods, Aristarchus estimated that the Sun was about 20 times further away than the Moon (it’s actually nearly 400 times more distant), providing the first indication that the Sun was an extraordinarily distant object.

Subsequently, the value for the solar parallax was to be better refined following the proposal of a new method to determine the Earth-Sun distance by Edmond Halley.

Halley spent a year on the remote south Atlantic island of St. Helena with the intention of measuring accurate positions for many of the southern stars which had hitherto been imprecisely observed. In this he was to succeed but it was following his observation of a transit of Mercury in November 1677 from the island that he hit on the idea that such an event could be used to determine the solar parallax.

If a transit was to be observed from different latitudes, then the ordinary parallax effect would cause observers to see a planet trace a slightly different track across the Sun's disk. The length of each respective track could be deduced from timing the ingress and egress. The parallax effect would be much greater for Venus than for Mercury, given the greater distance of the former from the Sun.

Halley knew that he would not live to see the transit of Venus in 1761 and so, in a paper he published, he exhorted a future generation of astronomers to make the critical measurements from far-flung corners of the globe.

## Early expeditions

Galvanised by Halley's words, well-prepared expeditions set off to observe the 1761 and 1769 transits. One of the voyages to the 1769 transit was led by none other than Captain James Cook. In fact, David and Carol Allen, in their 1987 book *Eclipse*, speculate whether Cook's expedition would have been mounted without the fillip of the transit. Were it not, then maybe Australians and New Zealanders might be using French or Dutch as their native tongue.

One of the more bizzare episodes are those misfortunes that befell the French astronomer Guillaume le Gentil who missed the 1761 and 1769 transits from India and eventually arrived back thirteen years after he left France only to discover he had been declared dead and his estate divided up!

Results from the transits in the eighteenth century, and the two that occured in 1874 and 1882, were disappointing to say the least. The accurate timings of ingress and egress were not possible due to a mysterious effect known as the "black drop" where the limb of Venus appears to cling to the edge of the Sun as it moves completely on to the disk. The phenomenon is now known to be the result of seeing effects in our turbulent atmosphere. The use of transits to measure the Earth-Sun distance has now been superceded by more modern techniques but their value cannot be underestimated in the early period of modern astronomy.

## Transit mechanics

The orbits of Mercury and Venus are tilted with respect to that of the Earth and so we do not necessarily see either cross the Sun when they pass through inferior conjunction.

Should Venus happen to pass through inferior conjunction where it's orbit bisects the ecliptic plane (the *nodes*) then we will witness a transit. Such events occur at intervals of 8, 105½, 8, and 121½ years.

## The 2004 transit

All the stages of the 2004 transit are visible from Ireland along with most of Asia, Africa and all of Europe. Part of the event will be seen from Australasia, the eastern two-thirds of North America and most of South America except the southern parts of Chile and Argentina.

However, considering the vagaries of Irish weather it is certain that some amateur astronomers will seek clearer skies abroad and combine the transit with a sun holiday!

So what will you actually see? The diagram on the opposite page highlights the important stages in the transit. The contact I point marks the beginning of the transit and shortly thereafter you will begin to see a small notch taken out of the solar limb.

Venus is invisible prior to contact I and after contact IV (when it has exited the disk) for most though the use of a hydrogen-alpha filter on a telescope may let you see the dramatic sight of the planet silhouetted against a solar prominence or the chromosphere.

At the contact II point the planet is considered to be wholly on the Sun's disk and some interesting effects may be seen such as the famous "black drop" mentioned earlier.

A rare sight would be to see the planet pass close to — or even across — a sunspot or sunspot group. Such an encounter would be dramatic and would allow you compare the inky colour of the planet's silhouette to the slightly less intense shades of a spot's umbra and penumbra.

Venus then slowly threads its way along an invisible chord, taking a little over 5½ hours to reach contact III when the limb of the planet is internally tangent with the Sun. The "black drop" effect may repeat — possibly with a thin sliver of light due to sunlight being refracted around the limb of the planet through its atmosphere. It then takes twenty minutes or so to reach contact IV when it finally slips off the disk and leaves transit.

With luck, those people utilising specialised solar filters may again briefly see the dark spot of the planet against a bright prominence or the chromosphere.

The planet is nearly one arcminute in diameter and should be visible during the transit to the naked eye but only with proper filtration. A piece of grade 14 welder's glass (the maximum) is ideal, or no. 13 at a pinch. Anything less is just not suitable and fails to fully filter harmful radiation.

Before and after inferior conjunction, the unlit portion of the globe of Venus seems to glow faintly — a phenomenon known as ashen light. Observations of it are rare and the effect may be due to refraction of sunlight in the planet's very dense atmosphere. Given the right equipment, some may see the phenomenon in the hours before and after transit.

An eight year gap to the next Venus transit awaits us when we will only witness the last stages of the 2012 event from Ireland. We then must bridge a period of one hundred and five years to 2117 when future astronomers will once again be enthralled by the sight of Venus crossing the Sun.

Considering this once-in-a-lifetime opportunity, make every effort to observe the event — but please, do so safely.

# Space missions in 2004

WHAT A THRILLING YEAR it promises to be for space exploration right across the solar system. A flotilla of spacecraft are Mars-bound with a lander to be dropped by each to the Martian surface while Japan's *Nozomi* orbiter reaches the Red Planet following a torturous journey from launch in July 1998. Mercury is due to be revisited after a 30-year gap with the launch of NASA's *MESSENGER* mission to the Sun-baked world while after a lengthy trip, the *Cassini-Huygens* mission reaches Saturn in mid-Summer. *Huygens* is a probe mated to the larger *Cassini* and will parachute into the atmosphere of the planet's largest satellite, Titan, returning valuable data on this enigmatic moon.

Comets too feature strongly on mission schedules with the *Stardust* spacecraft due to complete collection of samples of pristine cometary material following a flyby of comet P/Wild 2. The delayed *Rosetta* mission finally lifts off in February while later in the year we expect dispatch of *Deep Impact* to a rendezvous with comet P/Tempel 1 where, on arrival, a penetrator will be fired into the nucleus.

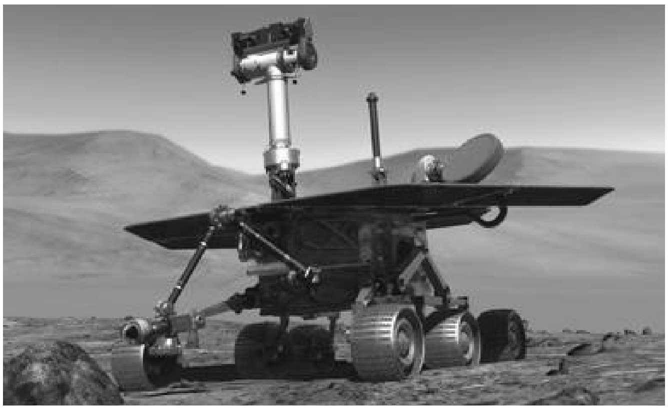
Following the tragic loss of *Columbia*, the subsequent enquiry, and recommendations by the investigation board, it is hoped the space shuttle will resume flight operations some time in 2004. Meanwhile, the *International Space Station* hosts a permanent caretaker crew but construction is seriously behind schedule, never mind the political and technical squabbles that continually seem to threaten the very existence of the project.

We must add our usual proviso in this preview whereby technical difficulties often throw the timetables of international space programmes into disarray but what we outline here are the most up-to-date details at the time of publication of *Sky-High* (September 2003). For the last couple of years we have expected the first Chinese taikonaut (astronaut) to orbit the Earth but secrecy surrounding the Chinese space programme has led to a difficulty in predicting the launch in advance. The latest information suggests a date in October 2003 but all we can do is wait and see.

## The Martian invasion

The latest bout of Mars exploration got underway in the Summer of 2003 with the launch Europe's *Mars Express*, closely followed by the pair of NASA *Mars Explorer* missions with each carrying a surface rover. The favourable geometry of the Earth and Mars instigated the current round of launches — the two planets are at a minimum distance from each other about every 26 months.

*Mars Express* consists of an orbiter and a lander called *Beagle-2* that was developed in the UK. The spacecraft will arrive at Mars on 2003 December 26 but will release the lander five days prior to this. The lander will then coast towards the Red Planet and slam into the atmosphere at 20, 000 km/h, using an aeroshell to protect it during the fiery descent. The craft will then deploy parachutes after the initial deceleration and then inflate airbags to protect the delicate lander when it hits the martian surface.



*Mars Exploration Rover-A*

Once on the ground, the top of *Beagle-2* will unfold to expose four solar array disks. A robotic arm on the lander will dig up soil samples to be deposited in the various instruments for study while a small "mole" will burrow under nearby rocks to collect further samples. One of the key aims of *Beagle-2* is to look for possible signatures of life.

Nasa's *Mars Explorer* spacecraft are both due to arrive at the Red Planet in January 2004 and will again use a heatshield to protect the delicate cargo during the fiery descent through the martian atmosphere. Once on the surface, initial tests of the status of each rover will be carried out before they roll down the ramp of their respective ferry vehicles.

Both landers will touch down just south of the equator on opposite sides of the planet to each other. The rovers are capable of travelling 100m per day across the surface with the two expected to survive about three months before succumbing to the harsh martian environment.

Japan's problem-plagued *Nozomi mission* is due to reach Mars orbit in early 2004 though even that is conditional. A flyby of Earth after launch in 1998 imparted insufficient acceleration to the spacecraft and two course correction burns used more fuel than expected. More recently, the power supply to the onboard heating system was damaged following exposure to strong solar flares in 2002. This must be recovered to allow the hydrazine fuel to be thawed out prior to orbit insertion. If successful, *Nozomi* will study the upper atmosphere of Mars and the moons Deimos and Phobos.

## Circling the Ringed Planet

*Cassini*, and the *Huygens* Titan descent probe, is a long awaited mission to the ringed planet Saturn that is expected to resolve many questions about the gas giant. Since launch in October 1997, the spacecraft has coasted by Venus twice, Earth once, and finally, Jupiter in December 2000, to build up the momentum to hurl itself into the outer solar system. The series of complex manoeuvres are known as gravity assists and enable the massive six-tonne vehicle gain enough energy to break free of the tug of the Sun.

The craft will reach Saturn in July 2004 where its engines will fire for 95 minutes to slow it down and allow it to enter orbit around the planet. *Cassini* will then begin a four-year mission that includes more than 70 orbits around Saturn and its retinue of moons.

Since the *Voyager* flybys in 1980 and 1981, scientists world-wide have never had as close a look at Saturn as that which *Cassini* will provide. Powerful cameras will image the atmosphere of the planet, the ring system, and its satellites while other instruments will measure the magnetosphere and near-Saturn environment.

The most exciting element of the mission however comes with the release of the *Huygens* probe that will be targeted to land on Saturn's largest moon Titan. *Huygens* separates from *Cassini* in December 2004 and will slam into the moon's opaque atmosphere after a 22 day coast phase.

The probe slows from 6 km/s at arrival to 400 m/s in about two minutes following entry with an aeroshell offering protection during this braking phase. Thereafter, three sets of parachutes deploy and *Huygens* will float towards the surface making a series of detailed measurements during the descent. The data will be relayed to *Cassini* and then to Earth.

After two hours, and at an altitude of 40 km, the parachutes will be jettisoned and *Huygens* free-falls the remainder of the way to the surface. From there, it may transmit for anything up to 30 minutes if sufficient battery power remains.

Many mysteries surround Titan and the organic "smog" that constitutes it's atmosphere — a cloud-shell many liken to the early atmosphere of Earth. *Huygens*, it is hoped, will go some way towards providing answers.

## Return to Mercury

Our only close-up views of Mercury to date have been provided by the *Mariner 10* spacecraft which flew by the planet twice in 1974, and once in 1975, returning photographs of its heavily cratered surface. The same lighted hemisphere was presented to *Mariner 10*'s onboard cameras during each encounter and since then astronomers have aspired to a return mission that will reveal more about the planet's environment and provide a complete map of the surface and its geological features.

NASA's *Mercury Surface, Space Environment, Geochemistry* and *Ranging* (*MESSENGER*) mission is a welcome return to the inner-most planet after a 30-year gap. The craft will blast off during a still to be selected launch window of either March or May 2004 and immediately heads for Venus which it will pass in late-June.

A second Venus flyby occurs in March 2006 and is part of a manoeuvre designed to slow the spacecraft to a speed whereby it can enter orbit about Mercury. Two passes of Mercury take place prior to the orbit insertion phase in April 2009. *MESSENGER* then spends a period of one Earth year circling the planet before the primary mission terminates in 2010.

## Chasing snowballs

The European Space Agency's delayed *Rosetta* mission finally gets the green light to leave Earth in early-2004. *Rosetta* is an exciting mission which will see the spacecraft rendezvous with comet Churyumov-Gerasimenko in November 2014 — recent enforced delays have meant the original target, comet 46P/Wirtanen, has been discarded in favour of the alternate.

The profile of the mission will see *Rosetta* enter a drift phase for approximately 90 days following rendezvous with Churyumov-Gerasimenko. This period will allow planners to gather sufficient data to precisely determine the relative position of the comet's nucleus in space and allow fine-tuning of the spacecraft's velocity for insertion into an eccentric orbit. *Rosetta* then begins a mapping phase with closest pass just 5 nucleus radii from the surface.

A number of areas on the nucleus will also be selected for closer observation and the information gathered will enable scientists to select a site to deploy a small lander that will touch down on the surface. The lander will transmit data to the still-in-orbit main spacecraft for relay to Earth.

*Deep-Impact* is an equally high-profile mission that leads to an encounter with comet P/Tempel 1 where the spacecraft will fire a projectile into the the comet nucleus. Observations will then be made of the ejecta, much of which will be pristine material from the interior.

The mission is due to be launched in mid-December 2004 and the craft will go into a heliocentric orbit where it will rendezvous with P/Tempel 1 in July 2005.

The on-board penetrator will be released on 3 July when *Deep-Impact* will be 880, 000 km from the comet and will strike the sunlit side of the nucleus 24 hours later; the main spacecraft will begin imaging just before impact from a distance of 10, 000 km. The crater excavated as a result may be as much as 25m deep and 100m across. The mission is scheduled to end in August 2005.

## Probing the Moon

At time of going to press the launch of the European Space Agency's *SMART-1* (*Small Missions for Advanced Research in Technology 1*) was still pending due to problems with one of the other satellites that is also due to be carried aloft on the same *Ariane* rocket.

*SMART-1* is Europe's first lunar probe and is an orbiter designed to test spacecraft technologies for future missions. The primary technology being tested is a solar-powered ion drive. It will also carry an experimental deep-space telecommunications system and an instrument payload to study the Moon. The craft spends 16 months cruising in space testing the new drive before slipping into orbit about the Moon.

*LUNAR-A*, to be launched in the autumn of 2004 is Japan's first effort to explore the interior of the Moon. The spacecraft carries two penetrators that will smash through the lunar surface and study the Moon's interior with seismometers and heat-flow probes.

The penetrators will be deployed on the lunar surface — one on the nearside and the other on the farside — where they will monitor lunar quakes from both sides of the Moon to determine if the Moon has a core and, if so, its size. Scientists also hope the results will help them understand how the Moon was formed.

The mission has been delayed since 1999 because a penetrator failed a drop-test designed to test the likely damage when they impact the surface at speeds up to 1000 km/h.

## Other missions

The *Genesis* mission has been in space since August 2001 and is designed to snare samples of the solar wind for return to Earth. The spacecraft operated near the sunward $L_1$ point where the gravities of the Sun and Earth are balanced. The mission is expected to capture about 10 to 20 micrograms of the solar wind, made up of invisible charged particles expelled by the Sun. The particles will then be returned to Earth with a spectacular mid-air helicopter capture in September 2004.

The science objectives of *Genesis* have been to obtain precise measurements of solar isotopic and elemental abundance and provide a reservoir of solar matter for future scientific analysis. Study of these samples will allow testing of theories of solar system formation and evolution and early nebular composition.

The *Stardust* spacecraft, launched in February 1999, encounters periodic comet P/Wild 2 in early January with the task of sampling material from the comet. The dust particles are collected on a disc-shaped sheet of aerogel mounted on a paddle deployed from the craft. Images of the nucleus will also be taken with an expected resolution of 30m.

*Stardust* will return the precious comet and previously collected interstellar dust samples to Earth in January 2006 for detailed study. On Earth the cometary samples, representing primitive substances from the formation of the solar system, will undergo detailed analyses.

*Swift* is a multi-wavelength observatory dedicated to the study of gamma-ray bursts. Three on-board instruments will work together to observe these energetic and powerful explosions in Universe, and study the afterglow in gamma-ray, X-ray and optical wavebands.

The spacecraft will be launched in April 2004 and will operate in Earth-orbit where it will have the ability to rotate and point its telescopes at a gamma-ray burst within minutes of it's first detection. *Swift* will also relay the burst's location to ground stations, allowing both ground-based and space-based telescopes around the world the opportunity to observe the afterglow.

## Manned missions

Resumption of space shuttle operations is expected some time after the Summer of 2004 but it is only a tentative schedule so far with much dependant on the speedy implementation of various recommendations and procedures following the investigation and report on the loss of *Columbia*. Some of those recommendations have NASA looking at ways to harden the shuttle to protect it from debris along with developing a material that can be used in space to repair lost or damaged heat tiles. The plans for return to flight also include more extensive training for mission managers.

The space agency is desperately keen to press ahead with construction of the *International Space Station* on orbit though the timetable for completion is now pushed out to at least 2008. The current caretaker crew of two — Yuri Malenchenko and Edward Lu — will be replaced in late-October 2003 by Michael Foale and Alexander Kaleri who will remain on board the station until May 2004. Subsequent crew rotations are under review pending return to service of the shuttle fleet.

China, in the meantime, have a real chance to focus the spotlight on their fledgling manned space programme should the rumours circulating about an October 2003 launch of their first taikonaut prove well founded. The country also harbour ambitions of orbiting a space station of their own in the future along with maybe attempting a Moon landing within the next decade.

The European Space Agency plans the first flight of its contribution to the *ISS* programme with the debut of the *Automated Transfer Vehicle* (*ATV*), the first of which was recently christened *Jules Verne* after the well-known science fiction author. Launch is provisionally pencilled in for the autumn of 2004 though teething problems with the *Ariane-5* rocket may cause the date to slip.

The unmanned craft is part space freighter, part space tug and will be capable of hauling up to 7·5 tonnes of food, water, pressurised air and fuel up to *ISS* crews. At least eight *ATV*s are expected to be built by ESA to cover the operational lifetime of the *ISS*. Earth's gravity causes the *ISS* to lose 650 metres altitude per day so the vehicle can also be used to boost the station to a higher orbit. The *ATV* is also designed to ferry rubbish and once loaded, can detach from the space station to burn up in the atmosphere.

## Looking at Earth

The understanding of Earth's environment and long term climate changes is the focus of two missions to be launched into orbit during 2004. *Aura* is a NASA mission designed to study the Earth's ozone, air quality and climate. It is part of a series of major Earth observing satellites that will study our planet from space. *Cyrosat* meanwhile is expected to undertake a three-year long mission to determine variations in the thickness of the Earth's continental ice sheets and marine ice cover. Its primary objective is to test the prediction of thinning arctic ice due to global warming.

The *Two Wide-angle Imaging Neutral-atom Spectrometers* (*TWINS*) programme consists of two small Earth-environment monitoring satellites with the second for launch in early 2004. The two craft will operate in tandem to produce three-dimensional images of the magnetosphere, the region of space dominated by Earth's magnetic field.

## Ongoing missions

The enduring *Galileo* spacecraft may have met its demise in September 2003 following its plunge into Jupiter's cloud-tops but many other probes throughout the solar system and beyond are actively engaged in research and observation.

Continuous real-time monitoring of the Sun and its environment is provided by *SOHO*, *TRACE* and others while the recently launched *SIRTF* infra-red space telescope augments the series of great observatories already in orbit such as *Hubble*. An armada of Mars-bound craft will join *Mars Global Surveyor* which is mapping the planet in great detail.

These robotic explorers, an extension of our senses, continue to return a rich bounty of scientific data and they, along with those due to be dispatched from Earth throughout 2004, can only add to the sum of human knowledge.

# A comprehensive guide to phenomena in 2004

PART OF THE evolution of *Sky-High* has seen us collate various tables of astronomical data and more extensive details of astronomical phenomena in 2004 into the last third of the booklet this year.

Here you will find the dates of maxima for variable stars and meteor showers, as well as orbital elements for comets that can be incorporated into sky charting programs on your PC to plot their path through the heavens. As always, we welcome feedback from you, the reader, to help us produce the annual in future years.

Aspects of the Moon are detailed in tabular form too with libration data provided courtesy of Gary Nugent of the IAS. John O'Neill, also a Society member, wrote the software to calculate the minima of the eclipsing binary Algol.

## The Sun

### Phenomena

| | | |
|---|---|---|
| *Earth at perihelion* | Jan 4d 18h | 147, 094, 349 km |
| *Spring equinox* | Mar 20d 06h | |
| *Summer solstice* | Jun 21d 00h | |
| *Earth at aphelion* | July 5d 11h | 152, 095, 257 km |
| *Autumnal Equinox* | Sept 22d 16h | |
| *Winter solstice* | Dec 21d 12h | |

### Carrington Rotation Numbers

| No. | Date | No. | Date | No. | Date |
|---|---|---|---|---|---|
| 2011 | 17 Dec | 2016 | 02 May | 2021 | 15 Sept |
| 2012 | 14 Jan | 2017 | 29 May | 2022 | 12 Oct |
| 2013 | 10 Feb | 2018 | 25 Jun | 2023 | 08 Nov |
| 2014 | 08 Mar | 2019 | 22 Jul | 2024 | 06 Dec |
| 2015 | 05 Apr | 2020 | 19 Aug | | |

Rotation number 2011 commenced on 2003 December17 while rotation number 2024 extends to 2005 January 2

### Solar coordinates for 2004

| | | $B_0$° | $P$ ° | | | $B_0$° | $P$ ° |
|---|---|---|---|---|---|---|---|
| Jan | 1 | -2·95 | 2·36 | Jul | 1 | 2·91 | -2·55 |
| Jan | 30 | -5·83 | -11·08 | Jul | 30 | 5·66 | 10·14 |
| Feb | 1 | -5·98 | -11·91 | Aug | 1 | 5·81 | 10·94 |
| Feb | 29 | -7·21 | -21·36 | Aug | 30 | 7·17 | 20·63 |
| Mar | 1 | -7·22 | -21·62 | Sep | 1 | 7·20 | 21·15 |
| Mar | 30 | -6·63 | -26·09 | Sep | 30 | 6·75 | 25·93 |
| Apr | 1 | -6·53 | -26·18 | Oct | 1 | 6·71 | 26·00 |
| Apr | 30 | -4·24 | -24·27 | Oct | 30 | 4·55 | 24·77 |
| May | 1 | -4·14 | -24·09 | Nov | 1 | 4·35 | 24·45 |
| May | 30 | -0·87 | -16·06 | Nov | 30 | 0·97 | 16·36 |
| Jun | 1 | -0·63 | -15·32 | Dec | 1 | 0·84 | 15·98 |
| Jun | 30 | 2·80 | -3·00 | Dec | 30 | -2·80 | 2·97 |

The table above indicates the variation of heliographic latitude $B_0$ (negative is south) and the variation of the position angle $P$ (negative is west) of the north point of the solar disk

## Solar eclipses in 2004

This year sees the minimum number of solar eclipses possible in a year with both being partial. Neither are visible from our shores but a group of intrepid Irish eclipse chasers are already well advanced in their plans for the 2005 annular eclipse that will sweep across central Spain and the great total solar eclipse that will cross central to northern Africa,Turkey and central Asia on 2006 March 29. More on the group and their adventures can be found at www.ecliptomaniacs.com

For the record, the eclipse of 2004 April 19 is partial from Antarctica and southern Africa while that of 2004 October 14 encompasses northeastern Asia, Hawaii, and Alaska.

## Safe solar viewing

Extreme care should be taken in observing the Sun because of the risk of instant blindness should you accidently look through a telescope without a proper filter in place. Many cheap telescopes come with a so-called sun filter. Often they are nothing more than pieces of smoked glass and are generally designed to fit over the eyepiece of the telescope. This does nothing to dim the full power of the sun and the filter can shatter without warning because of the intense heat concentrated at the eyepiece, driving shards of glass into your eyes. Neither do they filter out the more harmful invisible solar rays.

Such filters are therefore NOT SAFE and should be immediately discarded.

A more practical method is to project the Sun's image on to a piece of white card. Care should be used in case someone tries to take a quick glance through the eyepiece. Some telescopes may not be suited to using the projection method; one potential problem may be where the lens cement of eyepieces could melt. If in doubt, check with a local astronomical society.

# The Moon

## Phases of the Moon

| New Moon | | | | First Quarter | | | | Full Moon | | | | Last Quarter | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | d | h | m | | d | h | m | | d | h | m | | d | h | m |
| Jan | 21 | 21 | 05 | Jan | 29 | 06 | 03 | Jan | 07 | 15 | 40 | Jan | 15 | 04 | 46 |
| Feb | 20 | 09 | 18 | Feb | 28 | 03 | 24 | Feb | 06 | 08 | 47 | Feb | 13 | 13 | 40 |
| Mar | 20 | 22 | 41 | Mar | 28 | 23 | 48 | Mar | 06 | 23 | 14 | Mar | 13 | 21 | 01 |
| Apr | 19 | 13 | 21 | Apr | 27 | 17 | 32 | Apr | 05 | 11 | 03 | Apr | 12 | 03 | 46 |
| May | 19 | 04 | 52 | May | 27 | 07 | 57 | May | 04 | 20 | 33 | May | 11 | 11 | 04 |
| Jun | 17 | 20 | 27 | Jun | 25 | 19 | 08 | Jun | 03 | 04 | 20 | Jun | 09 | 20 | 02 |
| Jul | 17 | 11 | 24 | Jul | 23 | 10 | 12 | Jul | 02 | 11 | 09 | Jul | 09 | 07 | 34 |
| Aug | 16 | 01 | 24 | Aug | 21 | 15 | 54 | Jul | 31 | 18 | 05 | Aug | 07 | 22 | 01 |
| Sept | 14 | 14 | 29 | Sept | 21 | 15 | 54 | Aug | 30 | 02 | 22 | Sept | 06 | 15 | 11 |
| Oct | 14 | 02 | 48 | Oct | 20 | 21 | 59 | Sept | 28 | 13 | 09 | Oct | 06 | 10 | 12 |
| Nov | 12 | 14 | 27 | Nov | 19 | 05 | 50 | Oct | 28 | 03 | 07 | Nov | 05 | 05 | 53 |
| Dec | 12 | 01 | 29 | Dec | 18 | 16 | 40 | Nov | 26 | 20 | 07 | Dec | 05 | 00 | 53 |
| | | | | | | | | Dec | 26 | 15 | 06 | | | | |

July this year is noteable for two Full Moons falling in the same month. The second Full Moon in a month is popularly called the Blue Moon.

The Moon revolves around the Earth in just 29·53059 days (known as the *synodic* month) and so we may occasionally see the same lunar phase repeat in a month.

This occurs about every 2·5 years on average but we must wait until 2018 for the next occurance of *two* Blue Moon months in the same year.

Easter Sunday this year is on April 11th and is generally taken as the first Sunday after the first Full Moon following the Spring Equinox. The computation of Easter Day is a little more complex than this but it's a useful rule of thumb.

The Full Moon of September 28 is by definition the Harvest Moon; that is, it is the closest Full Moon to the Autumnal Equinox. On average. the moon rises around one hour later each night. What marks out the Harvest Moon as special is that it appears to come up around sunset for several successive evenings.

## Earthshine

When observing the Moon as a very slender crescent you may often see a phenomenon called Earthshine — also popularly known as "the old Moon in the new Moon's arms". This is due to sunlight reflected off the Earth onto the unlit portion of the Moon and was first explained by Leonardo Da Vinci. The brightness of Earthshine is often an indication of the weather situation on our own planet with dense cloud cover over the daytime side of the Earth reflecting more sunlight.

## Young Moons

The annual attempt of trying to spot the youngest Moon is a real thrill. Certain conditions need to be satisfied to come close to present records for the youngest Moon seen (how soon after moment of New the crescent is first spotted).

Currently, the records stand at 12·1 hours after New with a telescope, 13·5 with binoculars and 15 hours with the naked eye.

What factors are critical for spotting the crescent so close to New? Well, the time of year is important. During the spring months, the ecliptic, or apparent path of the Sun, makes its steepest angle to the horizon. This causes the Sun to sink rapidly, darkening the sky while placing the thin lunar crescent at a respectable altitude above the horizon.

Equally important is the time of New Moon. Calculations show that the lunar crescent becomes invisible when within 7° of the Sun because the limb will be obscured by shadows cast by mountains on the terminator. Ideally, New Moon should also fall some time between midnight and sunrise of the day you are attempting any sort of record sighting.

Two other factors can aid a sighting attempt. The further north the Moon is from the ecliptic, the longer it remains above the horizon after sunset and finally, the Moon should be at perigee, or closest to the Earth in its orbit. Then, it's orbital motion is fastest, thus rapidly increasing the angular distance between it and the Sun in the sky.

No real opportunity to spot a record-breaking Moon occurs for us this year but the young Moon of April 20th will appear as a slender curl just 31-hours old.

## Moon colours and Moon views

*Apollo* astronauts described the lunar surface as being grey in colour. It follows that the Moon's disk will adopt the colour of the sunlight it reflects; a yellow-white hue. But our perception of the brilliant white of the Full Moon at night is largely due to it being vastly brighter than its background. When low on a hazy night it can become a deep gold or honey colour.

When we look at the First or Last Quarter Moon we are looking right along the Earth's path around the Sun. The Last Quarter Moon marks the Earth's approximate position about 3½ hours hence while the First Quarter Moon marks the Earth's previous location by about the same length of time (and we're roughly either 370, 000 km ahead or behind the Moon in our orbit at these moments.)

## Lunar Apsides

| Perigee | | | | | | Apogee | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 19 | 362,767 km | Jul | 30 | 360,325 km | Jan | 3 | 405,706 km | Jul | 14 | 406,191 km |
| Feb | 16 | 368,319 km | Aug | 27 | 365,105 km | Jan | 31 | 404,806 km | Aug | 11 | 405,290 km |
| Mar | 12 | 369,509 km | Sept | 22 | 369,599 km | Feb | 28 | 404,257 km | Sept | 8 | 404,462 km |
| Apr | 8 | 364,547 km | Oct | 18 | 367,757 km | Mar | 27 | 404,519 km | Oct | 5 | 404,326 km |
| May | 6 | 359,811 km | Nov | 14 | 362,312 km | Apr | 24 | 405,402 km | Nov | 2 | 404,998 km |
| Jun | 3 | 357,248 km | Dec | 12 | 357,985 km | May | 21 | 406,261 km | Nov | 30 | 405,951 km |
| Jul | 1 | 357,449 km | | | | Jun | 17 | 406,574 km | Dec | 27 | 406,487 km |

The Full Moon of June 3rd is the closest of the year at 357, 248 km. Our companion world's orbit about us is not perfectly circular, resulting in its distance varying over the course of a month. This also leads to a variation in the Moon's angular diameter — June's disk measures 33' 25". Conversely, the most distant Full Moon of the year is on December 26th when it will be 406, 077 km from Earth and measures 29' 39". The terms *perigee* and *apogee* are used respectively to describe the points when the Moon is at its closest and most distant points from the Earth during the month.

## Libration maxima and minima

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3 | Jan | Min. 1.8° in P.A. 243.3° | 5 | May | Min. 2.4° in P.A. 32.1° | 5 | Sept | Min. 5.0° in P.A. 234.9° |
| 10 | Jan | Max. 8.6° in P.A. 140.7° | 11 | May | Max. 9.4° in P.A. 318.0° | 11 | Sept | Max. 7.3° in P.A. 151.4° |
| 18 | Jan | Min. 3.1° in P.A. 34.1° | 19 | May | Min. 2.8° in P.A. 244.0° | 18 | Sept | Min. 3.7° in P.A. 54.1° |
| 24 | Jan | Max. 8.8° in P.A. 317.7° | 27 | May | Max. 9.6° in P.A. 125.8° | 25 | Sept | Max. 7.1° in P.A. 341.1° |
| 31 | Jan | Min. 2.1° in P.A. 218.8° | 2 | Jun | Min. 3.5° in P.A. 29.1° | 2 | Oct | Min. 4.8° in P.A. 237.8° |
| 6 | Feb | Max. 8.1° in P.A. 145.5° | 8 | Jun | Max. 9.7° in P.A. 314.1° | 9 | Oct | Max. 7.6° in P.A. 142.1° |
| 13 | Feb | Min. 2.6° in P.A. 53.7° | 15 | Jun | Min. 3.5° in P.A. 223.8° | 15 | Oct | Min. 3.4° in P.A. 51.3° |
| 20 | Feb | Max. 7.9° in P.A. 327.6° | 23 | Jun | Max. 8.9° in P.A. 128.5° | 22 | Oct | Max. 7.7° in P.A. 330.2° |
| 27 | Feb | Min. 2.2° in P.A. 238.2° | 30 | Jun | Min. 4.6° in P.A. 28.7° | 29 | Oct | Min. 4.5° in P.A. 245.4° |
| 4 | Mar | Max. 8.4° in P.A. 142.5° | 6 | Jul | Max. 9.2° in P.A. 311.2° | 6 | Nov | Max. 8.0° in P.A. 133.2° |
| 11 | Mar | Min. 1.7° in P.A. 48.0° | 13 | Jul | Min. 4.2° in P.A. 222.1° | 12 | Nov | Min. 4.1° in P.A. 42.1° |
| 18 | Mar | Max. 7.8° in P.A. 328.7° | 20 | Jul | Max. 7.9° in P.A. 138.9° | 19 | Nov | Max. 8.4° in P.A. 323.0° |
| 25 | Mar | Min. 2.2° in P.A. 252.3° | 27 | Jul | Min. 5.3° in P.A. 39.2° | 26 | Nov | Min. 4.8° in P.A. 234.2° |
| 1 | Apr | Max. 9.0° in P.A. 135.9° | 3 | Aug | Max. 8.3° in P.A. 313.2° | 5 | Dec | Max. 8.1° in P.A. 128.3° |
| 7 | Apr | Min. 1.6° in P.A. 18.5° | 9 | Aug | Min. 4.8° in P.A. 229.3° | 11 | Dec | Min. 5.4° in P.A. 29.3° |
| 14 | Apr | Max. 8.6° in P.A. 325.5° | 15 | Aug | Max. 7.3° in P.A. 145.4° | 17 | Dec | Max. 8.6° in P.A. 310.3° |
| 21 | Apr | Min. 2.3° in P.A. 240.6° | 22 | Aug | Min. 4.8° in P.A. 58.4° | 24 | Dec | Min. 5.5° in P.A. 224.0° |
| 29 | Apr | Max. 9.6° in P.A. 129.4° | 30 | Aug | Max. 7.3° in P.A. 325.9° | | | |

The rotation period of the Moon is the same as the length of time it takes to revolve (orbit) around the Earth. This has the effect of tidally locking the Moon so that approximately the same aspect is always pointed towards us. However, various tiltings of the Moon's face, known as *libration*, allow us to peer a little beyond its edge.

The phenomenon can discovered by the naked eye observer. Close to the eastern limb of the Moon is the circular Mare Crisium, or Sea of Crises. To the unaided eye the Mare varies in appearance from a thin dark line close to the Moon's limb to an easily seen dark oval patch when libration conditions are favourable such as those around First Quarter on December 18th.

## Occultations

During its apparent course across the sky, the Moon passes between many stars and us. The body of the Moon hides the star and the phenomenon is called an occultation. As the Moon is moving from west to east with respect to the stars, the star disappears at the eastern (left) side of the disk and reappears some time later at the western (right) edge.

As a consequence of this, occultations are somewhat easier to observe between New and First Quarter. If you have never seen an occultation before you will be surprised by the suddeness of the event.

Occultations listed are for Dublin-based observers. That is not to say a particular occultation will be unobservable from other parts of Ireland; rather, the time quoted is when Dublin-based observers will note the object's disappearance (D) and reappearence (R). Graze events, where the star is not actually occulted but "nicked" by the limb of the Moon, are denoted by a "G" in the phase column (Ph.). The magnitude (Mag.) and position angle (P.A.°) are also listed. A magnitude limit of 6·5 has been adopted. The position angle is defined as the angle between the lunar north pole, the centre of the Moon and the position of the star at the moment of occultation. The angle increases in an eastward direction and is expressed in degrees.

| | | | Star | Mag. | Ph. | P.A.° |
|---|---|---|---|---|---|---|
| Jan | 4 | 19h 58m 45s | 300 B. Tauri | 6.3 | G | 161 |
| Jan | 5 | 20h 28m 34s | 125 Tauri | 5.2 | D | 80 |
| Jan | 5 | 02h 16m 58s | 315 B. Tauri | 6.3 | D | 50 |
| Jan | 6 | 06h 27m 10s | 139 Tauri | 4.8 | D | 114 |
| Jan | 8 | 20h 26m 55s | λ Cancri | 5.9 | R | 288 |
| Jan | 10 | 03h 03m 27s | 9 B. Leonis | 6.5 | R | 239 |
| Jan | 14 | 02h 12m 10s | γ Virginis | 2.8 | D | 77 |
| Jan | 14 | 02h 58m 29s | γ Virginis | 2.8 | R | 349 |
| Jan | 25 | 18h 29m 55s | 376 B. Aquarii | 6.1 | D | 111 |
| Jan | 31 | 18h 14m 34s | υ Tauri | 4.3 | G | 158 |
| Jan | 31 | 18h 29m 57s | 72 Tauri | 5.5 | D | 112 |
| Feb | 2 | 05h 33m 03s | 125 Tauri | 5.2 | D | 59 |
| Feb | 14 | 03h 07m 24s | δ Scorpii | 2.3 | R | 348 |
| Feb | 14 | 06h 37m 29s | 57 B. Scorpii | 5.9 | R | 260 |
| Feb | 15 | 06h 13m 30s | 118 B. Ophiuchi | 6.3 | R | 289 |
| Feb | 24 | 17h 59m 54s | ο Piscium | 4.3 | D | 1 |
| Feb | 27 | 21h 21m 42s | 192 B. Tauri | 6.1 | G | 167 |
| Mar | 2 | 19h 23m 52s | 76 Geminorum | 5.3 | D | 83 |
| Mar | 5 | 18h 50m 54s | 42 Leonis | 6.2 | D | 97 |
| Mar | 8 | 00h 58m 19s | 10 Virginis | 5.9 | R | 296 |
| Mar | 24 | 21h 22m 16s | 53 Arietis | 6.1 | D | 55 |
| Mar | 26 | 00h 26m 53s | Mars | 1.5 | D | 115 |
| Mar | 27 | 21h 30m 21s | PPM 94610 (Taurus) | 6.4 | D | 53 |
| Apr | 1 | 03h 30m 21s | 9 B. Leonis | 6.5 | D | 102 |
| Apr | 9 | 04h 01m 05s | 22 Scorpii | 4.8 | R | 342 |
| Apr | 26 | 20h 52m 12s | ω Cancri | 5.9 | D | 58 |
| Apr | 26 | 21h 17m 46s | 4 Cancri | 6.3 | D | 117 |
| May | 21 | 11h 10m 40s | Venus | -3.9 | D | 38 |
| May | 21 | 12h 09m 10s | Venus | -3.9 | R | 295 |
| May | 26 | 14h 44m 25s | η Leonis | 3.5 | G | 23 |
| Jun | 2 | 22h 20m 45s | 22 Scorpii | 4.8 | D | 69 |
| Jun | 2 | 23h 11m 28s | 22 Scorpii | 4.8 | R | 331 |
| Jun | 22 | 22h 25m 35s | 107 B. Leonis | 6.4 | D | 167 |
| Jul | 10 | 03h 42m 29s | ο Piscium | 4.3 | R | 275 |
| Jul | 13 | 02h 32m 52s | 37 Tauri | 4.4 | R | 242 |
| Jul | 13 | 02h 40m 08s | 39 Tauri | 5.9 | R | 212 |
| Jul | 14 | 03h 55m 45s | 98 Tauri | 5.8 | R | 265 |
| Aug | 6 | 03h 18m 27s | 96 Piscium | 6.5 | R | 223 |
| Aug | 8 | 23h 42m 02s | 22 H1. Tauri | 6.1 | R | 254 |
| Sept | 10 | 04h 50m 40s | ω Cancri | 5.9 | R | 305 |
| Sept | 10 | 05h 16m 30s | 4 Cancri | 6.3 | R | 236 |
| Sept | 27 | 04h 15m 17s | $\psi_1$ Aquarii | 4.2 | D | 13 |
| Sept | 30 | 00h 07m 13s | 269 B. Piscium | 6.5 | R | 231 |
| Oct | 2 | 22h 04m 32s | 32 Tauri | 5.6 | R | 301 |
| Oct | 2 | 02h 01m 27s | PPM 118924 (Aries) | 6.5 | R | 187 |
| Oct | 5 | 03h 51m 07s | 136 Tauri | 4.6 | R | 332 |
| Oct | 8 | 02h 48m 08s | $\upsilon_1$ Cancri | 5.7 | R | 355 |
| Oct | 8 | 01h 33m 29s | 28 Cancri | 6.1 | R | 337 |
| Oct | 20 | 18h 52m 24s | 59 Sagittarii | 4.5 | D | 110 |
| Oct | 24 | 18h 33m 00s | 351 B. Aquarii | 6.4 | D | 76 |
| Oct | 29 | 03h 01m 57s | ρ Arietis | 5.6 | R | 315 |
| Oct | 30 | 05h 08m 03s | 133 B. Tauri | 6.1 | R | 259 |
| Oct | 31 | 03h 31m 03s | PPM 93661 (Taurus) | 6.2 | R | 271 |
| Nov | 1 | 05h 39m 07s | 112 B. Aurigae | 5.8 | R | 206 |
| Nov | 2 | 22h 25m 41s | 47 Geminorum | 5.8 | R | 261 |
| Nov | 18 | 20h 42m 53s | 143 B. Capricorni | 6.2 | D | 59 |
| Nov | 23 | 02h 41m 27s | 80 Piscium | 5.5 | D | 19 |
| Nov | 23 | 00h 45m 23s | 77 Piscium | 6.3 | D | 100 |
| Nov | 24 | 20h 05m 04s | 29 Arietis | 6.0 | D | 86 |
| Nov | 28 | 21h 55m 13s | 415 B. Aurigae | 6.0 | G | 350 |
| Nov | 30 | 20h 40m 07s | 76 Geminorum | 5.3 | R | 260 |
| Nov | 30 | 07h 50m 25s | 47 Geminorum | 5.8 | R | 285 |
| Dec | 1 | 06h 04m 38s | ω Cancri | 5.9 | R | 311 |
| Dec | 1 | 06h 42m 11s | 4 Cancri | 6.3 | R | 257 |
| Dec | 5 | 06h 48m 52s | 308 B. Leonis | 5.8 | R | 252 |
| Dec | 17 | 22h 33m 32s | $\psi_1$ Aquarii | 4.2 | D | 58 |
| Dec | 18 | 19h 30m 28s | 27 Piscium | 4.9 | D | 359 |
| Dec | 18 | 21h 31m 17s | 29 Piscium | 5.1 | D | 11 |
| Dec | 19 | 22h 54m 41s | 155 B. Piscium | 6.4 | D | 59 |
| Dec | 20 | 16h 55m 49s | 263 B. Piscium | 6.2 | D | 8 |
| Dec | 22 | 20h 02m 33s | 54 Arietis | 6.2 | D | 69 |
| Dec | 23 | 19h 07m 43s | 32 Tauri | 5.6 | D | 79 |
| Dec | 25 | 17h 10m 26s | 112 B. Aurigae | 5.8 | D | 35 |
| Dec | 28 | 05h 05m 22s | 76 Geminorum | 5.3 | R | 280 |
| Dec | 28 | 20h 06m 56s | λ Cancri | 5.9 | R | 255 |
| Dec | 30 | 04h 50m 12s | 9 B. Leonis | 6.5 | R | 325 |
| Dec | 31 | 00h 28m 56s | 107 B. Leonis | 6.4 | R | 226 |

# Lunar eclipses in 2004

A total lunar eclipse occurs when the Moon passes through the shadow of the Earth cast into space. This means that we can only get a lunar eclipse during time of Full Moon when the Sun, Earth and Moon are in a straight line.

We don't get a solar or lunar eclipse every month however because the orbit of the Moon about the Earth is tilted with respect to the Earth's equator.

During a total lunar eclipse our atmosphere acts like a lens bending sunlight around the Earth's limb onto the Moon. Longer wavelengths of light (red and orange) penetrate our atmosphere better than shorter (blue) so during totality the Moon takes on a reddish-orange hue.

The effect is similar to the reddening of the setting Sun. It once led someone to comment that the red colour of the eclipsed Moon is due to all the sunrises and sunsets around the world being painted on the Moon — a rather nice and perceptive observation.

## Eclipse phenomena

Normally the light of the Full Moon floods the sky and washes out all but the brighter stars. During totality however, many fainter stellar pinpoints burst into view when the light of the lunar disk is dimmed.

Very little dimming is noticed during the initial stages of a lunar eclipse as the Moon slides through the penumbral, or outer, portion of the Earth's shadow. Thereafter, you will begin to see a slight darkening at the leading limb as the Moon slips deeper into eclipse. This is when we anticipate the dramatic play of effects on the lunar disk.

If the Moon passes well north or south of the centre of the Earth's shadow then the contrast between either hemisphere can be quite marked with the tones graded from bright to dark across the disk.

## The Danjon scale

Atmospheric conditions at the Earth's limb can often have an effect on the visibility of the Moon during an eclipse. The brightness of lunar eclipses can be rated according to a scale devised by the French astronomer Antoine Danjon. It is graded as follows:

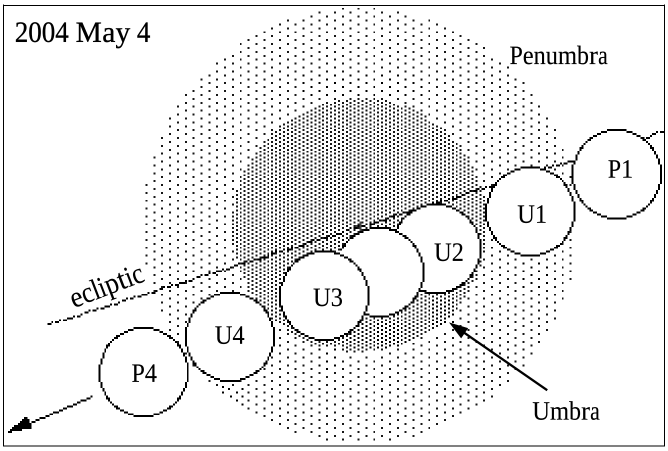
- L = 0: Very dark eclipse; Moon hardly visible, especially near mid-totality.
- L = 1: Dark eclipse; grey-to-brown colouring; details on the disk hardly visible
- L = 2: Dark red or rust coloured eclipse with dark areas in the shadow centre, the edge brighter
- L = 3: Brick red eclipse, the shadow often bordered with a yellow edge
- L = 4: Orange or copper-coloured, very bright eclipse with bluish edge

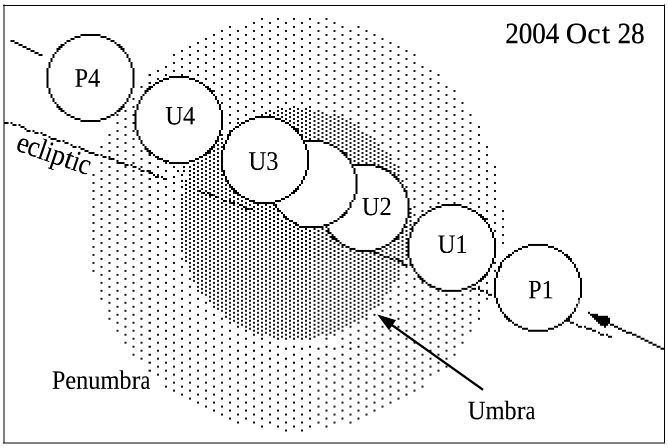
If anyone does happen to catch either eclipse event during 2004 and would like to do a little science then we'd love to hear of any eclipse brightness measurements.

The key is to carry out your estimation (on the Danjon scale) as close to mid-eclipse as possible. Make a note too whether each lunar hemisphere deserves a Danjon scale grading of its own.

Dust and ash ejected into the atmosphere from the eruption of Mt. Pinatubo in the Philippines during 1991 led to dark eclipses in the following years.

The lunar eclipse of December 1992 which was visible from Ireland was rated as L=0.5 by many observers. I recall having great difficulty in even finding it in the sky – it looked for all the world like a very tarnished ball bearing and was almost 3-dimensional in front of the dark of night.




Moonrise is just round about when totality begins for the May 4th eclipse and so we will see most of the total phase with the sky still brightly twilit. We also miss the pre-totality partial stages. Nautical twilight ends at 21h 38m that evening (Sun 12° below horizon).

Observers in Namibia witness an extremely rare event during totality of the May 4th eclipse — a graze occultation of the wide double star $\alpha^{2,1}$ Librae.

| | Stage | 2004 May 4 | 2004 Oct 28 |
|---|---|---|---|
| Penumbral eclipse begins | P1 | 17:50:51 | 00:05:32 |
| Partial eclipse begins | U1 | 18:48:18 | 01:14:23 |
| Totality begins | U2 | 19:52:06 | 02:23:25 |
| Totality ends | U3 | 21:08:24 | 03:44:41 |
| Partial eclipse ends | U4 | 22:12:12 | 04:53:42 |
| Penumbral eclipse ends | P4 | 23:09:34 | 06:02:42 |

the next *total* lunar eclipse visible from Ireland is 2007 March 03 (duration 74 mins) — mid-totality is 03h 42m

# The planets in 2004

This table will tell you at a glance the best times to view the naked-eye planets. Mercury and Venus, the inner planets, are very much tied to the realm of twilight though Venus can be well placed in a dark sky after sunset or before sunrise when at a favourable elongation. Mars, Jupiter and Saturn may be seen right throughout the night when they are at opposition.

| | *Morning Sky* | *Evening Sky* |
|---|---|---|
| Mercury | • first two weeks of January<br>• first two weeks of September and last week of December | • second half of March through to the first half of April<br>• brief period mid-July |
| Venus | • on view from the second week of July through to the end of 2004 | • excellent evening apparition from the start of the year up to late May |
| Mars | • reappears in the morning sky in late-October when it can be found in Virgo | • sets after midnight up to the beginning of May after which it becomes solely an evening sky object up to the end of June |
| Jupiter | • moves into the morning sky after the first week of October and rises during the early hours for the rest of the year | • can be seen in the evening sky up to late July. It is visible throughout the night when at opposition on March 4 |
| Saturn | • returns to the morning sky in late-July and rises before midnight from late-September. It will be visible throuhout the hours of darkness from the last few months of the year | • visible right throughout the night at the beginning of 2004 following its 2003 December 31 opposition. Is briefly just an evening sky object before being lost to view in late May |

**Uranus** spends the year in Aquarius though is too close to the Sun from the beginning of February to mid-March to be seen. It then reappears in the morning sky and reaches opposition on August 27th. **Neptune** spends the year in Capricornus and is at conjunction on February 2nd. It returns to the morning sky in late February and is at opposition on August 6th. Uranus and Neptune are solely evening sky objects from early-November. **Pluto** can be found in Serpens at time of opposition on June 11th as a feeble magnitude 13·8 glimmer 1½° southeast of ν Serpentis. A moderate sized telescope is necessary to glimpse this dim and distant world presently almost 4458 million kilometres (or just over four light-*hours*) distant from us.

## Mercury

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *great elong.* | Jan 17 | 23° 55’ W | *superior conj.* | Jun 18 | | *superior conj.* | Oct 05 | |
| *superior conj.* | Mar 04 | | *greatest elong.* | Jul 27 | 27° 07’ E | *greatest elong.* | Nov 21 | 22° 11’ E |
| *greatest elong.* | Mar 29 | 18° 53’ E | *inferior conj.* | Aug 23 | | *inferior conj.* | Dec 10 | |
| *inferior conj.* | Apr 17 | | *great elong.* | Sept 09 | 17° 58’ W | *greatest elong.* | Dec 29 | 22° 27’ W |
| *great elong.* | May 14 | 26° 00’ W | | | | | | |

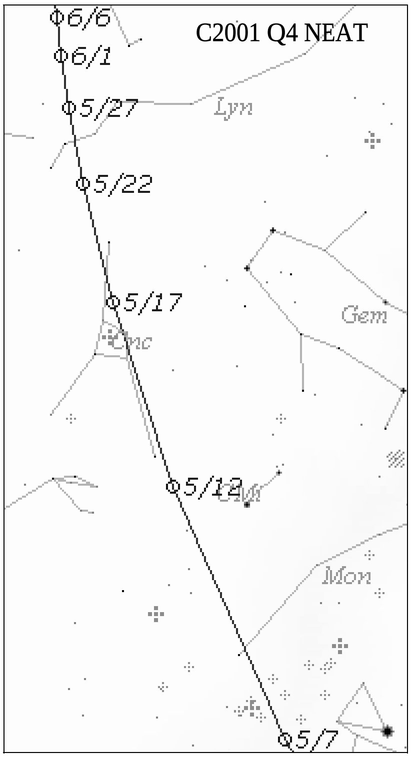
## Venus

| | | | | | |
|---|---|---|---|---|---|
| *greatest elongation* | Mar 29 | 46° 00’ E | *greatest brilliancy* | July 15 | mag. -4·5 |
| *greatest brilliancy* | May 02 | mag. -4·5 | *greatest elongation* | Aug 17 | 45° 49’ W |
| *inferior conjunction* | Jun 08 | transit | | | |

## Superior planets

| | Mars | Jupiter | Saturn | Uranus | Neptune | Pluto |
|---|---|---|---|---|---|---|
| *stationary (begins retrograde)* | — | Jan 4 | Nov 8 | Jun 11 | May 17 | Mar 24 |
| *opposition* | — | Mar 4 | — | Aug 27 | Aug 6 | Jun 11 |
| *stationary (prograde motion resumes)* | — | May 5 | — | Nov 12 | Oct 24 | Aug 31 |
| *eastern quadrature* | Jan 1 | May 30 | Mar 27 | — | — | — |
| *conjunction* | Sept 15 | Sept 22 | Jul 8 | Feb 22 | Feb 2 | — |
| *western quadrature* | — | — | Oct 20 | — | — | — |

# Comets in 2004




Two comets with the potential to reach naked-eye visibility are eagerly awaited by observers this year. Both were swept up while still some distance from the Sun by the automated search programmes hunting for near-Earth asteroids.

C/2002 T7 (LINEAR) begins the year as a binocular object in the evening sky. It slips into the twilight during the second week of March when it may reach borderline naked-eye visibility. The comet then passes through conjunction with the Sun after which it could surge in brightness to magnitude 3 as the distance between it and the Earth decreases. Southern hemisphere observers are favoured at this time though.

C/2001 Q4 (NEAT) could be the best of the year. It begins 2004 as a binocular object visible south of the equator and remains at a low declination until near perihelion in May at which time it may have reached magnitude 1 with a well developed tail according to some optimistic estimates. The comet is in the evening sky for us from the second week of May and becomes circumpolar (on view all night) in June. It remains visible to casual skywatchers up to the end of July when it fades from binocular range. The comet lies within 2° of the Beehive star cluster in Cancer on May 14th.

Best of the rest is likely to be another LINEAR discovery, comet C/2003 K4 (LINEAR) that could be a 7th magnitude object in the evening sky in late-August when it slowly drifts through the constellation of Boötes, the Herdsman.

This table will allow you generate ephemerides with any popular planetarium-type program. *T* is the perihelion time, *q* the perihelion distance, *e* the eccentricity, *P* the period in years, *w* the arguement of perihelion, *W* the longitude of the ascending node, and *i* the inclination.

## Dates of perihelion passage in 2004

| Comet | | *T* | *q* | *e* | *P* | *w* | *W* | *i* |
|---|---|---|---|---|---|---|---|---|
| 58P/Jackson-Neujmin | Jan | 10.0033 | 1.388550 | 0.660456 | 8.27 | 200.4467 | 160.6165 | 13.4558 |
| C/2003 L2 (LINEAR) | Jan | 19.2334 | 2.864595 | 0.981423 | | 119.8549 | 273.5575 | 82.0510 |
| 40P/Vaisala 1 | Jan | 22.9597 | 1.795578 | 0.633022 | 10.83 | 47.2230 | 134.7343 | 11.5393 |
| C/2003 E1 (NEAT) | Feb | 13.5362 | 3.245338 | 0.763574 | | 103.8401 | 137.0702 | 33.5377 |
| C/2003 H1 (LINEAR) | Feb | 22.6080 | 2.239812 | 0.999244 | | 196.1301 | 18.9984 | 138.6680 |
| C/2003 O1 (LINEAR) | Mar | 17.1770 | 6.847289 | 1.001244 | | 81.6698 | 347.6434 | 117.9815 |
| 43P/Wolf-Harrington | Mar | 17.8261 | 1.578708 | 0.544687 | 6.45 | 187.2570 | 254.7003 | 18.5199 |
| C/2002 L9 (NEAT) | Apr | 6.2087 | 7.033070 | 0.999019 | | 231.4414 | 110.4651 | 68.4539 |
| 88P/Howell | Apr | 12.5326 | 1.368117 | 0.561150 | 5.50 | 235.7838 | 56.8411 | 4.3820 |
| C/2002 T7 (LINEAR) | Apr | 23.0724 | 0.614454 | 1.000432 | | 157.7429 | 94.8535 | 160.5794 |
| 104P/Kowal 2 | May | 9.7120 | 1.395915 | 0.585629 | 6.18 | 192.0248 | 246.0955 | 15.4892 |
| C/2001 Q4 (NEAT) | May | 15.9375 | 0.961999 | 1.000725 | | 1.1993 | 210.2692 | 99.6385 |
| 103P/Hartley 2 | May | 17.9713 | 1.035986 | 0.699600 | 6.40 | 180.8117 | 219.9085 | 13.6031 |
| P/1996 R2 (Lagerkvist) | Jun | 7.4654 | 2.622650 | 0.308578 | 7.39 | 334.2792 | 40.2294 | 2.6022 |
| 29P/Schwassmann-Wachmann 1 | Jul | 16.7492 | 5.723075 | 0.044484 | 14.65 | 49.3869 | 312.7241 | 9.3938 |
| 121P/Shoemaker-Holt 2 | Sept | 1.4970 | 2.648639 | 0.338618 | 8.01 | 6.1664 | 99.6766 | 17.7164 |
| 120P/Mueller 1 | Sept | 30.2077 | 2.746256 | 0.337035 | 8.43 | 30.2010 | 4.4638 | 8.7859 |
| 48P/Johnson | Oct | 12.1201 | 2.309901 | 0.366197 | 6.96 | 207.7305 | 117.3285 | 13.6592 |
| C/2003 K4 (LINEAR) | Oct | 13.7066 | 1.023580 | 1.000364 | | 198.4420 | 18.6770 | 134.2533 |
| 130P/McNaught-Hughes | Oct | 23.3296 | 2.105067 | 0.405551 | 6.67 | 224.0924 | 89.8937 | 7.3069 |
| 78P/Gehrels 2 | Oct | 27.0781 | 2.007455 | 0.462767 | 7.22 | 192.9689 | 210.5642 | 6.2524 |
| 69P/Taylor | Nov | 30.2856 | 1.942194 | 0.467114 | 6.95 | 355.4776 | 108.8083 | 20.5639 |
| 131P/Mueller 2 | Dec | 17.6774 | 2.423100 | 0.342451 | 7.07 | 179.8837 | 214.2471 | 7.3486 |
| 111P/Helin-Roman-Crockett | Dec | 25.9489 | 3.474173 | 0.140606 | 8.12 | 10.3683 | 91.9430 | 4.2323 |

# Meteors in 2004

Most of the major annual showers are favoured by relatively Moon-free periods in 2004 with just the Quadrantids, peaking in January, seriously affected by moonlight. Recent studies of the Perseid meteor stream give a possibility of rates slightly exceeding normal levels in 2004 with a very slim chance of storm-level activity. We also highlight some of the understudied minor streams such as the June Boötids which may show enhanced activity this year.

*January* — ringing in the New Year are the fleeting fireworks of the Quadrantids that peak this year around dawn on the 4$^{th}$. The presence of the waxing gibbous Moon above the horizon will mean only a handful of the brighter shower members may be seen, if any. The Quadrantids exhibit a short, sharp peak lasting only a few hours with the radiant in northern Boötes.

*February* — activity during the month is dominated by a handful of minor showers with low rates from the Leo-Virginid complex. Sporadic activity tends to be very loose too with it difficult to distinguish shower members from the general sporadic background. Most of the meteor programmes for February are beyond the scope of this guide with the known showers in the month more suited to telescopic work.

*March* — again, March is characterised by low rates of meteors with only the Virginid complex of radiants producing some activity throughout the month. The cluster of minor showers loosely classed as Virginids are quite diffuse and may in fact be associated with the *anthelion* — a point nearly opposite the sun in the sky that produces low meteor rates throughout the year. These meteors are in low inclination orbits and circle the Sun in the same direction as Earth.

An occasional bright Virginid may be noted but membership is difficult to distinguish from the sporadic background. The anthelion is centred on Virgo in March and drifts slowly through the ecliptical constellations during the year.

*April* — a dark-of-the Moon period will let you spot members of the Lyrid meteor shower in the early hours of the 22$^{nd}$. Rates are rather low (ZHR ~15) but there have been occasional outbursts with the last being in 1982 when observers in America noted a ZHR of 90. The International Meteor Organisation is predicting maximum for 4h on the 22$^{nd}$ which will favour Ireland.

Given the unusual characteristics of the shower every effort should be made to add to the data collected to date on the Lyrids. The radiant does not reach a useful elevation from here until well after midnight. I've nicknamed the shower “The Tears of Orpheus” after the Lyre-playing character in the Greek myth though the moniker may never catch on within the astronomical community!

*May* — the h Aquarids, reaching a peak on the morning of the 5$^{th}$, are lost to the Full Moon this month. The radiant is low from here and is only really at a useful altitude in the pre-dawn hours. The stream is associated with Halley's comet which lays a trail of meteoroids that also give rise to the Orionids in October — the η Aquarids being scattered along Halley's outbound path. Venus fords this complex at the same time as we do on occasions and so a tenuous bridge of particles may span the millions of kilometres of lonely space between the two worlds.

*June* — With the enduring twilight at this time of year and most of the active radiants above the horizon during daytime, there is normally very little reason to carry out a meteor watch programme during June. However, there is a very strong chance we may witness enhanced rates from the June Boötids, active on the night of the 26/27 with the peak predicted for the early hours of the 27$^{th}$.

The shower is associated with comet 7P/Pons-Winnecke which orbits the Sun with a period of 6·37 years, following a path that takes it from a point near the orbit of Earth to just beyond the orbit of Jupiter. The trail of dust particles shed by 7P/Pons-Winnecke have probably not spread out evenly and so we occasionally run into one of the denser clumps of material. This is what happened in 1998 and recent work has suggested we may do the same again in 2004.

The unexpected 1998 outburst produced ZHR rates in excess of 75 and observers should be vigilant for similarly enhanced activity in 2004. Prior to 1998, further outbursts were noted in 1916, 1921, and 1927. The International Meteor Organisation expect the maximum around 1h 45m UT and although the waning gibbous Moon interferes a little this year, it sets for observers in Ireland around 1h local time.

*July* — The southern component of the d Aquarid stream is active during the early hours of the 27$^{th}$ but the waxing gibbous Moon will interfere somewhat with observation. The radiant is only at a useful height above the horizon after midnight and increases in altitude approaching dawn.

*August* — The waning crescent Moon, only four days from New, rises at 1h and will interfere only a little with observation of the Perseids that hit maximum this year on August 12$^{th}$. During the 1990s, the shower exhibited a double peak associated with the return of the parent comet, 109P/Swift-Tuttle, to the inner solar system in 1992. High rates were noted in the years following the comet's perihelion though the double peak seems to now have contracted into the single traditional maximum.

Recent studies suggest the Earth may this year pass close to the trail of debris left by the comet's return in 1862 which may lead to higher than normal rates with an extremely slim chance of storm levels. If high rates do occur, then it is believed the outburst may only last a very short period, maybe only 15 minutes or so, with many dimmer meteors. Perturbations by Jupiter have also nudged the recent trails to lower their orientation to the ecliptic so expect the unexpected!

*September* — the month is characterised by a number of active minor streams such as the Aurigid complex. However, the second half of the year often sees more *sporadic* meteors noted. Sporadics are meteors that have no known shower association and can appear from any direction in the sky. Some may also be remnants of a long defunct shower.

*October* — the Orionids are the best known shower of the month and are associated with 1P/Halley. The radiant is near the raised club of Orion and rates are good with many swift meteors. Moonset is before midnight on the evening of maximum (October 21) with excellent conditions in the wee hours as the radiant climbs higher in the sky.

The International Meteor Organisation draw attention to the fact that recent analysis has indicated a submaximum on the night of October 17/18 which is at least as strong as the primary peak a few days later. The dark of the Moon period during this time is an encouragement for observers to monitor the suspected submaximum and add to our knowledge of the shower.

Less well known are the Draconids, a minor shower with variable rates associated with comet 21P/Giacobini-Zinner. The comet last returned to the inner solar system in 1998 when hourly rates of 700 were noted. It next comes to perihelion in mid-2005 and with favourable conditions this year, every effort should be made to observe the shower.

The peak is predicted for 2h on October 8th and the radiant — close to the "head" of Draco — is *circumpolar* (above the horizon all night) from Ireland. Draconids are slow moving meteors which should help distinguish their shower association.

*November* — although we expect the Leonid rates to have declined back to normal levels following the enhanced activity the last few years, it doesn't mean meteor observers can relax! Observations at this time help determine the boundaries for storm levels and can build a longer history of the shower in "lean" years. The maximum is in the early hours of November 17th though the eastern seaboard of North America is favoured. The Moon is effectively out of the picture this year meaning conditions are ideal.

The other well known November meteor shower, the Taurids, are characterised by slow meteors with occasional high numbers of fireballs. The fluctuations has led some meteor researchers to suggest the increase in rates is due to a swarm of large particles in the meteorid stream with the next potential increase in fireball rates predicted for 2005.

An additional minor shower with variable rates are the a Monocerotids which produced an outburst lasting 30 minutes in 1995 when European observers noted a ZHR of 400. The enhanced displays seem to have a ten-year periodicy and similarly high rates may occur in 2005. With the Moon out of the picture by 1h on the night of maximum (November 20/21) it is definitely worth keeping a watch.

*December* — the Ursids (maximum on the 22nd) succumb to the nearly Full Moon but the Geminids are blessed with perfect observing conditions. Maximum is predicted for 22h on the 13th.

The Geminids could be considered richer even than the better known Perseids but inclement weather at this time of year means few observers are prepared to brave the winter chill to glimpse these celestial fireworks.

## Principal meteor showers of 2004

| Shower | Activity Period | Date of Maximum | Radiant R.A. | Position ° Decl. | Speed km/s | r | ZHR | Parent Body |
|---|---|---|---|---|---|---|---|---|
| Quadrantids | 01 Jan - 05 Jan | 04 Jan | 15h 20m | +49° | 41 km/s | 2.1 | 120 | - unknown - |
| Lyrids | 16 Apr - 25 Apr | 22 Apr | 18h 04m | +34° | 49 km/s | 2.9 | 20 | C/Thatcher (1861 G1) |
| η Aquarids | 19 Apr - 28 May | 05 May | 22h 32m | -01° | 66 km/s | 2.7 | 60 | 1P/Halley |
| δ Aquarids | 12 Jul - 19 Aug | 27 Jul | 22h 36m | -16° | 41 km/s | 3.2 | 20 | - unknown - |
| Perseids | 17 Jul - 24 Aug | 12 Aug | 03h 04m | +57° | 34 km/s | 2.9 | 110 | 109P/Swift-Tuttle |
| Orionids | 02 Oct - 07 Nov | 21 Oct | 06h 20m | +16° | 66 km/s | 2.9 | 20 | 1P/Halley |
| Taurids | 01 Oct - 25 Nov | 05 Nov | 03h 52m | +22° | 29 km/s | 2.3 | 5 | 2P/Encke |
| Leonids | 14 Nov - 21 Nov | 17 Nov | 10h 12m | +22° | 71 km/s | 2.5 | var. | 55P/Tempel-Tuttle |
| Geminids | 07 Dec - 17 Dec | 13 Dec | 07h 28m | +33° | 35 km/s | 2.6 | 120 | 3200 Phæthon (minor planet) |
| Ursids | 17 Dec - 26 Dec | 22 Dec | 14h 28m | +76° | 65 km/s | 3.0 | 5 | 8P/Tuttle |

A meteor shower is named for the constellation in which the *radiant*, or point of origin of the meteors, appears to lie. The suffix "id" has a Greek root and means "child of". The exception are the Quadrantids, named for a now defunct star pattern that was originally comprised of some of the stars of Boötes.

"r", the "population index", is an indication of the proportions of bright and faint meteors in a shower. It is computed from the shower's magnitude distribution. A value in the range 2.0 to 2.5 indicates meteors brighter than average while a result closer to 3.0 means fainter.

The date we give for a meteor shower is the expected date of the maximum. A shower's period of visibility may extend a few days either side of maximum – though much lower rates may be recorded. The ZHR, or Zenithal Hourly Rate, is a measure of a shower's activity. It is only a theoretical value however; it assumes perfectly dark clear skies, the radiant source overhead, and no meteors missed.

# Asteroids in 2004

Orbiting the Sun between Mars and Jupiter are innumerable rocky bodies ranging in size from hundreds of kilometres in diameter to small boulders. These are the minor planets, or asteroids, and since the first, Ceres, was spotted by Piazzi in 1801, we have added considerably to the number known. Over 30,000 now have their orbits accurately determined with more being found each month.

Their orbits are not just confined to the main asteroid belt; many range over highly elliptical paths that bring them closer to the Sun than Mercury while others merit a careful watch as potential Earth-crossers. In the last decade, members of the far-flung Edgeworth-Kuiper Belt of icy-bodies have been detected beyond the orbit of Pluto while exotica such as Centaurs and near-Earth asteroids are all the rage in Solar System studies.

One of the best known of the so-called Earth-crossing asteroids is 4179 Toutatis, a peanut-shaped five-kilometre long rock that will pass just 4 lunar distances from Earth on 2004 September 29.

Earth-crossers — also known as Potentially Hazardous Asteroids (PHAs) — pose a slim risk of collision with Earth, though they are officially classified as an asteroid that can come within 0.05 astronomical units (AU) of Earth's orbit and is larger than a few hundred metres across.

When closest at 13h 37m on September 29 Toutatis will appear as a rapidly moving magnitude 8·9 dot crossing the southern constellation of Centaurus — though observers have to contend with the Moon just past Full.

We should be able to follow it from here up to about September 25th when it can be spotted as a magnitude 9·4 "star" in Microscopium. Thereafter, it is too far south to be seen. The following websites will help you generate ephemerides though feel free to contact us should you like more information.

cfa-www.harvard.edu/iau/lists/MPLists.html

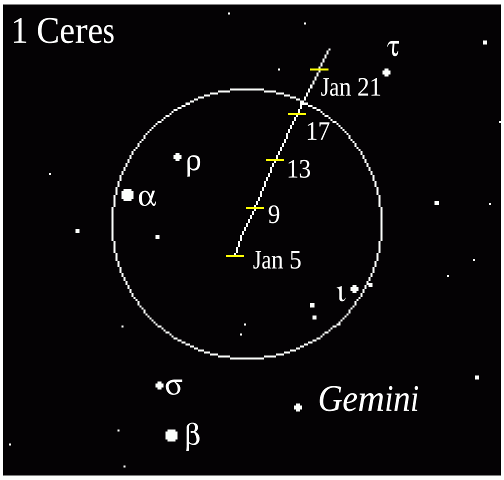
www.astrosurf.com/maury/asteroides/toutatis.html

## Bright asteroids in 2004

A number of asteroids can brighten to within range of binocular users while a small telescope will allow you to sweep up many more. Here, we highlight two of the brighter ones you might like to hunt during 2004. Plot the star field on a number of successive nights — the "star" that's moved from night to night will be the asteroid.

9 Metis, mentioned below, is even more remarkable in that it is the only such body to have been discovered from Ireland. It was found on April 26th, 1848 by the astronomer Andrew Graham while observing from Markree Castle, Co. Sligo — the ancestoral home of the Cooper family and once a renowned observatory.

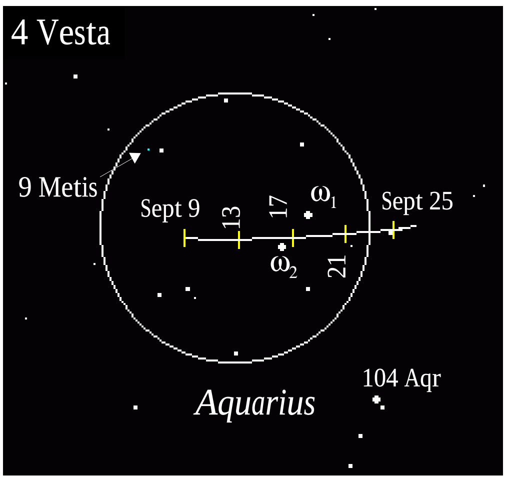
*Two bright asteroids for binocular observers.* The circle in each diagram represents the 5° field of view in a typical binocular while stars are shown to magnitude 7. Tick marks indicate the asteroid positions every four days.




Minor planet 1 Ceres comes to opposition on the evening of January 9 when it looks like a magnitude 6·8 "star" set within the pattern of Gemini. Look for it about 2½° southwest of the bright star Castor. Ceres is by far the largest asteroid with a diameter of 940 km, and orbits the Sun in 4·6 years.

Of all the known asteroids, only one, 4 Vesta, regularly becomes bright enough to be visible to the naked eye. It shines at magnitude 6·1 when at opposition on September 13 this year and lies within 1° of $\omega_2$ Aquarii.

Remarkably, 9 Metis is close to Vesta throughout the opposition period though a small telescope may be necessary to spot the magnitude 9·1 object. We'd love to hear if you succeed!




## Asteroid occultations of stars for Ireland in 2004

The most favourable event for Ireland this year is on 2004 September 16 when minor planet 638 Moira is predicted to occult a magnitude 8·8 star in Taurus at 4h 32m. Large binoculars mounted on a tripod may be sufficient to view the phenomenon but a small telescope is preferable.

Fuller details of the occultation are beyond the scope of this publication but the interested observer will find more information provided on a website hosted by the Belgian asteroid expert Edwin Goffin. The site provides detailed predictions for all asteroid occultations observable worldwide.

ftp://ftp.ster.kuleuven.ac.be/dist/vvs/asteroids/

# Variable stars in 2004

Not all stars shine with a constant light. Many fall into a category known as variable stars where the light output of the star varies over a period of time. Some may be part of a close binary system with a faint companion eclipsing the brighter such as Algol, or β Persei, while others are singular suns that dim and brighten because of genuine changes in light output.

The latter group contains the long period variables (LPVs). Most stars of this type are red giants and they can change in apparent brightness by a large factor. Their periods can range from 100 to 1000 days. The period of any long period variable is not very constant and variations of up to 20 per cent are not unusual. The brightness at maximum also varies within wide limits.

Cepheid variables also go through changes in their intrinsic brightness. They get their name from the star δ Cephei which was the first one of the class to be recognised. Most have a period of about five days and these periods are very regular. A typical Cepheid varies in brightness by a factor of two or three, but there are many exceptions. Like Algol, the variations in δ Cephei can be detected with the naked eye. Compare it to the stars lying near it over a period and you will notice the changes in relative brightness. Cepheids played an important part in determining the distances to nearby galaxies through the period-luminosity relationship.

The amateur community will continue to keep an eye on the unpredictable variations of the hypergiant ρ Cassiopeiae throughout the year too. The star is believed to be in the final stages of its life and is expected to erupt as a brilliant supernova within the next ten thousand years.

We list the favourable times of minimum light for Algol throughout 2004 while the table to the lower right lists the predicted maxima of some of the better placed long period variables that are visible with binoculars. The variations in brightness of Algol can be followed with the naked eye and the star is a delightful introduction to another aspect of the ever-changing sky.

Many amateur astronomers submit regular observations and estimates of the brightnesses of selected variable stars while others engage in nova or supernova patrols in an effort to catch these enigmatic objects flaring to brilliance.

The Irish Astronomical Society has an active variable star observers group that coordinates observations from members. Some Society members are also affiliated to the American Association of Variable Star Observers (www.aavso.org) who collate data from amateurs worldwide.

## Algol — the Demon Star

The table below highlights favourable minima of the celebrated eclipsing binary star β (Beta) Persei, or Algol. The star varies in brightness between magnitude 2·1 and 3·4 in a period of 68 hours and 49 minutes.

Algol appears as a single star in Earth based telescopes but is know to consist of two stars of unequal brightness quite close to and revolving around each other. The faint one eclipses the bright one once in every orbit and so we see the light drop.

During most of the time Algol remains bright but then over a period of about ten hours it loses then regains three quarters of its light.

| | |
|---|---|
| Jan | 3d 3h 42m; 6d 00h 30m; 8d 21h 18m; 11d 18h 12m; 26d 02h 18m; 28d 23h 06m; 31d 19h 54m |
| Feb | 18d 00h 48m; 20d 21h 36m |
| Mar | 11d 23h 24m; 14d 20h 12m |
| Apr | 3d 21h 54m |
| May | none favourable |
| Jun | 26d 01h 30m |
| Jul | 19d 00h 00m |
| Aug | 8d 01h 36m; 10d 22h 30m; 28d 03h 18m; 31d 00h 06m |
| Sept | 2d 20h 54m; 20d 01h 48m; 22d 22h 36m |
| Oct | 10d 03h 30m; 13d 00h 18m; 15d 21h 06m; 303d 05h 12m |
| Nov | 2d 02h 00m; 4d 22h 54m; 7d 19h 42m; 22d 03h 48m; 25d 00h 36m; 27d 21h 24m; 30d 18h 12m |
| Dec | 12d 05h 30m; 15d 02h 18m; 17d 23h 12m; 20d 20h 00m |

| Long Period Variable Star | Date of maximum | Magnitude range | Period in days |
|---|---|---|---|
| R Andromdae | Jan 07 | 6.9 - 14.3 | 409 |
| S Virginis | Jan 12 | 7.0 - 12.7 | 375 |
| R Bootis | Jan 13 | 7.2 - 12.3 | 223 |
| X Monocerotis | Feb 15 | 7.4 - 9.1 | 156 |
| T Ursae Majoris | Feb 20 | 7.7 - 12.9 | 257 |
| R Cassiopeiae | Mar 26 | 7.0 -12.6 | 431 |
| R Cygni | Apr 02 | 7.5 -13.9 | 426 |
| R Canes Venaticorum | Apr 07 | 7.7 - 11.9 | 329 |
| R Ursae Majoris | Apr 12 | 7.5 - 13.0 | 302 |
| R Draconis | May 10 | 7.6 - 12.4 | 246 |
| Chi Cygni | May 28 | 5.2 - 13.4 | 408 |
| R Virginis | Jun 02 | 6.9 - 11.5 | 146 |
| S Ursae Majoris | Jul 07 | 7.8 - 11.7 | 226 |
| R Leonis | Jul 29 | 5.8 - 10.0 | 310 |
| R Trianguli | Jul 31 | 6.2 - 11.7 | 267 |
| R Bootis | Aug 23 | 7.2 - 12.3 | 223 |
| R Hydrae | Sept 13 | 4.5 - 9.5 | 389 |
| S Coronae Borealis | Oct 02 | 7.3 - 12.9 | 360 |
| T Cephei | Oct 19 | 6.0 - 10.3 | 388 |
| V Monocerotis | Nov 07 | 7.0 - 13.1 | 334 |
| R Serpentis | Dec 11 | 6.9 - 13.4 | 356 |
| U Orionis | Dec 13 | 6.3 - 12.0 | 368 |

## Some useful websites

The Internet hosts a veritable treasure trove of information on astronomy and space for the sky-watching enthusiast. We've picked some of our favourite astronomy and space links to kick-start your own explorations in space and cyberspace. Additional links can be found on the website of the IAS — www.esatclear.ie/~ias

The Sun
www.spaceweather.com
find out when the next display of northern lights is due
www.bbso.njit.edu
solar images daily

Eclipses
sunearth.gsfc.nasa.gov/eclipse
lunar and solar eclipse information from NASA scientist Fred Espenak. Also carries details of the transit of Venus this June

Atmospheric optics
www.sundog.clara.co.uk/atoptics/phenom.htm
wonderful site on optical effects in the atmosphere
www.polarimage.fi
stunning photographs by Pekka Parviainen

Comets and Meteors
encke.jpl.nasa.gov
Charles Morris' site of comet observations worldwide
www.ast.cam.ac.uk/~jds/
British Astronomical Association's comet section website
www.imo.net
webpage of the International Meteor Organisation

Sites of Irish interest
www.irishastronomy.org
newsgroup and links to the Irish astronomical community
www.science.ie — news on science in Ireland from Forfas
www.dunsink.dias.ie — National Observatory in Dublin
www.birrcastleireland.com — site of the Great Leviathan telescope built by the Third Earl of Rosse
www.iscan.ie
the Irish Science Centre Awareness Network

Planetaria
www.armagh-planetarium.co.uk
homepage.eircom.net/~planetarium — Schull in Cork
www.worldwidelasers.com — museum situated on the Inishowen Peninsula in Greencastle, Co. Donegal

Telescope dealers in Ireland
www.andromedaoptics.com — based in Dublin
www.mccreaa.freeserve.co.uk — North Down 'scopes

Magazines
www.skyandtelescope.com
www.astronomy.com

Education and observing
www.badastronomy.com — righting astro wrongs
www.astrosociety.org
great resources from the Astronomical Society of the Pacific
www.astroleague.org — observing handbooks and lists

News
www.nightskyobserver.com
IAS member Gary Nugent's comprehensive news links
www.astro.uni-bonn.de/~dfischer/index.html
latest astronomy and space news from Daniel Fischer
science.nasa.gov/default.htm
interesting and timely articles written by Nasa scientists
www.universetoday.com
www.spaceflightnow.com/news/index.html

History
www.astro.uni-bonn.de/~pbrosche/astoria.html
History of Astronomy working group
lindahall.org/pubserv/hos/stars/welcome.htm
a wonderfully illustrated history of the star atlas

Satellite and *Iridium* flare predictions
www.heavens-above.com — *ISS* passes for your location

Spaceflight
www.floridatoday.com/news/space/index.htm
www.jpl.nasa.gov/calendar
www.russianspaceweb.com
www.esa.int
oposite.stsci.edu/ — *Hubble* space telescope
www.nssdc.gsfc.nasa.gov — database of spacecraft details

# The Irish Astronomical Society

Founded in 1937, the Irish Astronomical Society caters for those of all ages and interests in astronomy and space.

You don't have to be an expert to be part of our dynamic club. Many of our members are taking their first steps in the hobby and you are sure to receive friendly advice from some of the more experienced amateur astronomers in our group.

Activities include twice monthly meetings, observing groups, subscription to a bi-monthly magazine, e-mail alert notices of transient astronomical phenomena such as aurora, and outings to places of astronomical interest.

Members have joined expeditions to observe several total solar eclipses worldwide as well as catching the wonders of the night sky from home.

The Society also has a well stocked library of books and journals that members can borrow as well as access to a number of telescopes that can be loaned for a period.

A number of IAS members have made their own telescope while others possess telescopes ranging in size up to a 50-cm behemoth! Many are now experimenting too with the latest technologies to hit the amateur community such as CCD cameras. If you are considering purchasing a telescope then we'll point you in the right direction before you take the plunge and part with your hard-earned cash.

Want to know more? Then drop us a line at: The Irish Astronomical Society, P.O. Box 2547, Dublin 14 or you can also e-mail us at ias@esatclear.ie

Until we meet again in the pages of *Sky-High 2005*, we bid you the astronomers *adieu* – Clear skies!