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ASTRONOTES

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Moonbug

By Colin Johnston, Science Communicator

Earlier this year Astronotes covered the Saturn 5 rocket and the Command and Service Modules (CSM), great iconic pieces of Apollo hardware. Now it is time to describe and celebrate the third of the trinity, the Lunar Module (LM) which carried two-man crews to and from the Moon's surface.

As originally conceived, the entire Apollo spacecraft would have risen from Earth and landed on the Moon. By mid 1962 this concept had been studied and found to be grossly expensive to achieve, requiring the development of gargantuan booster rockets and to be so technologically complex that a landing might not be made until well into the 1970s. Instead a concept called Lunar Orbit Rendezvous was proposed. This promised to be easier and was possible with the Saturn 5 rocket which was being developed. An Apollo CSM would be launched along with a Lunar Excursion Module (LEM) on a single Saturn 5 rocket. The CSM and LEM would fly together into lunar orbit; two astronauts would fly the LEM to a gentle touchdown on our satellite. On completion of their explorations the pair would take off in the two-part LEM's Ascent Stage (leaving behind the Descent Stage with its heavy engine and landing gear) to rejoin their orbiting colleague. The three would discard the LEM before returning to Earth in the CSM. In July 1962 NASA requested LEM design concepts from the US aerospace industry, then at the height of its powers.

“Grumman considered equipping the astronauts with a rope ladder”

Nine designs were put forward, and the winning concept came from Grumman Aerospace, a company famed for its sturdy naval aircraft. In September 1962, Grumman's engineers set about the task of building the first true space-



Image Credit: NASA

LM Ascent Stage under construction Notice the cylindrical cabin crew compartment and spherical propellant tank without their usual skins.

ship. Why do I say that? All previous crewed spacecraft (and as of 2009 all subsequent spacecraft) passed through the Earth's atmosphere during part of their flight. In contrast the LEM would spend its entire working life in the vacuum of space and would make no concessions to aerodynamics. Right from the start, it would clearly look completely unlike the sleek rockets of 1950s pop-culture. A bulbous, spindly-legged vehicle was envisaged, and many in NASA and Grumman nick-named it the 'Bug'.

The Bug started weighing 10 tonnes. It featured a spherical Ascent Stage with a docking port on top and a second facing forward. The astronauts would use this to access the Moon's surface, while the pilot would look for a landing site through large bubble windows. The LEM was to have three legs, but analysis suggested that three was not enough to guarantee a safe landing on uneven terrain. Five legs would be much better, but heavier. To save weight four legs were eventually used. By early 1964, the LEM was recognizable as the craft that flew to the Moon. The boxy Descent Stage stood on four splayed-out legs, on top of it sat the curious-looking Ascent Stage. Grumman's engineers had sweated blood to reach this point, struggling to prevent the craft's mass ballooning to an unacceptable weight. The spherical cabin was gone, instead a cylindrical shape was used, the second docking port became a simple hatch and the large and heavy windows were replaced by small triangular panes, the astronauts even lost their



Image Credit: NASA

Spider over the Earth Apollo 9's LM is seen in Low Earth Orbit.

seats, instead standing shoulder to shoulder as they controlled the vehicle (an arrangement which proved no inconvenience in lunar gravity). Such was the need to make the LEM as light as possible that Grumman considered equipping the astronauts with a rope ladder or even a length of knotted rope to climb from the hatch to the surface. However an aluminium ladder was used, albeit a ladder too flimsy to support an astronaut's full weight on the Earth's surface. The lunar lander's shape was not the only thing to change: it was redesignated the Lunar Module as "Excursion Module" sounded too frivolous, as though it was intended for taking the astronauts on a picnic.

"the Bug had an alien appearance"

By the time the first LM flew in space on Apollo 7 (an unmanned test flight in low Earth orbit) the design was complete. As a creature of an alien environment, the Bug had an alien appearance. At either side of the cylindrical cabin was a propellant tank (of differing sizes, giving the Ascent Stage a lop-sided look), behind it was a box of electronics including the craft's Apollo Guidance Computer (the AGC, laughably primitive to contemporary eyes). Four sets of quad thrusters to manoeuvre the LM through the airless void were spaced evenly around the exterior. Radio communication and radar dishes

where placed here and there. The Ascent Stage sat on the legged Descent Stage, an octagonal box housing the throttleable rocket motor and its propellant tanks, and a modest cargo space for the equipment and instruments to be used on the Moon. Many accounts of Apollo refer to the LM with words like 'flimsy' and 'fragile' but these are not wholly correct. Much of the exterior was covered in protective foil, in some locations this was taped into place. Exhaust gases from the vehicle's engines and jets could disturb the foil and occasionally rip it to tatters, damage which is clearly visible in some images. However beneath the foil was the craft's sturdy metal skin and stringer construction. Although its weight had risen to almost 15 tonnes, the LM was a fine flying machine, handling like a "nimble, responsive jet fighter".

Men first flew the LM in March 1969, when Jim McDivitt, David Scott, and Rusty Schweickart successfully tested an LM (call sign Spider) in Earth orbit during the Apollo 9 mission. Months later Apollo 10 flew to lunar orbit in May. This mission did everything short of landing: astronauts Stafford and Cernan descended to within 15.6 km (9.7 miles) of the Moon's surface in the LM 'Snoopy' and cruised over the Moon's mountain tops. In July 1969, Armstrong and Aldrin made history landing Eagle on the Sea of Tranquility.

How did the crew fly the LM? Both crewmen could control the vehicle, but oddly it was primarily the Commander rather than the Lunar Module Pilot who piloted it to the Moon. After undocking from the CSM, the LM fired its descent engine for several minutes to drop out of lunar orbit, descending automatically under the control of the AGC (using radar to measure altitude) until it was 500 ft or so above the surface, then the astronauts would take manual control to use the LM's two hand controllers to adjust the programmed landing site to ensure they were going to land on a flat area and not in a boulder field or crater.

To leave the LM meant sealing up the spacesuits and venting all the air from its cabin, before crawling feet first through the hatch, down the porch to the ladder. Returning required the opposite procedure. The LM's crew enjoyed



Image Credit: NASA

Tranquility Base Apollo 11's LM Eagle stands in the morning sunshine on the Moon in July 1969. The legs and torso of Buzz Aldrin are just visible as he squeezes through the hatch to join Armstrong. The landscape is entirely flat, deliberately chosen for an uneventful landing. That horizon is actually about 2.5 km away from the vantage point. Other appearance are deceptive; although it looks small, the LM is almost 8 m tall, just a little shorter in height than a double-decker bus.

minimal human comforts with no cooking, washing or lavatory facilities. From Apollo 12 onwards hammocks were slung across the tiny cabin to allow the crew more comfortable sleep. Before taking off the crew would dump any surplus items to lighten the Ascent Stage. A little junkpile of discarded life support packs, overshoes and waste bags grew at the foot of the LM's ladder. Dressed in their spacesuits, the astronauts fired the small, simple but powerful ascent engine under their cabin and their tiny spacecraft would blast off, using the Descent Stage as a launch pad. Seven minutes later they would be in lunar orbit awaiting the rendezvous with the CSM.

Developing the LM was not easy and took longer than planned but in the end Grumman's engineering team succeeded brilliantly. The Saturn 5 and the Apollo CSM both suffered failures in their gestations, requiring extensive redesign, but the LM did not. Hoping to capitalize on the development effort, Grumman offered variants of the craft, including a wheeled version which could have landed and then trundled across the dusty moonscape. Another, in an example of ploughshares into swords, would have seen the LM, a vehicle of peaceful exploration, transformed for strange military purposes into the Covert Space Denial Module. This 'space fighter' for the USAF would have been able to use a mechanical arm to molest Soviet satellites, or even blast them to pieces with a recoilless gun. Only one LM variant

was actually built, the Extended Stay version. This was essentially a 'Mark II' LM, with more fuel to permit prolonged hovering to allow better selection of the landing site, with more cargo space for experiments and a roving vehicle, and improved life support for a longer stay (68 hours) on the Moon. Externally identical to its predecessors, this redesigned LM was used on Apollos 15 through 17.

Apollo 11 and the subsequent lunar landings were successes thanks to the superb design and construction of Grumman's Bug, and the LM's flexible design was instrumental in saving the lives of the crew of Apollo 13 (but that is a story for another time). Today, four complete LMs are displayed in US museums, the wreckage of five Ascent Stages lie scattered across the Moon's surface, Apollo 10's Ascent Stage orbits the Sun, while six LM Descent Stages rest on the lunar wilderness as memorials to the first days of space exploration.

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The Year of the Quiet Sun

By Orla O'Donnell, Education Support Officer

We here on Earth rely on one celestial object more than any other and that is of course the Sun. The Sun is, as we all know, a star, the closest star to Earth and the essential ingredient for life on our planet. The Sun not only heats the Earth but it is also the vital ingredient for photosynthesis providing energy and food. So it is therefore of little surprise that we pay a lot of attention to the activity of the Sun. Of late there has been much talk about the Sun's activity, or rather the inactivity of the Sun.

Solar activity is played out over an eleven year cycle. We are currently in the 24th cycle (which began on 4 January 2008. This eleven-year cycle is known as the 'solar cycle' and revolves around the number of sunspots seen on the surface of the Sun. Sunspots are magnetic storms and are about a thousand times cooler than the rest of the Sun at a mere 4000° C. Sunspots exist for a few days on average but larger spots can survive for a few weeks. The Sunspot cycle

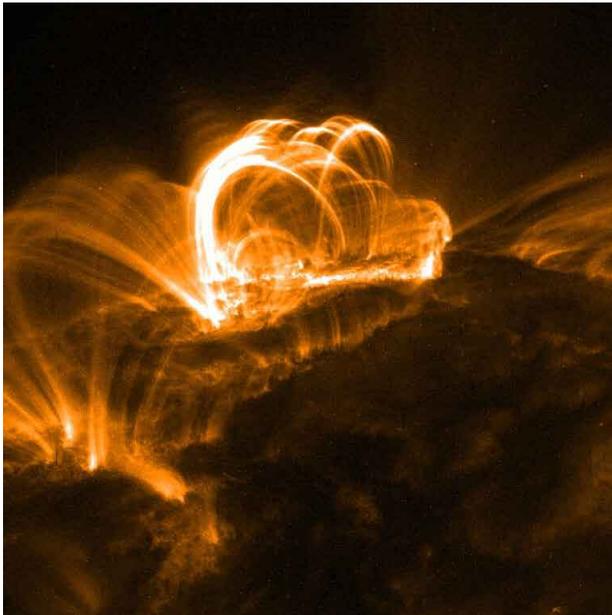
is of great interest to scientists as it is one of the solar mysteries: try as they may astronomers are unable to reliably predict future sunspots. Sunspots decrease when a solar cycle goes into decline and increases with the beginning of the next cycle. The abundance or absence of sunspots is used to measure the activity of the Sun, although we do not know precisely how this activity is related to the nuclear fusion processes deep in its core. The existence of sunspots was first documented by the great astronomer Galileo Galilei in 1610 and daily observations have been made by the Zurich Observatory since 1849.

“So if we are headed for a new mini ice age will this save us from the effects of global warming?”

The current solar cycle has been an unusually

quiet one, with the media claiming that the Sun was its quietest for a century. On 5 May 2009 the Sun seemed to come to life in its 24th cycle. The NASA Solar Terrestrial Relation Observatory (STEREO) satellite observed a Coronal Mass Ejection (CME) spewing from the Sun's surface. Scientists have stated that this activity is part of the 24th solar cycle as the CME originated above the Sun's equator and older activity would come from closer to the surface of the sun. Interestingly one solar cycle can begin before the last has complete-

Solar activity An X-ray view of prominences on the Sun's surface in more eventful times. Just think how this display would dwarf the Earth.



ly finished. So the Sun is not asleep but it is still relatively quiet according to solar records. Could this be a sign of cooling or even signal a new Ice Age is on the way?

“This was a time known as the Maunder Minimum and it may have been responsible for the mini ice age which occurred in the 17th century.”

The 17th century was a very turbulent time in the history of Ireland and Europe but it was a quiet period in the history of the Sun. This was a time known as the Maunder Minimum, about 70 years of minimal solar activity. Some say it may have been responsible for the “mini ice age” which occurred in the 17th century. So if we are headed for a new mini ice age will this save us from the effects of global warming? Recent history has shown this is not the case, the Sun’s activity has been on the decline since the 1980s and yet the effects of global warming have steadily increased. You still need to cut back on your CO2 emissions because a cooling Sun is not going to save us from global warming.

“So the Sun is not dying and we do not need to start preparing a nuclear bomb to reignite it as in the 2007 movie ‘Sunshine’”

Are we heading into a mini ice age? We currently have the ability to study the Sun in great detail but we have only been able to do this since the 1970s. Professor Mike Lockwood of the University of Southampton argues that since we have been studying the Sun, it has been involved in a Grand Solar Maximum. The Sun has been at the peak of its solar activity for the majority of the time we have been studying it. Scientists can measure the Sun’s activity in the past by examining Arctic ice sheets and ancient tree

trunks, the layers in both enable us to compare the Sun’s activities on a much larger time scale. The Sun’s activities can not only be measured by its eleven year cycle but also in a larger time scale known as Grand Maximums or Minimums. Grand Maximums or Minimums are played out in roughly 100 year period, the Maunder Minimum was part of this cycle. The Sun is currently moving out of a Grand Maximum and into a quiet period. We are more than likely moving into a ‘normal’ phase of the Sun’s life rather than a Grand Minimum.

Living in a normal period of the Sun may sound relatively boring but scientists are excited about the possibility of studying a quieter Sun with model instruments and techniques. Thankfully our Sun is not dying and we do not need to start preparing a nuclear bomb to reignite the sun like the 2007 movie ‘Sunshine’. Even so, we still need to protect ourselves from the harmful rays from our star so wear a hat and enjoy the quiet-ish Sun.

(See also ‘The Science of Sunshine’ in the March 2007 Astronotes)



Image Credit: Fox Searchlight Pictures

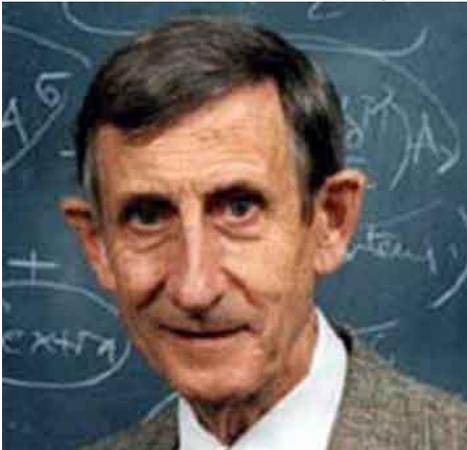
Sunshine Danny Boyle's 2007 movie looked beautiful. It also featured some really dopey Hollywood science and a script of occasionally staggering stupidity (would feeding oxygen to a fire on a spaceship really be the best way to extinguish it?)

Flowers on Europa?

By Alyson Kerr, Education Support Officer

The idea that life may exist on other worlds is a popular and interesting topic that many scientists theorize about. The endeavour collectively known as SETI (Search for Extraterrestrial Intelligence) scans the skies in the hope that we may someday be able to find and even communicate with other intelligent life forms in our galaxy and beyond. There have also been many theories on how life exists on Earth: one of these is panspermia, the idea that life has travelled throughout our system and beyond on the back of comets and other planetary bodies. It is speculated that the organisms that have hitched a ride landed on our planet and others and evolved into life as we know it. As yet, we have not been able to prove conclusively whether panspermia is a possibility or if intelligent life exists elsewhere in the Milky Way.

Recently the physicist Freeman Dyson (b1923) has come forward with the radical theory that



Freeman Dyson In his long career has made distinguished contributions to quantum electrodynamics and other areas of physics and mathematics. Even his stranger theories should not be idly dismissed

we are looking in completely the wrong place. To date, we have searched for, what he calls probable life forms. That is intelligent life. Dyson feels that our search would prove more successful if we concentrated on detectable life forms. An example of detectable life form would be flowers. This may seem far-fetched but Dyson bases his theory on the type of life that we find living in the harshest conditions our own planet. In the Arctic, there is a type of flower that survives in the extreme cold known as the Arctic poppy (*Papaver radicum*). This flower has adapted to suit its surroundings. By forming a parabolic shape, it maximises the light that reflect off the inside of the petals so the interior of the flower can use the energy as needed. This flower uses the Sun's light efficiently even in an area where light can be at a minimum.

“the search for life would prove more successful if we concentrated on detectable life forms”

Dyson speculates that Jupiter's icy moon Europa could be a candidate for similar life to grow. Europa, which is thought to have an ocean of liquid water beneath its icy shell, has long been a target for astrobiologists who hypothesize that there may be life under the surface. Dyson theorises that oceanic life under the icy crust works upwards, eventually evolving into forms that can survive on the harsh European surface. Flowering plants on Europa would establish themselves in cracks on the surface and receive nourishment from below. In these alien plants, unlike their terrestrial counterparts, the flower would be purely a solar energy collector.

While drilling into the thick ice (which could be up to 100km thick) on Europa would be a laborious and expensive mission, Dyson's

Image Credit: NASA



2021's Space Odyssey?

An artist's impression of the planned Europa Jupiter System Mission (called Laplace by ESA) As well as a Europa orbiter the mission would comprise a Ganymede orbiter and possibly even a Jupiter orbiter too.

think (see 'Hands up if you're an alien!' in the March 2009 Astronotes).

Freeman Dyson is renowned for his unusual theories. One concept that he is regularly associated with is Project Orion. This envisioned a spacecraft powered by nuclear pulse propulsion and the idea was initially proposed by Stanislaw Ulam during 1947 and Dyson was invited to work on it in 1958. At one time, this project was worked on by many famous physi-

cists who were convinced that it was a practical proposal. While this project never reached its full potential it did become a regular story device for many science fiction books (see 'Bam!..Bam!.. Bam!...Bam!' in the December 2006 Astronotes).

“European flowers could spread around the Solar System on meteorites or comets”

Another speculative theory expounded by Dyson was nicknamed 'Astrochicken' by him. It involved a small self-replicating automaton which might one day be built that could explore space through a combination of biology, artificial intelligence and microelectronics. This craft (a cyborg? a cylon? a Replicator?) would include a solar collector that feeds an ion drive and would be able to land and take off from other planets. This was a development of computer pioneer John von Neumann's automata theories, which state that it ought to be possible to construct a

hypothetical flowers might be visible from an orbiting spacecraft as the parabolic shape of the flower would reflect sunlight straight upwards through retroreflection. Retroreflection operates by returning light back to the source along the same light direction with a minimum scattering of light. We come across naturally occurring and man made retroreflectors on a daily basis. This device is used on cinema screens, road signs, vehicles, and clothing. When the headlights of a car illuminate a retroreflective surface, the reflected light is directed towards the car and its driver. An example of a naturally occurring retroreflector is obvious to anyone who owns a cat and has seen the phenomenon of eyeshine when trying to get a picture. Should some future Europa Orbiter, such as the proposed ESA/NASA Europa Jupiter System Mission (EJSM), detect sunlight beaming off the icy moon's crevices then exobiologists might at last have subjects to study!

Another element of his hypothesis incorporates panspermia. His European flowers, adapted to deep space conditions, could spread around the Solar System on the back of meteorites or comets. This is not as inconceivable as you may

robot which can gather the raw materials and process them into the components to assemble copies of itself. Dyson's idea being that rather than launch thousands of probes to explore outer space, we create a single astrochicken, send it into the void and let it get on with the exploring. Meanwhile it is fabricating (or hatching) more astrochickens, to continue the great adventure.

Dyson's theories may be extreme but inspire other scientist to look at subjects from a different perspective. You never know, one day his theories may be proved and he will be hailed as one of the greatest forward thinkers of our time.

Further reading

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A talk by Dyson on his theories can be found at http://www.ted.com/index.php/talks/freeman_dyson_says_let_s_look_for_life_in_the_outer_solar_system.html



Image Credit: NASA

What lies beneath? This (enhanced colour) image shows Europa's cracked and icy terrain. Arthur C. Clarke had previously (1982) described in fiction European plant life bursting through the surface, Dyson seems to be the first scientist to suggest this as a real possibility.

Relativitally Simple

by Colin Johnston, Science Communicator

Astronomers accept that, rather than being two separate things, space and time are just one, sometimes called spacetime. Rather than simply saying where something is located, it would be more correct to say how long it is there for too.

This is based mainly on the work of Albert Einstein (1879-1955), specifically his theory of General Relativity. Einstein's theories, most especially his Special Theory of Relativity (which would be better named Einstein's Theory of Gravity), had other important implications, one of which is that an object's gravity distorts spacetime. Rather than saying a planet exerts a gravitational pull towards it, it is truer to say its gravity bends the space around it. The path of a beam of light passing a star would be curved as it passes through the warped space around

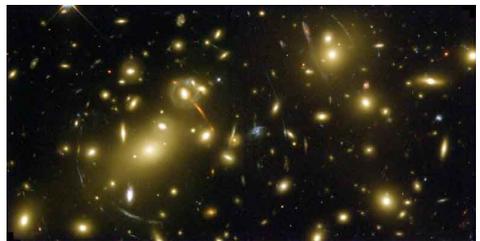


Image Credit: NASA, A. Fruchter and the EPO team (STScI)

Galaxy Cluster Abell 2218 This cluster of more than 10 000 galaxies is some two billion light years away. Its huge mass is bending the path of the light from more distant still galaxies behind it. the star. This has been observed and astronomers are now well aware of the phenomena of 'gravitational lensing' when the image of a distant galaxy is distorted by the gravity of other galaxies between it and the Earth.

Stranger still than space and time being one, gravity distorts time too. Time runs slower near a massive object such as a star than it does in empty space. This is not just some obscure prediction about the distant Universe, experiments with very accurate atomic clocks have verified that time moves slower on the Earth's surface than it does on high mountain peaks. This difference is so tiny as to be imperceptible to human senses but would be obvious near a black hole thanks to its extreme gravity field. If an astronaut could leave her spacecraft to somehow safely approach a black hole, her crewmates would see her appear to slow down until she became almost frozen in place.

In the 1920s Einstein and other scientists tried to apply his theories to the whole Universe. When this was done it, the equations indicated that the Universe was expanding. At this time Edwin Hubble had not yet discovered the expansion

of the Universe which was thought to be static, neither expanding nor contracting. Einstein was forced to add an extra term to his equations to make them yield the 'correct' static Universe. This fudge factor was called the 'Cosmological Constant', and was dropped as soon as the true situation was revealed. Einstein called the Cosmological Constant his "greatest blunder".

At present scientists are still trying to uncover the ultimate fate of the Universe. Will it keep on expanding forever or is there so much matter out there that gravity will eventually cause the Universe to eventually collapse in on itself? No one knows for sure.

(Editor's note: this article is the first in a series of short articles introducing topics in astronomy and space. They are intended to help those new to these wonderful subjects, please let me know if there is any topic you would like to see covered)

The Sky in June



M13 in Hercules The Great Globular Cluster in Hercules, a concentration of 100 000 stars gravitationally bound into a tight globule.

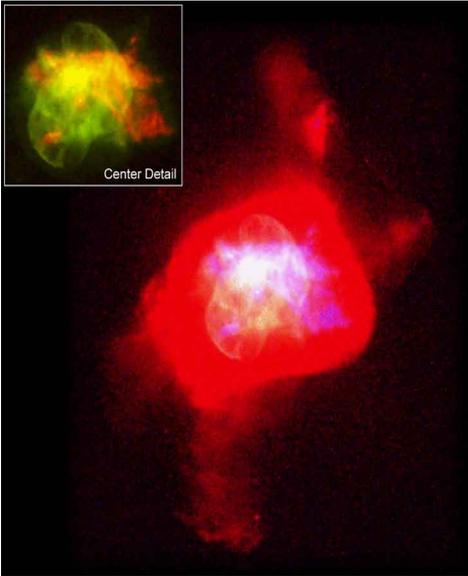
By Tracy McConnell Education Support Officer

Welcome back to the "Night Sky Guide" for June 2009. At this time of year, our nights are getting later and shorter, with the sun setting soon after 11.00pm and rising at approximately 4.00am. As

a result, the guide presented here is based on the stellar positions at 0:00am on 16 June, as it will only be getting truly dark at that time. There are several planets visible at this time. Saturn is visible in the West, low in the sky in the constellation of Leo the lion, just in front of Leo's rear paw. Saturn sets at approximately 1:30am and Jupiter rises in the SE just after 2:00am. Venus and Mars rise very closely together just before 4:00am in the East.

There are only three complete Zodiac Signs visible at this time. Libra the Scales, is directly south, Virgo the Maiden, looking like a large stick person lying across the sky, is in the SW and Leo the lion whose head looks like a backwards "?" is in the west. Scorpius the Scorpion is just rising over the southern horizon at this time

Above Scorpius is the large double constellation, Ophiuchus the Healer and Serpens the Snake, and above that again is the well-known mythical Greek hero Hercules (directly overhead facing



NGC 6210: The “Turtle in Space” Planetary

Nebula this planetary nebula may look like a space turtle, but it's actually a gas cloud resulting from the death of a star. The left over remnant of the star is visible in the smaller inset image.

south). The central structure of Hercules is that of a keystone, linking the four main stars. From that keystone radiates four arms, one from each of the corners. The overall pattern resembles a flattened bug. It is home to two globular clusters. A globular cluster is a large and tightly packed bundle of stars held together by gravity. The best-known in this case is M13 the Great Globular Cluster in Hercules, which is 25 100 light years (8 kpc) away and contains 100 000 stars. It can be seen with the naked eye under very good conditions. If you are facing south, this cluster is on the left hand side of the keystone. It will look like a small blurry smudge. The M92 globular cluster in Hercules is above the keystone shape and between two of the spiralling legs. It is not as bright as M13 but is still visible to the naked eye under the darkest of conditions, and is thought to be 26 700 light years (8.2 kpc) away. There is another less well-known deep sky object present just inside the left side of the keystone. It's a striking Planetary Nebula, which resembles a turtle.

Just left of Hercules is a constellation that looks

a bit like a bowl. It's called Corona Borealis, which means Northern Crown. It is part of the story of Princess Ariadne. Her father was King Minos of Crete. She helped Theseus defeat her half-brother, the bull-headed Minotaur, and later married Dionysus, the god of madness, wine and ecstasy, who gave her the beautiful jewelled crown as a wedding gift. Upon her death, Dionysus placed the crown in the heavens next to Hercules for safe keeping.

In this constellation is a group of galaxies which is very faint but quite spectacular if you have the proper equipment. The Corona Borealis Galaxy Cluster contains over 400 galaxies in an area of the sky about the width of your thumb. They are over a billion light years (300 Mpc) away and this is why they are so faint.

On the other side of Corona Borealis, high in the SW sky, is the constellation of Boötes, the herdsman (otherwise known as the celestial ice cream cone) and Canes Venatici, his hunting dogs.

The Summer Triangle is in the east, in the high to mid-sky and is pointing towards the horizon. Its three component constellations, Lyra the Harp, Aquila the Eagle and Cygnus the Swan are all fully risen.

The circumpolar constellations range from Draco the Dragon, high in the North facing sky, beside Hercules, Ursa Major NW next to Boötes; Cepheus is in the NE beside Draco and Cassiopeia is below Cepheus.

That covers most of the major constellations visible right now, and that's it for this months' guide of the night sky, which incidentally, is going to be my last “Night Sky Guide” for a while. I am passing the baton on to some of my colleagues', I will be writing news and interest based articles from now on. Here's wishing you clear skies and good stargazing.

Moon Phases, June 2009

Sun 7 June	FULL MOON
Mon 15 June	Last Quarter
Mon 22 June	NEW MOON
Mon 29 June	First Quarter

Image of the Month



Image Credit: NASA

Imaged here is the planetary Nebula Kohoutek 4-55 which was named after its discoverer Czech astronomer Lubos Kohoutek (of comet fame). Kohoutek 4-55 is a planetary nebula, where the outer layers of a star have been pushed into space as it has aged and ultraviolet radiation from its core has caused it to glow. K 4-55 has a rare multilayered structure.

This image is special not only for its beauty but also because that it was the final image taken by the Hubble Space Telescope's longest running planetary camera, the WFPC2 (Wide Field and Planetary Camera two). The camera was replaced by the shuttle Atlantis mission STS-125. This final mission to the telescope was launched on 11 May 2009 from Kennedy Space Center, Florida. Atlantis is equipped with a robotic arm which attached to the HST and allowed the astronauts access to the telescope. There were

seven crew involved, including four specialist space walkers who ventured out to repair the telescope. They not only replaced the camera but also thermal blankets and repaired some of the other instruments. The mission's aim was to improve the observations of the HST and extend its life span for a further five to ten years.

In its time the WFPC2 uncovered some wonderful images of the Universe. The camera was replaced by a much more powerful and effective camera WFPC3. The lead space walker on the mission John Grunsfeld stated that "Wide Field Camera 3 is just going to blow people away with the pictures it is going to be able to take". We are all waiting with baited breath for the new images from WFPC3 but for now we can enjoy this beautiful picture.

(Caption by Orla O'Donnell, Education Support Officer)



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