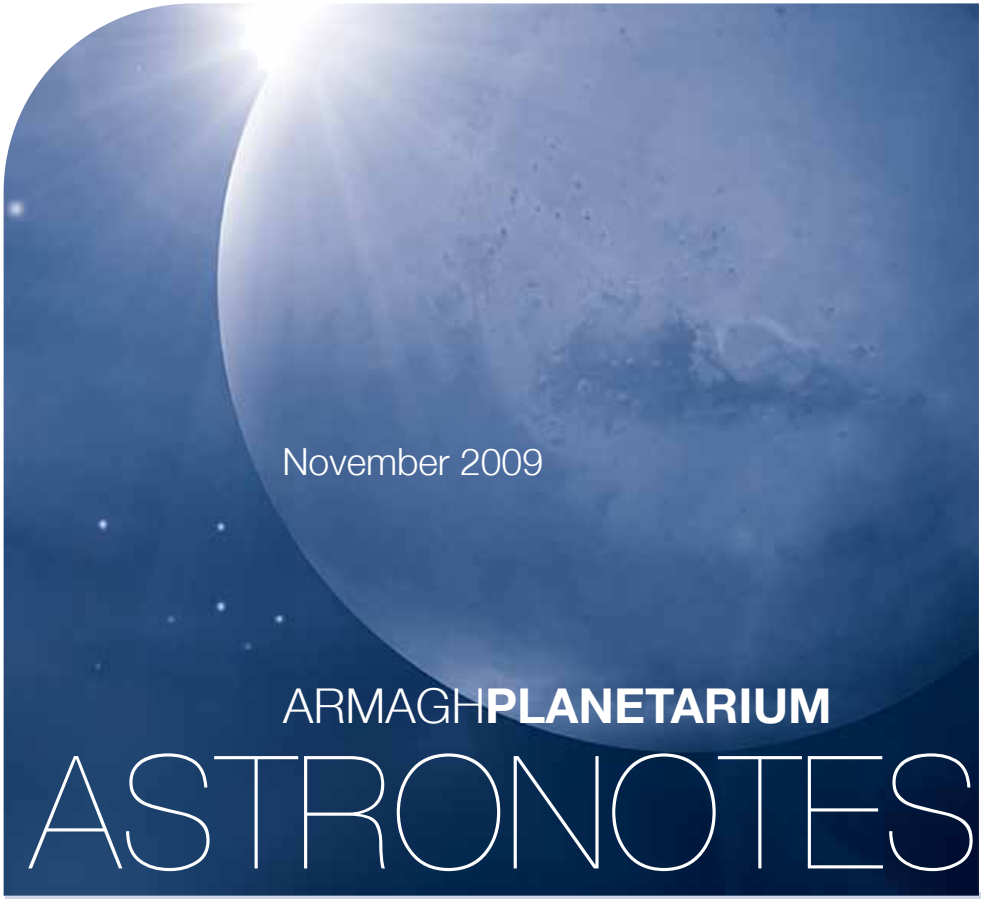

November 2009

ARMAGH**PLANETARIUM**

ASTRONOTES

Incorporating **FRIENDS' NEWSLETTER**

Sailors on the Ocean of Storms

By Colin Johnston, Science Communicator

1969's other manned Moon landing might have ended in disaster 36 seconds after liftoff. It was 14 November and the mighty Saturn 5 rocket carrying the crew of Apollo 12 was steadily ascending into the Florida sky when it was hit by lightning.

The mission's commander, Charles "Pete" Conrad (1930-99) saw a bright flash of light and felt his spacecraft tremble as though it was flinching from an assault. Alarms rang and every warning light on the boards lit up. Then the Apollo spacecraft's computer shut down and electrical power to the Command Module (CM) was interrupted. Suddenly the astronauts were plunged into darkness. Coolly, Conrad ignored the Abort handle, yanking it triggered the escape rocket which would hopefully blast the CM clear of the Saturn. The giant rocket was continuing to ascend, so Conrad was going to hold off aborting the flight until he was sure of how bad the situation was. Things suddenly got worse. Sixteen seconds later, proving an old saying wrong, a second bolt of lightning struck the spacecraft.

Image Credit: NASA

Apollo 12 at liftoff The lightning strike wreaked havoc on the Apollo spacecraft's systems but the Saturn 5's own guidance system was unaffected.

> "Alarms rang and every warning light on the boards lit up"

Meanwhile someone at Mission Control was babbling the cryptic phrase "Try SCE to Aux" into the astronauts' headsets, Conrad and the Command Module Pilot, Dick Gordon (b1929), scanning dozens of instruments to gauge how bad a mess they were in had not a clue what this was all about. Luckily, the third crewman, Alan Bean (b1932), the Lunar Module Pilot, remembered this was the procedure to reconnect the spacecraft's fuel cells, doing this would wake up the concussed computer.

He saved the day by punching in the instruction and the computer, vital to the mission, slowly rebooted. One by one, without a fuss, the warning lights went out. Conrad, Gordon and Bean, all US Navy officers, cracked jokes all the rest of the way into orbit. It is worth remembering the flight controller who also saved the mission by determining the procedure to restart the Apollo's electrics. His name was John Aaron and he was just 24 years old at the time.

Check out procedures in parking orbit suggested that the vehicle was in good shape despite its ordeal, so the Saturn S-IVB stage fired boosting the mission moonwards. (After the Lunar Module separated from this stage, the S-IVB should have been allowed to sail on into permanent

orbit about the Sun. A minor error meant this did not happen as planned and in 2002 amateur astronomer Bill Yeung rediscovered this relic of Apollo orbiting the Earth). On 19 November 1969 Conrad and Bean left Gordon alone in lunar orbit in the CSM Yankee Clipper and descended in the Lunar Module Intrepid to their destination. This was Oceanus Procellarum (the Ocean of Storms), a huge lunar "sea" (mare).

Three months earlier Armstrong and Aldrin's dialogue as they flew to Tranquility Base had been terse and matter-of-fact. In contrast, Conrad, who was renowned as a comedian, kept up a stream of banter as he brought Intrepid down to the barren plain. Neither had he a solemn saying prepared for his first footsteps another world. Jumping off the LM's ladder he announced "Whoopie!" adding "Man, that may have been a small one for Neil, but that's a long one for me!" Bean joined him and the exploration began.

"Conrad kept up a stream of banter as he brought Intrepid down"

Despite a series of navigational problems throughout the mission (unrelated to the lightning strike), Intrepid was just 800 ft (244m) from the planned landing site. A mere 400 ft (122m) away stood Surveyor 3, a probe which had landed there two and a half years earlier. Laden with hammers, tongs, scoops and other paraphernalia, Conrad and Bean made two EVAs (moonwalks) of about four hours each (with a twelve hour break in the middle).

One of their first tasks was a failure, as they deployed a colour TV camera it was accidently damaged and so there was no live broadcasts from the Moon for the audience on Earth. Some claim this disappointment started the public's loss of enthusiasm for the Apollo project. The two men succeeded in setting up their ASLEP, a bundle of scientific instruments (see "How NASA proved the Moon isn't made of cheese!" in Astronotes, July 2009), some 450 ft (137m) from the LM before trekking another 600ft (183m) to the rim of Middle Crescent Crater.

Image Credit: NASA

Robot Rendezvous It has been claimed that terrestrial bacteria survived lunar conditions on the Surveyor probe, this is now thought to be unlikely.

On their second EVA the explorers walked considerably further, inspecting Head, Bench and Sharp craters before descending on the Surveyor probe which rested in a large crater latter named Surveyor Crater. They removed components from the now moribund probe to carry home so scientists could see the effects of the lunar environment on equipment left there for long times (this would be helpful for the design of gear for the Moon bases that would surely be established in the 1970s and '80s).

"Whoopie! Man, that may have been a small one for Neil, but that's a long one for me!"

Conrad and Bean collected numerous samples of lunar material, including ejecta from the titanic impact which created the great crater Copernicus, and took many stunning photographs before returning to Intrepid for the last time. Forty year later, NASA's Lunar Reconnaissance Orbiter imaged Apollo 12's landing site from lunar orbit. The two sailors' footprints were still there, enabling us to retrace their perambulations.

As we have noted in earlier articles in this series, on Apollo missions the Commander piloted the Lunar Module, while the Lunar Module pilot acted more as a co-pilot and navigator. However, before Intrepid's ascent stage rendezvoused with the CSM, while behind the Moon and thus out of contact with Earth, Conrad allowed Bean to take control of the craft. The engineers at Grumman had done a fine job; the little spacecraft flew splendidly, being one of those flying machines, like the Spitfire, that handled as though it were an extension of the pilot's own body. Bean enjoyed putting the craft through its paces and is still grateful today for his commander's breach of regulations.

"The three men were the first to see the Earth eclipsing the Sun"

After rejoining Gordon, Yankee Clipper set sail for its homeworld. On the voyage home, the three men were the first to see the Earth eclipsing the Sun. The CM splashed down in the Pacific Ocean on 24 November. In an unlikely accident, the last of an eventful trip, Bean was knocked unconscious when a camera fell at the moment of touch down, striking him on the head, but he suffered no lasting effects.

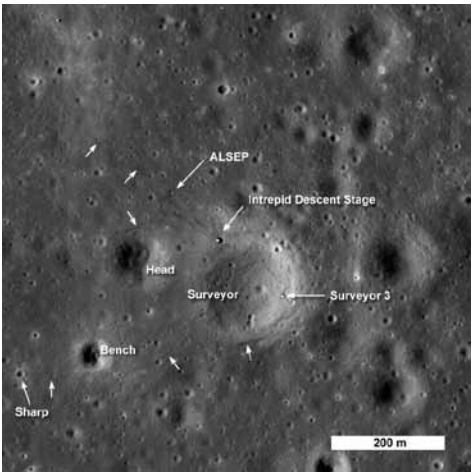

Image Credit: NASA

40 Years on, Intrepid's descent stage, ALSEP and the Surveyor 3 spacecraft are all visible. Astronaut footpaths are marked with unlabeled arrows. This image is 824 m (about 900 yards) wide.

Two of the crew believed that they would return the Moon. Conrad was a candidate to command Apollo 20 and Richard Gordon was selected to lead Apollo 18, while Bean planned to stick around for the Mars missions. As it was, Gordon never flew in space again, retiring from NASA for a career in business. Conrad commanded the first manned Skylab mission before joining the McDonnell Douglas aerospace corporation.

After retiring he was killed in a motorcycle accident. Al Bean had once thought he would get to walk on Mars, but his final spaceflight was as part of the second crew of Skylab in 1973. Garments he wore there were displayed at Armagh Planetarium in the mid-70s. Since his retirement he has become well-known as an artist, painting scenes of lunar exploration.

Overshadowed by the triumph of Apollo 11, Apollo 12 is unjustly unremembered today. Yet it was a hugely successful mission which showed that despite adversity NASA could reliably send people to the Moon and back and to carry out science on another world. The stage was set for an epic programme of discovery. The next mission would be Apollo 13, surely its crew would have an easier trip than Apollo 12's crew had.

Further reading

Chaikin, A, A Man on the Moon, Penguin, London, 1995 (I admit stealing this article's title from one of Mr Chaikin's chapter titles)

Godwin, R (ed), Apollo 12: the NASA Mission Reports, Apogee Books, Canada

http://www.nasa.gov/mission_pages/LRO/multimedia/lroimages/lroc_20090903_apollo12.html

http://www.jsc.nasa.gov/history/mission_trans/AS12_LM.PDF

Christmas Star Show

By Tracy McConnell, Education Support Officer

From the 30 November Armagh Planetarium will be showing the Evans and Sutherland production “Mystery of the Christmas Star”. In this show, we will journey back 2000 years to Bethlehem, as we seek to discover a scientific explanation for the Star the wise men followed to find the baby Jesus.

We’ll investigate possible dates for the birth of Christ and look at the historical records of significant astronomical events which occurred in the time interval which includes Christ’s possible birth date. We’ll see which of these signs in the sky could have been remarkable enough to cause the wise men to travel across the desert from Babylon to Bethlehem just to see a newborn King. We are sure that this modern retelling of the Christmas story will charm and captivate audiences of all ages.

It is essential to pre book your tickets. Please check the website for opening times and show times, www.armaghplanet.com and be sure to call us on 028 3752 3689 (ROI 048 3752 3689) to reserve your seats in our ultra-modern Digital Theatre.

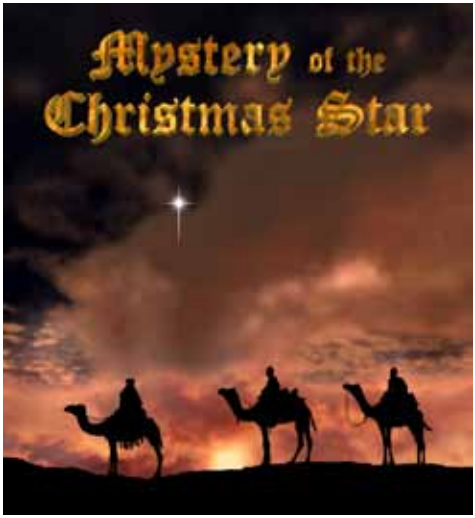

Image Credit: Evans and Sutherland

The Star of Bethelehem: was it a star? Find out in our Digital Theatre show.

The Women Space Forgot

By Orla O’Donnell, Education Support Officer

On 18 June 1981 Sally Ride made history to become the first American woman and third woman ever to venture into space. The second woman in space, a Russian cosmonaut Svetlana Savitskaya, preceded Ride by only a year. The first woman in space, Valentina Tereshkova preceded both women by almost 20 years, flying in space on 16 June 1963. The time line makes Tereshkova’s achievements even more impressive.

Could history have been different? There was a group of American women who tested to become astronauts in the 1960s.These women would never venture into space but their story is still intriguing. The USSR and the USA were very different worlds in the 1960’s. Why did the USSR choose to send a women into space and the USA did not?

The USSR selection of a woman cosmonaut was a publicity stunt to promote their Communist ideology that all women and men are equal. They were also careful to select a woman from a working class or proletarian background. The USSR used an automatic spacecraft, the Vostok, so the craft did not require an experienced pilot but did require a high level of physical ability, which Tereshkova possessed.

In the USA there seemed very little hope for a woman to become a trained astronaut in the 1960's. NASA was seen as a bit of a boys' club, look at any pictures of the control rooms of NASA in the 1960's and you see that there is a complete absence of women. There was however an attempt made to see if women could pass the tests required to become an astronaut.

"There was a complete absence of women."

In 1960 Dr William Lovelace II (1907-1965) a researcher who had been involved in developing the tests for the male astronauts decided to see if it was possible for a woman to pass the same tests. Dr Lovelace invited a woman called Geraldyn 'Jerrie' Cobb (b.1931) to undergo private testing to see if she could pass the initial tests. Cobb was an accomplished pilot having had held a private pilot's license since she was 17.

Cobb went on to pass the first phase of testing and the results grabbed media attention when it was announced at a conference in Stockholm. Cobb's results encouraged Lovelace to invite more women to undergo astronaut testing.

Twenty five women were invited to be tested, of which thirteen were asked to stay on for further testing. The women underwent a number of tests that were both physically and mentally stressful.

Image Credit: NASA

Jerrie Cobb being tested in the Gimbal Rig, a device used to test the ability of a pilot to control the spin of a tumbling spacecraft.

The assessments on the women included asking them to swallow a rubber tube to test their stomach acid, having ice water shot into their ears to induce vertigo and other grueling tests.

Image Credit: NASA

Seven of the original 13 women who tested in hope of becoming the first women in space were invited to the launch of the Space Shuttle Discovery by Eileen Collins, NASA's first female pilot, in recognition of their ground-breaking exploits.

The thirteen women who were tested were Jerrie Cobb, Wally Funk, Irene Leverton, Myrtle Cagle, Janey Hart, Gene Nora Stumbough (Jessen), Jerrie Sloan (Truhill), Rhea Hurrle (Woltman), Sarah Gorelick (Ratley), Bernice Trimble (Steadman), Jan Dietrich, Marion Dietrich and Jean Hixson. This group of thirteen women became know as the First Lady Astronaut Trainees (FLAT) and later the 'Mercury 13'.

"The women underwent a number of tests which were both physically and mentally stressfull

Unfortunately none of these wanabee astronauts got the chance to bring their undoubtable skills any further. The women were due to undergo more testing when they received telegrams telling them not to report to the Naval Aviation Center in Florida. The testing was not sponsored by NASA and the Navy could not run the tests without government sponsorship. This was the end of FLAT. Some of the women, in particular Jerrie Cobb, continued to campaign for women

to be allowed entry to NASA but to no avail. Interestingly one of the main obstacles for women to enter NASA lay not with NASA but with the Pentagon.

All candidates for NASA astronaut training not only had to be academically gifted and to have achieved a degree in engineering but also to have been graduates of a military test-flying program. Women were not permitted to fly as test pilots in the armed forces and therefore were not eligible. Cobb was a civilian test pilot but NASA were not willing to make any exceptions.

The eight surviving members of the Mercury 13 were honored with PhDs from the University of Wisconsin-Oshkosh in Wisconsin. The Mercury 13 women may not have had the opportunity to fly in space but their ambition and courage has been an inspiration for many women. Since the pioneering ambition of the FLAT ladies much has changed at NASA, not only have women gone into space, but also they have piloted and commanded missions.

Thanks to the pioneering attitudes of the people like the Mercury 13, the door of space travel has been opened to excellent people from all backgrounds, genders and races.

What might have been!

By Colin Johnston, Science Communicator

As a follow-up to a pair of articles previously published in Astronotes this year ('Who mourns for Apollo?' in February's issue and 'Lightcraft Flight Handbook' in the September issue) here is a fascinating piece of early 1960s concept art. Painted by artist Gordon Phillips and entitled "Dyna-Soar Hypersonic Glider", it shows the racy-looking Dyna-Soar craft (below right).

Also known as the X-20, this was a planned military spaceplane for the US Air Force, which never actually flew although a prototype was being constructed when the project was cancelled in December 1963.

The other craft in the right of the image is more interesting still. As far as I know (and I'm not 100% certain, so I'll be delighted to be corrected) this is the Martin Company's lenticular concept for the Apollo command module, one of several unorthodox designs rejected in favour of the more familiar conical shape. Note the extended periscope to give forward vision to the pilot.

It is strange to think that if history had proceeded differently, Apollo crews could have ended their lunar missions by gliding to a touchdown on a runway at Edwards AFB in a flying saucer! (Although to me it looks as though it belongs in the shuttle bay of Captain Kirk's USS Enterprise)

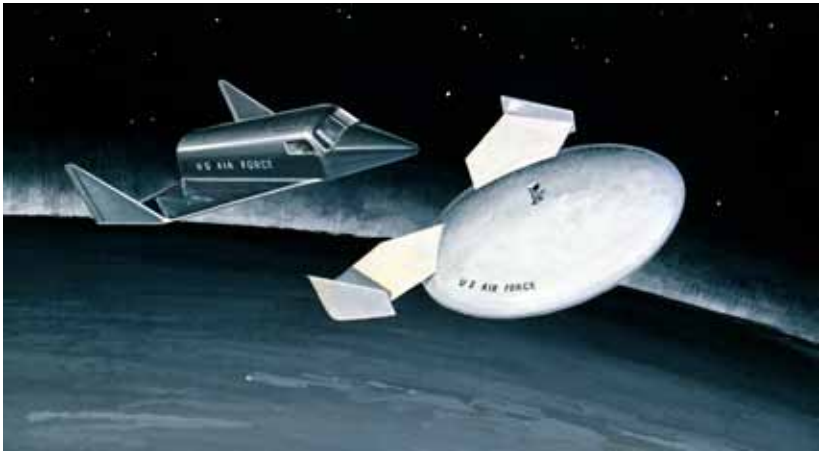

Image Credit: NASA

Lunar water source?

By Tracy McConnell, Education Support Officer

When scientists discovered trace amounts of water in the lunar rock samples brought back from the Moon by the Apollo astronauts, the discovery was dismissed as an earthly contaminate as it was known that the storage containers had leaked.

Image Credit: NASA

LRO Lunar Reconnaissance Orbiter Satelllite in orbit around the Moon.

The water found was indistinguishable from that found on Earth. As a result the surface of the Moon was believed to be bone dry. In spite of this scientists continued to hope that water ice may be found upon further study of the coldest spots of the lunar south pole, in the craters there which are never exposed to sunlight.

Recent discoveries have led to great excitement and a new view of future space travel to the Moon. On 18 June this year, NASA launched the Lunar Reconnaissance Orbiter, or LRO, a robotic spacecraft which was put into orbit around the Moon. Part of its mission was to search the south pole of the Moon, studying the craters there, in the hopes of finding some evidence of water ice. Such a discovery would make the establishment of a lunar base much more possible by providing drinking water and hydrogen for fuel.

One of the LRO's instruments, the Lunar Exploration Neutron Detector (LEND) obtained preliminary results that looked positive. In fact not only was evidence of water found in the craters of the south pole, but also all over the surface of the Moon, although in very small quantities, one ton of the top layer of the surface should hold about 32 ounces (907 grams) of water.

These are not the first findings of their kind. They are backed up by those of three other spacecraft. India's first-ever probe, Chandrayaan-1, was launched by the Indian Space Research Organisation in October 2008. The mission included a lunar orbiter and an impactor probe. The probe impacted near Shackleton Crater on 14 November 2008 and ejected underground soil to be analysed for the presence of lunar water ice. It detected indications of either water (H2O) or hydroxyl (OH) widely spread throughout the lunar soil.

When the Cassini probe passed by the Moon on its way to Saturn in August 1999, it found evidence of water and hydroxyl over the entire surface too, even during daylight. NASA's Deep Impact mission observed the Moon's north pole from 2 to 9 June 2008. These observations revealed changes in the amounts of water and hydroxyl as the Moon rotated. The data showed a loss of water from morning to noon, recovery through the afternoon, and a return to a steady state by evening.

> "The water found was in differentiable from that found on Earth"

In order to further study the possibilities of water on the Moon, NASA's other mission LCROSS, Lunar Crater Observation Sensing Satellite, impacted one of the south pole craters, Cabeus (proper), on 9 October 2009, aiming to generate debris which could then be analysed for further signs of water. Data is still being collected from the LCROSS' instruments, and it will be interesting to see what results are determined.

Image Credit: NASA

LCROSS NASA's Lunar CRater Observation and Sensing Satellite was a smashing success, returning tantalizing data about the Centaur Rocket Stage impact before the spacecraft itself impacted the surface of the moon.

Finding water sources on the Moon has lead to a debate of sorts, as to the direction of further manned space travel. Should we go to the Moon? Or to Mars?

On the lunar side of the argument there are the points that it would be lower cost and would increase chances of development. On the Martian side of the debate there is the fact that it contains a higher concentration of water ice, which may well be more easily sourced. As well as some atmosphere and gravity that is just over a 3rd that of the Earth's (as opposed to the moons gravity which is a 6th of the Earth's).

The leading question I have is that after all the studies of the Moon which have taken place in the 40 years since the Moon landings, what else might we have missed? I think we would be wise to consider much more in depth investigation of our nearest neighbour in space. Who knows what else it has to teach us?

November Night Sky

By Colin Johnston, Science Communicator

A clear night sky is a thing of beauty and wonder. Thousands of scattered stars twinkle in the darkness. What are the stars? Over the past century or so astronomers have by observation and calculation established the true nature of these gleaming specks.

"Look out at the sky tonight ans you will see how stars vary in brightness"

Now we know that stars are basically enormous balls of very hot gas, mainly hydrogen, with some helium and small amounts of a few other things. Inside the star huge quantities of energy are generated by a nuclear process called fusion where light atoms bash together buliding bigger atoms with the release of energy. Planets, in contrast are balls of rock, metal and gas without any internal nuclear energy source. Earth is a planet, while the Sun is a star.

Although all stars are made of essentially the same stuff they are not all the same. Stars come in different brightnesses, sizes and colours. Look out at the sky tonight and you will see how stars vary in brightness. Some are bright because they are relatively close to us, while others are bright because they are thousands of times brighter than our own nearby Sun. Find the easily-spotted constellation of Orion the Hunter (south east about 11.30 pm in mid-November). There you will see the red star Betelgeuse in his shoulder, the bluish white Rigel in his foot.

Betelgeuse is an enormous red supergiant star more than 135 000 times as bright as the star which dominates our Solar System and is estimated to be 640 light years (196 parsecs) or so from us. Rigel is a blue supergiant some 66 000

thousand times as bright as the Sun and lies about 770 light years (236 parsecs) away. Giant stars spend their nuclear fuel extravagantly and live short dazzling lives. Betelgeuse is somewhat further advanced than Rigel, and probably close to its end.

"Some stars are different sizes, different colours and different brightness"

To bring order to star catalogues, astronomers classify stars into what are called spectral types. This means stars are listed and placed in an order based on the temperature and brightness of their surfaces and the characteristics of the spectrum of light that shines out. The first attempt to do this was made in the 1860s; since then we have learned more and more so the original classification system has been modified, refined and reworked several times; eventually ending up with the system we use today.

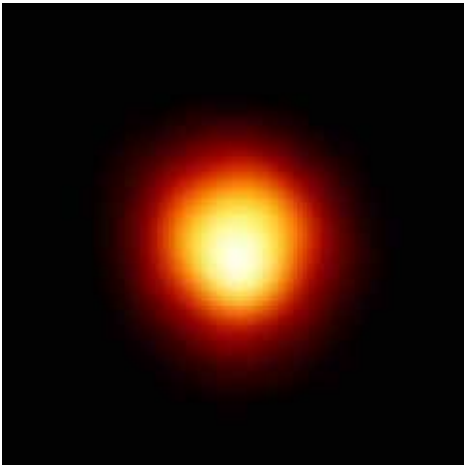

Image Credit:NASA/ESA

Brilliant Betelgeuse The giant star blazes in this Hubble Space Telescope image.

In order of brightest to dimmest star, the sequence runs OBAFGKM. (Most people can tell you that our Sun is classed as a G type star. Here is the classification sequence:

- O- blue-white, brightest and hottest (30 000°C or more);
- B- white,very bright stars;
- A- bluish white stars;
- F- yellowish white stars;
- G- yellow stars (about 5500°C);
- K- orange stars, not as bright as the Sun;
- M- red stars (about 3500°C).

On average, very bright stars are rare in space but they are the most common stars listed in star catalogues because they are easy to find and see. Although the vast majority of stars we see in the night sky are brighter than the Sun, actually small and dim M type stars called red dwarfs (stars physically smaller than our Sun are classed as dwarf stars) seem to be the most common stars in space, at least in our part of the Milky Way galaxy. The fact that the majority of stars we see in the sky are brighter than the Sun, also means that most stars in the galaxy are too dim for us to see!

"Our Sun is a main sequence star, these stars are in the prime of their life."

Stars come in different sizes, different colours and different brightnesses. Can we tie all this together? When we gather together lots of information on stars it is possible to plot a graph of stars' spectral type against their actual brightnesses. Scientists call this the Hertzsprung-Russell diagram and it is the most important diagram in astronomy. It shows that stars are divided into several groups. The most important group is the 'main sequence'.

Our Sun is a main sequence star. These are stars in their prime of life, steadily converting hydrogen into helium in their hot, seething centres and producing heat and light as a by-product. The red giants are another group. These are stars which have run out of hydrogen in their cores and are instead generating energy using other fuels, swelling enormously into huge bloated stars with reddish surfaces, cool by stellar standards. In the distant future

our Sun is fated to become one of these red giants.

A third group are the white dwarfs. These are essentially the cores of dead stars. Red giant stars are believed to experience huge internal eruptions, blasting off great concentric shells of gas in the process until eventually all the star's outer layers have been blown away into space. The tiny shrunken core, about the size of the Earth, remains as a white dwarf. White dwarf stars no longer produce light by nuclear fusion, merely continuing to glow like dying embers until they have slowly cooled to cold black balls of dense matter not much bigger than a planet. This will be the ultimate fate of our Sun.

Stars larger than ours have more spectacular ends: their red giant stages terminate in cataclysmic explosions called supernovae (this is the fate awaiting Betelgeuse). A supernova is a giant star tearing itself to pieces in nature's most destructive detonation. Debris from the explosion forms a great cloud or nebula. At the centre remains a tiny shrunken remnant composed of strange superdense matter.

Image Credit: NASA/STScI Digitized Sky Survey/Noel Carboni

Illuminated by Rigel The Witch Head Nebula (IC2118) is an interstellar gas cloud lit up by the light from Rigel (which would be about 1cm off the right-hand side of this image).

Such a stellar corpse is called a neutron star. Larger still stars will explode in a supernova but leave behind the strangest object of all; a black hole, matter crushed so tightly that not even light escapes its gravitational grip.
In the past couple of decades astronomers have added a new member to this stellar zoo: brown dwarf stars. These are too small to be classed as proper stars. A star must produce its own heat and light. These objects are either very dim or even black when looked at in visible light. The little energy they radiate is mainly infra-red light. Brown dwarfs can be thought of

Image Credit: NASA/CXC/Penn State/G.Garmire et al

RCW 103 When stars are more massive than about 8 times the Sun, they end their lives in a spectacular explosion called a supernova. A new X-ray image shows the 2000 year-old-remnant of such a cosmic explosion, known as RCW 103.

as failed stars; much bigger than a planet but just not big enough to make it as a star. Perhaps millions of these tiny brown dwarfs lurk undiscovered in the space between the stars. None can be seen with the naked eye.

Studying the great cosmic drama of stellar life and death is fascinating, but most marvelous of all is to step into the night to look up in wonder at this great show above our heads.
Happy star-gazing!

Moon Phases, Nov 2009

Monday 2 November	FULL MOON
Monday 9 November	Last Quarter
Monday 16 November	NEW MOON
Tuesday 24 November	First Quarter

Image of the Month

Image Credit: Hubble Heritage/NASA

V838 Monocerotis is currently the leading contender for the title of "Most Mysterious Star". At a distance of 8000 light years (2451 parsecs) V838 was found to be in outburst in 2002 and was initially thought to be a classic supernova.
Observations have shown that the erupting star transformed itself over a period of months from a small under-luminous star a little hotter than the Sun, to a highly-luminous, cool supergiant star undergoing rapid and complex brightness changes.

Such a transformation does not fit with our current understanding of stellar life cycles.

V838's most notable feature is its expanding nebula which has been studied by Hubble for years. Some of the observations and images taken have been gathered together in this composite print to show the progression of this stars spectacular death.

The star is found in the constellation Monoceros, one of the fainter patterns usually found in the northern hemisphere. The Monoceros constellation is completely visible in the south east at approximately 2.00am this month.

(Caption by Tracy McConnell, Education Support Officer)

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