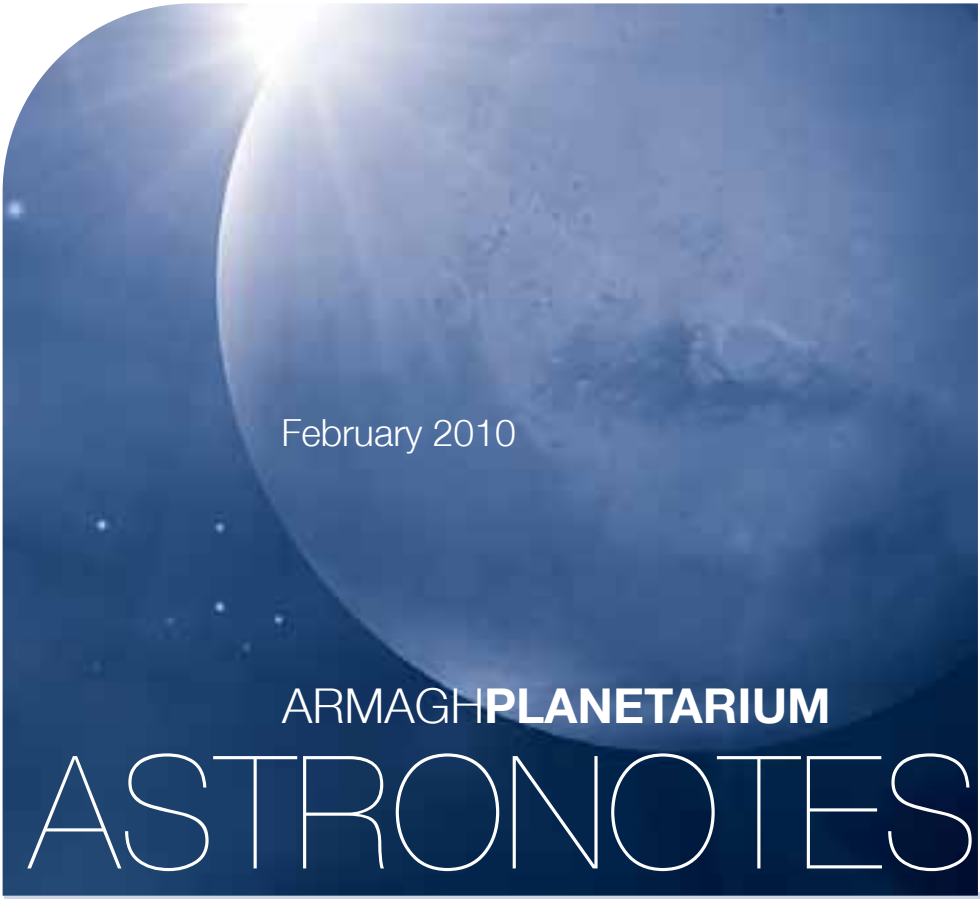

February 2010

ARMAGH**PLANETARIUM**

ASTRONOTES

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The heart of the Crab

By Colin Johnston, Science Communicator

On 4 July 1054 AD Yang Wei-T'e (?-?), astronomer to the Chinese emperor, carefully recorded a 'guest star' in the constellation of Taurus. Yang was puzzled by this newcomer to the heavens, as it was unmarked in his charts and over the centuries none of his predecessors had marked it in their meticulous records. The new star was brighter than Venus, bright enough to be seen in daylight for 23 days before it faded away. It was also observed by Muslim astronomers and in the Americas the Anazasi people of Arizona who recorded it in a rock painting. Despite its brilliance in the sky at the time it went unrecorded in Dark Ages Europe.

Yang's work was unknown outside of China until the 1940s so when John Bevis (c1695-1771) in England noted a misty patch in the same location in 1731 as Yang's guest star he had no idea of its significance. Shortly afterwards Charles Messier (1720-1817) catalogued it among other comet-like objects as M1. Almost 800 years after Yang, in 1844 Lord Rosse (1800-67) brought his telescope (not the famous 'Leviathan of Parsonstown' which was not completed until the following year), to bear on the faint nebula in Taurus. Rosse was unaware of Yang's observations, but would have known this nebula had changed its appearance since it was first studied through telescopes in the Eighteenth Century. His sketches based on his observations made over several years showed the nebula to contain wisps and filaments vaguely reminiscent of a crab's pincers. As a result this object is now known as the Crab Nebula. The Crab Nebula lies about 6500 light years (2000 parsecs) from Earth but is a faint (magnitude 8.4), unimpressive object best observed on a moonless night.

Image Credit: NASA, ESA, J. Hester, A. Loll (ASU)

Stardoom The nebula really does look like a vast cosmic explosion in this Hubble Space Telescope image

"the Crab Nebula contains a powerful energy source"

Since Rosse's time the Crab has expanded further, and based on this known rate of expansion (about 1500 km per second) its time of origin can be calculated with sufficient accuracy to determine that the Crab Nebula and the Chinese guest star are the same object.

Over the decades, astronomers have continued to observe the Crab and by the 1950s many were puzzled by some of its features. Rosse's filaments were red in a wavelength associated with hot hydrogen (not unexpected) while much of the rest of the nebula was a pale blue. This blue light originates from high energy electrons spiralling at near light speed through an intense magnetic field, an effect known as synchrotron radiation. This was a surprise as the power source accelerating the electrons to such a fantastic speed was unknown. What is more, the nebula's rate of expansion should be slowing as it encountered resistance from the surrounding interstellar matter, yet appeared constant implying that something is maintaining the expansion.

Clearly, the Crab contained a powerful energy source (estimated to be 75 000 times as powerful as the Sun). As a result the nebula is a bright object at radio, X-ray and gamma wavelengths. In 1968 this mysterious power source was confirmed to be a pulsar, a rapidly spinning neutron star. To explain what a neutron star is, we need to look at how giant stars die.

An aging giant star ends not with a whimper but a bang, exploding as a supernova, perhaps the most powerful events in the Universe. In their final red supergiant stages, such stars are ticking timebombs.

> "Compared to neutronium a block of lead is an insubstantial ghost"

Deep inside the star is frantically trying to stay alive. It no longer has the plentiful hydrogen of its youth to fuse into helium; instead it is generating energy by 'burning' ever heavier elements. The star races up the Periodic Table until it is fusing silicon and sulphur into iron in its core. That is its doom. Fusing iron into heavier elements does not release energy, rather it absorbs energy. Like a house with its ground floor demolished, the star collapses and the outer layer falls inwards. As it implodes, the material from the star's outer layers, still relatively rich in lighter elements, 'ignites' in an awesome nuclear explosion. The star tears itself to pieces, blasting its material across space, enriching the interstellar medium with heavy elements including everything that makes up a human being.

But what about the former star's core? The initial implosion has left it compressed to an incredibly dense state; a really large star would have ended up as a black hole, but the star which died to create the Crab Nebula was not quite that massive, probably it was not unlike Antares (about ten times the mass of the Sun). Instead it became a neutron star. Neutron stars are formed in supernovae as the star's core implodes. Neutron stars are about the size of a city yet are about twice as massive as our Sun. They are essentially balls of neutrons crammed tightly together. 'Normal' matter, the stuff which makes up you and me is made of atoms with nuclei of protons and neutrons. The atoms are finished off by shells of orbiting electrons. The electrons are comparatively distant from the nucleus, as a result any matter we are familiar here on Earth is mainly empty space. This is not so for neutron star material (sometimes called neutronium) where the atoms are so crushed together that the electrons have merged with the protons in the nuclei, forming more neutrons.

Matter cannot be more compressed than this weird material. Compared to neutronium a block of lead is a mere wisp, an insubstantial ghost. A spoonful of this stuff would weigh about a billion tonnes or so.

The neutron star retains the magnetic field it had as a living star, but it is compressed into a smaller volume of space, leading to incredible magnetic fluxes. The Crab neutron star's magnetic field is about a trillion times stronger than Earth's! By a still unexplained mechanism, a neutron star generates awesome beams of energy from distinct regions near its surface (almost certainly its magnetic poles). As it spins, these beams may sweep across the Earth, revealing the pulsar's presence to us, just as its rotating lamp reveals a distant lighthouse. This property has led to the term 'pulsar'.

All that is left of the 1054 supernova is such a pulsar, a mere 30km (18.6 miles) in diameter. Pulsars are believed to slow down as they age, but the Crab pulsar spins rapidly, making it among the youngest known pulsars. At present, the pulsar is rotating thirty times per second but is

Image Credit: NASA

Ghost of a dead star This image from the Chandra X-ray observatory shows the Crab Nebula's central pulsar surrounded by tilted rings of high-energy particles. Perpendicular to the rings, jet-like structures produced by high-energy particles blast away from the pulsar. The diameter of the inner ring in the image is about a tenth of a light year across.

slowing at a measurable rate, and it is the energy lost as it slows which illuminates the surrounding nebula. In the vicinity of the pulsar the nebula is a violent and dynamic environment, which changes over days. Hubble Space Telescope observations of the nebula around the pulsar have revealed evidence of waves of gas rippling

> "The nebula is a violent and dynamic environment."

away from the pulsar, possibly energised by the pulsar's beam. Glowing a moody blue, swirling with flowing gases and crackling with energy, the Crab Nebula's interior would be a perfect dramatic location for a showdown between science fiction dreadnoughts. In reality though, it would be an utterly lethal location to visit thanks to the extreme radiation levels permeating the nebula.

An utter mystery to astronomers of old, today the Crab Nebula is regarded as the classic example of a supernova remnant. Yang and all those other observers saw a mighty star die that day. If they had known the truth, I wonder what myths and legends would have been born that day. Even today there is still much about it that is unknown. On the millennium anniversary of Yang's discovery in 2054 it will still be a source of fascination to stargazers around the world.

Image Credit: NASA

The Crab's pulsing heart The neutron star in this artist's impression looks suitably menacing, however on her visit to Armagh in February 2007 Joyceln Bell Burnell told me that if you saw a pulsar up close "It would be a small, dull ball, but emitting a lethal beam of radiation"

Further reading,

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February Night Sky

By Tracy McConnell, Education Support Officer

Welcome everyone to my guide to February's night sky. This guide is based primarily on the star positions at 11.00pm on 15 February 2010. Please allow for differences depending on the time of your observations, as with the Earth's rotation, the stars will appear to move across the sky throughout the night. The sun will be setting at approximately 7.00pm and rising again at approximately 6.30am; the sky will be particularly dark as the new moon is on the 14th. At sunset, the planet Mars should be easily visible high in the sky, due east. The mystery of this celestial ruby is still unravelling as we continue to investigate via satellite and landing vehicles. Today we know Mars to be a relatively barren cold desert with water ice at its poles and a very cold thin atmosphere, although this was not always thought to be the case.

For many years Mars was thought to house a thriving population, partly because it has a day lasting a similar length to ours and a year almost twice as long, as well as having ice caps at its north and south poles. One Mars enthusiast, Percival Lowell (1855 – 1916), believed he had found solid evidence of canals, believed to be carrying water across the Martian surface. This was after a mistranslation of Giovanni Virginio Schiaparelli's (1835 – 1910) studies of the planet's surface in which he described "canali", meaning channels, criss-crossing the surface of the planet. Lowell's idea was later discredited when the first probe images were sent back from Mars in 1965.

Mars got its name from the Roman god of war, who was initially the god of agriculture and fruitfulness. Over the years Mars took on the characteristics of the Grecian god of war, Ares, son of Zeus and Hera. Ares was infamous for his brutality on the battlefield which may be why this name was chosen for the distinctly reddish planet. In Greek mythology Ares married Aphrodite (Venus in Roman culture) the goddess of love and beauty, and together they had two sons and a daughter. The sons Phobos (Fear) and Deimos (Terror) were the names later given to the two moons of planet Mars.

As well as the planet Mars, the planet Saturn is visible at this time of year. It rises in the eastern sky at approximately 9.00pm and slowly makes its way across the south side of the sky during the night, following the earlier path of Mars. At 11.00pm Mars can be found high in the sky, directly south and Saturn is low in the ESE. At this time there are also several of the constellations we talked about last month which are still visible. Orion and Taurus are in the southwest and around them you can still see Gemini the Twins, Canis Major and Canis Minor the hunting dogs, and Auriga the Charioteer. For more information about these patterns, see the January 2010 guide to the night sky.

There are also seven Zodiac signs visible at this time of year. Virgo the Maiden, is just rising in the east, Leo the Lion is southeast, Cancer the Crab is south, as is Gemini the Twins. Taurus the Bull is in the west along with Aries the Ram and one of the fish of Pisces. Next to Taurus, Leo is the other Zodiac constellation which contains very bright stars. Looking southeast, over half way up the sky, this constellation can easily be spotted by the pattern of stars known as "the sickle", a hook shape of stars which mark Leo's head and mane, with some fainter stars making up the body. The brightest star in this constellation is Regulus, at the bottom of the sickle. It's one of the brightest stars in the sky, 77.5 light years (23.8 parsecs) away from Earth. It's actually a multiple star system of four stars, two binary systems. Regulus A, the brightest star and blue-white in colour, is paired with a star thought to be a white dwarf which has yet to be observed. Regulus B and Regulus C are both main sequence stars. Leo also contains five bright Messier objects, galaxies M65, M66, M95, M96 and M105, are all found under the belly of Leo the Lion.

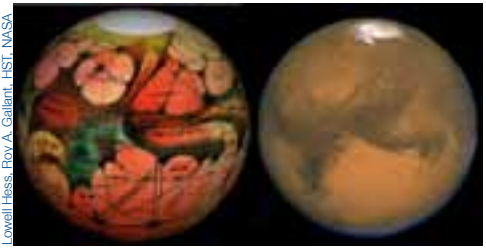

Image Credit: Tom Ruen, Eugene Antoniadi, Lowell Hess, Rov A. Gallant, HST, NASA

The relatively close opposition of 1894 was used to make drawings like the one digitally re-scaled on the above left. The above map was originally prepared by Eugene Antoniadi and redrawn by Lowell Hess. In more modern times, the latest Mars opposition has allowed the Hubble Space Telescope to capture a picture of similar orientation.

Image Credit: NASA/ Scott Anttila

Two galaxies in the constellation Leo, M95 on the left and M96 on the right. This image was taken with visible light only. M96 is the brightest in this cluster of galaxies.

Directly overhead and in the north facing sky we can find the circumpolar constellations, the most easily recognised being Ursa Major, the Great Bear, because it contains the asterism the "Plough". If you can find the saucepan shape of the plough, and follow the curved line of the handle towards the eastern horizon, you'll find a very bright orange star called Arcturus. This is one of the brightest in the sky and the brightest in our next constellation, Boötes the Herdsman, which looks like a giant ice cream cone. It's said that Boötes earned his place in the heavens by

Image Credit: NASA/STScI/WikiSky

This is a Hubble Space Telescope image of the globular cluster NGC 5466 found in the constellation Boötes. It can be seen through most telescopes and is located 51 800 light years (15.9 kiloparsecs) away from Earth.

creating the plough and impressing the goddess of agriculture, Ceres.

The region of the sky occupied by this constellation seems to be mostly void of further galaxies, the only exception being the Boötes dwarf galaxy, a satellite of our Milky Way, which is very faint and 197,000 light years (60 kiloparsecs) away from Earth. The only other object of note here is NGC 5466, a loose globular cluster which can be seen using most telescopes.
Happy Stargazing!

Moon Phases, Feb 2010

5th February	Last Quarter
14th February	NEW MOON
22nd February	First Quarter
28th February	FULL MOON

How Many Stars?

By Tom Mason, Director

Last night, Saturday 23 January, at around 19:50 local time my brother observed a fireball as it streaked over Belfast city from WNW to WSW. As I write this I have no confirmation of other observations, but he saw it brighten as it flew overhead, and surmised that it may have broken up into more than one fragment. What he saw was the fiery end of a journey that began 4.6 billion years earlier, if it was a meteor derived from our Solar System. I have been thinking about other solar systems recently as we commence working on developing new workshops in the Planetarium for our young visitors. The conundrum is how to present the mind-boggling facts and information relating to huge numbers in such a way that our youngsters will feel the urge to follow up and find out more for themselves.

One way is to go for big: in astronomy size certainly matters. The current value for the age of the Universe is around 13 billion years old (13 x 10^9 years). Not long ago we were pondering how to work out the number of stars in the Universe by a method that would be understandable by everyone, and without straining the mathematical ability of the average person. We assumed that everyone can add and do simple multiplication. So we started by looking at the amazing Hubble Space Telescope images of deep space. There are three in particular that were worth noting. These are the two Hubble Deep Field images taken in the northern and southern hemispheres, it is estimated that they contain

> "In astronomy size certainly matters!"

1500 galaxies in their field of view. This is taken as evidence that galaxies are spread throughout the sky. By far the best of the three images is simply known as the Hubble Ultra Deep Field image (HUDF), taken of a dark, apparently empty area of the sky near the southern skies constellation of Fornax. The 11.5 day total exposure captured photons of light that had set out from their distant galaxies long before the Solar System formed! So the Hubble is also an amazing time machine allowing mankind to see the very earliest galaxies, almost back to the beginning of the Universe.

Table estimating number of stars in known Universe based on HUDF data.

Size of HUDF image	11	square arc minutes				
	Estimated	No. of stars/galaxy	1E+11	= 100 billion		
		Galaxy in HUDF image	10000			
Total sky size		Night Sky Hemisphere	Sphere	Divide field of view	Galaxies	Stars
360	Degrees	21600	466 560 000	4.24E+7	4.24E+11	4.24E+22
60	Minutes					
				Increase stars/galaxy	200 billion	8.48E+22

The calculation is fairly straightforward. I just need to make sure that you understand the notation of large numbers: observe that they are usually written with an exponential notation. This is typical of modern calculators, where the ending E+11 for example means that the number has 11 zeroes. Using this notation ten (10) is 1E+1, one hundred (100) is 1E+2, one thousand (1000) is 1E+3 and so on. In this scheme 100 is the same as the notation 10^2. One million can therefore be written as 1 x 10^6 or 1E+6, and 1 billion is 1 x 10^9 or 1E+9. Armed with this information you can now read the table. The size of the Hubble Ultra Deep field image is 11 square arc minutes. This is a very small portion of the whole sky. So let us work out how many arc minutes there are in the sky.

The total sky size scanning the horizon is 360 degrees. Each degree is divided into 60 minutes. Thus, the circle which defines the horizon contains 360 x 60 = 21600 minutes. The half circle sweeping from horizon to horizon over our heads contains 180 degrees x 60 minutes = 10800. But this is only the sky above our heads in the northern hemisphere and as we want to know how many stars there are in the Universe, we need to double this up as the southern hemisphere also has 10800 minutes of overhead sky. So we need to multiply 21600 by itself (21600 horizon arc minutes x 21600 overhead arc minutes in northern and southern hemispheres) to obtain the number of square arc minutes in the whole sky.

We know that the HUDF image is 11 square arc minutes in size so we can divide this into the total, to find out how many images Hubble would need to take to cover the whole sphere of the night sky that we can see from all of the points on Earth's surface. This turns out to be 4.2414545E+7 images which incidentally would need 4.7E+8 days (1.29 million years) to take all of the images.

And so to the answer to our primary question. What is our best estimate of the number of galaxies in the whole Universe, and from that, how many stars? If there are 4.2414545E+7 Hubble image equivalents in the sky, including both hemispheres; and we know that the Hubble imaged 10000 galaxies in the image near Fornax; and astronomers think that galaxies are spread fairly evenly throughout the heavens; then there are around 4.2414545E+7 times 10000 (1E+4) galaxies. We add exponents, so the galaxies number 4.2414545E+11, and if we conservatively estimate that there are 100 billion stars (100000000000 or 1E+11) in each galaxy the number of stars is around 4.2414545E+22. This is 42 sextillion.

"In 2003 astronomers announced that there were 70 sextillion stars in the known Universe"

While this is an enormous number, other estimates of the number of stars are even greater, as we have used only 100 billion stars per galaxy, and there are likely to be more than that. Also we now know that there are rare stars between the galaxies. Our estimate is in the right order of magnitude, but compared with astronomy's best estimate, it appears to be an underestimate by a factor of two. In 2003 astronomers announced that there were 70 sextillion stars in the known Universe, based on their best estimates at that time. This number is 70 thousand million million

Image Credit: NASA/ESA

NGC 4710 When staring directly at the centre of the galaxy, one can detect a faint, ethereal "X"-shaped structure. Such a feature, which astronomers call a "boxy" or "peanut-shaped" bulge, is due to the vertical motions of the stars in the galaxy's bar and is only evident when the galaxy is seen edge-on.

million. Using our scientific mathematical notation we can also write it as (((70000 x 10^6) x 10^6) x10^6).

To make this simpler we can add the exponents to reduce it to (70000 x 10^{18}) and simplifying further to 7 x 10^{22}: this is 70 sextillion. This is very close to our primary calculation, and can be made even closer if we change just one of our figures which is to say that galaxies contain around 200 billion stars instead of 100 billion. Our rough calculation then works out that there are 8.4829090E+22 stars, or 84 sextillion which is closer to the 2003 estimate.

As stars are forming and dying all the time, and as Hubble is imaging galaxies as they existed billions of years ago, perhaps the best statement is that the number of stars in the known Universe is a huge indeterminate number. You can therefore say that there are zillions of stars in the known Universe, and no one can dispute this statement as a zillion is defined in the dictionary as a huge indeterminate number.

Further reading
Age of the Universe: www.astro.ucla.edu/~wright/age.html
Number of stars: www.space.com/scienceastronomy/star_count_030722.html

Where have all the Martians gone? (part 1)

By Colin Johnston, Science Communicator

"Is there life on Mars?" We get asked this question regularly at Armagh Planetarium. In this two-part article I am going to describe both the historical background to this question and the current evidence. By the end I hope to be able to give you a definitive final answer to this age-old question. Why is life on Mars even regarded as a possibility? Even two hundred years ago, it was obvious that Mercury was so close to the Sun that it must be a dried up cinder, while Jupiter and planets beyond were so cold as to be incapable of hosting life. Only Venus and Mars were potential homes for creatures like ourselves. The Venusian surface was obscured by unbroken clouds, so astronomers imagined it to be inhabited by dinosaurs and sea monsters and no one could prove them wrong. The Martian surface could be seen though, revealing intriguing features, and astronomers could try to predict conditions there.

Briefly Mars is just over half the size of Earth, its day is about 24 hours 40 mins long and its year is 686 days long. We now know that the planet's carbon dioxide atmosphere is extremely thin (only 1/100th of the pressure at Earth's surface) and –5 °C is the average temperature on a nice day. Compared to Mars, even Portrush on a wet winter's day looks inviting. However once upon a time the Martian deserts seemed more welcoming.

"Lowell counted 437 individual canals on Mars"

Scientific thinking about life on Mars began in the late 1700s when William Herschel (1738-1822) observed that Mars' polar caps shrunk in the planet's summer and grew back in the winter. Clearly the ice was melting and refreezing with the seasons, but what was happening to the water between thawing and freezing? By now you'll have read Tracy's article (see page 4) and you know the answer. The melt-water was trickling through Italian astronomer Schiaparelli's "canali". This word was mistranslated into English as "canals" (mistakes like this were common at this time as Babel Fish did not run very efficiently on the steam-driven Victorian internet's Babbage Engines).

Bostonian Percival Lowell (1855-1916) had a rich life as business man, diplomat and author, but he was also an astronomer. However he was not a Proper Astronomer being a mere amateur. However Lowell didn't care a jot about professional star-gazer's opinions as he was extremely rich. Appropriately enough when you consider his other great astronomical interest, searching for a trans-Neptunian planet, he was a plutocrat. In fact he was so wealthy he founded his own observatory complete with 24 inch telescope near the high altitude and then remote town of Flagstaff, Arizona, chosen for the excellent observing conditions. (He may have had other reasons to retreat from Boston, it appears that Lowell had a sort of Niles-Maris-Daphne thing going on with Constance, his formidable battleaxe of a wife, and the Observatory's understanding secretary Wrexie Leonard.)

Since the observatory was his own he could do what he wanted there and until his death he churned out maps of the elaborate Martian canal network (he counted 437 individual canals) and discussed his observations of the planet and his theories on its inhabitants in hugely popular lectures and a series of books. Basically Lowell established the idea of life on Mars in the popular imagination. And how! Mars, he said, was a dying world, losing its atmosphere and water. The planet's advanced inhabitants (tall, dignified, humanoids who probably dressed in togas) were responding to this crisis by irrigating their crops with water from the polar caps distributed via the canals. The public lapped this up, and it inspired authors to use this wonderful background in their stories.

Ah, was there ever a more romantic myth than the pre-Space Age Mars? With its canals criss-crossing vast and ancient dry seabeds haunted by ghosts and brigands, of towering crystalline cities where the beautiful but decadent and dying Old Martians linger on. Meanwhile, monstrous octopods in their tripedal war machines slowly and surely draw up their plans for conquering Earth. Inspired by Lowell, this lingering vision was created and maintained by several prominent authors such as Wells, Burroughs (Edgar Rice, not William), Bradbury (Ray, not Malcolm) and Brackett (Leigh not Dame Hilda).

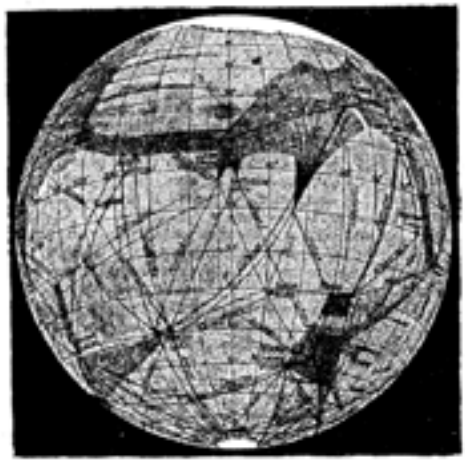

Image Credit: Apavlo via Wikipedia.org

How it used to be A Lowell map of Mars showing canals.

Image Credit: via /www.fabioteminofantascience.org/

HG Wells' other Martians Wearing his scientist hat, the great author wrote a piece for a magazine in 1910 describing possible inhabitants of Mars. Note their elongated appearance, a result of the planet's lower gravity. Surprisingly, the magazine was Cosmopolitan, a journal not famed today for its exobiological speculations (perhaps in the same issue there was a quiz asking, "Is your guy a Martian?")

All fantasy of course. The idea of Mars being habitable to creatures like ourselves was already on very shaky ground when Lowell's speculations were at their peak. Spoilsport scientists pointed out that spectroscopic examination of the planet's atmosphere had found no sign of water vapour, for that matter the atmosphere was too thin to allow large bodies of liquid water to exist. Also there was the failure of observers outside Lowell's circle of sympathizers to see the canals, nor could the canals be photographed. This was of course because they did not exist, sadly Lowell was deluding himself (and so he is now often described in histories with words like "buffoon" and "mountebank", as a genuinely gifted observer and theoretician - when he wasn't looking at Mars - he deserves to be remembered better).

Lowell (and the public) ignored the criticisms, but most scientists lowered their expectations. Gone were the great Martian civilizations, yet great expanses of vegetation, weirdly adapted to the harsh climate, were still thought likely and perhaps there were alien arthropods nibbling on their leaves. The evidence for this idea was the "Wave of Darkening". This was a well-observed phenomenon when the dark areas visible on the planet's surface through even amateurs' telescopes got darker in their hemisphere's summer. The only possible explanation was that these areas were masses of vegetation, possibly mosses or cacti, bursting into a lush growth period as the temperatures rose. To reflect this, these areas were usually depicted as bright green in artists' impressions of the planet. The areas without vegetation were covered in gently rolling dunes of orange sand. The planet's surface was cold, and the atmospheric pressure there approximated that at the summit of Mt Everest. Humans could probably survive there wearing fur coats and breathing through oxygen masks, or at worst a goldfish bowl over their heads,

This vision of Mars persisted widely until the early 1960s. The older library books in the primary schools I attended in the 1970s all described life growing and crawling across the Martian plains as a certainty. This vision was accepted even by experts. A 1959 report for the US government claimed that "there is rather good evidence that some indigenous life forms may exist" on the planet. Even more startling was the report on the first NASA-sponsored feasibility study for a Mars landing (carried out in 1963) which called for one of the first three men on Mars to be a biologist, who would evaluate the landing site for "unfriendly life forms." Any local lifeforms unfriendly or benign would be assessed for "for possible nutritional value." (Gulp!)

"Mars, with its canals criss-crossing vast and ancient dry seabeds"

We said goodbye to this view of Mars as a cradle of life and potential larder in July 1965 when Mariner 4 spoiled the fun! Mariner 4 was the first spacecraft to successfully reach Mars, With what would now be regarded as a laughably primitive camera it took 21 images and transmitted them to Earth. There was not a canal to be seen. The surface appeared barren and as cratered as the surface of the Moon. Hopes that we would find anything living on Mars dropped to an all time low. Mars, it seemed, was as dead as the Moon. These hopes rose again when Mariner 9 arrived at Mars in 1971 and returned hundreds of im-

Image Credit: NASA

Boldly going This artist's impression from the early '60s shows a spacecraft derived from Apollo technology skimming past Mars, complete with canals. Such manned flyby missions were studied throughout the decade until budget cuts made them unfeasible and technological improvements to unmanned probes made them unnecessary.

ages of all regions of the planet's surface. Some showed vast extinct volcanoes and evidence of enormous seasonal dust storms (these storms proved to be responsible for the wave of darkening as they deposited light dust on the darker highlands in the autumn). The most amazing Mariner pictures showed what appeared to be dried up water courses. If the surface of Mars had once been even slightly damp, then simple life still seemed possible.

In 1976 NASA attempted to prove this once and for all, when the Agency sent the two Viking space craft to land on the planet's surface. For a first attempt at a Mars landing, these were an amazing success (virtually forgotten now are the USSR's handful of attempts to reach the planet's surface in the early 1970s; just one reached its destination intact, only to break down after 20 seconds). The primitive humans of the 1970s would drop to their knees in awe at the very sight of an iPhone or Ninento DS, yet these ancient people built and designed the Vikings, which represented very advanced technology. Clearly our ancestors were not the long-haired and dim-witted primitives of popular imagination. Either that or they had help from space aliens.

Both Viking 1 and 2 came to rest on plains that were much rockier than expected and entirely devoid of flora or fauna. Immediately the probes launched into a programme of photography and research into Martian meteorology, seismology, soil chemistry and biology. The biology experiments and their results are still controversial today. Each Viking lander used its mechanical arm to scoop up Martian soil and deposit it into a sophisticated miniature laboratory on board the probe. The soil was tested in a number of ways to try to verify if it was home to a thriving culture of micro-organisms. One of the experiments involved feeding a rich nutrient 'broth' to the soil. Cunningly this soup was laced with mildly radioactive carbon; in tests on Earth any earthly organism exposed to the food gobbled it up and 'breathed out' radioactive carbon dioxide. This was easily detected by the instruments on board each Viking.

> "The first men on Mars … would evaluate the landing site for unfriendly life forms"

The premise was any Mars bugs in the soil would slurp up the food and the Viking would detect their satisfied after dinner burps. No such gaseous emanation would be expected from lifeless soil. What do you think happened?
(To be continued)

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Sheehan, W and Misch, A, The great Mars chase of 1907, Sky and Telescope, November 2007

http://beyondapollo.blogspot.com/2009/09/philcon-aeronutronic-mem-1964.html

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Image of the Month

Image Credit: NASA and the Hubble Heritage Team (STScI/AURA)

This unusual shaped ring galaxy is called Hoag's Object. It was discovered in 1950 by astronomer Art Hoag who initially thought it might be a planetary nebula, the glowing remnants of a Sun-like star. He quickly decided that it was more likely to be a galaxy, which was confirmed in the 1970's.

This image was taken by NASA's Wide Field and Planetary Camera 2 on the Hubble Space Telescope on 9 July 2001 and shows the galaxy's near-perfect ring of hot, blue white stars orbiting the bright yellow nucleus face on.

This galaxy is slightly larger than our own Milky Way at 120 000 light years wide and is 600 million light years away in the constellation Serpens, the Snake. You can also see another ring-shaped galaxy in the background through the central gap.

It is thought that the shape of Hoag's Object was caused by a galaxy passing nearby and losing some of its stars to this galaxy's gravitational pull. This encounter may have happened between two and three billion years ago.

(Caption by Tracy McConnell, Education Support Officer)

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Tel: 02837 523689 Email: cj@armaghplanet.com

Editor: Colin Johnston
Assistant Editor: T McConnell