South-West Herts Astronomical Society Newsletter Feb. 2021

Notes of our online meeting on 29th January 2021

By Richard Westwood

Astro-news presented by Len Mann

Len Mann brought us up to date with the developments in the field of spaceflight this month.
Despite the ongoing Corona-virus issue, remarkable progress has been made on launch vehicles and orbit capabilities: Virgin Orbit has successfully achieved orbit with a vehicle launched from a 747 aircraft (Len wryly commented that Virgin do have a few 747's spare at the moment!) Not only does this mean that a launch site isn't needed; but the rocket can be smaller. This particular mission carried 150 cube sats to Earth orbit.

Virgin Reaches Orbit

Virgin Galactic

Len also mentioned Virgin Galactic's White Knight 2, an ambitious Earth-orbit vehicle for fare-paying passengers.

Spacex is also in the news, having tested its Earth-to-orbit craft Dragon Super Heavy, based on the Falcon 9. The First Stage, not yet tested – Will have 30 engines; one of which was the propulsion used in the test.

Spacex together with NASA are testing an oilrig as a mobile launch pad. This could mean that satellites could be launched from many different locations and not near population centres.
Let's pause for a moment… maybe it's me; but… we now have the means to launch lots of small payloads into Earth orbit. But what about the missions that have to pass through this area? I am reminded of the problems with space junk that's already up there: are we adding to it?

Mike Leggett – Early Astronomical Instruments

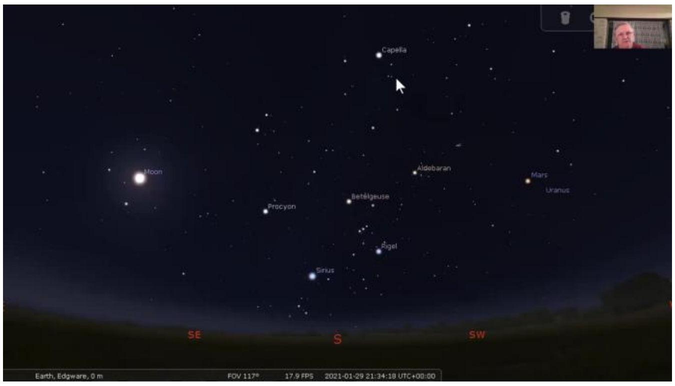
Galileo and other 17th Century scientists were the first users of telescopes to observe the sky. They revealed a universe vastly more complex and richer in variety than they could have imagined. But what of the preceding millennia? How did the ancients contribute to our knowledge? And what did they discover?
In this talk by Mike Leggett, we learnt that the earliest records go back to pre-historic times; bones had notches cut in them, representing a primitive Lunar calendar. Later, around 4,500bce burial mounds, or long barrows were found to be aligned with certain stars. Circular stone monuments – such as Stonehenge and Avebury – constructed about 3,000bce – are quite complicated astronomical computers; marking risings and settings of various bright stars and also the summer and winter solstices. To the ancients, the winter solstice was much more important, as the cold months could be brutal to a culture without adequate shelter; even the Romans had a solstice festival – Saturnalia – to welcome the longer days.

Moving on to ancient Egypt, the first pyramid builder, Imhotep, aligned the tomb of Djoser with the stars; and the Pyramid of Kufu has ventilation shafts aimed at Thuban (α Draconis), which at that time was the Pole Star, and also, in the correct season, Sirius.
To the Egyptians, astronomy was vital: they needed to know when the Nile would flood, as then they would plant their crops. The method they used was to watch for Sirius rising with the Sun as a signal to plant.
They also needed a way to measure time: for this they used a Sun stick, the precursor of the Gnomon of a sundial. When the shadow was at its shortest, it marked midday. The hours were counted using a Clepsydra (water clock). Also, during the night, they made up groups of constellations called 'Decans' that, as they crossed the meridian, counted the passage of time.
The Babylonians, one of the major countries in Mesopotamia, constructed huge towers, called Ziggurats, (the biblical Tower of Babel) as observation posts to watch the heavens and report planetary alignments and other events. These were noted and tables composed for future use. Even now these baked tablets are used by astronomers for data on astronomical events in the distant past. The Babylonians and Assyrians were believers in Astrology and therefore used this data to warn of dangerous periods, like the death of the King. They noted that the Sun, Moon and planets moved in a confined region of the sky; and made the star groups along this path special – we know it as the Zodiac.
Mike reminded us that our 24 hours, 60 minutes and 60 seconds both in time and angular measure comes directly from the Babylonians.
In Classical Greece, much of the practical knowledge of these civilisations was codified and given mathematical rigor. Following Pythagoras, they excelled in geometry and theorised the structure of the cosmos. It's in this period that the circle became the perfect figure for planetary motion and Aristotelian physics took root.
Mike pointed out that the later Greek period, after Alexander the Great is referred to as the Hellenistic age. This is the time of the Great Library in Alexandra in which all of the science of the past was made available. Using this data, Eratosthenes measured the circumference of the Earth! He had read that the midsummer Sun at noon shone directly down a well in Syene (now Aswan) whereas from Alexandria it didn't. He knew the distance between the two places, so using the value of π he obtained a result close to the modern value
By 250bce Aristarchus of Samos had attempted to measure the Earth-Sun-Moon distance; recognising the fact that at First Quarter, the Earth, Moon and Sun are at right angles. He also developed a type of sundial Unfortunately, his later ideas concerning the Sun-centred system were too advanced at the time.
Around this time, the mathematician Apollonius of Perga had designed a very useful device to measure the altitude of celestial objects and much else. This was the astrolabe.
Using such an instrument, in 150bce Hipparchus, working on Rhodes had completed a star map and invented the magnitude system we use today, he also discovered precession, although Mike commented that this could have been allowed for in the building of Stonehenge.
In 150ce, the mathematician Ptolemy wrote the Mathematical Syntaxis, a compendium of knowledge from, as he thought, the golden age of Greek learning. This included Hipparchus' work, a world map and planetary tables, based on the earth centred theory and mathematics, including geometry.
At this point the Greek centres of learning were destroyed by fanatics.
The birth of Islam in the late 6th century brought a need for better astronomical tables: Moslems were required to face Mecca to pray: also, the start of every month had to be proclaimed by a crescent Moon at sunset.
The Arabs translated Ptolemy's work – now called the 'Almagest' (the Greatest) and begun revising it, using more sophisticated astrolabes, mural quadrants (literarily a north-south wall with a 90^o scale on it)
Astronomical centres emerged at Bagdad, later moving to Cairo and even later to Istanbul, these were centres of learning and also manufacture of instruments, including the armillary sphere: a teaching device showing the celestial equator and ecliptic – things we would now use a planetarium for.
This period of great activity enabled the science of astronomy to come back to Europe through Moorish Spain from Cordoba in 900ce much refined. The use of the 'Arabic' number system; and Abelard devising the figure 'zero'. Other people in Europe worked in this area. Roger Bacon, Richard of Wallingford built a clock for St Albans Abbey and Geoffrey Chaucer, who in his spare time from writing Canterbury Tales was responsible for

traffic on the Thames; wrote a treatise on the use of the quadrant. The scene was set for the latest and most unusual character in the pre-telescopic period – Tycho Brahe.
A Danish nobleman, he built on the island of Hveen, a series of sighting instruments for measuring angles and positions. Some required to be in hollows, or on high walls. All of them must have been very uncomfortable to use for his many assistants – especially on cold winter nights.
But the precision of his measurements and his many discoveries ensured that his successors would have the best data.
This is a very short, abridged sketch of Mike's talk. It gave us a lot of information regarding a subject rarely covered – thanks Mike!

Observer's Corner

There have been very few opportunities to observe the sky in January! I only had three sessions myself!

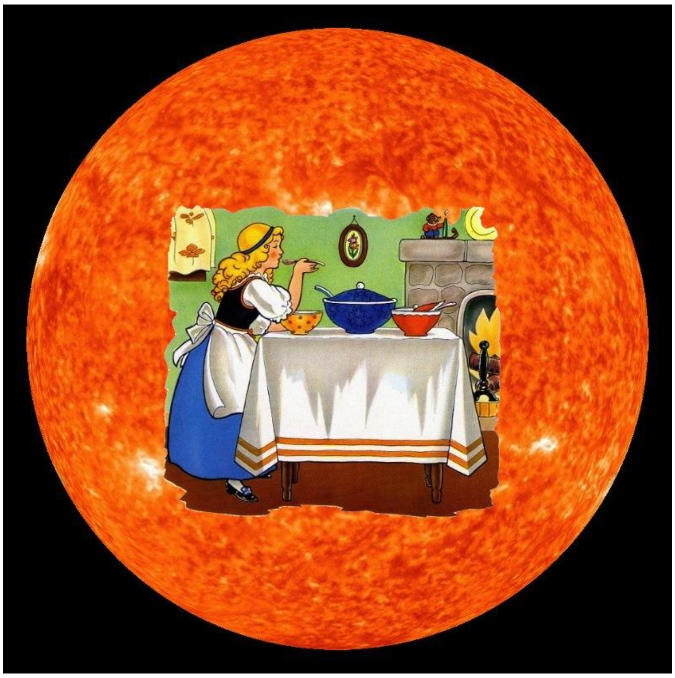


In March, Orion is high in the south mid-evening. This means that anyone taking their dog for a walk tends to notice it. I know this because it's this time of the year when I get phone calls from people to tell me that they've seen 'three bright stars pointing to a very bright one' I tell them that it's only Orion taking his two dogs for a walk.
Orion's place is now occupied by the lion, Leo. I must say the shape is reminiscent of a crouching lion. The brightest star is Regulus, the little king. It's a first magnitude 'a' type star and marks the Lion's heart 'Cor Leonis'. One of the best known double stars is located a little above Regulus: this is γ Leonis; a small scope will show the pair of yellow very well. For those imagers and deep-sky observers, the galaxies M65 and M66 lie just below ι Leonis.
As we approach spring the Plough is nearly overhead and just below the end star in the handle, η Ursae Majoris lies M51, the fabled Whirlpool galaxy. First seen as a spiral in 1845 by the Earl of Rosse through his 72" reflector, it's a favourite target. However, you're going to need a very large scope to see the spiral arms. I've seen them only once, at a star party in Arizona! As a consolation prize, there are two double stars just above η Ursae Majoris, ι and κ Boötis that are colourful and in the same field at low power.
Talking of Boötes, Arcturus is now well visible in the south-east during the evening reminding us of warmer days to come – as it's snowing tonight, that's a warm thought!
By the way, Mars is going to be very close to the Pleiades later in the month – a good photo opportunity!
More next time!

Richard W

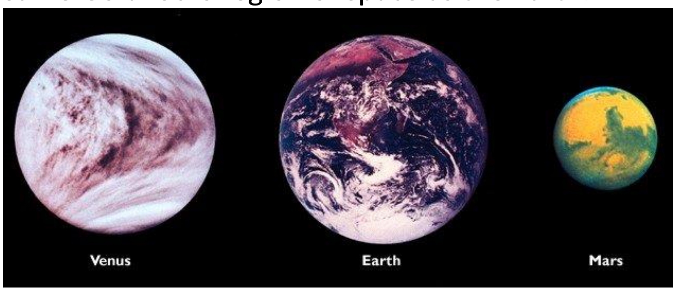
Feeling lucky?
By Graham Marett

Our planet, third rock from the Sun, is often described as being in the Goldilocks zone for habitability: not too hot, not too cold, but just right for liquid water to exist and promote the conditions for life to evolve and flourish.



Venus is much too hot, with runaway greenhouse effect resulting in temperatures well in excess of 400 degrees; Mars is too cold, with its thin atmosphere unable to retain liquid water on the surface.

But of course things are not that simple. In passing it is worth noting, for example, that our own Moon is not considered to be habitable, in spite of the fanciful selenites with a sophisticated underground civilization as imagined by H.G. Wells in his 1901 novel *The First Men in the Moon*. As far as distance from the Sun is concerned, the Moon occupies the same Goldilocks region of space as the Earth.



Exploratory probes sent to Venus and Mars provided evidence that Earth's habitability requires a more detailed explanation. Why does Venus have such a dangerously corrosive, dense and thick atmosphere, unique amongst the inner planets? And the evidence shows that Mars was almost certainly once warm enough to sustain liquid water on its surface; why and how did it lose its habitability?

Habitability is a precarious characteristic, and we now know that there have been very considerable variations in Earth's climate during its long history. Somehow the conditions remained suitable for the evolution and maintenance of life over a period of almost four billion years. Specifically, the input and output of carbon from the atmosphere, in the form of carbon dioxide, has remained within limits conducive to life. A loss of atmospheric CO_2 would have led to the freezing of the oceans within a few million years; likewise a large excess of CO_2 would have led to the oceans boiling away within a few tens of millions of years. In addition, it is now known that the Sun's luminosity has increased by a third during that period, a factor to which evolving life had to adapt.

A recent study by the National Oceanography Centre at Southampton University, published in the journal *Nature*, suggests that simple good luck played a significant role. The long term habitability of the Earth has been largely contingent on chance rather than being an inevitable outcome.

The widely held view is that stabilising feedback mechanisms operating over long periods of time led to our planet remaining habitable. The Southampton team used computer modelling to follow the long-term evolution of the climate on 100,000 hypothetical planets in the habitable zone, with variations in initial temperatures and faced with a random selection of perturbations. The modelling runs were repeated 100 times with small variations in the parameters.

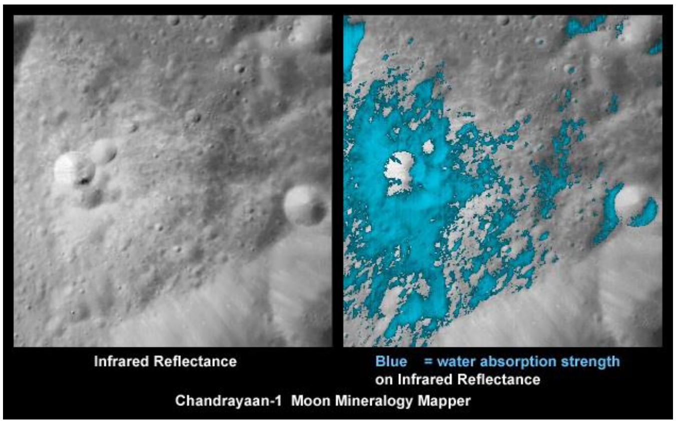
The conclusions showed that in the majority of cases long-term stability could not be maintained over the three billion or more years which would be required for evolution leading to the emergence of Homo sapiens. Major perturbations which have taken place on our own planet include periodic eruptions of super-volcanoes and occasional strikes by large asteroids. It seems clear from the modelling that if the magnitude or timing of these events had been different, the outcome for the climate could have been very different and life may well not have survived.

We are indeed very lucky to be here. Our planet is currently undergoing another major perturbation in the form of man-induced climate change. Whether life on Earth, and Homo sapiens in particular, can survive this new assault remains to be seen by future generations.

Graham

WATER ON THE MOON, A BEGINNER'S GUIDE By Phillipa Goss

Water on the moon comes in several forms



1. Ice surviving in the permanently shadowed craters at the poles. This is thought to have come from cometary impacts over billions of years. The permanently shadowed regions are thought to act as cold traps for vaporised water molecules that migrate across the sunlit surface of the moon.
2. Water molecules in the upper few millimetres of the lunar surface, which is thought to be formed when hydrogen ions in the solar wind hit the moon's surface, and react with oxygen atoms in silicate minerals.
3. Magmatic water, which is present in the magma deep underground, but which has found its way to the surface following excavation by asteroid impacts.
4. Micro cold traps. New research by scientists at the Planetary Science Institute in Arizona has found that micro cold traps could also exist on the moon inside small craters or behind boulders. They might be just a metre across, but could harbour up to a fifth of all the frozen water on the moon.

Why is this subject in the news now?

In October 2020 NASA managed to distinguish between water and hydroxyl, which has one hydrogen atom less than a water molecule. The discovery was made by SOFIA (The Stratospheric Observatory For Infrared Astronomy), a 2.5 metre telescope in a Boeing 747SP jet.

The fact that the water was on the surface in direct sunlight presented a mystery. The sunlit surface can reach temperatures of 230 degrees Celsius. This would not feel "hot" as we understand it, because there's no atmosphere to contain the heat, but water molecules on the surface should evaporate quickly and either retreat into cold traps or escape into space. This led to the conclusion that water must be replenished at a relatively high rate.

They therefore concluded that in addition to the hydrogen ions in the solar wind there must be other mechanisms of water formation. One idea is that it comes from micrometeorites raining down onto the surface carrying small amounts of water with them. These could then flash heat dust grains, forming tiny beads that trap water molecules.

How they have found water on the moon

Moon rock samples from Apollo. These were so incredibly dry that it was thought at the time that the water must have contaminated the rocks after arriving on earth.

By driving impactors into the permanently shadowed craters. One example was NASA's Centaur rocket which crashed in to a crater at the lunar south pole in 2009, sending a plume of debris above the rim. The spectral analysis found it contained 5.6% +/- 2.9% water by mass. It was deduced this water came in small chunks, maybe 10cm across or as a thin coating over grains of surface dust (regolith), as opposed to a large thick glacier.

By measuring the spectral signature of water molecules in the upper few millimetres of the lunar surface from spacecraft flying past the moon.

<u>How much ice?</u>

There is quite a bit of water on the moon, but it is mostly thinly spread. The area where water was discovered by SOFIA last October inside the Clavius crater is 100 times dryer than the Sahara Desert, or the equivalent of a coke can's worth per football pitch.

There is an estimated 600 million metric tonnes at the lunar north pole, scattered among 40 craters. It is thought to be more concentrated at the south pole.

The laser altimeter on NASA's Lunar Reconnaissance Orbiter concluded that 22% of the surface of the Shackleton crater at the lunar south pole is covered in ice.

<u>What they hope to discover and why</u>

It could help to tell us where earth got its water from. They used to think it was from comets, but the scientific consensus is now starting to favour carbonaceous chondrite asteroids as a source, as these have the same isotope ratio as earth's water.

Helping to understand how the moon was formed. Scientists had thought that the moon was ripped from the young earth's crust by a Mars-sized protoplanet, and that the intense heat of the collision would have boiled away any water.

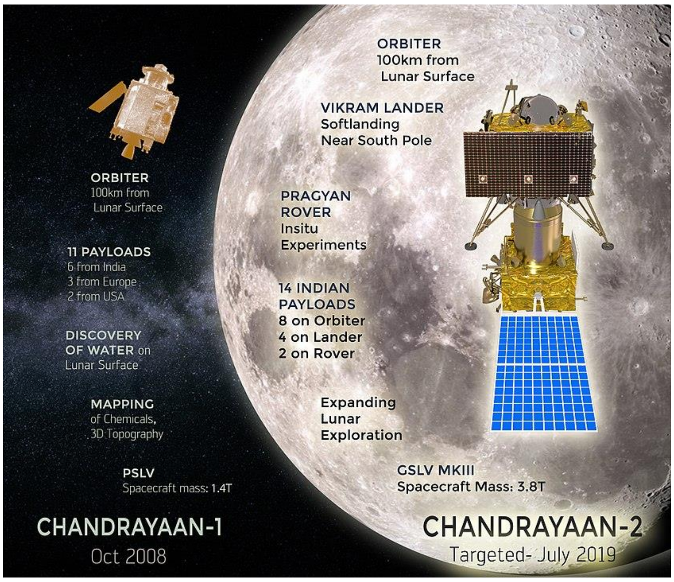
Humans returning to the moon. They would need water to drink. Splitting the H_2O to provide oxygen and hydrogen could provide oxygen for breathing and be used to manufacture rocket propellant. (The problems involved in getting access to useful amounts of water on the moon is a subject of its own).

<u>Planned projects</u>

NASA has just given the go-ahead for the Lunar Trailblazer cubesat mission which will map water on the moon. This small spacecraft will launch in 2025 to examine the permanently shadowed regions, look for micro cold traps and study the lunar water cycle (changes in surface distribution throughout a lunar day).

This will supplement VIPER (Volatiles Investigating Polar Exploration Rover) a robotic rover which is due to launch in 2023 to explore permanently shadowed regions and drill into the surface in search of water.

Chandrayaan – 2 (Indian Space Research Organisation) (launched in 2019) uses radar to search for water and will be joined by another NASA mission, due to launch in 2021, Lunar Flashlight, which will use infrared lasers and spectrometers to map the ice.



PHILIPPA GOSS
(Summarised from an article by Keith Cooper, Astronomy Now, January 2021)

Society Notices

All Meetings at The Royal Masonic School are suspended until further notice.

Our Next Meeting - Friday 26th Feb. 2021 at 8pm

“OSIRIS-REx - To Bennu and Back”
by John Mclean

As UK Mission Ambassador for NASA’s OSIRIS-Rex Asteroid Sample Return Mission to asteroid Bennu, John is in a unique position to tell you the inside story of this incredible mission. In this talk you will be introduced to the mission, including details of the mission plan, the spacecraft and scientific instruments used. You will discover how the Mission developed from an idea to a successful operation and some of the incidents and problems that arose, and how they were solved. This talk is able to provide insights directly from the mission teams and includes up to date information.

A Zoom meeting link for the event will be sent out to all members two days before the meeting, but if you would like to put a placeholder or reminder on your calendars now, the meeting will take place **on Zoom.**

Meeting protocols

We will allow access to the meeting approximately 15 minutes before the start time of 8pm. This will allow members to “chat” beforehand if they wish to do so.

Once the meeting commences, all mics will be muted to avoid extraneous noises.

You can ask questions at any time throughout the presentation by using the chat function, but to avoid disruption, these questions will be not be answered until the end of the presentation.
You will also be able to ask questions using audio at the end of the talk.

The meeting will be recorded and made available to members on our YouTube channel afterwards.

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