

South-West Herts Astronomical Society Newsletter May 2021



Notes of our online meeting on 30th April 2021

By Richard Westwood

The Evolution of Planetary Rovers – Dr Elizabeth (Ezzy) Pearson

Ezzy began by explaining the ways of exploring other worlds; as they fall into different categories:



Human: Very expensive and needs a lot of complicated hardware, plus consumables. However, humans are better at 'on the spot' decisions.

Static Lander: This robotic craft is very useful: however, only the immediate vicinity can be explored in detail.

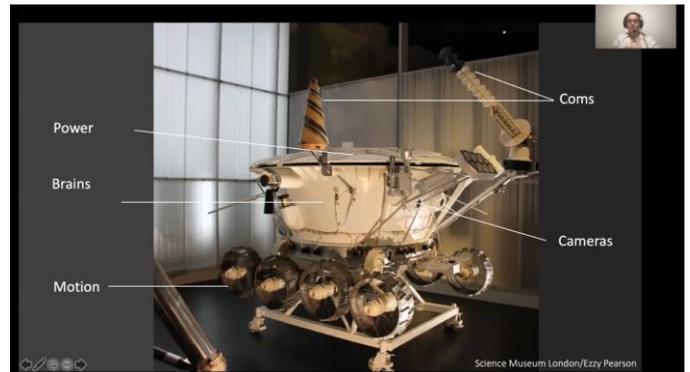
Impactor: Useful for geology and soil analysis, temperature, etc.,

Mobile: The best option, but more expensive; gives the ability to compare different geological areas, leading to a greater understanding of conditions on the planet. Curiously, the first rovers were sent by the Soviet Union to the Moon. After Neil Armstrong and Edwin Aldrin had stepped on the Moon, they realized that that race was over. But each of the very expensive missions only examined one site each – even with the Lunar Rover on the later missions.

The first 'Lunokhod' landed on the Moon on 17th November 1970 and worked until 4th October 1971, exploring the Mare Imbrium.

Later, in 1973, Lunokhod 2 was active in the Le Monnier crater area. The mission lasted from 11th Jan to 11th May – its career was ended by the mission scientists pushing the engineers to go the riskier (interesting) areas – something the conservative engineers didn't allow with their very expensive craft on the first mission.

Ezzy showed us images of the Lunokhod standing on its landing platform, ready to roll onto the surface. Each craft had a strange appearance: a bath on wheels!



This was a very practical design; the electronics and film camera with processing equipment were located in the body, the communications antennae on the roof, the whole machine resting on eight detachable wheels. They looked as though they had been designed by Roland Emmet – indeed at this time he had indeed built a bicycle lunar rover for Patrick Moore to ride around Selsey! However, they worked; taking pictures from cameras mounted, like headlights, at the front of the vehicle. It was using these images that the craft was steered – not easy with a 1.5 sec delay due to light speed. One very useful piece of information obtained from the Lunokhods was that the Luna regolith material is very sharp.

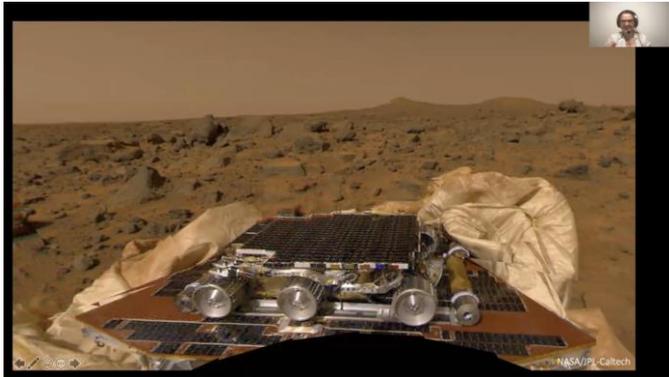
In 1976 the first NASA craft landed on Mars: named the Viking Mission, these two landers provided much of the early knowledge about the conditions on the red planet; not all of it confirmed by later missions.

The exploration of Mars has been a NASA and later ESA project: the USSR having a run of unsuccessful attempts. This is surprising; Ezzy told us, as they landed two successful craft on the very hazardous and toxic surface of Venus.

The first Martian rover was the Pathfinder Mission, NASA Administrator Dan Goldin's cheap and quick Mars missions; and that wasn't intended to be that way. Apparently, the scientists wanted to fit an alpha-proton x-ray spectrometer and the only way this would function was to locate it on the top of the vehicle. The rovers name was Sojourner and as despatched from the spacecraft enclosed in a landing craft, wrapped in a gigantic bubble-wrap which, in turn was enclosed in a heat shield for the fiery descent. The braking was

achieved by parachute after which, the craft bounced to a stop on the Martian surface.

Once clear from the wrapping; the landing craft opened like the petals of a flower, and Sojourner, in an echo of the Lunokhod mission, ran down the ramp and started work, carried by its six-wheeled frame bogie ('bogie' is a word better known to railway enthusiasts for a wheeled truck – did anyone notice on the slide diagram of the craft it was referred to as the 'boogie' – a Glen Miller design, perhaps!)



Landing on 4th July 1997 Sojourner was very productive in its lifetime of 92 days (Sols) in the Ares Vallis area: several of the rocks it discovered were given names 'Yogi' 'Zafod' and 'Indy' to name but three. One interesting discovery was that the minerals are very varied; meaning that a medium must have carried them to this place. The obvious one being water.

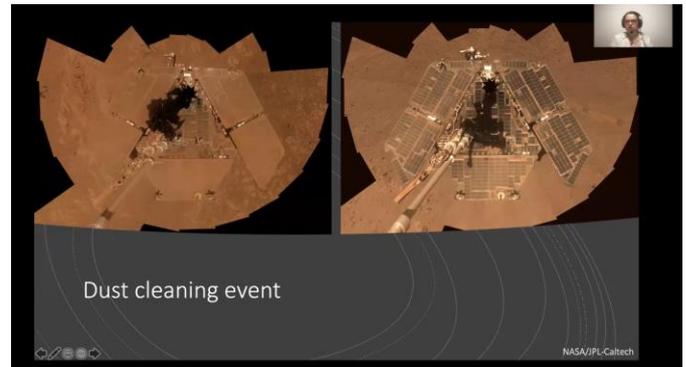
The rover finally 'ran out of steam' when its solar panels, located on the top of the craft, got coated with Martian dust, so could not generate any more power. The next rovers were 'Spirit' and 'Opportunity' in 2004; launched separately; Spirit on 10th June and Opportunity on 7th July 2003. The reason for this was to locate each craft on opposite sides of the planet. There were many issues and problems related to these craft. For example; Spirit had a shutdown problem – so much so that a special program routine was 'shutdowndammit! Even on the launch of Opportunity the launch rocket had to have its cork lining replaced by skilled craftsmen as the original material was damp! Each rover was fitted with a 'RAT' – an abrasion tool designed to expose the inner material of rocks. The covers for these devices were made from steel from the World Trade Center after 9/11.

Spirit landed at Gusev crater on January 3rd 2004. Its main objective was to study the crater, as it was thought that it could have had water – actually it did much more than that, going on to the 'Columbia Hills'. Finally, it ran out of power, due to winter conditions mired in a site called 'Troy' in 2003. In all, it covered over 4 miles

Opportunity fared better and covered over 28 miles, visiting several craters, over 14 years.

The dust problem that cut short Sojourner's mission was not repeated with this mission: about every 2 months Mars' winds neatly cleared the solar panels. There was great sadness after the demise of these explorers: due to the problems and the way they

performed though adversary and their connection to the 9/11 atrocity. Possibly there was a little bit of anthropomorphism, after all, they do look like the Disney character Walle, with their binocular 'eyes' and the tapered solar panels.



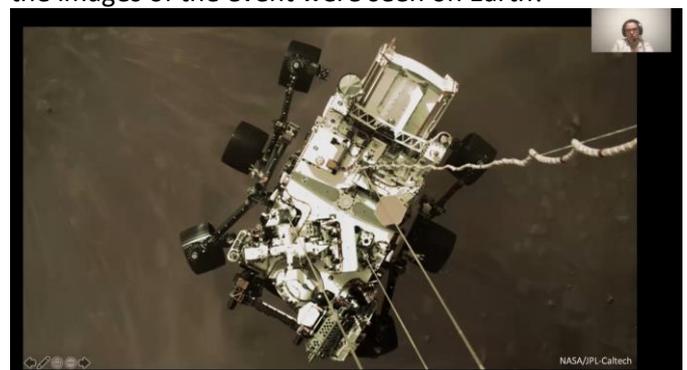
All these rovers built up our modern view of the red planet as having evidence of water in the geological structure and also highlighted the atmospheric features, such as dust devils and clouds. They also gave us a cosmic view of the Earth with Martian sunset images.

Opportunity continued with the rover Curiosity, launched in 2011. This was much more ambitious – it's as large as a small car! The landing technique was much more sophisticated: the bubble wrap was replaced by a 'sky hook'. After the parachutes had slowed the lander down, a retro-rocket provided the final approach and touchdown on 4th August 2012.

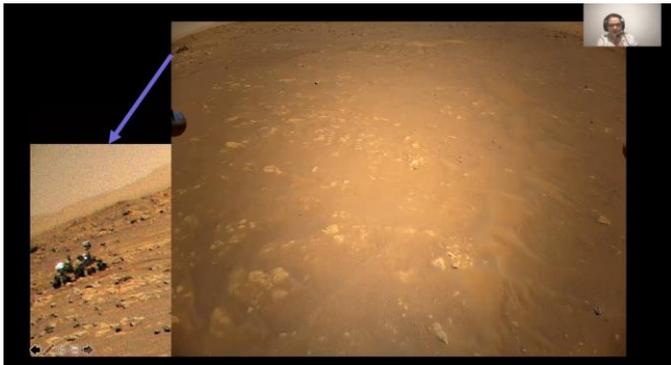
Curiosity was designed to be a mobile laboratory for example it has an oven to heat minerals for analysis. It confirmed the presence of water on Mars; but this history is complicated; as Mars hasn't been wet all the time. Its main area of study was the Gale crater, in craters it's possible to get a picture of the site's geological history. At the moment the rover is still working; and has travelled over 16 miles.

The images from Curiosity show the surface features in very high definition; and the views of the atmospheric features give a much better guide to Martian weather – even astronomical images have been taken – Phobos eclipsing the Sun!

The latest rover, Perseverance, currently beginning its mission; is even more autonomous than Curiosity. Again, the landing was by 'skyhook'. Interesting to reflect that the landing had already happened before the images of the event were seen on Earth!



It's the first part of a project by NASA jointly with ESA, which involves a three-part mission to gather, sort and return samples of the regolith (broken rocks and soil) to Earth, and to look for ancient life. To this end Perseverance is equipped with a drill and tubes to store the samples until they can be cached for later collection. Included in the craft are experiments to check for ways of a sustained human presence would be possible - making oxygen from rocks, finding subsurface water and doing meteorology - Because of this mission statement, the rover is in the most favourable area, the crater Jezero. To do reconnaissance also on the mission is a helicopter(!) – the first human built flying vehicle on another world. This is a mission to watch!



Perseverance as seen from the Ingenuity helicopter

Ezzy moved on to other worlds that could be studied using rovers – Europa, the moon of Jupiter is a prime candidate and also plans are being made to send a mobile craft to Titan, the largest moon of Saturn. We mustn't forget that the Chinese are sending rovers to the Moon and getting excellent results – until they landed on the farside with a rover, nothing had studied this region from the surface!



We must thank Ezzy for an excellent talk on this important and intriguing subject. I'm sure that the dedicated teams involved in the driving these rovers must enjoy their work: even though they have to live on 'Mars time' while they do it.

Observer's Corner

Sometimes we forget that the Sun is a star: in fact, it's the only star we can see surface detail on. And, at the moment, as we are coming up to the summer solstice, it's above the horizon for many hours. Why am I mentioning this? Maybe it's because I've just managed to find a method of attaching my 90mm Thousand Oaks solar filter to the 90mm refractor –

despite the filter was designed to fit a similar scope, I've had to get a drainage pipe from B&Q to connect the two together.

As I was doing this; I idly looked at the 'Sun Warning' in the leaflet that came with the scope. Believe it or not, the warning cautions against using the projection method of solar observing. Years ago, that was the only safe way you could observe. Patrick Moore never used any other way; as the filters available then fitted into the eyepiece and could possibly crack due to the heat near the point of focus.

So, what had changed to render this safe solar observing method unwise? In the 50's and 60's, the refractor consisted of an achromatic doublet, uncoated the metal tube with a rack-and-pinion focuser. The eyepiece was much simpler – in the case of refractors it might be a Hygienian design, just 2 plano-convex lenses, flat surfaces facing the eye. The equivalent design for reflectors was the Ramsden type, again, plano-convex; but with the curved surfaces inside. The most advanced eyepiece in the 60's observer's arsenal was the Orthoscopic; designed by Carl Abbé for Carl Zeiss. This had a three-element field lens. None of these eyepieces were coated.

Today eyepieces are all coated, as are objectives – this is why projection is not a good idea.

So, have I looked at the Sun? Yes, I have; I had a very good view on Wednesday 19th May and saw a fine spot close to the limb.

While we are talking about the 60's amateur astronomer, there are words that wouldn't be understood today; for example, 3" OG; this means object glass (refractor). Spec, short for speculum. Reflectors use to be made of an alloy of copper and tin and were replaced by glass in the 1880's but the name stuck. Spode is another word – actually a euphemism for sod! Spode's law states that if something is going to go wrong: it will and be worse that you can think! I'm afraid that planetary observing is still confined to the early morning; only Mars and Venus are in the evening sky just after sunset.

There's one constellation that is located on the Zodiac but is not included in the astrologers' prognostications. Ophiuchus. If you find α Herculis, a little to the right is α Orphuchi. He is the serpent bearer and represents Aesculapius, the first doctor, who brought people back to life. So, Zeus hit him with a lightning bolt! The snakes are represented on the *Caduesis*, the symbol of medicine.

There are three objects in this constellation really worth looking at; the beautiful colours of 70 Oph, a fine double star; part of a 'V' shaped asterism. The very green planetary nebula NGC6572 is just to the north. Binocular observers will like NGC6633 a little higher in the sky

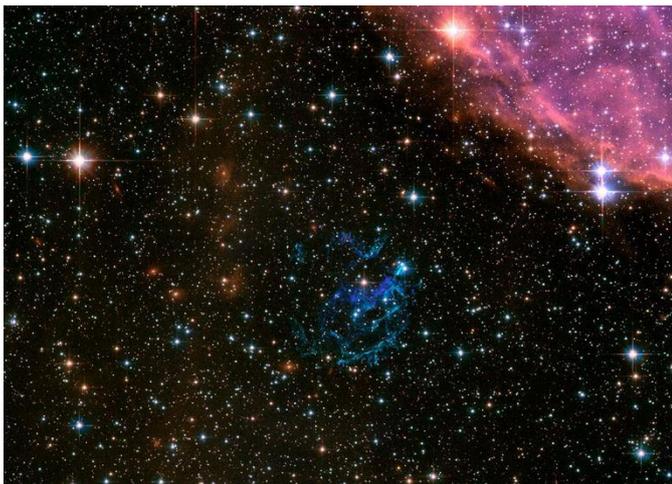
Extraterrestrial Plutonium

A rare isotope of plutonium has been discovered from the Pacific seabed, giving important clues about the origins of the heavier elements in the periodic table. The plutonium is believed to have been produced from extraterrestrial sources, and rained down through Earth's atmosphere as cosmic dust sometime within the past ten million years. A team of physicists from a number of research facilities including the Australian National University and the Helmholtz Centre in Dresden published their findings in the journal Science earlier this month.

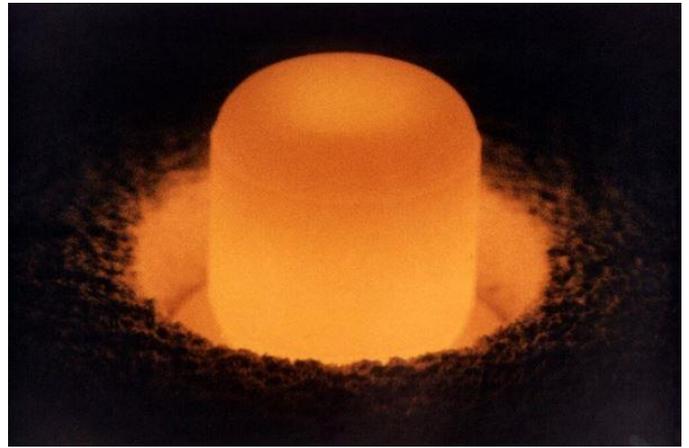
The highly dangerous element is often considered to be man-made, since it is a product of nuclear reactors where it occurs as the isotope ^{239}Pu . But small quantities of other isotopes do occur naturally, and the isotopic composition gives clues as to its origin.

The rare plutonium isotope ^{244}Pu is produced by a neutron capture process known as the r-process. This is believed to have two origins, either from certain types of supernova or from mergers between orbiting neutron stars (themselves the result of supernova events). Only a few atoms of the rare isotope were recovered, but critically they were found to be associated with atoms of the iron isotope ^{60}Fe .

The ratio between the iron and plutonium isotopes is such that neutron star mergers are the most likely source. The researchers have already moved on to study a larger sample, from which they hope to unlock more secrets of the origins of heavy elements.



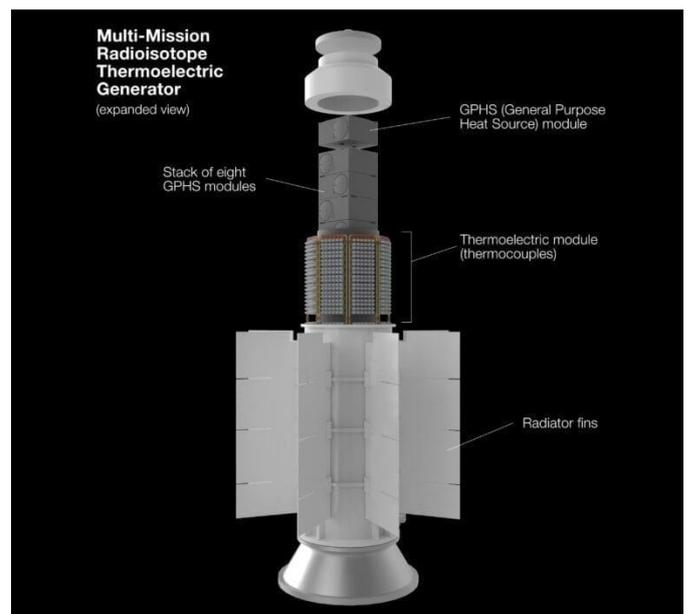
The images show a supernova remnant, above, (blue-green) near the Small Magellanic Cloud), and a pellet of plutonium (below) glowing from its own energy.

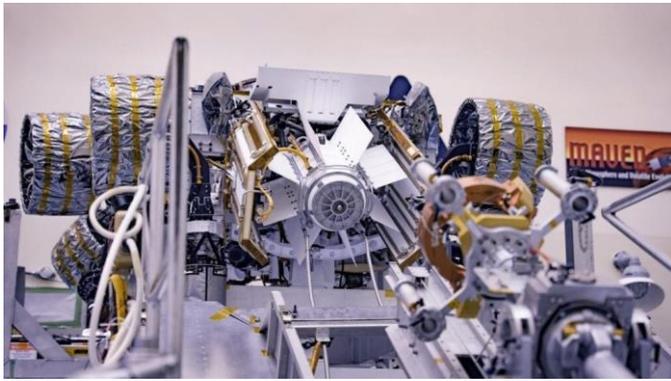


Meanwhile, NASA has been sending man-made plutonium into space, as a power source for the Mars rovers (plutonium is also used to power other space missions).



The images (below) show the Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) power source on the Perseverance rover recently deployed on Mars. The device weighs about 45 Kg, and has about 5 Kg of plutonium oxide as its fuel.





The steady decay of the plutonium gives a steady supply of heat, and this is used to generate about 110 watts of electricity. Different isotopes of plutonium have half-lives varying from years to thousands of years; the isotope chosen for the MMRTG (^{238}Pu) should easily provide enough power for the rover's planned operational life of around 14 years. The generated power level will slowly fall, but only by a few percent per year.

The electricity is generated using a device called a thermocouple. The process is known as the Seebeck effect, discovered in the 18th century by the German physicist Thomas Seebeck. This relies on a junction between two metals which are maintained at different temperatures: in the case of the MMRTG the higher temperature is provided by the plutonium, and the lower temperature is the frigid ambient temperature on the Martian surface.

Graham

Society Notices

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

Our Next Zoom Meeting - Friday 28th Apr. 2021 at 8pm

SWHAS AGM

Hopefully we will return to the RMS on :

Friday 24th Sept. 2021 at 8pm for a talk on the “Antikythera Mechanism – New Developments” by Aris Dacanalis

We will keep you updated on progress in this respect – nothing is certain in these unprecedented times !

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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