When considering the programme for the u3a Science Network's Anniversary meeting in 2022, it was decided to take *What was happening in Science in the 1980s, What's happening in 2022* and *What might be happening in the future* as the basis for the 3 planned talks. These were presented on 26 July by John Marriage from Lyme Regis u3a; Mike Perry from Tring u3a and Leigh Edwards from Exeter u3a.

I usually write up the talks for inclusion in TAM and for publishing on the u3a Science Network website but presentations at the 26 July meeting are so full of detail that a succinct write-up is almost impossible. I've asked the presenters to let me have pdf copies of their presentations so that copies can be sent to anyone who attended the meeting and who makes a request to weare40@u3a.org.uk with *Science Network meeting 26 July* in the Subject field.

John Marriage - *Blowing Hot and Cold in the 1980s - dealing with hot and cold fusion*

John Marriage's talk Blowing Hot and Cold in the 1980s was about two temperature-related breakthroughs which might change the world. Cold Fusion and High Temperature Superconductors appeared as apparent breakthroughs in the 1980s, both with promise to reshape fundamentally the way we generate and use energy.

Cold Fusion: the Prof. Stanley Pons and Prof. Martin Fleischmann team came up with Cold Fusion in 1989: but scorn was poured on this and the race for the ultimate super-conductor began. Unlike Cold Fusion, superconductivity is completely genuine, still being actively researched, and in regular industrial use.

Superconductivity:
Heike Kamerlingh Onnes, a Dutch physicist, who received the Nobel prize for Physics, discovered superconductivity in 1911, the ability of certain materials to conduct electric current with practically zero resistance. For many years, it was thought to consist simply of a vanishing of all electrical resistance below the transmission temperature until the Bardeen-Cooper-Schrieffer theory (BCS) developed in 1957, the first microscopic theory of superconductivity since Onnes's 1911 discovery.

The application you are most likely to have met in person is the medical MRI machine, which uses a very strong magnetic field generated by superconducting coils, also working in liquid helium at 4.2°K. The first superconducting MRI was built in 1980, and they are now found in every large hospital. Superconductors have two key properties: at the critical temperature:

- Resistance suddenly drops to zero
- Magnetic fields are excluded from the interior of the material (the Meissner Effect)

In 1985 the world changed with the discovery of materials that superconduct in liquid nitrogen rather than liquid helium, potentially a big deal as liquid nitrogen is cheap, easy to manage and widely available. The discovery also alerted physicists to the possibility of room-temperature superconductors.

In the Meissner effect, as long as the superconductor is below its transition temperature it excludes the magnet's field and repels the magnet. When it warms up the magnet is suddenly no longer repelled and falls down. In 2003, an operational magnetic levitation train in China floated a little way above the track by magnetic repulsion and was driven the same way. It travelled very fast (270 mph), with great acceleration and was quiet, with low maintenance. Today there are maglev trains in Japan, South Korea and China – the primary challenge facing maglev trains has always been cost. Maglev requires a dedicated infrastructure including substations and power supplies and cannot be integrated directly into an existing transportation system.

Applications include big motors, generators and transformers
At IRD in Newcastle upon Tyne John Marriage was part of the team which built the world's first superconducting 50HP motor in 1966. It was followed up with a 3250HP experimental one – which was too large a step. John invented the contact brushes and the method of making them, by silver-plating fine carbon fibres. The brushes worked fine, but control of the huge magnetic fields worked less well and the project was abandoned when the machine effectively destroyed itself after working for a short period at full power.

Although the IRD project was not a success, work on motors continues still, one intended to power a Cessna light aircraft should weigh a third less and be more efficient, for the same power as a conventional motor.

Currently, various formulations are available: Cuprates, some of which can be made into wire or tape for practical use; YBCO made into magnets, cheap and easy to use. There may be applications for Borides (cheap, light and abundant) and Ferropnictides (iron-based and a too high critical temperature).

And it continues …
Press release from MIT, July 2021
Graphene is a new wonder-material, invented in Manchester in 2004, Nobel Prize 2010. It has remarkable mechanical and electrical properties. Is it also a HT superconductor? - Maybe, but the MIT team say they have a lot of work still to do, and they don't quote the critical temperature.

These results give a tantalising feel that, just as with Cold Fusion, if only there were another breakthrough, the implications for the way make, distribute and use electricity are colossal.

Mike Perry - The Carbon Imperative

Natural systems on Earth exist in balance and have done so for billions of years – they are a precursor to life on earth, including us but human presence and activities have reached a stage where we are unbalancing the Earth's natural systems: Earth is our home for the foreseeable future.

We are now faced with a climate crisis – most imminently, Global Warming. Evidence from Planetary space probes provide objective evidence of rapid atmospheric warming caused by increases in atmospheric carbon. If we allow continued unbalancing of the Atmosphere it is likely that a similar process will play-out, is playing out, in Earth's Atmosphere.

Mike's personal view is that once we pass through the tipping point the mechanisms will be beyond our control – which is not a good outcome. A big unknown is how far away or, how near we are we to that tipping point – we just do not know . . . but what we do know is that core samples from Antarctica show that we have not had the current density of Atmospheric Carbon since the last Ice Age.

The Atmospheric Imperative is driving the need for substantial, immediate action to rein-in, at very least, carbon emissions; senior figures have commented that Policies, Regulations and Standards will not achieve that reining-in and it is the responsibility of each individual to be aware of their carbon emitting activities and to take control to reduce them. And that includes every one of us attending this event.

In the 1960s the carbon problem started to grow. Essentially we live in consumer based societies and we must take action to ensure we have sustainable life styles. According to NASA there has been a 1 degree increase in temperature since 1880. A key objective for Perseverance's mission on

Mars is astrobiology, including the search for signs of ancient microbial life. According to Mike, Australia has already reached the tipping point. So what must we do?

We must accept the need for substantial reduction of carbon emissions.

Where do carbon emissions come from in the UK and Europe?
Transport 38%
Gas boilers 29%
Office and Industry

We should consider the need to use private transport. Look at carbon miles associated with purchases and look to make local purchases. Electric cars reduce carbon emissions at point of use. How do we dispose of spent batteries? We can't displace one problem with another. We can switch to electric heating, gas central heating has fixed carbon contact. No new gas boilers after 2024 in new homes, so no replacement boilers from 2030.

Each individual is responsible for all the actions each takes and the environmental impact.

Forests in the Amazon basin were cleared faster than ever before in the late 1970s through the mid 2000s. Vast areas of rainforest were felled for cattle pasture and soy farms, drowned for dams, dug up for minerals, and bulldozed for towns and colonization projects.

Workplaces of the 1920s and 30s are now much further away. New Zealand has a lower carbon footprint. We could replace carbon with hydrogen but would need an infrastructure to distribute hydrogen. Incandescent light bulbs for energy efficiency?

How do we influence the power brokers? How will we support our economy? How will we cope with electric cars? UK power demand couldn't cope if we had to rely on pulling power from Belgium.

We've heard these messages for decades. Will it take several more heatwaves to get any action?

Leigh Edwards – Human colonisation of space

Modern humans left Africa 80,000 years ago. Today people ask 'Why colonise space?' – one answer is, it's there, it's available and it also stimulates the economy. It's now 60 years since the first orbit of the moon. On July 20, 1969, American astronauts became the first humans ever to land on the moon. Apollo 17, the final manned moon mission, took place in 1972.

There is still no base on the moon, landing requires huge amounts of energy and the cost is significant. A constant supply of crew, fuel, food and water as well as waste removal would be required and a new study revealed the effects of microgravity: sleep deprivation, flatulence, space sickness, bone mass, muscle wastage, loss of peripheral vision, loss of red blood cells. Damage also includes radiation from the sun, cosmic rays causing cataracts, cancer and infection. Pressurised suits and visors, cooling and heating are needed and approximately 8 x-rays a day in high and low earth orbit. All rely on supply and resupply journeys to support fully sufficient colonies. There is also the question of who controls the moon.

The original purpose of the space shuttle, that it could be re-used, failed to materialise. In 2016 there were more private providers than government, launch costs were dropping year by year giving rise to new optimism but new propulsion systems need to be more fuel efficient. NASA planned to put in place sustainable infrastructure which will allow us to explore and study more of the Moon than ever before and get ready for human exploration of Mars. To achieve this, it will be

important to generate products with local materials, a practice called in-situ resource utilization. What about the amount of space junk in the atmosphere?

Materials needed in space cost a lot less if they are mined there

Earth's huge gravity well means that it's best to bring materials down to Earth, not carry them up to space. Every kg saved saves 7–11 kg of propellant up into Low Earth Orbit, Helium 3 mining on the Moon. The International Space Station is the largest modular space station currently in low Earth orbit, a multinational collaborative project involving five participating space agencies.

What are our colonisation options and the issues associated with them?

There is a range of options available, many of which have associated issues. To ensure this document is kept as short as possible, I have listed the options as bullet points and then created a range of issues. For a full interpretation, I suggest that members who attended the meeting on 26 July send a request to weare40@u3a.org.uk for pdf files of the presentations.

- Low Earth Orbit Colony Options
- International Space Station issues
- High Earth Orbit Colony Options
- Moon Exploration and Beyond
- Moon Base Colony Hazards
- Solar System Colony Options
- Mars Colony Options
- Mars Colonisation
- Interstellar Colony Options
- Intergalactic Colony Options

Issues cover costs, de-orbiting, difficulty of space walks, distances, heating and cooling, heavy reliance on supplies from earth and removal of waste, launch dates, length of surface missions, radiation hazards, repairs and general maintenance constantly needed, especially collision avoidance, search for life or past life.

Progression of the Colonisation of Space

The first priority will be ensuring survival, providing safe habitats - life support in general, food, water, energy accompanied by increased self sufficiency - growing food, local materials / resources, improvements in Science, enjoying life, population increase – new colonists then children
People and their occupations will specialise.

Permanent Colonisation of Space

Most disruptive event in our lifetimes & the most inspiring
Ask any 10-year-old child if he/she wants to go to Mars - children who are now in primary school are going to choose to live there.
Most importantly, permanent colonisation of space will make us a spacefaring species which means humans will survive no matter what happens on Earth.
We will never be the last of our kind but we will diverge as a species

Best commercial ever?