

Summer 2010 Issue 30

space:uk

Missions to Mars

**Have you got the right stuff
to become an astronaut?**

The spacecraft helping to save the rainforest

Houston: we have a litter problem

**Plus: Ice mission success, space weather, alien moon,
UK space pioneers and does nail varnish chip in space?**



**UK SPACE
AGENCY**

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FROM THE EDITOR



What would happen if all the satellites stopped working? For a start, there would have been no World Cup on the TV (although I know some people might welcome that) and a lot of us would get lost without GPS. But looking through this issue of *space:uk*, you'll also find many more things we'd miss. Without satellites, our ability to see the extent of environmental disasters, the loss of rainforest or the effects of climate change would be severely impaired. Our weather forecasts would be much less accurate and we'd lose global communications.

This our the first issue published by the new UK Space Agency and inside you'll discover some of the benefits of satellites and the threats they face – from adverse space weather to space junk. You can also read about the UK scientists and engineers looking beyond the Earth, with ambitious plans to investigate the mysteries of Mars and the wider cosmos. The UK's first official astronaut at the European Space Agency (ESA) is now well into his training and we catch up with Tim Peake to discover the joys of microgravity.

Putting this issue together has made me realise how vital space is for all our lives. I hope you think so too.

Richard Hollingham
Editor



8/10

Credit: ESA



11/13

Credit: ESA



14/15

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EYE ON CLIMATE CHANGE



Credit: ESA

The launch of CryoSat-2 on a Dnepr rocket

A new satellite designed to reveal the effects of climate change on the North and South Poles has sent back its first readings. CryoSat-2 is measuring the thickness of the polar ice sheets. Launched in April and scientifically led from the UK, the satellite is monitoring the rate of change of ice cover in the Arctic and Antarctic. The first test results show it is on track to make important observations.

“Right now we are involved in checking out the satellite and data from a technical point of view,” said lead scientist Duncan Wingham. “All the indications are that the hardware is working extremely well.”

Data from the satellite won’t just show whether and how fast the polar ice is melting, it should also help scientists get a better understanding of how the melting ice could

affect ocean circulation patterns, sea levels and global climate. Wingham and his team at University College London have been working on the mission for the past 11 years and are now able to investigate what is happening to the ice near the Earth’s poles.

“This is timely,” said Wingham. “Arctic ice data have shown some recovery since 2007 but CryoSat-2 will tell us whether the total mass of ice has recovered or whether it is simply its area that has fluctuated.”

CryoSat-2 replaces the first CryoSat satellite, launched in October 2005. Although the launch failed, the European Space Agency (ESA) agreed to fund a second mission because of its importance. The new spacecraft was built by a consortium led by Astrium and has had a number of improvements, these include a duplicate payload so the mission can continue if there are any problems with the instruments.

Measuring just a bit more than an average 4x4, CryoSat-2 is orbiting at an unusually high 700m above the Earth. Its radar altimeter will measure the thickness of the floating sea ice and detect minute changes in the ice sheets. With a resolution of 250m, the satellite can produce extremely accurate data. CryoSat-2 will monitor each polar region 14 times a day and transmit its findings 11 times a day to an ESA ground station in Northern Sweden.



Credit: ESA

CryoSat-2 can measure changes in floating sea ice

SPACE:UK NEWS

WELCOME

David Williams, Chief Executive (Acting) of the UK Space Agency, tells us more about the decision to create a space agency and introduces us to the new minister...

It's thank you and farewell to the British National Space Centre (BNSC) and welcome to the UK Space Agency. It's hard not to feel a sense of nostalgia. Created in 1985, BNSC had just reached its 25th anniversary when the decision to create the UK Space Agency was made by the Government. BNSC achieved a huge amount during this time, supporting many exciting science missions and working across government to promote UK civil space activities both nationally and internationally.

So why create an agency if BNSC was doing well? It resulted from a combination of recommendations from a public consultation and the industry led Innovation and Growth Strategy. But behind that was a recognition that space is now an integral part of many aspects of everyday life. Space supports weather forecasting, climate work, and the basic scientific understanding of the Earth, Solar System and Universe. Navigation and mapping has been revolutionised by satellites. And, very importantly, it contributes to the economy and has seen consistent growth throughout the current recession. This growth will help the UK emerge from the economic problems we face today. As a result, the agency was launched on 1 April 2010. The launch marked the culmination of a number of months of extremely hard work, and there is much



“These really are exciting times for space in the UK”

David Williams,
Chief Executive (Acting)
of the UK Space Agency

more to do as the transition team continues to work with other Government departments and partners to create a fully functioning agency.

The other big news is that following the general election, we have a new Minister of State for Universities and Science, David Willetts. David is a strong advocate of the space industry and in recognising the importance of the space sector to the UK economy, he has said he intends to do all that he can to support space activities. This includes putting effort into the continuing work to establish the Agency as a full executive agency.

With this continued support and ambition, the UK Space Agency will remain at the heart of UK efforts to explore space and support our space scientists and space industry. These really are exciting times for space in the UK.



David Willetts,
Minister of State for
Universities and Science
(attending Cabinet)



Tim Peake at the launch of the UK Space Agency

SATELLITES RESPOND TO OIL DISASTER



Credit: ESA

This Envisat image of the Gulf of Mexico shows the extent of the oil spill

“The satellite images are proving vital, revealing more than monitoring from the air alone”

On 22 April the Deepwater Horizon oil platform sank 70km off the coast of Louisiana in the Gulf of Mexico. Within hours, the US Geological Survey triggered an international space effort and an army of satellites controlled by countries across the globe turned to look as the crisis unfolded.

Around 20 spacecraft are available to monitor the Gulf of Mexico as part of the International Charter Space and Major Disasters. That includes all five of the UK-built Disaster Monitoring Constellation (DMC) satellites, as well as ESA's environmental satellite Envisat.

“The US Geological Survey requested images to help them prepare for potential oil pollution in coastal areas,” said DMCii managing director Dave Hodgson. “DMC imagery with its wide area coverage at high resolution is commonly used for this purpose.”

The satellite images are proving vital, revealing more than monitoring from the air alone. Satellites can see the entire area of the expanding oil slick and have radar to penetrate cloud and the area at night. What's more, the information can be transmitted in seconds. The US Government is using satellites to estimate how much

oil has leaked from the destroyed rig and to work out where the oil slick is likely to spread. Relief workers are also using the information to help plan clean-up efforts.

The platform sank after a huge explosion that killed 11 people and injured 17 others. It's still uncertain how much oil has gushed from the remains of Deepwater Horizon but estimates from the US Geological Survey said that, at its worst, it could have been losing as much as 40,000 barrels a day. At the time of writing, attempts to slow the flow seemed to be working. However, experts fear that the oil spill will cause an unprecedented environmental disaster. With both wildlife and people's livelihoods at risk, satellites will be monitoring the area for a long time to come.

ASH CLOUD



Iceland's Eyjafjallajökull volcano creates a huge cloud of ash

When the Eyjafjallajökull Volcano erupted in southern Iceland on 20 March, no one could have predicted the effect it would have on the rest of Europe. Within days, huge areas of European airspace closed and thousands of people were stranded away from home.

The smoke and steam spewing from the volcano was monitored by a host of satellites thanks to the International Charter. Imagery from ESA's Envisat and MetOp were used to follow the direction of the smoke and judge the volcano's potential effect on air traffic.

Although the satellite data proved invaluable, calls have been made to develop even more sensitive equipment to help airlines decide whether it's safe to fly.

SPACE:UK NEWS

NEWS IN BRIEF

Broadband satellite test success

A UK-built satellite designed to bring broadband to remote areas of Europe has successfully completed a month-long series of tests designed to expose the satellite to the rigours of space. The Highly Adaptable Satellite (HYLAS) has been built by Astrium UK for Avanti Communications. It will provide high speed internet



Credit: Avanti

to places that are unlikely to receive any ground-based service within the next ten years. The satellite is due for launch later this year from the European spaceport in French Guiana.

Alien smells

Strange, smelly and explosive: that's what any life would be like if it evolved on Saturn's moon, Titan. "Hollywood would have problems with these aliens," said William Bains, who's carried out research into how extreme the chemistry of life could be. Speaking at the Royal Astronomical Society's recent meeting in Glasgow, Dr Bains from Rufus Scientific in Cambridge said that if life were to exist on Titan it would have blood based on liquid methane rather than water. "Beam one onto the Starship Enterprise and it would boil and then burst into flames which would kill everyone in range."



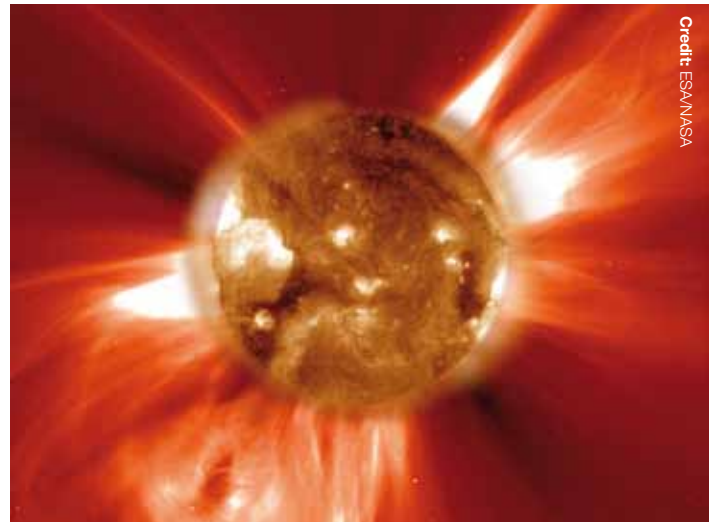
Credit: NASA/ESA

The International Cassini-Huygens mission has, so far, found no evidence of life (however smelly) on Titan.

Winning with Sat Nav

Entries are open for the European Satellite Navigation competition. The contest, which is co-sponsored by the UK Space Agency and the Technology Strategy Board, is aimed at businesses with an idea that uses satellite navigation technology for position, time, navigation or any other application. GRACE, at the University of Nottingham, now runs the UK leg of the competition. In addition to the £10,000 UK prize fund, they are offering businesses support to develop their idea. Entries close on 31 July and more details can be found at www.ukesnc.com

FORECASTING SPACE WEATHER



Credit: ESA/NASA

A stormy Sun can be bad news for Earth

Blasts of solar wind bombarding the Earth should be easier to predict thanks to research by UK scientists. A team from the University of Leicester is using observations from NASA's ACE satellite and the twin STEREO spacecraft to forecast when this space weather is likely to hit our planet.

The solar wind is a stream of charged particles shot out of the Sun at hundreds of kilometres a second. The magnetic shield surrounding the Earth, known as the magnetosphere, normally absorbs a lot of these particles. We can sometimes see this effect on Earth as the Northern and Southern Lights. But the solar wind can also be dangerous: particles that break through the magnetosphere can bring down power grids and cause millions of pounds worth of damage to satellites and spacecraft. After a period of calm, the Sun's activity is expected to increase, so it's important to be able to predict when solar storms are heading our way.

The Leicester team is monitoring high-pressure pulses of solar wind and using data from the three satellites to work out how fast they are travelling. Then the researchers estimate when the solar wind will arrive at the Earth as well as Venus and Mars.

"Our estimates from ACE and STEREO are in good agreement with data from Mars Express," said Anthony Williams from the Leicester team. He now plans to use data from STEREO to get even closer to the action: "To develop a good forecasting system, we need to be able to track the features much closer to the Sun."

IMPOSSIBLE STAR

The first scientific results from ESA's Herschel space telescope have revealed the birth of an 'impossible star' that could become one of the biggest and brightest stars in our Galaxy. The star contains eight to ten times the mass of the Sun and is surrounded by gas and dust equivalent to 2000 Suns, which it can use to grow even further.

There are already several of these massive stars. The problem is current theories of star formation suggest they are impossible.

"The fact that stars like this exist at all is one of the biggest mysteries in astronomy and this star is going to be huge," said Derek Ward-Thompson of Cardiff University. "Now that we've seen such a young example we can start to investigate why our current theories can't explain its existence."

Herschel is the largest-ever infrared observatory and is designed to examine some of the coldest and most distant objects in space. Its major objectives are to discover how the first galaxies formed and evolved. One of the three instruments on board, SPIRE (Spectral and Photometric Imaging Receiver), was designed in the UK and is led by a scientist at Cardiff University.



Herschel image of a blue cloud of gas, called RCW120, being blown out by a massive 'impossible' star

"The problem is current theories of star formation suggest they are impossible"

Starry Eyed

Images from ESA's Planck space observatory are helping to reveal the hidden forces that give birth to stars. Stars are formed behind veils of dust and gas, a process invisible to optical telescopes. Planck, however, observes microwave radiation so can peer into these glowing regions of the galaxy. The spacecraft has also captured images of giant filaments of cold dust stretching through space (see picture right). Scientists will analyse these images to investigate the forces that shape the cosmos.

In some ways these findings are a sideshow to Planck's primary mission: to measure the ancient light left over from the Big Bang, known as Cosmic Microwave Background radiation. Planck is designed to help answer fundamental questions, such as how did the Universe and galaxies form. Detectors on

board the spacecraft operate at just 0.1 degrees above absolute zero – making it one of the coldest places in the Universe.

Launched with Herschel in May 2009, Planck finished its first complete survey in February 2010. The aim is to complete four full surveys before the end of the mission.



SPACE:UK NEWS

NEWS IN BRIEF

New satellite for Africa

Two new satellites, built in the UK for Nigeria, are scheduled for launch in October. NigeriaSat-2 and NigeriaSat-X have been made by Surrey Satellite Technology Limited (SSTL) for the West African country's space agency. NigeriaSat-2 is the most advanced small satellite ever to be launched. Its powerful cameras will provide high-resolution maps. They will also be used to monitor crops to help ensure the country has enough food. NigeriaSat-X will assist with disaster relief and environmental surveys as part of the international Disaster Monitoring Constellation.

Mars in Moscow

It's the space challenge that puts Big Brother into perspective: on 3 June six men entered a space station in a Moscow suburb, not to be let out for 520 days. The crew of the Mars500 facility are simulating a full-length mission to Mars so researchers can study the challenges of long duration space travel. The idea is for the volunteers to experience something close to a real space voyage without leaving the ground. Their mission is to simulate a flight to Mars, a Martian landing and return to Earth. With communication by delayed email, showers once a week and no windows, 520 days could feel a very long time indeed.



ESA crew members Romain Charles and Diego Urbina inside the Mars500 facility

Honour for Inmarsat

A UK satellite company has been awarded Britain's most prestigious prize for innovation. Inmarsat received the Royal Academy of Engineering MacRobert Medal for its pioneering development of the Inmarsat-4 satellites, which provide telephone and internet services almost anywhere on Earth via a portable laptop-sized device. Inmarsat customers include governments, aid agencies, broadcasters, airlines and ship operators.

SPACE AT FARNBOROUGH

Visitors to this year's Farnborough Airshow have the chance to learn what it's like to live in space, find out about the new UK Space Agency and meet the people behind some of our most exciting space missions.

The airshow runs from 19 to 25 July and its Space Zone will look at how space can help us build our future. The UK Space Agency will join the European Space Agency (ESA) and Italy's Agenzia Spaziale Italiana, along with UK and European industry, for a packed programme.

During the airshow, Science Minister David Willetts is expected to set out his vision for space in the UK, including the focus for the UK Space Agency. There will also be advice on space careers and opportunities to gather learning materials and meet people working in the space industry at Careers4Space. Futures Day will give students the chance to meet an astronaut.

Space Zone at a glance:

Monday 19 July

New Funding and Support for Space Entrepreneurs.

Tuesday 20 July

Careers4Space: a special session for careers advisers.

Wednesday 21 July

Space Day: Science Minister David Willetts is joined by ESA Director General Jean-Jacques Dordain. Open to industry, academia and the media.

Thursday 22 July

International Trade Delegation briefings.

Friday 23 July

Futures Day: Students can meet an astronaut, take a guided tour around the Zone and see the winning entries in the 'Our Space – Digital Adventures in Space' competition.

Saturday 24 and Sunday 25 July

Public days: Discover more about space through live science demonstrations.

The Space Zone is in Hall 3. To book your tickets visit www.farnborough.com

HUBBLE'S BIRTHDAY

The international Hubble space telescope celebrated its 20th birthday in April with another set of incredible images. Hubble has been one of the most important astronomical projects of all time, and writers (certainly this writer) tend to run out of adjectives when describing its pictures and achievements. So, instead, we thought we'd let the pictures speak for themselves:



Credit: ESA/NASA



Credit: ESA/NASA

New Hubble images of the Carina Nebula, one of the largest areas in the Galaxy where stars are born

SPACE GIANT MOVES CLOSER

A working replica of a camera being built for Hubble's replacement has been shipped from the UK for testing at NASA. Development of the Mid InfraRed Instrument (MIRI) was led by a team from the Astronomy Technology Centre in Edinburgh. MIRI will be one of the key instruments on the James Webb Space Telescope, due for launch in 2014.



Credit: STFC

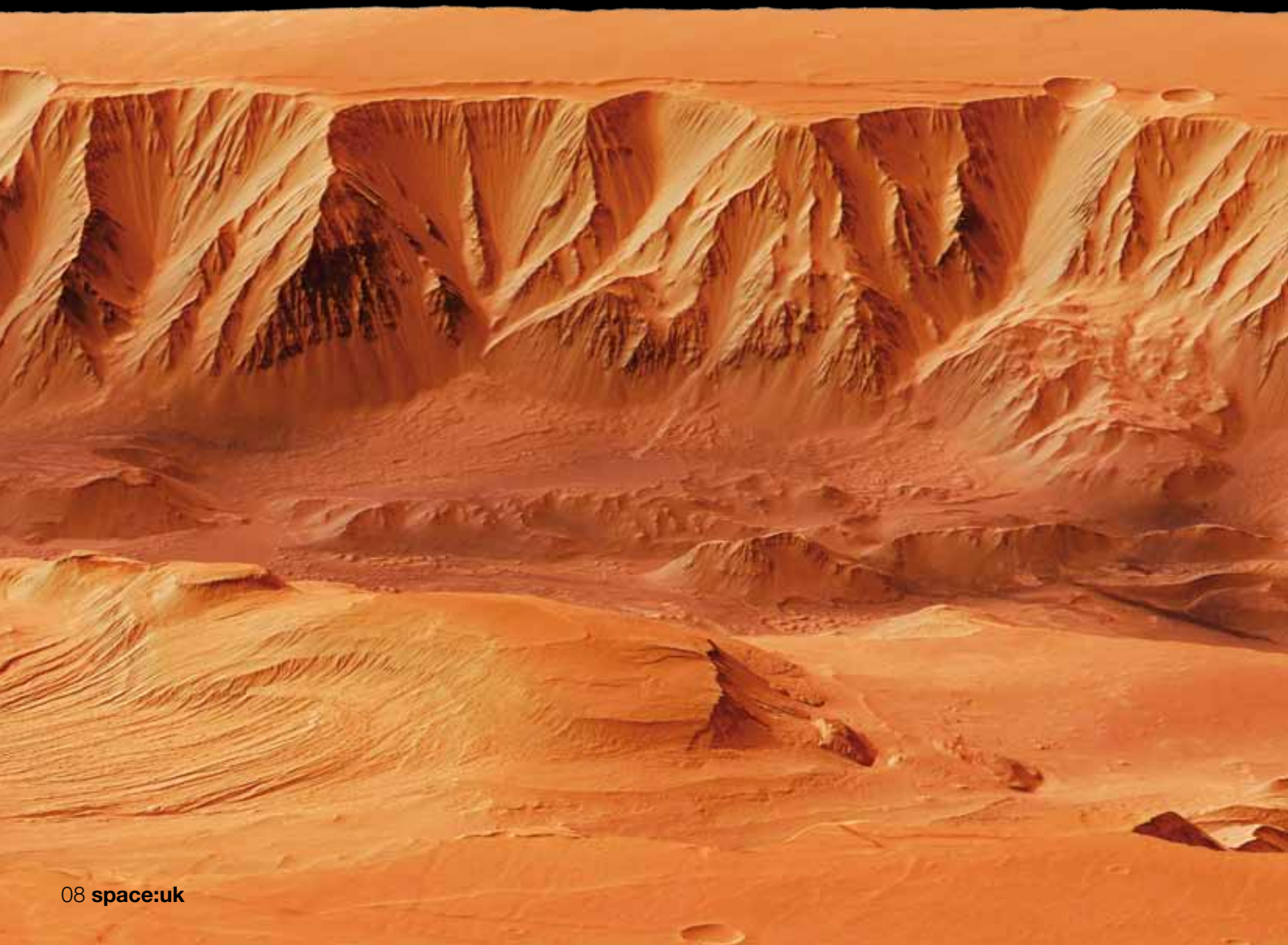
Scientists and Engineers in a clean room at the Science and Technology Facilities Council's Rutherford Appleton Laboratory with a model of the MIRI instrument

"The MIRI team is delighted to have reached this important technical milestone," said the European Principal Investigator on the mission, Gillian Wright. "It is inspirational to see how well the team has worked to make this happen."

The Webb Telescope is a joint mission between NASA, ESA and the Canadian Space Agency. At the heart of this new observatory is a mirror 6.5 metres in diameter, making it three times the size of the one on Hubble. UK scientists are taking a leading role in the mission which is designed to investigate the origin and evolution of galaxies, stars and planetary systems.

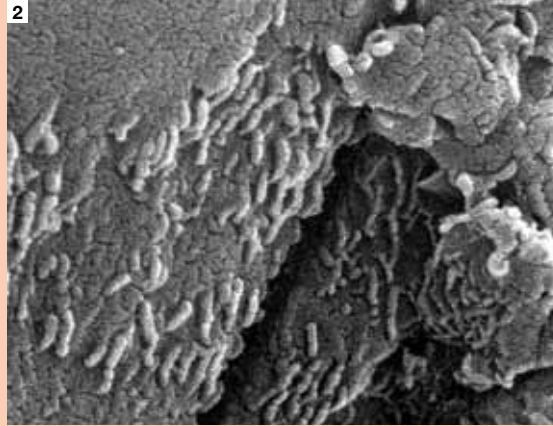
Missions to Mars

It has the largest volcanoes in the Solar System and dust storms so great they can rage across the entire planet for months at a time. All of which makes visiting Mars quite a challenge, as Sue Nelson reports:



“Every time we go to Mars we learn something new...with ExoMars an exciting new era of exploration is underway”

David Parker, Director of Space Science and Exploration, UK Space Agency



Main image: A feature seen by Mars Express on the surface of Mars known as Candor Chasma
Credit: ESA

1. Artist's image of a future Mars rover
Credit: ESA

2. Some scientists suggest that these indentations on a Martian meteorite are fossilised bacteria
Credit: NASA

Life on Mars

The rover is a portable laboratory on six wheels. UK scientists are involved in four of the ten instruments on board, including the UK-led Life Marker Chip, which can detect organic molecules from crushed samples.

Mars is a planet of extremes. There are mountains higher than Mount Everest, gorges bigger than the Grand Canyon, and frozen clouds of carbon dioxide form in its atmosphere. This astonishing scientific laboratory is offering clues to Earth's evolution, climate change and the development of habitable environments. Both of its poles contain ice and there is even the possibility that life is either present or has existed in the past.

“Every time we go to Mars we learn something new,” says David Parker from the UK Space Agency, “and with ExoMars an exciting new era of exploration is underway.”

ExoMars is a joint mission plan between the European Space Agency (ESA) and NASA. An ESA-led orbit will launch in 2016 to study the Martian atmosphere and put a demonstrator lander on the dusty red and rocky surface. Then, in 2018, a European rover will travel to Mars with a NASA rover to search for evidence of life.

“In 2003 scientists discovered active methane emissions on Mars and this raises the question of whether its origins are geological or biological,” explains Parker. “The European rover is special because it can drill up to 2 metres beneath the surface.”

Although spacecraft began observing Mars in the 1960s, many questions remain unanswered – including one that has inspired scientists and science-fiction writers for generations: is there life on Mars?

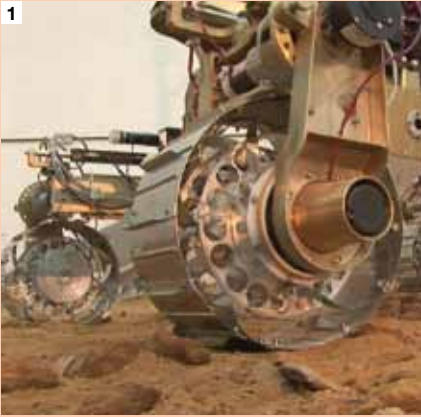
Not all scientists were convinced by reports of fossilised bacteria found inside a Martian meteorite in Antarctica. The issue remains inconclusive but future ExoMars missions could provide an answer.

“The real challenge is getting there,” ExoMars Vehicle Project Manager Mark Roe declares, mindful perhaps that two out of every three Mars missions has encountered problems, and no doubt keen to ensure the rover makes it in one piece.

“NASA has shown it can get to the planet's surface, so we feel extremely positive,” says Roe, “because we have a robust partner that has delivered successful missions to Mars.”

Roe works at Astrium and is at the heart of the UK team working on the European ExoMars rover. The team draws on experience from across the UK including the Surrey Space Centre, UK companies Roke Manor Research and ABSL Space Products, as well as the universities of Dundee and Aberystwyth.

continues >



1. The ExoMars rover is put through its paces in the Mars Yard

Credit: Astrium UK

2. Field testing the high-resolution Panoramic Camera

Credit: Claire Cousins

Mars Yard

Astrium has developed three early-engineering demonstrator rovers, nicknamed Bridget, Bruno and Bradley. The latest model has been undergoing testing at the UK's own little piece of Mars... in Hertfordshire.

"The Astrium Mars Yard in Stevenage is essential to understanding and proving the navigation software programmes," explains Roe. "There are stereo cameras on the rover and we must understand what we see. We take images, calculate distances and heights of objects and work out if there's a hazardous area or where we can go."

A fourth rover is already in development and this one is capable of 'wheel walking' – when the back two pairs of wheels are locked so that the front pair of wheels can drag the rover up an incline.

"Wheel walking gives us the ability to stretch and pull ourselves up out of the soft sand," says Roe. "We've seen that NASA's Mars Exploration Rover has driven into soft sand and had to rock itself back and forwards like a car to get out – which is why we've added wheel walking to ExoMars."

"If there is evidence of life on Mars, we hope to find it"

David Parker

2016

The 2016 mission will put an ESA-led orbiter around Mars to study the origin and distribution of methane and other trace gases in the atmosphere. Europe's ability to undertake a controlled landing on Mars will be tested as the mission will also carry a lander.

Eyes of Mars

The rover's handlebar-style mast supports a high-resolution camera for close ups and a Panoramic Camera (PanCam) consisting of two wide-angle cameras to give a three dimensional view of the local environment. Partly designed and built in the UK, PanCam is the rover's science eyes and contains filters to see the landscape at different wavelengths.

"We have 12 filters looking at the geology," says Claire Cousins, one of the researchers at University College London's Mullard Space Science Laboratory working on the camera. "The information can tell you what minerals are present and what the geochemistry might be."

"Geological filters haven't changed much since NASA's Pathfinder rover in 1997," Cousins adds, "so we're considering new information we have about the Martian surface – particularly mineral deposits that indicate past environments containing liquid water."

For the UK, this is an important responsibility. "PanCam is the only surface remote sensing instrument on the rover," she says. "It's the first scientific data you get from the rover which will ultimately decide where the rover will go."

As well as PanCam, UK scientists at the University of Leicester and e2v Technologies Limited are involved in the rover's Mars-XRD instrument. This will measure sample composition and mineral content. The UK is also supplying a laser and digital camera system for the rover's Raman Laser Spectrometer, which is searching for signatures of life.

"If there is evidence of life on Mars," says Parker, "we hope to find it."

2018

The 2018 mission will place ESA's ExoMars rover and a NASA rover on the planet's surface. The instruments on board ExoMars will investigate the surrounding area, perform soil samples and search for evidence of past and present life.



So you want to be an astronaut?

[continues >](#)

Tim Peake is now well on his way to qualifying as a European Space Agency (ESA) astronaut. His aim is to fly on the International Space Station. So how tough is the training? Richard Hollingham has been finding out how Britain's first official spaceman is getting on...

Tim Peake learning to float in microgravity
Credit: ESA

So you want to be an astronaut continued

1. The ESA trainee astronauts during their parabolic flight
Credit: ESA

2. Astronauts practice space walks in a large swimming pool
Credit: NASA

3. The adapted Airbus A300 used for parabolic flights
Credit: Novespace

4. Tim seen during medical training in January 2010
Credit: ESA

5. ESA astronaut Christer Fuglesang spacewalking outside the International Space Station
Credit: NASA

6. The International Space Station as seen by the crew of Discovery in September 2009
Credit: NASA



No one said it was going to be easy. But it's not the survival training, diving or microgravity flights that have proved to be the toughest challenge. It's not even the media interviews. To qualify as an astronaut, Tim Peake has had to learn Russian.

"We have swimming pools where we can sink modules which represent the space station. Then we can wear spacesuits and dive and practice doing space walks, fixing the space station and doing other tasks that we might be called on to do for real."



"It's fair to say it's been quite hard work," says Peake, who I suspect is understating the effort involved. "Out of the last six months training, three of them have been taken up learning Russian – including one month in St Petersburg," he says. "The other lessons were very wide ranging including fluid physics, biology, life sciences and orbital mechanics." He's also had lessons in photography and healthcare, including how to give a sick astronaut an injection.

Floating in a tank of water is very different to floating outside a real space station, so the trainees also get to experience real weightlessness in an aeroplane. Known to generations of astronauts as 'the vomit comet', the plane – ESA uses a modified Airbus – flies in a parabola.



Spacewalking

We meet in London during one of his visits back to Britain. After a day's training, Peake has just arrived on a flight from Germany. While most of us would be a bit weary, he exudes energy and enthusiasm. Mind you, he does have one of the best jobs in the world.

"The aircraft can pull to about 45 degrees nose-up and push over the top as if you're going over a humpback bridge," Peake explains. "During that period when you go over the top of the bridge – if you like – you can experience about 22 seconds of weightlessness before the pilot has to pull out of the dive and prepare for the next parabola". Puts your average theme park ride into perspective.

After spending most of his training so far in the classroom, he's now starting the more practical stuff – like spacewalking. "It's one of the dream tasks for any astronaut," Peake says. To spacewalk on Earth, astronauts dive in giant – and very deep – swimming pools.

At the end of May, the trainee astronauts took their first parabolic flight.

"The sensation was absolutely unique, exhilarating, fantastic fun – a really great experience!" exclaims Peake. But the flight wasn't just for fun. After five test flights, during which they experienced gravity on Mars

(38% of the Earth's gravity) and the Moon (17% of the Earth's gravity), the astronauts were set to work – trying out some of the skills they'd been learning underwater. This included working with tools and clipping themselves onto tethers as if they were about to go outside the space station. They even had to play pass the parcel: "They had us passing quite large boxes from one person to the other, just to get a feeling for how doing things like unloading cargo in the space station is going to feel."

Ambassador

But there's more to being an astronaut than just preparing to go into space. Peake is also becoming an ambassador for space-based careers. Despite the name, this doesn't necessarily mean careers based in actual space.

"I see this role as one of interacting more with the UK population," he says. "In particular younger generations in order to inspire them to get involved in science, maths and engineering and also educate them into what kinds of careers are available in the space industry." This could range from building satellites to broadcasting football matches, managing mission teams to analysing signals from distant spacecraft.

Peake readily admits that not everyone can be an astronaut: "There are six new trainee astronauts but 68,000 people in the UK alone in space-related careers. Whatever your area of passion and speciality, there will be a career for you in the UK space industry."

So what sort of career can Peake look forward to once he qualifies?

Challenge

The workplace of choice for today's astronauts is the International Space Station.



Orbiting some 350 km above the Earth, the 400 tonne station is usually home to six astronauts – living and working for months on end in a space not much bigger than a two-bedroom house. However trainees might have to wait several years for a place to become available.

"We'd be looking at a six month tour and with the space station recently having its life extended until 2020, that's fantastic news for us. Hopefully there are plenty of opportunities to really maximise the space station now and achieve as much science as possible from it over the next ten years."

Still, to work on the station you have to understand its complexities: learning everything from how to dock a spacecraft (such as the European Automated Transfer Vehicle) to the correct procedures for scientific experiments. Astronauts have to be engineers, pilots, scientists and doctors. They even have to learn how to use a space toilet – and that's something you don't want to get wrong.

If all goes to plan, Tim Peake will qualify as an astronaut later this year but there's still a lot of work to do. "We've got a very exciting few months ahead of us," he says. "We're now getting into the real operations. So learning about the Automated Transfer Vehicle and the Columbus module, which is the European laboratory on the space station."

He's also got survival training – including some further outdoor training next year during a Russian winter.

No one said it was going to be easy.

"Whatever your area of passion and speciality, there will be a career for you in the UK space industry"

Tim Peake





Above the trees

Fiona Hatton reports on how satellites are being used to help save the rainforests from destruction.



Deforestation is devastating the world's rainforests. It's happening across the planet and fast. The United Nations (UN) estimates that around 13 million hectares of forest – an area the size of Panama – is lost every year. But that's just what it is. An estimate.

Although the rainforests have been monitored – sometimes once a year, possibly by air, sometimes on the ground – it's expensive, takes a long time and the results can be out of date before they're properly analysed.

The Earth's rainforests provide a rich habitat for thousands of different species of animals and 'soak up' vast amounts of carbon dioxide – a major cause of climate change. Without them, we could lose whole species of creatures and changes to our climate would accelerate. But lacking proper information about the rate of their destruction,

governments are in the dark when it comes to knowing where to act to stop illegal logging.

Over the past twenty years, satellites have been helping to monitor rainforests from space. These include ESA's Envisat which has covered the Amazon Basin, and NASA's LandSat-7 which has captured images of rainforests in Brazil and Peru. Now a new generation of satellites is tackling the problem. With the ability to visit the same area many more times than older satellites and cover large areas at high resolution, these new spacecraft are making a big difference.

Made in Britain

The UK-built Disaster Monitoring Constellation's (DMC's) five satellites monitor the Brazilian rainforest at a resolution of 22 metres and can map up to 2.6 million square

kilometres a day. DMC International Imaging (DMCii) Director, Paul Stephens, explains: “Since 2005, the DMC satellites have imaged the entire Amazon Basin every year. Now we’re focused on rapid repeat monitoring of the critical southern arc of deforestation.” This is where around 80 per cent of the country’s forest is being destroyed.

The constellation passes over the area daily to detect changes in forest cover. The information is then passed to the Brazilian government so they can analyse the images and respond to any changes. Although the latest figures show the rate of deforestation in Brazil is slowing, it still has one of the fastest rates according to the UN. The country is closely followed by Indonesia.

The DMCii team is now working with the Indonesian authorities to show researchers how to use satellite images and help them develop the techniques already employed by Brazil. “We’ve also started to monitor the entire Congo Basin, and aim to do this twice a year,” says Stephens. “The end of the conflict in that area means we’re starting to see commercial logging gather pace.”

It’s not just logging that’s devastating the forests, people are also clearing the land to grow crops and graze cattle. To combat this, a UN-proposed scheme called Reducing Emissions from Degradation and Deforestation will pay countries to reduce their levels of tree-loss. “But they have to prove they’re doing it,” says Stephens. “And reliable statistics are impossible to get without help from satellites like those in the DMC.”

With Royal approval

Another British team is also on the case. Ten researchers from the Rutherford Appleton Laboratory (RAL) are developing a camera for the Brazilian Space Agency’s new Amazonia-1 satellite, scheduled for launch in 2012.

RAL’s Director of Space Science and Technology, Richard Holdaway, says: “The purpose of the mission is to monitor



deforestation in Amazonia and the Congo, giving fast feedback on illegal logging so that governments can act accordingly.”

RALCam3 will produce detailed images of the rainforest. Returning to the same area every day, the data from the camera will be another weapon in the Brazilian government’s fight against deforestation. The compact 64-megapixel camera cost £1million to build and can view around 100 square kilometres at a time. Its development has received interest from high places. The Duke of York helped the team secure funding so RALCam3 could be built. Speaking at a visit to RAL last year, the Duke said: “This is a vital piece of technology, which will play an important role in countering the damaging actions of illegal deforestation in this delicate part of the world.”

There is some good news for the world’s forests. Monitoring illegal logging and deforestation also shows where forests are growing in size. Forests in Europe are expanding. And Asia has reported a net gain of forests in the past five years. This is mainly down to China – which ran a huge re-forestation programme from 2002 until last year. Unfortunately, it’s just a drop in the ocean.

Main image: Deforestation in the Amazon basin

1. The golden lion tamarin monkey found in Brazil

2. Envisat view of the Xingu River in Brazil

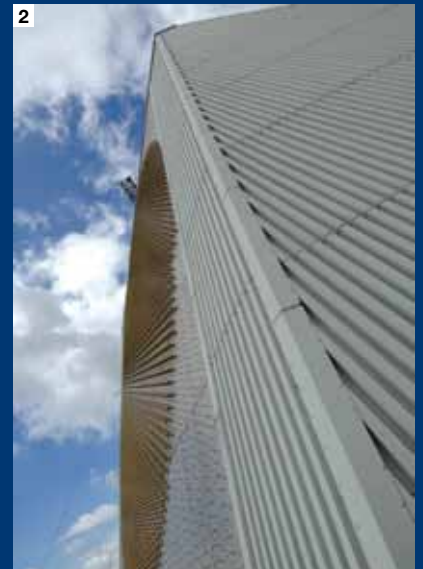
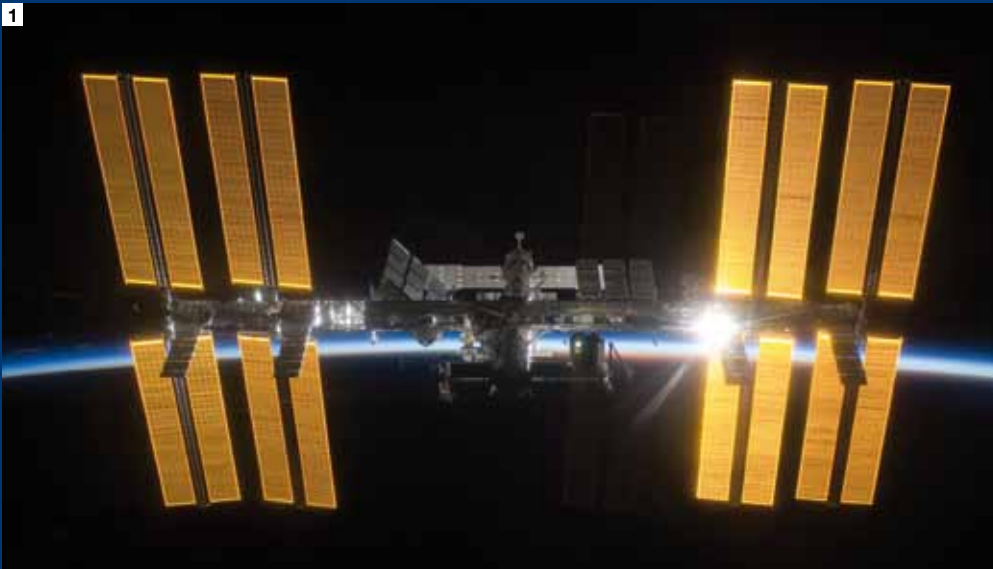
Credit: ESA

“...reliable statistics are impossible to get without help from satellites like those in the DMC”

Paul Stephens

Space Debris

**If you think
clearing up your
room's bad – how
about tackling
the Earth's litter
problem?**



A cloud of junk known as space debris surrounds the Earth. This orbital litter includes the remains of dead satellites, fragments of spacecraft and even flecks of paint. More than 13,000 objects are being tracked by radar, all placed in orbit since 1957 when the first satellite, Sputnik, was launched. Only 800 of these objects are working satellites. There are tens of thousands more bits and pieces, but they're too small to be monitored.

This stuff isn't staying still either – it's whizzing around the Earth at speeds of up to 40,000 km per hour and can do a lot of damage. Even a small fragment of metal could break a satellite or punch a hole in the International Space Station – putting astronauts' lives in danger.

Cosmic collision

At RAF Fylingdales in North Yorkshire, staff are on duty 24 hours a day to track objects orbiting the Earth. The radar station is part of the worldwide Space Surveillance Network and last year witnessed the collision between two satellites. The Russian Cosmos and US Iridium satellites smashed into each other some 800 km above the Earth. The crash resulted in a cloud of debris and helped serve as a warning that something needed to be done.

There are two ways to tackle the problem of space debris: clear it up and stop it getting any worse. The UK Space Agency is working with other countries to prevent the clouds of debris from increasing in size and number. These days most companies and governments have plans in place to deal with

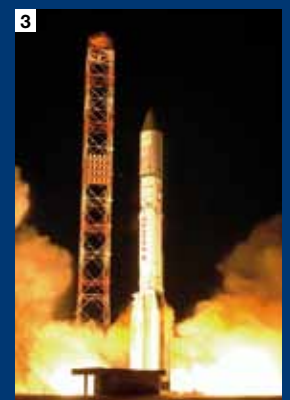
satellites once they've reached the ends of their lives. Satellites that are relatively close to the Earth are usually set on a course to burn up in the atmosphere. Satellites in higher orbits are sent to 'graveyard' orbits where they can safely circle the planet for eternity without getting in anyone's way.

Litter laser

Engineers at Surrey Satellite Technology Limited in Guildford have come up with another clever way of disposing of space junk. They're building Cubesail – a tiny satellite (only 10 cm x 10 cm x 30 cm) containing a folded up plastic sheet. When the satellite reaches orbit, the sheet will unfurl. Even in space, there should be enough air molecules pushing against this sail, to drag the satellite back towards the Earth so it can burn up in the atmosphere. Cubesail is due for launch in 2011. If it's successful, the sail could be fitted to future satellites and rockets.

So what about the stuff that's already there? Getting rid of that is going to be a much harder task. All sorts of ideas have been suggested. They include orbiting rubbish carts to collect space debris, lasers to zap it and systems to knock it out of orbit. This final approach is similar to Cubesail and might prove the most practical. Nudging a dead satellite just a few kilometres could eventually send it spinning towards the Earth to burn up in the atmosphere.

But with some 5,500 tonnes of junk in orbit, there's a lot of tidying up to do. All of which puts cleaning up your room into perspective.



Main image: The Earth is surrounded by a cloud of satellites, debris and junk
Credit: ESA

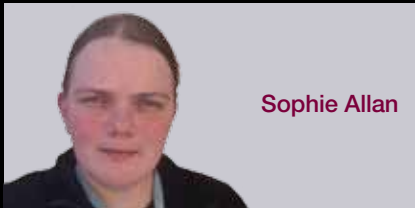
1. Mission controllers have to adjust the International Space Station's orbit to avoid it getting hit by space debris
Credit: NASA

2. RAF Fylingdales
Credit: RAF

3. Whenever a new satellite is launched, it has to be navigated through space debris on the way to its final orbit
Credit: ESA

If you have a question about space, we'll track down the right person to answer it.

This time our questions come from Year 9 students at St Bede's Catholic College in Bristol.



Sophie Allan

National Space Centre, Leicester



Chris Welch

Principal Lecturer in Astronautics, Kingston University



Lewis Dartnell

Planetary Scientist, University College London

Does your nail varnish chip in space?

Unfortunately, living in space does not get rid of the problem of chipping nail varnish. Nail varnish chipping is caused by a combination of oils your nails produce weakening the bond between the nail varnish and nail, and the general knocks, bangs and stresses your nails receive everyday. Astronauts are required to carry out many hands-on activities in space, from conducting experiments to general maintenance and so the nails are no more protected than here on Earth. Sadly, the oils which weaken the nail varnish are still produced when floating in microgravity so your nail varnish would indeed chip in space.

Applying nail varnish would itself be a very difficult task. In a microgravity environment, liquids form globules held by their surface tension. If you tried to apply your nail varnish in space, you would see the contents of the bottle float up all around you. Not a great way to get the glossy finish you're after.

Astronauts are also limited when it comes to taking hygiene products into space. Since parts of the water supply of the International Space Station are generated through recycling the humidity in the air, nail varnish remover is prohibited because it contains alcohol. With alcohol in the air, the regenerated water will be more like vodka! So even if you did successfully paint your nails, you would have no way of removing the varnish when it does chip.

Sophie Allan



1. Nail varnish

2. Artist image of how a Mars base might look

Credit: ESA

3. Jupiter's icy moon Europa might sustain life beneath in its oceans

Credit: ESA

If we found a habitable planet, how would we move people there?

Of the planets that we've found outside the Solar System so far, the one most likely to be habitable is Gliese 581d. This is 20 light years away, very close in galactic terms. Unfortunately, that is about 200 trillion kilometres and our fastest spacecraft (Voyager 1 now heading away from the Sun at 62,000 km/hour) would take 370,000 years to get there. Barring 'science fiction physics', the fastest spacecraft we could build in the foreseeable future would take many human lifetimes to travel between stars.

Even in our own solar system, moving more than a small number of people between planets may be difficult if it is done purely by rocket because of the amount of fuel needed. Fortunately, there are solutions to this problem, such as the Mars Cyclor proposed by Apollo astronaut Buzz Aldrin. The Cyclor would be a space station in an elliptical orbit around the Sun that would pass Earth and Mars on a regular basis. People would join the Cyclor at one planet and ride it to the other planet before getting off – a sort of interplanetary bus service!

Chris Welch

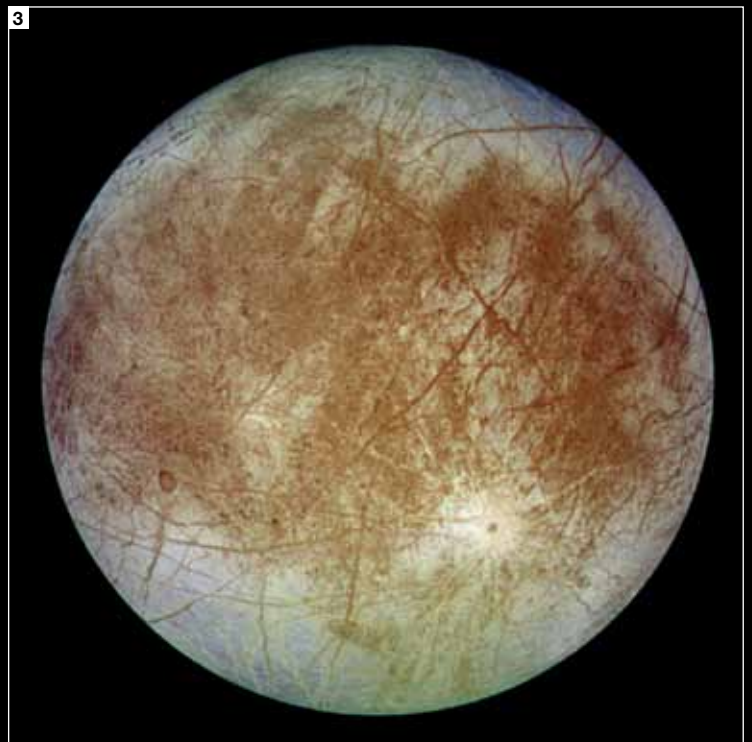


Is there any evidence that there are other life forms in the Universe?

Scientists haven't found any convincing evidence yet of life beyond the Earth but we're starting to look very hard. 'Astrobiology' is the science involved in understanding the possibility of extraterrestrial life. My own research focuses on the planet Mars, which was once much more like the Earth and so might have evolved simple bacterial life. Some astrobiologists think they've found signs of fossilised life in a meteorite from Mars but most people aren't convinced by the evidence. Europa, one of the icy moons of Jupiter, is also thought to support a 'habitable' environment suitable for life in its great ocean hidden beneath the frozen surface. Some astrobiologists even say that Saturn's giant haze-shrouded moon Titan could harbour exotic lifeforms based on liquid methane (rather than water like us).

The only way we'll really be able to tell for sure is by going out there and studying these other worlds up-close, first with sophisticated robots and eventually human explorers. Perhaps the best hope for alien life, though, is on a world much more like the Earth, one with a thick atmosphere and warm oceans and continents. Astronomers working on the new Kepler space telescope think they'll spot dozens of Earth-like planets in the next few years, and some might even show signs of life.

Lewis Dartnell



Teaching resources

Provided by Jeremy Curtis, UK Space Agency

Space missions are extremely complex, bringing together all kinds of engineers and scientists from many disciplines to make them successful. So it's not surprising that a huge range of education materials have been created using space to make lessons more exciting. A new endeavour will bring all these materials together to make it easier for teachers and college lecturers to share good practice, find useful information as easily as possible and to act as the first point of contact for all space education and careers information.

The UK European Space Education Resource Office, based at the National STEM Centre in York, will be launched in September with funding from the Department for Education and ESA. Teachers will be able to download materials direct from the web and organisations that have already developed useful resources are encouraged to contact UK-ESERO to include them (see www.esero.org.uk).

Space for All

Twelve UK school pupils have won a trip to NASA's Johnson Space Centre following a national competition, run by Imperial College London and part funded by the UK Space Agency through its 'Space for All' programme. The International Space Settlement Design Competition challenged school students around the world to design a colony in space to carry people and cargo between Earth and Mars. Its aim is to give young people a glimpse into real work pressures and priorities, as well as to excite interest in engineering and science. The competition to represent the UK saw 160 pupils descend on Imperial College in April for a weekend of designing and presenting their proposals.



Credit: Imperial College London

50 years

Next year is the 50th anniversary of human spaceflight and a group has been formed, with support from the UK Space Agency, to promote and coordinate the many events across the UK that are being planned to celebrate Yuri Gagarin's historic flight. The kick-off of YuriGagarin50 was held at the House of Commons on 10 June and any groups wishing to get involved should go to www.yurigagarin50.org or email: office@yurigagarin50.org.



Credit: NASA

CAREER FILE

Fancy a job in space? In every issue of *space:uk* we talk to someone who has a career in the UK space industry...



Matt Balme is a Science and Technology Facilities Council 'Aurora' Research Fellow at the Open University. He also holds a research scientist position at the Planetary Science Institute in Tucson, Arizona.

What does your job involve?

My job is to find things out about planets – specifically Mars. My research at the moment aims to understand the geology and climate of Mars better and to work out how the surface has changed over the last few million years. Perhaps even more important than understanding Mars itself, is finding out how similar or different it is to Earth and why this should be.

So what do you do in a typical day?

I spend most of my time analysing the latest images of Mars taken by the spacecraft that are currently orbiting the planet. Most of the data comes from the ESA Mars Express mission and the NASA Mars Reconnaissance Orbiter spacecraft.



1. Artist's image of Mars Express
Credit: ESA

2. Dust devil in Arizona
Credit: Matt Balme

It's a detective job – trying to work out what geological or climate processes shaped the surface. By studying the potential for liquid water on Mars, this type of research also helps us work out where and when there might have been conditions that were suitable for life.

You also do field work?

For the last few years I have spent my summers in Nevada and Arizona studying dust devils – dusty, mini-whirlwinds that are common both on Earth and Mars. We do this with a nice flat desert and a fast pickup truck covered in instruments! We measure wind speed, temperature, pressure, and dust content when we drive through each dust devil. It's quite exhilarating – a bit like the movie *Twister* except much safer – dust devils are far less powerful than tornadoes fortunately!



What is it about Mars that so fascinates you?

Mars is so Earth-like, yet so alien all at the same time. We're realising more and more that Mars isn't a dead planet, and that the surface is still evolving due to water, ice and wind – just like the Earth. The real hook for me is that I can imagine humans standing on the bits of the planets that I study at some point in the future. Perhaps they'll be laughing at how naive the interpretations I made were, or perhaps they'll be impressed we did so much with such little data – who knows!

What advice would you give someone considering a career in space?

First, make sure you keep studying maths or science when you have the chance – don't give up chemistry because media studies sounds easier! I know that sometimes science or maths seem really hard, and what you learn doesn't seem relevant, but when you get to University you'll find that being able to explore the same subjects to deeper levels really brings out the fun in them.

Second, space careers involve a wide range of skills, from geology, physics, astronomy, engineering and technology to management, PR, design, law and even art. As long as you are truly fascinated in space and have determination you'll find a career that suits your skills.



SIR BERNARD LOVELL

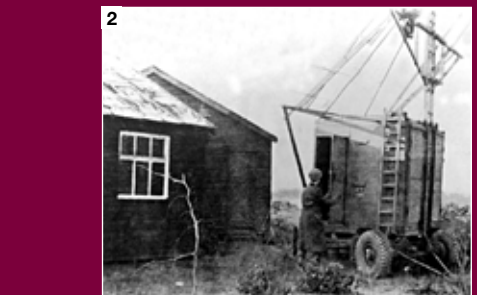
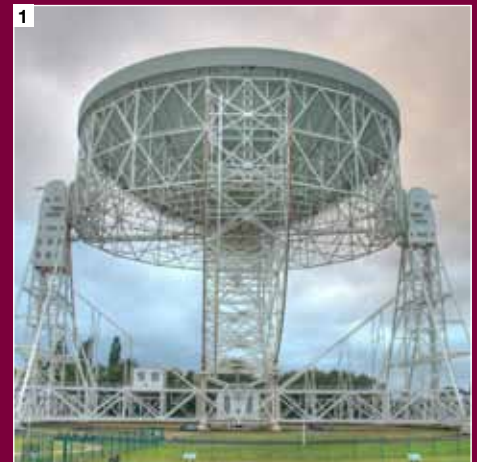
Sir Bernard Lovell is a pioneer of radio astronomy. He led the development of the giant radio telescope at Jodrell Bank in Cheshire and has made major contributions to our understanding of the cosmos. He has even bounced radio signals off the Moon. During the Cold War, Lovell's work enabled the West to track Soviet satellites. He was knighted in 1961 for his contributions to the development of radio astronomy.

Bernard Lovell was born in Bristol in 1913 and studied physics at Bristol and Manchester Universities until the outbreak of the Second World War. During the war he helped develop radar systems for aircraft and flew on many high altitude test missions. It was during air raids that he developed many of his scientific ideas.

After the war he acquired a small radar unit to pursue his research into cosmic rays. He was given permission to set up his equipment at Jodrell Bank and eventually got the funds to build the Mark 1 telescope – then the world's largest steerable radio telescope. Since renamed the Lovell Telescope, it remains an impressive feat of engineering and still uses gears from battleship gun turrets to tilt its 76 metre wide dish.

Sir Bernard's scientific discoveries include the investigation of meteor showers, cosmic rays and quasars. These extremely distant astronomical objects can emit enormous amounts of energy including strong radio emissions, X-rays and gamma rays.

In October 1957, just months after it was completed, the Mark 1 telescope proved the only way of tracking the first satellite, Sputnik. It also played a vital role as an 'early warning' radar to protect the UK against a surprise nuclear missile attack.



1. The Lovell Telescope

Credit: Jodrell Bank Centre for Astrophysics, University of Manchester

2. One of Bernard Lovell's early experiments

Credit: Jodrell Bank Centre for Astrophysics, University of Manchester

