

# space:uk

## Flying by satellite

**Ministers agree Europe's  
space plans**

**Tweeting from orbit  
as space goes social**

**Plus:  
Galileo success, new UK space investment, Mars pull-out poster  
and tweet the experts**



**UK SPACE  
AGENCY**

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**Front cover image:** One of the ground stations tracking Europe's new satellite navigation system

**Credit:** ESA

# From the editor

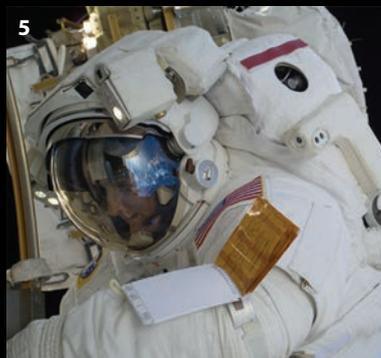


As I write this, the weather on Mars is sunny with a temperature of around zero with a moderate easterly wind. How do I know this? Because the Curiosity rover just sent a tweet from Gale Crater.

Following NASA's tweeting rovers, as well as social media from space agencies or mission scientists and engineers, is a great way to keep up with the latest space news. The UK Space Agency has adopted Twitter as one of its main means of communication. It's not only fast, it allows people to interact with the Agency and feel a part of what's going on.

We have dedicated six pages of this issue of *space:uk* to social media to give you some ideas about who you might want to follow, like or listen to. However, we have also kept room for some old school communication: to celebrate the 50th anniversary of the UK in space, the Royal Mail has brought out a series of stamps. Reproduced in all their glory on pages 8 and 9, they will surely inspire you to want to send a letter. And if you do, you can always tweet about it.

Richard Hollingham  
Editor



Credit: NASA



Credit: Boffin Media



Credit: SSTL



Credit: Boffin Media

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## Go for Galileo

**With the successful launch of two new satellites, Europe's civilian satellite navigation system, Galileo, can be used to fix a position on the Earth for the first time.**

In October the second pair of Galileo In-Orbit Validation (IOV) satellites was successfully launched on a Soyuz rocket from the European spaceport in French Guiana. The satellites' payloads – containing the navigation equipment – were designed, manufactured and tested by Astrium UK in Portsmouth.

Each satellite carries two hydrogen maser clocks. These are the most precise clocks ever flown in space and lose just one second every three million years. The clocks are synchronised with a global network of control stations on the ground, from Antarctica to the Arctic, to produce highly precise navigational positioning.

The latest two satellites join the first pair of IOV spacecraft, which were launched in 2011. Together they make up the minimum number of satellites required to obtain an accurate position on Earth.

"This is another major step towards the start of Galileo services," said Catherine Mealing-Jones, Director of Growth, Applications and EU Programmes for the UK Space Agency. "It's only once services start that we will see the growth that Galileo promises to deliver."

Satellite navigation and accurate timing play an increasingly important role in the European economy. They are not only used for navigation but are vital for everything from the timing of financial transactions, to emergency response or calculating the most fuel-efficient shipping routes.

As well as their atomic clocks, the latest satellites carry a search and rescue antenna and payload – as will all future satellites in the system. This provides a fast emergency response for ships or planes in distress.

Jointly funded by the European Space Agency (ESA) and the European Commission, the In-Orbit Validation phase of Galileo consists of verifying the signals from the four satellites as well as validating the ground station system.

The IOV satellites have now taken over from two experimental satellites: the British built GIOVE-A and GIOVE-B, launched in 2005 and 2008. GIOVE-A, built by Surrey Satellite Technology Limited (SSTL), flight-tested the atomic clocks, investigated radiation levels at Galileo's orbit (23,000kms) and secured radio frequencies. The mission formally ended in June, a few months before the Astrium-built GIOVE-B mission also officially ended.

SSTL is also building the navigation payloads for the next 22 Galileo satellites. When complete, by 2018, Galileo will consist of a constellation of 30 satellites including the four IOVs and three spares.



Ready for launch: the Soyuz on the pad at the European Space Port **Credit:** ESA, Corvaja

**Welcome to the winter 2012 edition of *space:uk*, writes Emma Lord, Director of Policy and Operations for the UK Space Agency. As our Australia-bound Chief Executive bids us farewell, this is a good time to look back over the last twelve months and ahead to some of the things coming up next year.**

2012 has seen many highlights including celebrations of the 50th anniversary of the UK in space, stunning space images from missions such as Herschel and Curiosity, an international event for the Mission-X campaign, the space zone at the Farnborough Air Show, the completion of the first (UK built) instrument for the James Webb Space Telescope... I could go on but you can keep up to date through our magazine and website, so I'd like to tell you about some of the work which has been taking place inside the Agency.

The year started, as it has ended, with plenty to do and lots of deadlines. Staff from all sections spent time representing the UK at international meetings, many in Paris and Brussels working with the European Space Agency (ESA) and the EU. These meetings are critical towards forming European space policy and agreeing programme priorities with international colleagues. The ESA meetings have been more frequent than usual this year to prepare for the Ministerial Council meeting. The outcomes of this meeting (see pages 4-5) will be at the top of the in-tray for the new Chief Executive when they are appointed.

The issue of space debris has been a recurring theme throughout the year. We have a world expert, Richard Crowther, leading this work for the UK. Although it's highly unlikely that a satellite will hurtle towards you from outer space any time soon, it's good common sense to work internationally towards managing the increasingly busy orbital bands around the Earth.



Credit: Swindon Advertiser

Emma Lord,  
UK Space Agency Director of  
Policy and Operations



Engineers and scientists at NASA's Goddard Space Flight Center huddle around the UK-built MIRI instrument, a key part of the new James Webb Space Telescope **Credit:** NASA

Next year will see the launch of the UK's first CubeSat mission, the second UK Space Conference and who knows what Curiosity will find next? We will also see a new face at the helm of the agency as David Williams leaves us for foreign shores to start his post at the Commonwealth Scientific and Industrial Research Organisation in Sydney, Australia.

David has been Chief Executive of the UK Space Agency since its launch, in 2011, as a full executive agency of the Department for Business, Innovation and Skills. The Agency replaced the British National Space Centre, where David served as Director General from 2006. So, over to David for the final words:

***As Emma says, I've made the decision to accept a new position in Australia. This move is tinged with both sadness and excitement. Leaving the Agency will be a big wrench for me and the highlights of my time here are too many to mention. But time passes and everyone needs new goals. Maybe this is a more dramatic change than perhaps is normal, but it is a great opportunity for me and for whoever takes over at the UK Space Agency. So thanks and farewell to everyone at the Agency and to all the supporters of the UK space programme. Keep up the good work and keep the flag flying!***



Credit: UK Space Agency

## Mars mission digs deep



The Curiosity rover's view of the surface of Mars **Credit:** NASA

**A new mission to investigate the interior of Mars will include a British instrument backed by funding from the UK Space Agency. NASA's InSight mission is due to launch in 2016 and will take the first look deep into the geological structure of the red planet to investigate why it is so different to Earth.**

The UK is funding the SEIS-SP instrument, a seismometer that will listen for 'Marsquakes'. The information it provides will be used to map the boundaries between the rock layers inside the planet and help determine if it has a liquid or solid core. It should give some clues as to why the surface of Mars is not divided up into tectonic plates as on Earth. Detailed knowledge of the interior of Mars in comparison to Earth will improve our understanding of how rocky planets form and evolve.

SEIS-SP will be led by space scientists from Imperial College London and the University of Oxford, including Principal Investigator Tom Pike. "InSight will be the first mission to look at the deep interior of another planet," said Pike. "We are delighted to be playing a key part in a mission which will deliver ground-breaking science and technology."

The InSight spacecraft will consist of a static lander, carrying the seismometers, as well as two cameras and a robotic arm. It will also include a probe that will be pushed into the surface to reveal how the planet is cooling, and a sensor to monitor how much the planet wobbles on its axis.

Meanwhile, a team of soil scientists from Cranfield University has developed a replica soil for Mars as part of an ESA project to improve the performance of future robotic rovers. The soils will be used to help recreate the terrain of the Martian surface during testing of ESA's ExoMars rover.

## Lift off for new weather satellite

**Europe's latest weather satellite, MetOp-B, has been successfully launched on a Soyuz rocket from the Baikonur cosmodrome in Kazakhstan. Measurements from the new satellite will be used to improve weather forecasting and predictions of future climate.**

Designed and manufactured by Astrium and operated by the European Organisation for the Exploitation of Meteorological Satellites, MetOp-B is the second in this series of satellites and joins MetOp-A in polar orbit. This orbit takes the satellites over the poles, enabling them to monitor the atmosphere across the entire planet in great detail.

The MetOp satellites can measure temperature and humidity, ocean surface wind speed and direction as well as concentrations of ozone and other trace gases. They are also fitted with a data relay system, linking up to buoys and other automatic data collection devices.

MetOp-B's main structure, propulsion system and the Microwave Humidity Sounder, which measures surface temperatures on Earth and the humidity in the atmosphere, were built in the UK. Operating alongside similar American satellites, the MetOp system complements sources of weather information from other satellites as well as weather balloons, ground based weather stations and observers.

MetOp-A was launched in 2006 and a further satellite, MetOp-C, is already built. During its six years in orbit, data from MetOp-A has been used on a daily basis by Met Office forecasters to improve computer models of the weather. The system is credited with significantly improving one and two day weather forecasts.



MetOp-B being eased into its faring, ready for launch **Credit:** ESA

## Investing in space

**The UK has agreed to invest £1.2 billion in major European space projects. Minister for Universities and Science, David Willetts, made the commitment after two days of negotiations at November's ESA Ministerial Council meeting in Naples.**

The aim of this important meeting was for ministers from ESA member states to agree funding for the next five years. The money committed by the UK will be spent on a wide range of international space projects, ranging from satellite communications to Mars rovers. For the first time the UK has also agreed to put money into human spaceflight, with funding for the International Space Station programme and microgravity research.

Investment in these projects will bring a return to the UK space industry, which is now worth some £9.1 billion and continues to grow. "Space is big business for the UK," the Minister explained. "It is important for us to make strategic investments that will continue the growth of this thriving industry."

The £1.2 billion pledged by the UK will be spread over five years and makes Britain the third largest funder of ESA. A large part of that money – £320 million – will be spent on space science. The remainder will be split between ten other programmes, selected to maximise economic benefits to the UK.

"The programme of investment we've negotiated at ESA will not only allow us to get ahead in the global race by securing more major contracts for UK industry," said the Minister, "but will provide us with the tools to manage major challenges like disaster relief and climate change."

The Chair of the space industry trade association UKspace, Ruy Pinto, said he was "delighted" at the outcome of the ESA Ministerial meeting and that it represented "a platform for growth for the space sector".

"We believe that decisions made by David Willetts in Naples this year will stimulate private investment into commercial programmes at a rate of at least 6:1," Pinto said.

The UK's increased commitment to ESA programmes follows a recent Government pledge of an extra £60 million per year to the UK Space Agency. Outgoing Chief Executive, David Williams, said the UK is now in a leadership role for several major ESA projects.

"With the world space market likely to grow to at least £400 billion by 2030, the UK needs to stay in the game and build on its growing success," said Williams. "Space is rapidly becoming a fundamental part of our everyday lives and strong UK investment will ensure we continue to exploit this essential engine of the global economy."

**For a behind the scenes look at the Ministerial, see page 14.**



Ministers meeting in Naples, the UK delegation is on the left **Credit:** ESA

## Space station surprise



Sunita Williams on a space walk outside the International Space Station **Credit:** NASA

**One of the big surprises to come out of the ESA Ministerial Council meeting was the UK's commitment to put money into human spaceflight programmes, writes *space:uk* editor Richard Hollingham.**

Although relatively small, the £16 million investment in the International Space Station (ISS) is a significant development for the UK. Britain was one of the original signatories to the treaty that enabled the space station to be built but it has never contributed financially.

Rather than being used for day to day operations, this money is likely to be put towards the development of improved communications systems for the ISS and the engines for a new spacecraft, the Orion Multi-Purpose Crew Vehicle. Orion has been developed by NASA as a replacement for the Space Shuttle. It will be capable of supporting astronauts beyond Earth's orbit in future missions to asteroids, the Moon or beyond.

ESA member states have agreed to provide the propulsion unit for Orion and, by putting money into this project, UK industry will be awarded contracts to develop technology for this new spacecraft. The investment could see British technology taking the first astronauts to Mars.

The UK has also agreed to put money into the European Life and Physical Sciences Programme. This £12.4 million investment will be spent on using the unique microgravity environment of space to study biomedicine, materials science and physics. It will enable UK scientists to fly experiments in microgravity on the ISS as well as use sounding rockets and droptowers (see issue 34 of *space:uk*) and could be used to develop medicines or study new materials.

**In addition to the mandatory programmes, the UK has agreed to invest in the following:**

**Telecommunications: £161 million**

The UK is a world leader in satellite communications and this funding will stimulate the development of this important sector

**International Space Station: £16 million**

Focused on propulsion and communications technology

**Weather satellites: £81 million**

This investment will be used to develop the next generation of weather satellites

**Earth Observation Envelope Programme: £166 million**

Another major area of strength for the UK, satellites are vital for monitoring our changing world

**Global Monitoring of the Environment and Security: £25.9 million**

Using satellite data to monitor natural disasters, climate change, food and energy security

**Satellite navigation: £18 million**

Preparing for the next generation of European navigation satellites

**Mars robotic Exploration Preparation Programme: £18 million**

Developing new power sources for future rovers

**Microgravity research: £12.4 million**

Using microgravity to study fundamental and applied science

**Generic Support Technology Programme: £28 million**

Helping industry with space technology research and development

**Space hazards: £6 million**

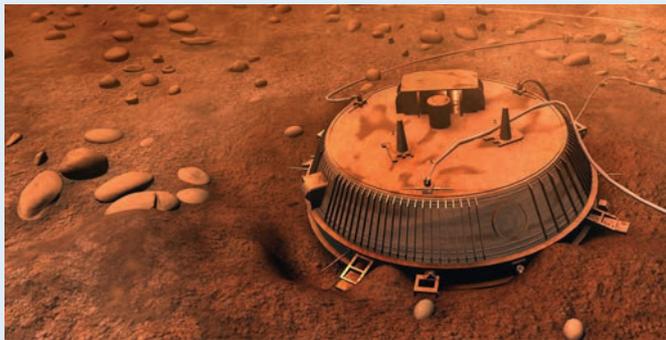
Monitoring and dealing with space weather and space debris



Testing the new Orion spacecraft **Credit:** NASA

## Bouncing on Titan

Europe's Huygens lander bounced, wobbled and slid before coming to rest on the surface of Saturn's moon Titan, according to a new analysis of the probe's historic 2005 landing. The chain of events, which also reveal that Huygens made a 12cm deep hole on impact, was put together from instrument data, computer simulations and a drop test using a model. The results of this latest study, from the Max Planck Institute in Germany, suggest that the area where the probe landed had the consistency of soft, damp sand.



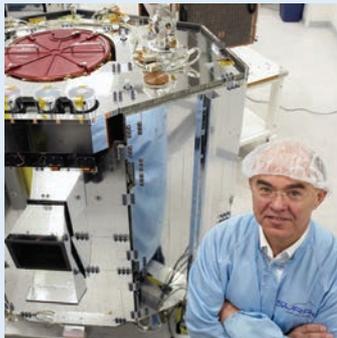
Artist's image of Huygens after parachuting down to the surface of Titan **Credit:** ESA

## New search service

A service that uses satellite data to help people search for information such as jobs, shops or restaurants by the time it takes to get to them – rather than distance – has won the UK Satellite Navigation Competition. iGeolise turns conventional web-searching into 'journey time' searches and means that rather than, for example, searching for a job within a mile of your house, you could look for one within a 30 minute public transport commute. The contest, which is backed by the UK Space Agency, is part of a global competition aimed at stimulating innovations in services that use satellite navigation. iGeolise beat 76 other UK entries to win a £10,000 prize fund to support the project's development.

## Sweeting success

The founder of UK space company Surrey Satellite Technology Limited (SSTL), Sir Martin Sweeting, has picked up two major international awards. SSTL won an American Institute of Aeronautics and Astronautics award for the Disaster Monitoring Constellation. This group of satellites is used to provide images to countries, aid agencies and rescue workers following natural or man-made disasters.



Sir Martin standing next to NigeriaSat-2 **Credit:** SSTL

Sir Martin himself also won the prestigious Von Karman Wings Award for his contributions to aerospace. The ceremony recognised Sir Martin's pioneering work in developing low-cost and highly capable small satellites for Earth observation, communications and space science.

## Star mission tested

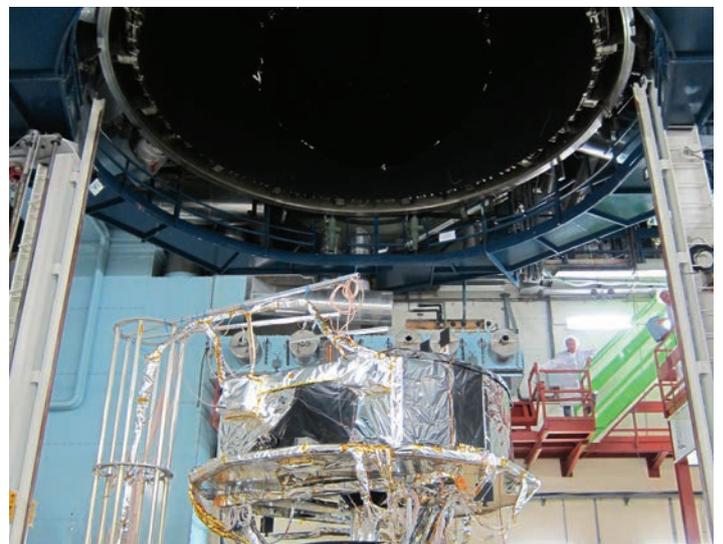
**An ambitious ESA mission to produce a 3D map of the galaxy has been undergoing an extensive testing programme to prepare it for a 2013 launch. Gaia is designed to pinpoint the exact location of more than a billion stars and will be able to view objects 400,000 times fainter than those seen with the naked eye.**

Gaia's instruments include two optical telescopes and sensors that will measure and analyse the light from stars, minor planets and supernovae. The high-resolution survey will give the chemical elements, ages, speeds, masses and orbits for hundreds of millions of stars and other celestial objects to help determine the composition, formation and evolution of the Milky Way.

Backed by £10 million from the UK Space Agency, British space scientists and engineers are at the heart of the mission – from engineering work on the spacecraft's propulsion, electronics and electrical systems, to designing the crucial sensors that detect the starlight.

Astrium in Stevenage is responsible for the spacecraft's super precision guidance and control system as well as the powerful computers needed to process the torrent of data it will produce. Gaia's camera includes the most sensitive set of light detectors ever assembled for a space mission. Produced by UK company e2v, these will have nearly one billion pixels covering an area of 2.8 square metres.

Recent tests have included subjecting Gaia to the extremely low temperatures it will encounter in space of -170°C. Sections of the complex spacecraft have also been undergoing vibration testing to prepare it for the stresses of launch. This is currently scheduled for next year on a Soyuz rocket from the European Space Port in French Guiana.



The Gaia service module being lifted into the vacuum testing chamber in Toulouse **Credit:** ESA

## Small but mighty

**UKube-1, the UK's first CubeSat mission is due to be launched in the spring. The shoebox-sized satellite, a collaboration between the UK Space Agency, industry and academia, will be packed with experiments.**

Based around units that are only 30cm cubed, CubeSats are much cheaper to build than conventional satellites. UKube-1 is made up of three of these units.

"UKube-1 is almost ready to fly," said outgoing Chief Executive of the UK Space Agency, David Williams. "We are eagerly awaiting the start of the innovative experiments that this small – but mighty – satellite will perform once in orbit around our planet."

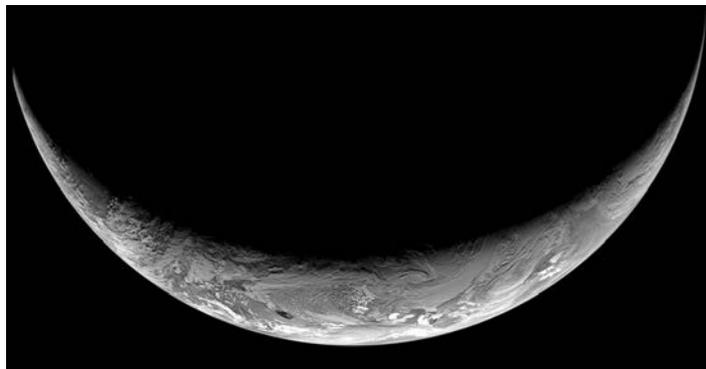
The five instruments on board UKube-1 include a new type of space camera and science experiments that will enable students and hobbyists to take part in the mission. The satellite will also carry a GPS device designed to measure space weather – the interaction between particles from the Sun and the Earth's magnetic field.

UKube-1 is due for launch on a Soyuz rocket in March and will be launched alongside several other satellites – another factor that keeps the costs of the mission down. The project is seen as a pilot for a full national CubeSat programme which would allow the UK to fly educational projects, test new technology and carry out space research quickly and efficiently.



UKube-1 is being built and tested by Glasgow company, Clyde Space **Credit:** Clyde Space

## Boffins win



Rosetta captured this view of the South Pacific on its way to its destination **Credit:** ESA

The Space Boffins podcast beat off strong competition from the BBC and NASA to win the Best Space Media category of the 2012 Sir Arthur Clarke Awards. The podcast, which has been partly supported by a UK Space Agency 'Space for All' grant, was described as having a "relaxed but inquisitive style". The award delighted its co-producers and presenters: Sue Nelson and *space:uk's* Richard Hollingham. "We didn't expect to win with such an amazing shortlist," admitted Nelson, "so this is a brilliant surprise."

The Open University's Professor Ian Wright, who won Best Space Activity for his Rosetta Ptolemy team, was also a delighted winner. "I've never won anything before in my life," he said. ESA's Rosetta mission launched in 2004 and is nearing the end of its 10-year journey to comet 67 P/Churyumov-Gerasimenko. On arrival it will make the first ever soft landing on a comet's surface.

The awards, commonly known as 'the Arthurs', were hosted by Lord Cobbold at the House of Lords and presented by impressionist Jon Culshaw in a variety of voices, ranging from astronomer Patrick Moore and physicist Brian Cox to the great science fiction author himself, Arthur C. Clarke.

### Award winners

Best Space Activity (industry/project) – NigeriaSat-2 team, Surrey Satellite Technology Limited

Best Space Activity (Academic study/research) – Ian Wright and the Rosetta Ptolemy team from the Open University

Best Space Education and Outreach – Heather MacRae, Venture Thinking

Best Space Education – Student Achievement – Charlotte Lucking, University of Strathclyde

International Achievement – Jean-Jacques Dordain, ESA Director General

Lifetime Achievement – Paul Money, astronomer, writer and broadcaster

## Stamp of approval for UK space missions

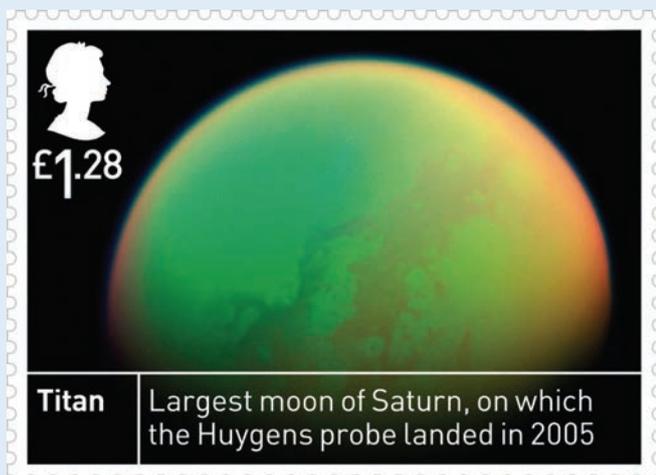
The Royal Mail has issued a set of stamps to celebrate the 50th anniversary of the launch of the UK's first satellite, Ariel-1. The launch of Ariel-1, in April 1962, made Britain the world's third space-faring nation and laid the foundations for the UK space industry. Today that industry is worth some £9 billion – definitely something to celebrate.



In orbit around Mars since 2003, ESA's Mars Express has sent back remarkable images and data of unprecedented quality. The UK has been involved in the design, operation and science.

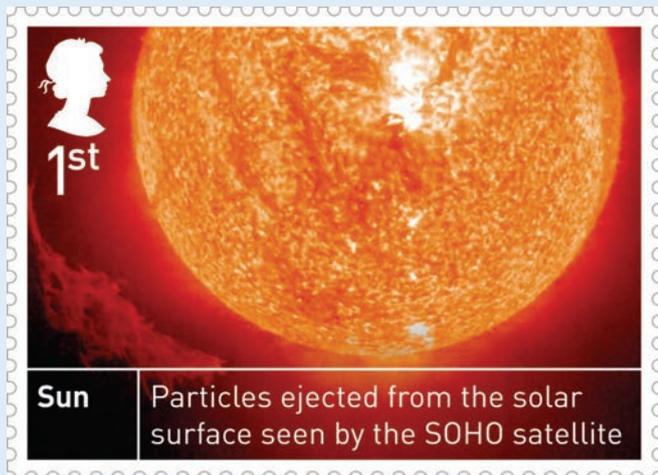


Since 2004, the international Cassini-Huygens spacecraft has been making an extensive study of the ringed planet and its moons. Its images and observations have transformed our understanding of the Saturn system.

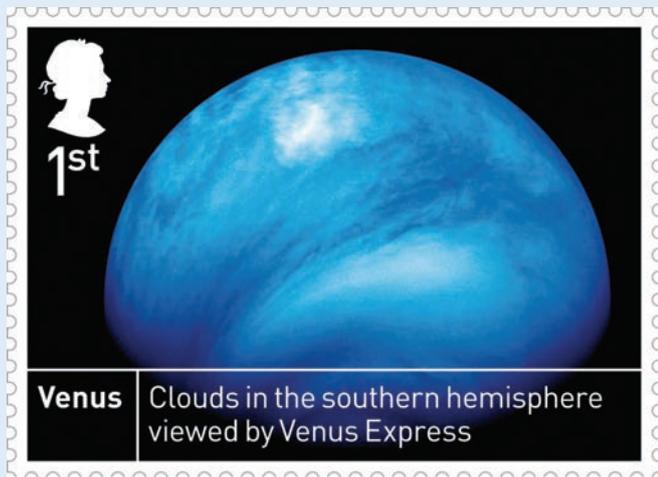


The Huygens probe landed on Titan in 2005 – the first component to touch the surface was made in the UK. The moon is smothered in a thick petrochemical atmosphere and there is evidence of methane rain and erosion on the surface.

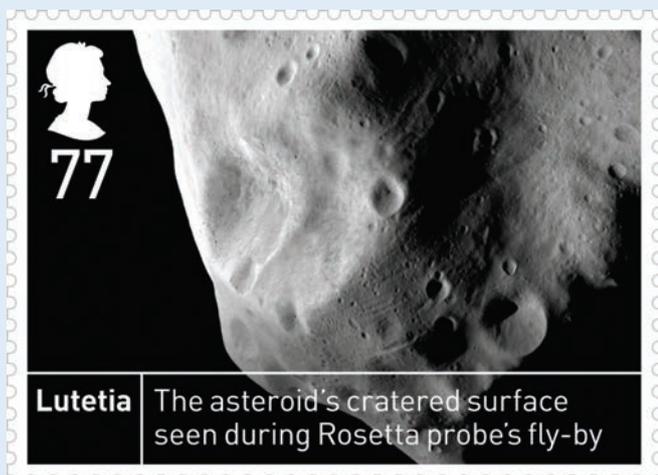
For More information on all the missions featured on the stamps, visit the missions section of the UK Space Agency website.



SOHO continues to investigate the Sun – from its deep core through to its outer atmosphere, the corona. The ESA mission has also been investigating the origin of the solar wind - the stream of charged particles that blow outward through the Solar System.



ESA's Venus Express is unravelling the mysteries of Venus, its atmosphere and its interaction with the solar wind and interplanetary environment. UK scientists and industry have participated in planning the mission and are involved in five of the instruments.



Rosetta is on an epic ten-year – 7100 million kilometre – journey to rendezvous with comet 67P/Churyumov-Gerasimenko. Due to arrive in 2014, the ESA mission comprises an orbiter and a small lander with a key UK instrument.



# Island hopping with EGNOS

Image above: The EGNOS system gives pilots a 3D view of the airspace around them  
Credit: Boffin Media

**A new European satellite navigation system is being used in the Channel Islands to help land aircraft. So how is it performing after a year in service? Sue Nelson goes for a flight:**

The 15 minute flight from Guernsey to Alderney is unique. For starters, the plane is a perky sunflower yellow Trislander, with a third engine on top of the tail fin and 16 passenger seats arranged in rows from one side of the plane to the other. In other words, every seat has a window view and, boy, is that view worth seeing.

The turquoise waters and sandy bay of Herm Island pass beneath us shortly after take-off, my view unsurpassed after being allowed to sit beside the pilot. "It's so clear you can see Alderney on the horizon," says Captain David Rice, as he programs in his approach to Alderney on one of the two digital displays in the cockpit.

Rice taps his finger on the display to select a place called Torvi, which can't be found on any land map of the Channel Islands. "It's a navigational point in space," informs Rice. "They're called GPS (Global Positioning Satellite) waypoints."

A narrow stretch of land looms in the distance and, disorientated, I wonder aloud if it's Jersey. "It's the northwest tip of France, the Cherbourg peninsula," says Rice. "And see those chimneys? That's a nuclear power station."

This is another reason why this short flight is unique. The proximity of France and the constraints of French airspace mean that approaching Alderney's runway is tricky for all but the most experienced pilots. As if that wasn't enough, the wildlife on the island can also prove problematic.

Alderney is well known for its blonde hedgehogs and puffin colonies, one of the reasons a puffin decorates Aurigny Air Service's Trislander fleet – but it's the larger birds that can get in the way. "You often see game on the runway," admits Rice.

No passengers are at risk, of course, not least because the Guernsey based Aurigny is trialling an additional safety feature to GPS. It's called EGNOS (European Geostationary Navigational Overlay Service) and uses three geostationary satellites and a network of ground stations to produce more accurate positioning. It does this by transmitting overlapping signals that contain information on the accuracy of GPS positioning signals. EGNOS then compares any errors, takes into account any disturbances in the atmosphere and makes corrections so that an improved, more accurate signal can be retransmitted. Positions can then be determined to within 1.5 metres.

EGNOS was developed by ESA, the European Organisation for the Safety of Air Navigation and the European Commission, who are now managing the project.

Operated by the European Satellite Service Provider, the UK's National Air Traffic Service oversaw the first commercial application of EGNOS at Aurigny.

The airline has been trialling EGNOS since early 2011, initially in good weather but, from December 2011, the system went live in all conditions. Throughout the past year Aurigny

Image below: Captain David Rice by the Trislander  
Credit: Boffin Media



***"It's a nice piece of kit"***

Captain David Rice  
Aurigny's Flight  
Operations Director

continues >

## Island hopping with EGNOS

continued

Top image: The Trislander on the runway

**Credit:** Boffin Media

Image bottom right: The satnav display in the cockpit as the plane prepares for takeoff

**Credit:** Boffin Media



has been equipping the rest of the fleet with the equipment and training pilots.

“The Trislander seems the ideal aircraft to trial it,” says Rice, who is also Aurigny’s Flight Operations Director, “partly because it’s relatively simple and cheap to equip compared with other aircraft, and also because Alderney is a suitable airfield as there are no instrument landing systems there.”

Instrument Landing Systems (ILS) are expensive and not all small or medium airports have them. Planes or helicopters can only make what is known as a non-precision approach.

“GPS only gives you a 2D approach,” explains Rice. “EGNOS gives you it in 3D with vertical information as well.” A satellite-based system onboard an aircraft therefore gives planes the equivalent of an ILS at airports that don’t have them – and act as a back up system for those that do.

“It’s more accurate, it can be completely on autopilot, it’s independent of any equipment on the ground at the airport,” says Rice, “and it gives you a lower safe altitude compared with traditional non-precision approaches.”

By reducing the altitude that planes can fly before making a decision on landing or ‘going around’, airlines using EGNOS will therefore have a commercial advantage over their competitors

as it minimises delays and the need for costly diversions.

“Aurigny Air’s use of EGNOS shows that these European Union space programmes can have a real day to day impact,” says Catherine Mealing-Jones, the Director responsible for Growth, Applications and European Union Programmes at the UK Space Agency. “These smaller airports can open for longer in worse weather. That is good news for the airline and for passengers.”

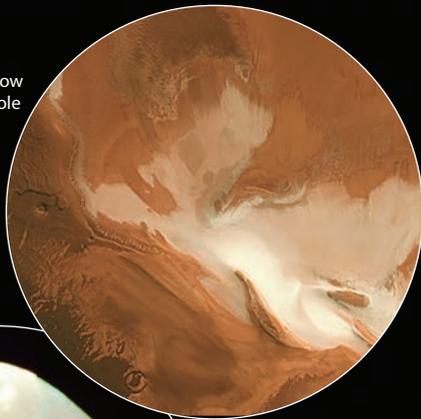




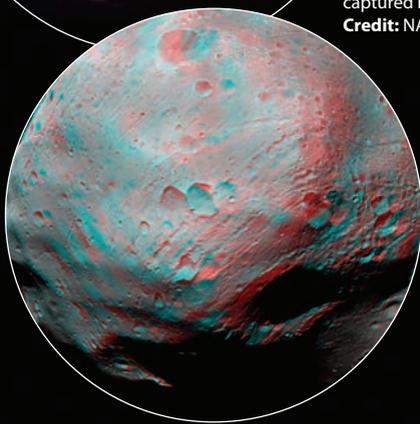
# Mars

**Mars is the most Earth-like planet in the Solar System and boasts scenery on a massive scale – with deep valleys, vast rust-coloured plains and mountains three times the size of Everest. The red planet has fascinated us since the dawn of time but one big question remains: did it ever support life?**

Mars Express image of snow near the Martian north pole  
Credit: ESA



Martin moons Deimos and Phobos may be asteroids captured by the planet's gravity  
Credit: NASA, ESA



**The fourth planet from the Sun continues to fascinate. Astronomers once thought Mars was might have supported microscopic life. Mars is the most visited planet in our solar system and**

## Red planet

Named after the Roman god of war, Mars can be seen with the naked eye when its orbit brings it close to Earth. The Romans associated the red planet's colour with blood although it turns out the orange-red appearance results from soil rich in iron oxide – more commonly known as rust.

Although relatively small – its radius is about half that of the Earth's – Mars boasts scenery on a massive scale. An enormous set of canyons called the Valles Marineris runs roughly along the equator. This split in the Martian crust is around 4000km long, up to 600km wide and 7km deep in places. Mars also boasts the highest volcano in the solar system. Three times the height of Everest, Olympus Mons stands 26km above the surrounding plain.

The Martian environment is far from hospitable. The thin atmosphere is made up mostly of carbon dioxide. The temperature can drop as low as -133°C, although in the Martian summer it's more typically around 25°C. The surface can be extremely stormy with winds reaching speeds of up to 350km per hour.

Mars has two moons, which are among the smallest in the Solar System. Phobos and Deimos are both lumpy, heavily cratered and covered in dust and loose rocks.

## Life on Mars

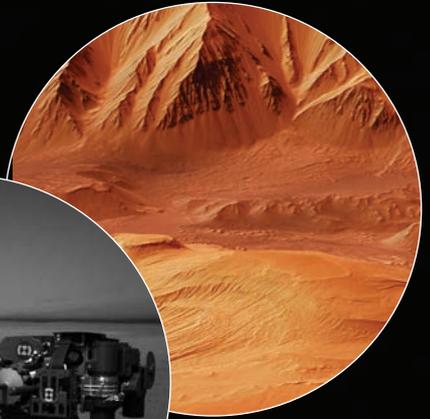
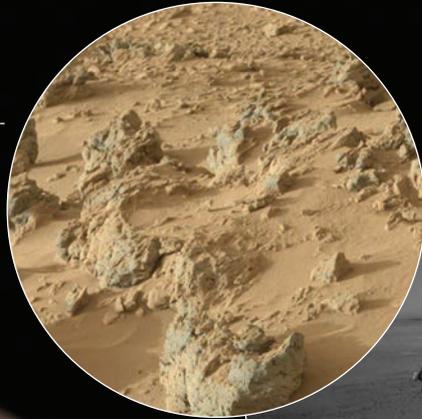
During the 18th and 19th centuries, scientists became convinced that there was civilised life on the red planet. They suggested Mars had weather, snow, water and a network of canals. Plans were even drawn up to communicate with our nearest planetary neighbours.

In the early 20th century, the idea that aliens from Mars might attack us was fuelled by books such as H.G Wells' War of the Worlds and subsequent films. Today scientists are certain that even if there are any aliens on Mars, they won't be little green men but microscopic bacteria. There is also a strong possibility that if Mars ever had life, it is long dead.

# ent Mars

home to an advanced civilisation; now, scientists are investigating the possibility that it and there are currently several missions in orbit and robotic landers on the surface.

Curiosity's view of wind-blown Martian sand  
**Credit: NASA**



A valley in the northern part of Valles Marineris  
**Credit: ESA**



Curiosity's robotic arm poised above the planet's surface  
**Credit: NASA**

## Missions to Mars

Since 1960, there have been 43 attempts to reach Mars but only 18 missions have succeeded. The first successful flyby of Mars was made in 1964 by US spacecraft, Mariner 4. It took scientific measurements and sent back pictures of the terrain. The first lander to reach the surface, the Russian Mars-3, touched down in 1971 but only managed to send back 20 seconds of data before its instruments stopped working.

In 1976, Viking 1 and Viking 2 – each consisting of an orbiter and lander – arrived at Mars. The orbiters captured images of the entire surface and the landers sent back images and took samples to analyse them for signs of life.

The first European mission to Mars, Mars Express, reached the planet in 2003. The mission included the UK-built Beagle 2 lander, which was successfully released towards the surface. Unfortunately, the lander never sent back a signal and is considered lost. However, Mars Express continues to orbit the red planet, capturing spectacular images and data. NASA's Curiosity rover is currently investigating the geology of Mars for evidence that the planet might have been able to support life. Several UK scientists are involved in this important mission.



Flying over the tiny island of Herm  
**Credit:** Boffin Media

## ***“Aurigny Air’s use of EGNOS shows that these European Union space programmes can have a real day to day impact”***

Catherine Mealing-Jones  
 UK Space Agency

There’s also a bigger picture at work, as EGNOS is the precursor to Galileo, Europe’s first global positioning satellite navigation system. Four operational satellites have already been launched and, once complete, a constellation of 30 will orbit the Earth providing Europe with its own independent and civilian satnav system (since GPS is run by the US military).

“The UK Space Agency wants to see the EGNOS and Galileo programmes delivering tangible benefits as quickly as possible,” says Mealing-Jones. “With EGNOS now operational and initial Galileo services starting in 2014, I want the Agency to make sure that the UK is in a great position to exploit this.”

As Europe’s first regional airline to use EGNOS, Aurigny has been praised for its pioneering use of the technology. “Over 2012 we’ve been equipping the rest of the fleet with the equipment and training pilots how to use it,” says Rice. “It’s a nice piece of kit. It’s all touch screen, very user friendly for pilots, and operates through menus.”

Aurigny has now done a flight trial for Southampton airport and Rice will be validating the system for Southend airport. Jersey and Guernsey are expected to introduce EGNOS shortly and Brittany’s Dinard airport also plans to introduce it in 2013.

“Airports and airlines across Europe are seeing the benefits of EGNOS,” says Mealing-Jones. “Its use is growing steadily within aviation.”

Not surprisingly, the landing at Alderney airport is smooth and flawless. “I’m operating on autopilot,” says Rice as we approach the island. “As you come into the approach I have to reduce power at the appropriate moment and lower the flaps at the appropriate moment.” For a non-standard approach such as Alderney’s, this is one of EGNOS’ strengths, as it reduces the pilot’s workload during potentially difficult manoeuvres.

Disappointingly, there are no signs of pheasants or any other game on the runway and after a short break for sandwiches and coffee at the tiny airport cafe, we return to Guernsey with a new set of passengers. It is then that I notice a suitcase displaying a medical cross.

“A lot of the flights from smaller islands are health related, a specialist check up or access to a service not available on the island,” says Rice, “so better, more reliable services are really important to these communities.”

Rice, who was brought up on Alderney as a child, is well aware of these advantages. “We provide 24 hour medical evacuation for Alderney as there’s only a tiny hospital with very limited facilities here,” he says. “Because we can fly in worse weather using EGNOS, it could make the difference and save someone’s life by airlifting them to Guernsey. And that on its own would justify everything.”

# When Ministers meet

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Earth observation missions  
are increasingly important in a  
changing world  
**Credit:** ESA, NASA

**Every four years government space ministers meet to discuss future priorities for Europe in space. These gatherings are vital for UK industry, space science and, ultimately, the UK economy. Preparations for the ESA Ministerial meeting take many months and Richard Hollingham has been finding out what goes on behind the scenes:**

“A huge amount of effort goes into it,” exclaims Emma Lord. As Director of Policy and Operations for the UK Space Agency, Lord is responsible for putting together the UK’s negotiating position for Europe’s future space programme. When I catch up with her, a fortnight before the ESA Ministerial Meeting, it’s clear that she has not had time to think of much else.

“Over the last twelve months the number of meetings with European member states has increased exponentially, there have also been discussions within the Agency, with the Treasury and the Department for Business, Innovation and Skills.”

The ESA Ministerial Meeting allows space ministers from across Europe, including Minister of State for Universities and Science David Willetts, to continue to fund existing programmes or sign up to new projects. For every ESA member state there’s a lot of money and jobs at stake, not to mention political considerations. With many European economies struggling, ministers are conscious that every penny has to be justified.

“Space is taken for granted,” says Lord. “We need to remind people what we use space for and explain why it’s important that we stay in these European space programmes.”

In the UK at least, the space sector is doing extremely well. The latest survey suggests the UK space industry is worth some £9 billion to the economy and growing at more than seven percent a year. Much of that success has come

directly – or indirectly – through long-term investment in ESA projects.

The way the system is designed to work is that for every pound (or Euro) invested in ESA for specific projects, a pound comes back to the UK to fund the industry or academics involved. But the business case for any investment needs to be strong so that, ideally, every pound invested in space science or technology will ultimately return even more to the British economy.

But if space means so much to the UK, why not go it alone?

“20 nations working together are going to provide the potential to do much greater things than any individual state,” says David Southwood, Senior Research Investigator at Imperial College, London and also a member of the UK Space Agency Steering Board. “This applies not only to science but to any programme in ESA.”

As ESA’s former Director of Science and Robotic Exploration, Southwood has overseen dozens of international space science projects. “UK scientists do tend to punch collectively above their weight in European space science. British scientists can and do lead, the new ESA Jupiter icy moons mission makes a fine recent example.” (see box)

“The alternative,” says Southwood, “is for space scientists to be involved in bilateral cooperation with the US. However, one is always the junior partner in such cooperation.”

Image bottom right: Artist image of the JUICE mission to Jupiter  
Credit: ESA

**“The benefit of investing in space is no longer in doubt in the UK”**

David Southwood  
Imperial College  
London

## Mission Jupiter

The Jupiter Icy Moons Explorer (JUICE) is a good example of a new European space science mission with key UK involvement. Due for launch in 2022, JUICE will be the first ESA mission to the outer solar system. It will explore Jupiter and its three largest moons: Europa, Ganymede and Callisto, as well as fly past the moon Io.

UK space scientists helped draw up the plans for the mission and are leading an international consortium to put together a suite of instruments for the spacecraft.

Europa, Ganymede and Callisto are particularly interesting as they may even harbour the conditions for life.



continues >

**When Ministers meet**  
continued

Top image: Images like this captured by the international Cassini-Huygens mission demonstrate the benefits of nations working together in space  
**Credit:** ESA, NASA

Bottom image: ESA has 20 member states  
**Credit:** ESA



**“We need to remind people what we use space for”**

Emma Lord  
UK Space Agency

Space science is treated slightly differently to other areas of European space funding because, not only is backing for science missions compulsory for ESA members, all member states participate in proportion to the size of their economy. Still, that doesn't mean there hasn't been plenty of lobbying behind the scenes in the build up the Ministerial.

“Everyone is anxious to sustain, improve or shape the level of involvement in their favoured programmes,” Southwood explains. “Much takes place behind the scenes and I'm happy at the prospect of never again facing working long into the night to achieve acceptable compromises to get programmes going.”

Although space science missions often grab the headlines, they represent only 15% of the ESA budget. Other programmes covering navigation, communication and the development of new space technologies are vitally important for the UK space industry.

Co-Chair of the UK's Space Leadership Council and former CEO of Logica, Andy Green, describes space as a “vibrant sector” for Britain. “We are fantastic users in the UK of space technology, from our television to our sat nav to the way we find our way around the streets on our smartphones,” he tells *space:uk*. “And increasingly, as we look at the world's resources and how we share them amongst the growing population, Earth observation will become more and more important. So space is really well embedded in what goes on in the world.”

Green argues that it's important, with limited funds, that the UK selects space investment projects carefully. “We want to concentrate on those areas where we believe we can get a good bang for our buck. In other words, by the





Top image: The UK space industry is worth some £9 billion

**Credit:** SSTL

Image below: Another UK-built satellite heads into orbit

**Credit:** Corvaja, ESA

Government putting money in we can get six or eight times the money going in from industry."

"We're looking at all the hard work in agreeing spending priorities to make sure the UK gets a leadership position to allow industry to invest strongly alongside government to create growth for the future," says Green. "Our ambition is to grow the UK's share of the world space market from 7 to 10 percent over the next ten or fifteen years and to grow 100,000 really high value-added jobs in the UK."

It's those wider, long term, benefits to the UK of putting money into space programmes that also appeal to Southwood. "The benefit of investing in space is no longer in doubt in the UK," he says. "Not only does space science inspire people to learn about technology, and in the end often to pursue skilled careers, but there are few applications that do not have their roots in space science."

So, given the amount at stake, what's it been like being involved in all these negotiations?

"It's not a complete game of poker," says Lord, "where you all try to keep your cards hidden until the last possible moment."

"Because we're all in this together, it makes sense to understand what the other nations are going to be looking to support," she says.

The decisions made at the Ministerial will set the scene for the coming years. With space one of the key growth sectors of the UK economy, these investments could have an effect on all our lives.



# space & social media

## Space goes social

Space might seem unreachable, but it certainly isn't untweetable, writes Kate Arkless-Gray. With this guide to social media in space we'll have you swapping news with space agencies, astronauts and Mars rovers in no time.

While 'rocket science' is still touted as an almost mystical endeavour of clever people that you will probably never meet, the reality is quite different. Gone are the days when it's only CapCom and close family who get to send messages to astronauts on the International Space Station. Believe it or not, you can too.

Remember that when you use social media, keep your personal stuff private and think about what you say and do. Some sites (such as Facebook) also have minimum age requirements. For guidance on Internet safety visit: [www.thinkuknow.co.uk](http://www.thinkuknow.co.uk)

### Facebook

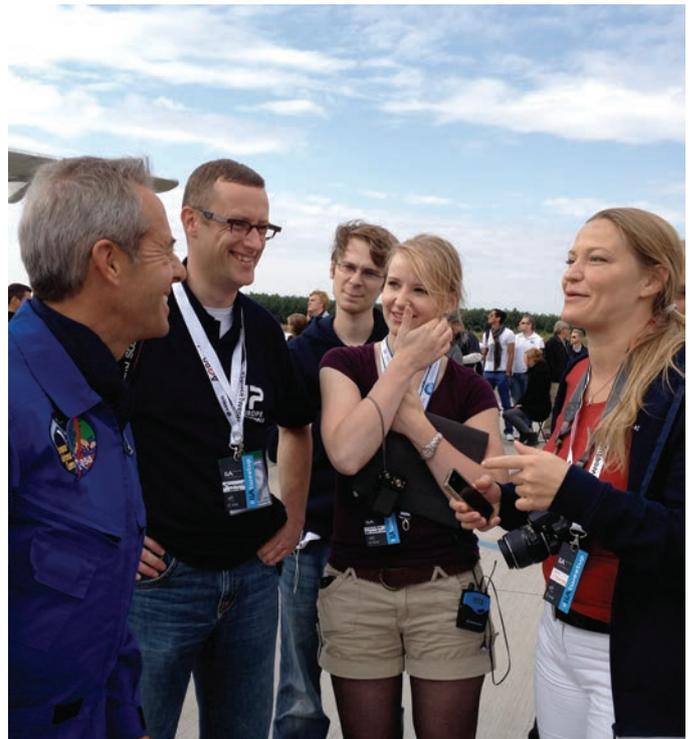


Since one in seven of the world's population is now on Facebook, we suggest you find the official page of your favourite space agencies and check out who else they like. There is an active fan page for Mars Curiosity (facebook.com/marscuriosity) and it's also a good place to keep up with the escapades of everyone's favourite rubber chicken, Camilla SDO. She is the mascot of NASA's Solar Dynamics Observatory and when not flying up to the edge of space on a high-altitude balloon, she travels the world doing space outreach events and teaching people about coronal mass ejections from the Sun.



Camilla SDO, space chicken **Credit:** NASA

### Space communities



Delegates at the recent ESA TweetUp in Berlin with astronaut Jean-Francois Clervoy **Credit:** Boffin Media

There is a fantastic space community online too. Based around Twitter, the Space Tweep Society brings together space fans from around the world.

ESA and NASA have taken the social media connections to the next level by inviting members of social networks to join them for special events such as launches or facility tours. These 'SpaceTweepUps' give participants an exclusive chance to see first hand what the space agencies are doing.

While you have to fund yourself to get there, and there may be age restrictions, these TweetUps provide a wonderful opportunity to get behind the scenes and meet top people – from space scientists to astronauts.

Follow **@SpaceTweepUp** to find out about forthcoming ESA events.

## Twitter



Twitter is an excellent space resource, so even if you are not sure you want to start sending 140 character updates about your own life, it's worth signing up to follow some of the amazing updates from people who are working at the cutting edge of space technology.

You can follow UK companies including SSTL (@SurreySat) and Reaction Engines Limited (@Reactionengines), individuals – such as space scientist Lucie Green (@Dr\_Lucie) – or science journalists. Twitter is often the quickest way to find out what's going on.

An increasing number of astronauts have also begun tweeting their experiences from aboard the space station, sending down incredible views of Earth that they are lucky enough to be able to snap from the window. You can even send them a message but just remember they are pretty busy up there and you might not get a personal response.

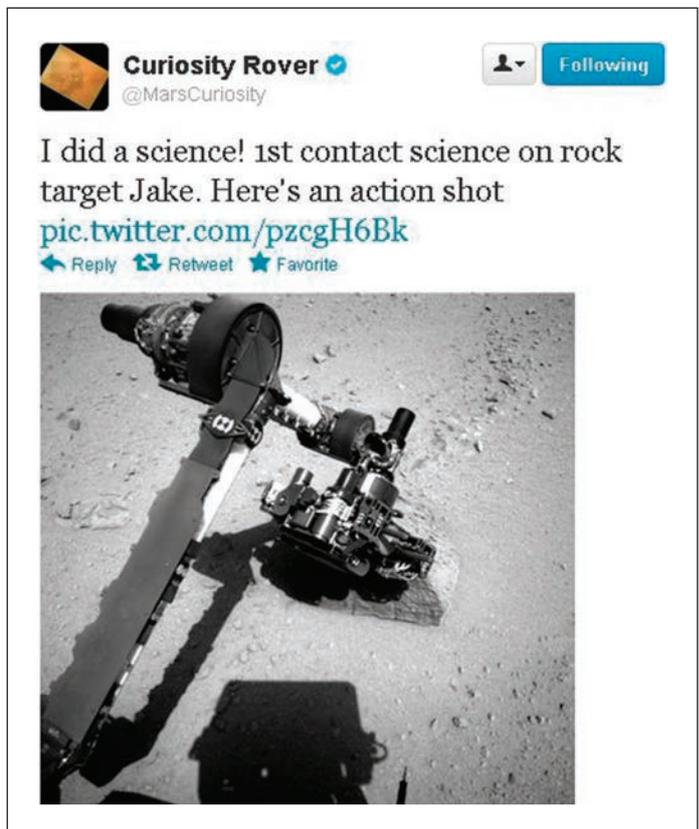
You can also follow the latest news from the UK Space Agency and many missions have their own special Twitter accounts. But it's not just astronauts and agencies that you will find on Twitter. The Mars Curiosity rover is an active tweeter, and you can find deep space probes, mission controllers and even a few rocket scientists.

Here's short list of people we suggest you follow:

UK Space Agency: **@spacegovuk**

Our very own astronaut: **@astro\_timpeake**

Royal Observatory Greenwich: **@ROGastronomers**



A tweet from the Curiosity rover on Mars **Credit:** NASA, Twitter

British Interplanetary Society: **@BIS\_spaceflight**

BBC Science correspondent: **@bbcAmos**

Space Boffins: **@spaceboffins**



Astronauts tweet regular updates from orbit **Credit:** ESA



Tim Peake training in the Soyuz simulator at Star City near Moscow **Credit:** ESA

## UK astronaut Tim Peake – follow his training

Major Timothy Peake was selected by ESA to be part of the astronaut class of 2009 and is currently in training for a mission to an asteroid.

You can follow his training via the astronauts' blog at [blogs.esa.int/astro\\_timpeake](http://blogs.esa.int/astro_timpeake) and via Twitter [@astro\\_timpeake](https://twitter.com/astro_timpeake).

## Flickr



We cannot all be in space, but that does not mean we cannot enjoy some of the fantastic photographs that get sent back to Earth.

Flickr hosts a whole range of space-related images from agencies, astronauts and people who have been lucky enough to experience rocket launches first hand.

Take a look at the photos from the UK Space Agency ([spacegovuk](http://spacegovuk)) and amazing images from the UK-built Disaster Monitoring Constellation (DMCii).

## Video and audio



There are plenty of space-related videos on YouTube and one not to be missed is Curiosity's 'seven minutes of terror' Mars landing video from NASA JPL. This went viral before the landing of the Mars Science Laboratory and describes the incredible series of events during entry, descent and landing that were required to get the rover safely on the red planet.

The UK Space Agency's channel ([spacegovuk](http://spacegovuk)) includes a new video marking 50 years of the UK in space, which features some rare archive film.

There are many excellent space podcasts available. Top of our list is the award-winning Space Boffins podcast (although as it's co-presented by *space:uk* Editor, Richard Hollingham, we may be biased).

On the same website you will also find the Naked Astronomy podcast:

[www.thenakedscientists.com/HTML/podcasts/astronomy](http://www.thenakedscientists.com/HTML/podcasts/astronomy)

## Space Storify

This summer, 60 students from across Europe congregated in an Austrian alpine village to design a mission to the Solar System's outer planets. Now in its 36th year, ESA's Alpbach summer school provides science and engineering students with expert guidance and support from renowned space scientists and engineers, together with top lecturers from a diverse international mix of universities.

Jane MacArthur, an MSc student at University College London, joined this space summer school near Innsbruck and has shared her experiences on social media site Storify. This site allows you to pull together, or curate, a wide range of content from several social media sites – such as Twitter or Facebook – as well as photos and media. The resulting story can have a diverse range of writers (or reporters) and is much easier to follow.

Journalists and media organisations are increasingly using Storify to cover breaking news stories and Jane's experience was similar. Her team had just eight days to design a mission to Uranus.

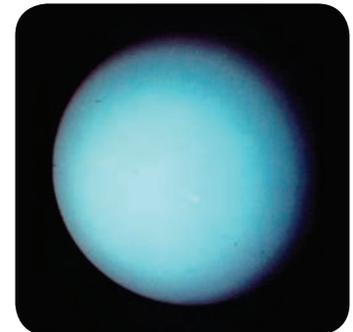


The British team at Alpbach **Credit:** MacArthur

To find out if Jane succeeded and to follow her story of hard work, late nights and impossible deadlines, search for 'Alpbach summer school' on **storify.com**



Another late night in the classroom for Jane's team **Credit:** MacArthur



This image of Uranus was captured by Voyager 2 – the only spacecraft to fly past the planet (so far...)  
**Credit:** NASA

## About the author

You can put your new-found social media skills to the test and get in touch with the author of this guide on Twitter as **@SpaceKate**, on her blog **SpaceKate.com** and listen to her interviews with the fascinating space people she meets on her adventures at **audioboo.fm.SpaceKate**



The author – for reasons that are not entirely clear – in the snow  
**Credit:** Kate Arkless-Gray

# Tweet the experts

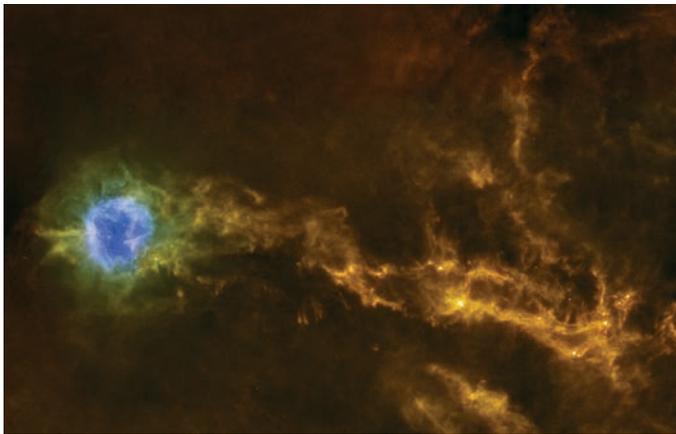
To mark world space week, the UK Space Agency held a series of question and answer sessions on Twitter with leading space experts. You can read the full exchanges on our Twitter feed – @spacegovuk – but here, in 140 characters or less, is a selection of tweets from the conversation:

## Questions to Matt Griffin, Principal Investigator for the Herschel Space Telescope:

### How did you become interested in astronomy?

I first became fascinated by space through the Moon landings and the film 2001 A Space Odyssey...

which still remains the best film about the universe and our place in it



Filaments of gas seen by Herschel Credit: ESA

## Questions to Emma Lord, Director of Policy and Operations at the UK Space Agency:

### Apart from a degree in Physics, Engineering, etc what are other highly desirable skills in the space sector?

Any STEM subject will give a good foundation. Also drive, determination, enthusiasm...and an interest in space helps

### What makes a great astronaut?

A great astronaut needs to be fit, good at STEM subjects, good with languages, able to learn quickly, enthusiastic, brave, calm in a crisis...good working with people in a team and good at leading others. A good sense of humour probably helps too!

### Are there any avenues for business students without an engineering or physics background to space sector careers?

Yes. It could be a barrier to some roles but space policy and space law are examples of where other qualifications are handy...

And all space companies need people to run the corporate functions. It's still the space sector...just not rocket science!

### Is it true that the world will end by the Sun exploding?

The Sun will expand rather than explode, becoming a red giant star and engulfing the Earth in its atmosphere...

it will be far too hot for life to exist on Earth. But it won't happen for about five billion years

### What's the most fascinating thing you've seen in space?

The amazing filaments of gas and dust in our galaxy that the Herschel Space Observatory has found

The pictures are great and it's in these filaments that new stars are born

### Where does the inspiration for spaceship designs come from?

In the case of real spaceships, function is much more important than style and the design is purely practical

If they happen to look good that's a nice bonus. When it comes to spaceships in science fiction, anything goes.



Space isn't only rocket science Credit: ESA

## Questions to Ralph Cordey, Head of Robotic Exploration for Astrium UK:

### **How expensive are the robots that we send into space?**

Complex ones can cost several hundred million pounds. Curiosity plus its rocket, landing system and operations cost NASA \$2.5 billion

### **Do you think the Mars Curiosity Rover will find evidence of life on Mars?**

Curiosity should tell us lots about the possibility of past life on Mars, but proof may need future missions like ESA's ExoMars

### **What, in your opinion, is the benefit of robotic missions over manned?**

Ignoring cost, for me it's the ability to go to extreme and distant places for long periods of science operations



Building a Mars rover doesn't come cheap – this working copy of the Curiosity rover is seen here at NASA's Jet Propulsion Laboratory **Credit:Boffin Media**



The Earth is surrounded by a cloud of space debris. In this image the size of each object has been enlarged **Credit: ESA**

## Questions to UK Space Agency Chief Engineer, Richard Crowther:

### **What are the chances of a satellite (or piece of space junk) falling on my head?**

Extremely low. Compare the size of your head with the surface area of Earth, you'll see why no one has yet been killed by re-entering debris

### **How do you detect asteroids if they are about to hit Earth?**

We use telescopes which allow us to identify all of the big asteroids many years in advance, so enabling us to mount a deflection mission

## Questions to ESA astronaut, Tim Peake:

### **Who inspired you to be an astronaut?**

My journey started as a teenager – inspired by [my] great Chemistry teacher [who] always said you get out of life what you put in.

### **Have you thrown up during your training and, if so, how many times?**

Not yet – but give it time! Medication is often used to help prevent nausea on parabolic flights. Centrifuge can be tough though

### **How do you feel about going into space?**

Going to space is my ultimate dream – to look down on Earth & get a different perspective on the Universe

Bound to be some apprehensive moments – had some of those already during 20 years of flying!



Tim Peake during recent underwater training to simulate an asteroid mission **Credit: ESA**

## Teaching resources

image top right: Delegates at the conference

Credit: ESERO

### Space for learning

**Resources are now available from a conference celebrating the use of space to enrich teaching and learning.**

ESERO-UK, the UK Space Education Office, recently held a conference for organisations that provide support to teachers and students in the use of space as a context for enhancing teaching and learning in schools. Attended by representatives from space agencies, Government, industry and other key organisations, the event celebrated the work carried out by many groups in the UK that promote space as an inspirational context for teaching STEM subjects.

The event kicked off with an inspirational space lecture from Professor David Southwood, former Director for Science at ESA and President of the Royal Astronomical Society. Delegates were then given the opportunity, through a soapbox session, to exhibit teaching resources and showcase excellent practice. Each three minute slot was packed with information and ideas for using space in the classroom. The afternoon session included a teacher panel, so that attendees could listen to teachers and understand what they need to enrich teaching and learning of STEM subjects.

You can view the speaker presentations, find out about the teachers on the panel and see the myriad of information from the soapbox sessions on the ESERO-UK website:

[www.esero.org.uk/news](http://www.esero.org.uk/news)

Meet the team:

#### Allan Clements

ESERO-UK manager



#### Tom Lyons

ESERO-UK Teacher Fellow



#### Alice Coates

STEM Project officer, National STEM centre



### Space Education Directory

ESERO-UK has started to create an ESERO-UK Space Education Directory. This directory currently lists the contact details and education activities from providers who attended the conference. The intention is that this directory will grow over time, to capture space related education activities from across the UK. The latest draft of the directory is available on the ESERO-UK website.

# Made in the UK

**SCISYS provides spacecraft and ground control centres with software. Chris Lee, business development manager from the company's Space Division, tells *space:uk* about its huge range of work:**



**Chris Lee**  
Business  
Development  
Manager

## How important is software in today's space industry?

All modern satellites have software at the heart of their operations. SCISYS covers all parts of the mission: onboard software inside the satellite to control the payload or manage resources, software on the ground within the mission control system, and in the data processing and receiving system – gathering data from the satellite and turning it into useful information.

## Where can SCISYS technology be found?

Recent missions include CryoSat-2, SMOS, the Meteosat Second Generation ground system and many of ESA's deep space missions, such as Mars Express, Venus Express and Rosetta. Currently we're working on the Galileo ground system, developing the software for the ESA Swarm and Aeolus missions and starting work with CubeSats. Quite a diverse range.

## What work are you most proud of?

For our ground segment team, it would probably be the mission control facility in Darmstadt, Germany, for EUMETSAT and their Meteosat Second-Generation series of satellites. It's possibly the most automated mission control in Europe.

Meanwhile our 'onboard' software team is looking forward to more autonomous missions – where a spacecraft or rover can think for itself and take decisions based on what it senses about its environment. We recently supported an experiment for ESA in Chile's Atacama Desert driving a Mars rover for 6km using low cost sensors, without any ground intervention. We think that's a world first so our team is rightly proud of that. If we can show ESA that these things are credible then they'll include them on future missions.



Image bottom left: SCISYS software is onboard ESA's Rosetta spacecraft, which is on an 11 year mission to a comet  
**Credit:** ESA

Image top right: Testing rover software  
**Credit:** SCISYS



## How does this compare with current Mars rovers?

If you look at the NASA Mars Exploration Rover missions, Opportunity and Spirit, they could travel 100-200 metres self guided. The current Curiosity mission is geared to do up to 1km on a flattish plain and so what we're pushing is much further.

## SCISYS has offices in England (Bristol and Chippenham) and Germany, what makes an ideal SCISYS employee?

Obviously software skills are essential. But quite a lot of our activity is working on site with customers so we also need people who are flexible and have an affinity for travel and relocation. Our mission control centre staff need data communication or IT skills, while those who write our simulators – the software version of the satellite – need a physics and maths background.

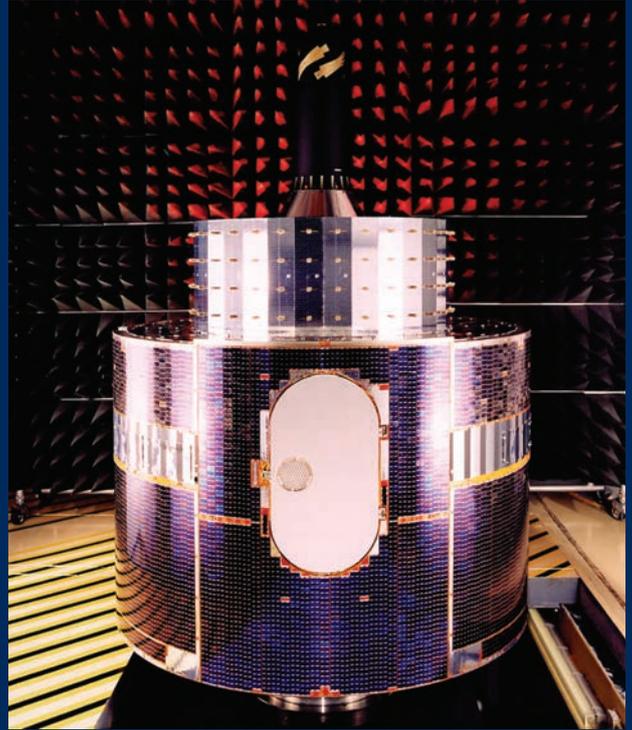
However, space is a business. We're around 450 people in total with 150 working on our space programmes here in the UK and in Germany. We are always keen to attract staff with a broader, commercial perspective – especially those who are motivated to meet customers and understand their needs.

# Meteosat-1

**Europe's first weather satellite was launched in November 1977, providing a permanent view of the weather across 100 countries.**

The information provided by weather satellites not only helps you to decide whether to carry an umbrella, it is vital for the construction, transport and energy production industries. European satellites have been giving us continuous weather data for 35 years.

The project began in 1972 when the UK, along with seven other nations, committed to develop the Meteosat programme. The mosaic of solar cells on the main body of the satellite made Meteosat-1 look rather like a shiny disco ball. Weighing almost 63 Kg, the satellite's main instrument took measurements in three channels. The visible light channel showed cloud cover, the water vapour channel gave an indication of humidity levels, while the infrared channel could be used to determine the height of the clouds. The subsequent images were combined to give important meteorological information.



Europe's first weather satellite **Credit:** ESA

Meteosat-1 was launched into a geostationary orbit, so it always appeared above the same place relative to Earth. Meteosat-1 covered most of Europe, all of Africa, the Middle East and the eastern half of South America and was Europe's contribution to an international network of meteorological satellites that monitored the planet. The satellite was capable of generating a new set of images every thirty minutes, day and night, which enabled evolving cloud systems to be studied and weather patterns predicted.

One of the main benefits of the Meteosat system was the speed at which these images could be transmitted back to Earth. This changed the way that weather reports were created. Television stations incorporated satellite imagery into their weather forecasts to show how clouds were moving and pictures from Meteosat satellites have been seen by billions of people.

The UK continues to support the Meteosat programme which is now operated by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). The second generation of Meteosats, that provide even more frequent and comprehensive data, are currently active and a third generation is being developed.

