SPACE SHOWCASE

Inspiration for your World Space Week celebrations

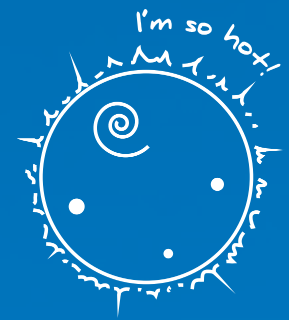
EXPLORE YOUR UNIVERSE

ATOMS TO ASTROPHYSICS

Contents

Image credit: ESA/S.Martí

Introduction



World Space Week

World Space Week is a global celebration that takes place every year from 4-10 October as designated by the UN. The dates represent two important events that opened up the exploration of Space; the launch of the first man-made satellite Sputnik-1 on 4 October 1957, and 10 October a decade later, when the treaty on the peaceful use and exploration of space was signed.

During this week, events take place across the globe that range from conveying the broad range of benefits space activities provide to the public, to inspiring the next generation of scientists and explorers.

In 2012 the UK Association for Science and Discovery Centres (ASDC) in partnership with the Science and Technology Facilities Council (STFC) offered small grants to ASDC members to help them to celebrate World Space Week in their communities. These grants were again offered in 2013 to ASDC members to increase awareness of the celebration, with a strong focus on highlighting contemporary activities that the UK and Europe is involved with.

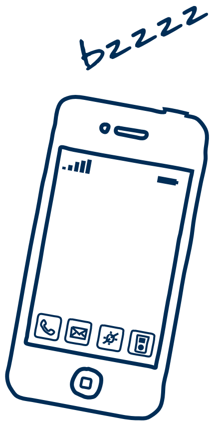
It is widely accepted that space has the power to engage a broad range of audiences with all the sciences, a context that can bring many subjects to life. Space is an exciting topic that has the power to spark the imagination. From looking at what life on other planets might be like, and learning how our own solar system formed, to discovering the host of technological innovations inspired by space research.

This booklet takes on board the expertise and learning from space engagement experts and our grant holders, and is intended to support awareness of current space activities that the UK and Europe are involved in, providing inspirational and intriguing research stories to link hands-on demonstrations to.

UK Association for Science and Discovery Centres

Science & Technology Facilities Council

1 SPACE TECHNOLOGY IN EVERYDAY LIFE



Space technology has impacted our daily lives in many ways, from the satellites that orbit the planet providing us with mobile communications and satellite navigation, to the myriad of ways that space technologies have been used for more 'earthly' applications.

Satellites

Currently there are estimated to be around 3000 man-made satellites in operation. The majority are dedicated to industrial and civil functions such as allowing us to forecast the weather, to remotely monitor land-use and infrastructure on Earth, to find our way around, and to relay television signals.

Because satellite positions are highly predictable, there are many web and smart phone apps available that can help pin-point their position, such as European Space Agency (ESA's) 'Where is the Satellite' (WIS), and 'GoSatWatch'.

ESA covers many activities, including telecommunications, satellite research and design, and providing the launchers and launching facilities to get the equipment to its intended place in space.

The UK has a thriving space-technology industry, turning over £9.1 billion a year. It specialises (and is a world-leader) in satellite development, design and manufacture. You can find your nearest space technology company by looking at the UK Space Education Office's website www.esero.org.uk/space-in-the-uk.

Currently, the majority of satellite navigation infrastructure in space is in fact American military equipment (the GPS system), but soon this will change; ESA's Galileo project aims to produce Europe's own civilian satellite navigation system. Over the next decade there will be staggered launches to achieve the full set of 30 Galileo satellites required for full operational capacity.

'The UK has a thriving space-technology industry, turning over £9.1 billion a year'

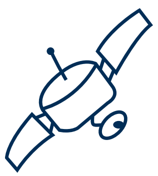
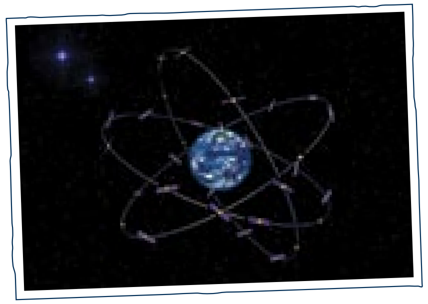


Image credits: kaczor58 / Shutterstock.com, ESA-J. Huart, NASA, Evan-Amos, ESA-P. Carril, 2012, Navtronics BVBA



Here on Earth

Some technology originally designed for space has found more 'earthly' applications. There are some classic examples of space technology in our lives, such as freeze-dried food, cordless power tools and the infrared thermometer. Did you know that space technology has found its way into a broad range of industries, and that this is something that ESA actively supports? The process of adapting technology from one use to another is known as knowledge transfer.

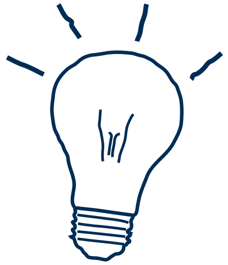
Technologies deployed in space need to cope with harsh conditions, and must also be extremely durable and reliable. These constraints are addressed by engineers and designers who often come up with innovative new solutions, employing new materials, design processes or software. This drives innovation and accelerates technological development. When new uses back on Earth become apparent, 'spin-off' companies can then develop the technology.

Examples of these space 'spin-offs' are:

- Sensing technology designed for the Canada arm used on the International Space Station is being used by a car company to improve its **airbag deployment**, pedestrian safety systems, and has even been used for touch-pad interfaces.
- Technology designed for safely **landing the sensitive Huygens probe** on Saturn's moon Titan has been used by a packaging company to learn more about how to drop a potato chip into a bag without it breaking, consequently speeding up the time it takes to pack crisps.
- The light-weight and high-strength carbon fibre material originally designed for use with the Alpha Magnetic Spectrometer (AMS-01) experiment, currently studying anti-matter on the ISS, was used to make **high-performance prosthetic limbs** that have been used by Paralympians.
- A special kind of satnav has been developed for use by **farmers to automatically steer tractors** with centimetre accuracy, improving efficiency, productivity and producing less impact on the environment.
- Super-efficient data compression software developed originally for saving the massive amounts of data created by earth observation satellites is utilised in phones and PCs **to allow more data to be stored**, at high quality.
- Clean air-flow technology designed to keep the recycled air on the ISS free of viruses and bacteria **is used on aeroplanes**, in hospitals and for food transport systems.

Worksheet 1

DESIGN YOUR OWN SATELLITE



What you'll need

- Boxes, tubes, tubs and other craft materials
- Glue
- Paint
- Tin foil
- Paper
- Pens
- Calculators

How long it takes

15mins – several hours (depending on detail)

What to do

1 First of all introduce the range of different activities that take place in space and the idea of a satellite, and use some examples of local industries and research to convey what different sorts of satellites can be used for.

2 You can demonstrate the idea of perpetual free-fall of satellites using a larger sphere for Earth and a smaller object to represent the satellite.

3 Ask what sorts of equipment a satellite might need to be able to do what it needs to do.

4 Introduce the idea of the expense of launching objects in to space – based on £ per Kg.

5 Ask participants to think about how they might address this issue (e.g. material design, only sending up required equipment etc).

6 Get participants to think up a problem they think they would like to solve by using a satellite.

7 Get them to design the satellite on a bit of paper.

8 Now let participants make their satellite design.

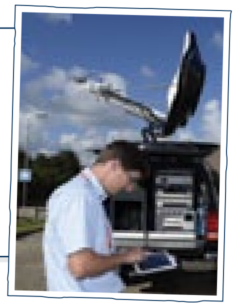
9 Let each team/individual present their satellite design.

Top tip

Some people might not realise how many people and companies in the UK and Europe are involved in designing, testing and building satellites and other space technology. Highlighting these activities can spark the imaginations of people and bring space a little closer to them, as well igniting aspirations about possible career directions.*

Other resources

- **www.esa-downtoearth.eu**
- **www.esero.org.uk**
- **www.esa.int**
- **www.bis.gov.uk/ukspaceagency**
- **www.howstuffworks.com/satellite.htm**



*The UK satellite industry is looking for more 18 year olds to train **bit.ly/132OEKP**

Image credits: ESA - A. Le Floc'h, ESA

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EARTH OBSERVATIONS

'The UK Space Agency will invest over £200 million on Earth Observation and related satellite technology over the next 5 years'

There's a lot happening on our little blue planet that can be hard to track from the ground. A birds-eye view from space can give us greater insight into what's happening across large areas, and how this changes over time.

Climate monitoring

One of the most well-known uses of Earth Observations (EO) is to help weather forecasters. Satellites such as MetOpA and MetOpB provide detailed measurements of cloud cover, temperature, humidity, and wind speed and direction. Combined with ground-based measurements, meteorologists can build up detailed pictures of current weather conditions and then model what might happen, helping to produce more accurate forecasts.

More than simply helping you know whether to take an umbrella, weather information is vital for transport, construction and energy production.

Taking earth observation data from accross the globe over time climate scientists build up complex models of how our climate is changing, and what factors affect these changes, be they natural or man-made factors.

A particularly startling example of how we've watched the planet change is the changing levels of ice cover at the poles. You can find out how CryoSat has been using its twin radars to monitor polar ice cover on ESA's website (**bit.ly/16wQp5J**). Unfortunately, there has been a 9% decrease in the volume of arctic sea ice between 2003 and 2012. This may have knock-on effects on our global climate, by changing for example the salinity of the oceans and their currents, carbon dioxide release, or how sunlight is reflected from the surface back out to space. (**bit.ly/Wl2wPe**).

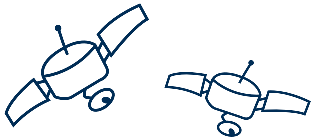
BIOMASS is a satellite that ESA will be launching in 2020, that will be capable of detecting the mass of living vegetation across the

northern hemisphere on Earth. Data from this will provide climate researchers with more information on the carbon cycle, which is an integral part of understanding CO_2 recycling and storage, and therefore providing more accurate information on its potential effects on global temperature change over time.

There's a whole host of other important satellites and projects studying our climate, check ESA's 'Observing the Earth' section of their website for more information **www.esa.int/Our_Activities/Observing_the_Earth**.

Land use

ESA's Earth Observation (EO) data is freely available through their website for researchers. The Data User Element (DUE) app shows a range of examples of how datasets have been used and applied to practical solutions by charities, companies and more.



Some examples of the ways that satellites can provide information for land management are:

- **Natural Resources:** Satellite data has been used in Norway to accurately measure elevation and snow-cover, giving clearer information to predict how water will run-off high ground and collect in basins. This enables hydroelectricity operation analysts to optimise energy production and set electricity prices. EO also helps with identifying the sunniest spots to place solar panels, and the windiest areas to erect wind turbines.
- **Agricultural forecasting:** EO satellites can detect biomass and even detect the health of vegetation and soil moisture, for example cultivators can determine more precisely how and when to act with irrigation. EO has also been used effectively to guide rice farmers in how much to irrigate rice paddies, by showing when the rice is in its latter stage of growth and is healthy – saving potentially scarce water supplies and helping to produce more rice – one of the world's staple foodstuffs.
- **Urban monitoring:** EO has been used to monitor the expansion of cities to give an overview of urban growth so that energy distribution can be optimised. This helps the environment. EO can also be used to help plan urban areas e.g. where to place mobile telecommunication antennae and to efficiently plan the provision of utilities.

Image credits: ESA, ESA - P. CARRI

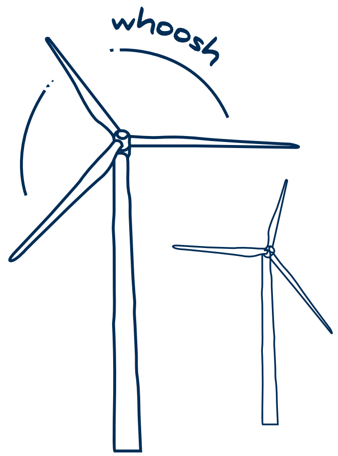
- **Transportation routing:** Information obtained from EO satellites can provide long-distance route planners with detailed information on the lay of the land to help decision making when laying out routes for road and rail. EO data can also provide information on the movement of land, for example by helping developers to avoid construction on land liable to subsidence. EO data has also been used to provide guidance for the areas most in need for snow plough efforts after winter storms.
- **Archaeological use:** Satellite images in visible and infrared light have directed archaeologists to sites of interest – e.g. University of Oxford researchers have discovered important Roman villas by looking at coastal sites in Libya by satellite before visiting the site on foot to carry out more extensive assessments.

Disaster management

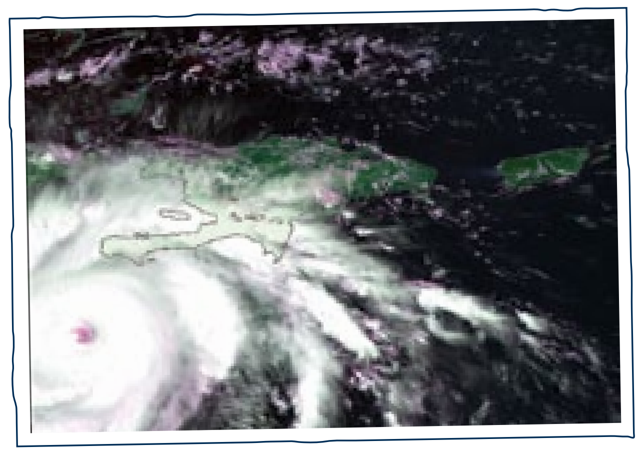
When disasters such as floods volcanic eruptions, forest fires or Earthquakes strike, the capability to map and follow the event can help response teams to better direct and focus relief, and react to the needs of people caught up in the disaster in a more efficient manner.

These days getting this information quickly couldn't be easier thanks to a special international treaty. Activation of the International Charter of Space and Major Disasters ensures images from satellites can be accessed by just a phone call.

ESA's 'Earth from Space' booklet is available free for the iPad via iTunes, and ESA Web-TV runs a regular slot on 'Earth from Space', highlighting a breadth of different projects and applications of EO technologies.



'Activation of the International Charter of Space and Major Disasters provides images from satellites, and is just a phone call away'



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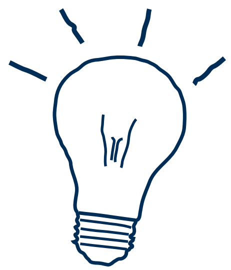
Worksheet

THERMAL SWIRLS



What you'll need

- Hot water
- Cold water
- A tray or basin
- Thermal imaging camera

How long it takes

10 minutes

What to do

1 Once you've introduced the principles behind what infrared radiation is, set up the significance of being able to measure temperatures across Earth over time.

2 Take a tub, tray or basin of cold water and show what it looks like through an infrared camera.

3 Take a cup of boiling water; again show what it looks like on an infrared camera.

4 Focus the thermal imaging camera on the tray.

5 Pour in the boiling water.

6 Observe the temperature-driven currents that begin to form.

7 Investigate how different factors affect how these currents are set up, e.g. salinity.

8 Introduce how various currents in the ocean and the atmosphere can affect global temperatures and weather over time, e.g. to show the effect the polar ice caps melting may have.

Top tip

The time and size scales of our planet are hard to grasp – using surprising examples can help people start to understand how small changes over time can result in big changes. For example Mount Everest is growing by around 5cm every year, so hundreds of millions of years ago it was the sea floor.

Other resources

- National Centre for Earth Observation **www.nceo.ac.uk**
- EduSpace - ESA's educational resource based on EO **www.esa.int/SPECIALS/Eduspace_EN**
- Search YouTube for 'Earth from Space' for a selection of stunning views of Earth.
- A selection of EO projects and quotes from the researchers leading it at **bit.ly/17XDG0S**
- Hints, tips, research and info on climate change outreach **www.climateoutreach.org.uk**

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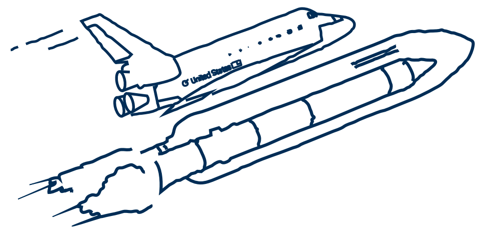
HUMAN SPACEFLIGHT



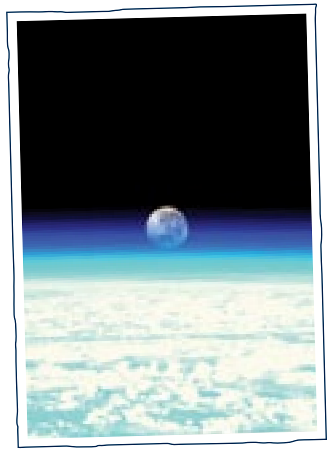


Image credit: ESA/NASA

The first manned spaceflight took place on April 12 1961 when Russian cosmonaut Yuri Gagarin orbited Earth once aboard the Vostok-1 spacecraft before returning safely. Since then over 530 people from 38 nations have been into space, but only 12 people have made it to the Moon.

Fun facts:

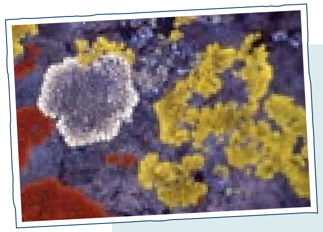
- Russian Valeri Vladimirovich Polyakov holds the record for longest single spaceflight, at over 14 months in space aboard the Mir Space Station.
- Activated charcoal filters are used to remove methane produced by the intestines, and ammonia from astronaut's sweat on board the ISS.
- Helen Sharmen was the first Brit in space. She's a chemist originally from Sheffield who worked for a time at Mars investigating the flavours of chocolate.

'All research is intended to provide benefits for us back on Earth in our daily lives, and in preparation for future human spaceflight beyond Earth'

Since November 2000, Earth's orbit has had a continuous human presence aboard the International Space Station (ISS). The ISS is an international collaboration between the American, Russian, Japanese, Canadian and European Space Agencies, providing a platform to carry out important scientific research, and to develop new technologies.

ESA have led 110 experiments in space, centred on the Columbus Laboratory module. The topics of these experiments include fluid physics, material sciences, radiation physics, the Sun, the human body, biology and astrobiology (the search for life on planets other than our own). All research is intended to provide benefits for us back on Earth in our daily lives, and in preparation for future human spaceflight beyond Earth.

Examples of research projects on board ISS include:



- **Biology:** An experiment undertaken outside the ISS exposed different organisms to the conditions of space, from lichens to bacteria and algae to see whether they could withstand the harsh environment. The samples, when returned to Earth, showed that Lichens could continue to grow once exposed to space. This supports hypotheses that life could possibly survive transit through space, e.g. on asteroids.
- **Physiology:** An interesting result from research on astronauts may hold implications for people back on Earth with osteoporosis. In microgravity, humans absorb more salt and less fluid, and this, rather than the microgravity environment itself, is what is responsible for the loss of bone density experienced by astronauts who stay in space for prolonged periods.
- **Physics:** Investigating liquids made of suspensions of tiny particles is hampered here on Earth because of gravity. Research on the ISS has led to important findings on how quantum forces can control the structures in these 'colloidal' fluids, paving the way for future developments in creating nanomaterials.
- **Astrophysics:** The Alpha Magnetic Spectrometer (AMS) is mounted on the outside of the ISS. It is looking for antimatter from cosmic rays, and is hoped to reveal the mysteries behind dark matter, providing insight in to the formation of the universe.

'Most eyes are on Mars for the future, and even private investors have been looking to lead a manned mission to Mars'

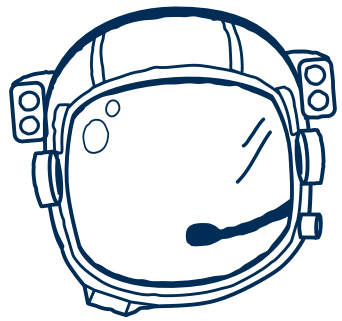
The ISS itself is a marvel of engineering endeavour, and many benefits have spun off from items initially developed for use on board.

The ISS is a modular structure made up of 18 pressurised sections, including additional structural and power-providing components. It was completed over time, through successive additions of new modules, with more planned for the future. ESA leads the Columbus laboratory module, and completed the Cupola that has a turret-like structure featuring a window through which astronauts can get an amazing view over Earth.

Six crew members can be aboard the ISS at one time. They need to be protected from the harsh environment of space that has high radiation levels, low temperatures and no pressure. Contrary to popular belief, their blood wouldn't boil (skin is a pretty good container) rather they would be more likely to suffocate due to the lack of air. In addition to the science and servicing equipment, there are sleeping quarters, a galley (kitchen), exercise equipment and a myriad of life support systems, which provide an Earth-like atmosphere, maintain temperature and ensure a 'fresh' water supply.

Image credits: NASA, ESA - T. Peake, ESA - M. Koell, 2009

'In November 2015, Major Tim Peake will be the first British astronaut sponsored by the UK Government to go into space, with a 6 month mission to the ISS'



Being in microgravity for long periods of time can have adverse effects on the human body including muscle atrophy in the legs and back. Astronauts require extensive physical rehabilitation upon return. Microgravity can also decrease the strength of the immune system.

Astronauts undergo lengthy and intense bouts of training before going up to space. ESA's 'CAVES' expeditions provide experience of isolation and intense team-working for future astronauts. It involves a week-long journey deep into the caves of Sardinia, with a programme of scientific research. CAVES 2012 even identified a new species of cave-dwelling woodlouse.

But you don't need to go out to space to experience some of the aspects of what a manned mission to Mars might be like. Facilities in Germany and Russia carry out 'bed-rest' and isolation experiments, such as the 'Mars 500' experiment that simulated a mission to Mars, shutting crews away in a mocked-up space ship for over 500 days in one go, even simulating delayed communications.

Most eyes are on Mars for the future, and even private investors have been looking to lead a manned mission to Mars, such as 'Inspiration Mars' and 'Mars One', which intend to start a Human settlement. Other possible manned missions to comets have been proposed and Tim Peake has even done some training related to this objective.

Space tourism is another avenue that has progressed. Currently, only 7 people have been to space on 'private missions'. Private start-up companies such as SpaceX and Virgin Galactic have had successes.

Worksheet

EXPLODING MARSHMALLOWNAUT

What you'll need

- Bell jar and vacuum pump
- Marshmallows
- Cocktail sticks
- Tin foil (optional)

Or simply use...
a syringe and marshmallows

How long it takes

5 minutes

What to do

1 Start off by asking what might be required to survive in space and whether anyone knows what would happen if astronauts didn't have spacesuits. Discuss the effects of pressure, e.g. from our atmosphere.

2 Show the effect of pressure on the boiling point of a liquid. Put some hot (but not boiling) water in a syringe, trapping a bubble. When you pull the plunger with the end covered the water boils.

3 Create your Marshmallownaut using cocktail sticks and marshmallows.

4 Introduce Mr/Ms Marshmallow – a new astronaut, or Marshmallownaut. Place inside the bell jar and seal, or in a syringe.

5 Turn on the vacuum pump or pull on the syringe with your finger covering the end of the syringe and say how you're creating a vacuum, decreasing pressure.

6 Describe what is happening to Mr/Ms Marshmallow (i.e. he is growing in size; the pockets of air in the marshmallow are expanding).

Alternatively you can use a semi-inflated balloon in a bell jar and watch it expand.

Top tip

We can't go to space, but we can bring space a bit closer with our imaginations. Immersive environments and narratives, such as building little sets or using role play, can be a powerful way of using people's imaginations to bring any activity alive. Try dressing your Marshmallownaut in a tin foil space suit and watch it rip as they expand!

Other resources

- ESA's Volare mission blog – **blogs.esa.int/luca-parmitano**
- Mission X, train like an astronaut – **www.trainlikeanastronaut.org**
- Spaceship Earth resources – **www.esa.int/Our_Activities/Human_Spaceflight/PromISSe/Spaceship_Earth**
- We Are Aliens activity resources from the National Space Centre (inc. videos) **www.wearealiens.com/resources/classroom-activities/physics**

4 WHAT'S OUT THERE?

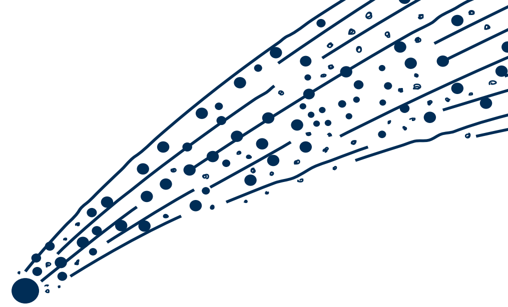


Image credit: ESA

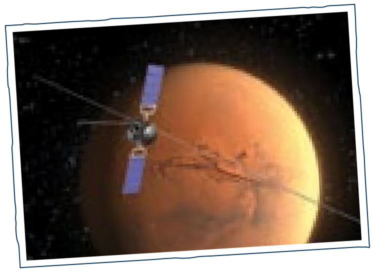
'The Huygens probe is the only device to have landed on anything in the outer solar system'

Earth is just one of 8 planets, many more dwarf planets, and other smaller objects, orbiting our Sun. Whilst early discoveries and observations were all made by peering outwards, more recently we've been sending out various probes to investigate our celestial neighbours and send back information.

Cassini-Huygens is a recent example of a mission to learn more about our solar system – specifically Saturn and its Moons. Launched in 1997, led by NASA and ESA, its 7-year journey to Saturn took it past Earth, Venus and Jupiter. Since it reached Saturn we've learnt more about the planet and its atmosphere, its moons, and in fact discovered 7 more moons. It carried the Huygens probe that landed on Saturn's moon Titan, the only device to have landed on anything in the outer solar system. It relayed information back about the surface of the moon, which is of interest because of the presence of organic molecules.

Rosetta has been hurtling around the solar system for 9 years, to catch up with Comet 67P/Churyumov-Gerasimenko. It'll be awoken from hibernation in January 2014 to catch up with the comet, and over several months seek to rendezvous and orbit around it. The orbiter will then release a probe, called Philae, to dock with the comet. This is the first time anything will have ever 'landed' on a comet, and it is hoped that it will provide researchers with information on the composition and behaviour of the comet as it comes closer to the sun and begins to create the well-known tail, or coma. Comets are some of the oldest unchanged objects in the solar system, effectively time capsules. Rosetta will provide new insight into the formation of our solar system, and other planetary systems around stars other than our own.

A little bit closer to home, **ExoMars**, the European mission, which includes landing a rover on Mars, is due for launch in 2018. This will be looking for signs of life past and present on the red planet. This



is the first mission to Mars that will have the ability to drill deep under the surface of the planet, where radiation cannot penetrate, collecting samples to search for the tell-tale signs of life.

Venus Express launched in 2005 and is still operating. The craft has, and continues to provide, the most comprehensive study of the Venusian atmosphere yet. The long duration of observations has given scientists insight into the dynamics of Venus's atmosphere, possibly contributing to our understanding of climate change back on Earth. Venus Express observed lightening, and found evidence of past oceans.

BepiColombo is a partnership between ESA and the Japanese space agency, JAXA, to send a craft to orbit around Mercury to provide detailed insight into the planet. The mission is due for launch and will be carrying a variety of instruments that will provide information on the formation and evolution of Mercury, including details of the composition of the planet and its atmosphere, study its magnetic field and also confirm Einstein's theory of general relativity.

Another ESA mission planned for launch in 2022, 'Jupiter Icy Moons Explorer' (or JUICE), will explore Jupiter and its moons. In particular the mission will be taking detailed looks at the moons Europa, Ganymede and Callisto, of interest to astrobiologists as possible harbourers of life. All of these moons are thought to have reservoirs of liquid water underneath icy crusts.

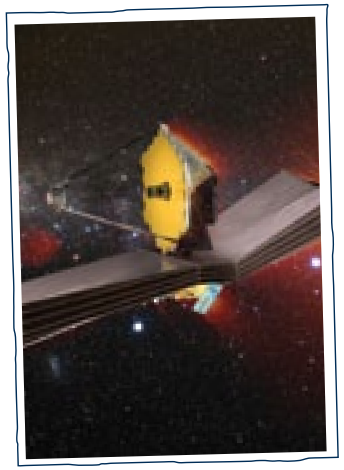
Many telescopes, ground-based and space-based, have captured breath-taking images of our celestial neighbours and galaxies further away. We've seen the different stages of the life-cycles of stars and caught the earliest glimpses of galaxies, giving us greater understanding of the universe.

Planck looked at the oldest light in the universe, formed just 380,000 years after the Big Bang. This light is now present all around us as microwaves. The detailed map Planck produced showed that the cosmic microwave background (CMB) featured areas with stronger or weaker signals than others. This is helping researchers understand why our galaxy looks the way it does now.

Herschel looked at infrared light, allowing us to see through the vast swathes of cosmic dust blocking visible light. This provided a view to the centre of our own and other galaxies, and captured new information about the birth of stars in nebulae.

Kepler watches a specific patch of sky to spot exoplanets – planets around stars other than our own. Specifically Kepler is looking for tiny periodical dips in the intensity of a star's light as a planet passes in front of it (transit method). To date there are 723 confirmed and 3098 candidate exoplanets recorded in the Kepler database (correct June 2013). Planethunters.org has allowed amateurs to get involved in the search for exoplanets via the internet and smartphone apps.

Image credits: ESA, C. Carreau, ESA - P. Carril, ESA/ATG medialab; background: ESO/S. Brunier, ESA - C. Carreau, ESA



'ExoMars, the European mission that includes landing a rover on Mars will be looking for signs of life past and present on the red planet'

The next generation of telescopes are due for launch soon. First will be Gaia in October 2013, which is set to survey the stars in our own galaxy in unprecedented detail. Gaia will create a 3D map of one billion stars - more than ever before but still only 1% of the stars in the Milky Way. It will answer questions about the structure and formation of the solar system and help researchers understand more about the formation of our galaxy. It may also help us discover more exoplanets.

The James Webb Space Telescope (JWST), the successor of Hubble, is due for launch in 2018, and features a 6.5m diameter mirror which will provide researchers with incredibly detailed information on objects outside our own solar system. This will provide us with further insight into the birth and death of stars, and the formation of planets and galaxies. It might even be able to give us information on the make-up of the atmospheres of exoplanets orbiting nearby stars. The Mid-Infrared Instrument (MIRI) is a British-led instrument for the JWST that has been built at the UK Astronomy Technology Centre in Edinburgh and is so sensitive it could spot a candle burning on Jupiter.

Space is big. Really big. So logically, according to Drake's famous equation, there must be life out there. Of the billions of stars in our own Galaxy, some will have planets orbiting them, and some of those may have conditions ripe for life, if they orbit in the so-called Goldilocks zone. Perhaps not life as we know it, but living organisms nonetheless. And of course, our galaxy isn't the only one in the universe. And we know that life on Earth can survive in some of the most extreme environments. But will we ever make contact?

Drake's Famous Equation

www.seti.org/drakeequation

$$N = R^* \cdot f_p \cdot n_e \cdot f_e \cdot f_i \cdot f_c \cdot L$$

Where: N = the number of civilisations in our galaxy with which communication might be possible; and R* = the average number of star formation per year in our galaxy, fp = the fraction of those stars that have planets, ne = the average number of planets that can potentially support life per star that has planets, fl = the fraction of planets that could support life that actually develop life at some point, fi = the fraction of planets with life that actually go on to develop intelligent life (civilisations), fc = the fraction of civilisations that develop a technology that releases detectable signs of their existence into space, L = the length of time for which such civilisations release detectable signals into space.

Worksheet 4

SIGNS OF LIFE

What you'll need

- Samples per group (in clear tubs or jars):
  - **Sample A**: 3 tbsp sand, 1 tbsp sugar and 1.5 tsp yeast.
  - **Sample B**: Sand, sugar and a crushed effervescent tablet.
  - **Sample C**: Sand and sugar only.
- Each group will need a cup of hot water.
- Worksheets to record observations before, during and after.

How long it takes

45 minutes

What to do

1 Ask "What is life?" Discuss what signs we might look for when searching for life on other planets, and how these will differ from other dynamic processes.

2 Give each group a set of samples and ask students to describe what their samples are made from. The samples should more or less look the same.

3 Ask students to discuss in what sorts of ways they might be able to discern any differences between the samples.

4 Give each group a cup of hot water (not so hot that you cannot hold it), and tell them to add enough to cover the material in each sample.

5 Ask them to observe what happens to each sample, recording what they see over a period of 5-10 minutes. Sample A will create bubbles after about 5 minutes. Sample B will start fizzing instantly. Sample C will do nothing.

6 Discuss the basis of what might have caused differences (e.g. quick, chemical reactions vs. sustained slow biological reactions).

7 Discuss past and on-going investigations of our solar system and exoplanets e.g. Goldilocks zones, and other signs astrobiologists may look for such as tell-tale chemical signatures of organisms.

Why not incorporate this as part of a '**build your own Martian rover**' activitiy? For this, you simply need to get your hands on building materials, such as Lego, K'Nex, or craft materials. You can give aims and objectives to participants e.g. design your rover to collect a sample to be analysed.

Top tip

• Young kids often don't realise that the equipment that is sent to other planets won't be coming back – if you have replica rovers, be sure to point out that the real thing stays on the planet.

• Visitors often assume that astronomical images are computer-generated images – be sure to point out they're real!

Other resources

- **www.planethunters.org**
- Explore Herschel's images using Chromoscope from Cardiff University - **www.chromoscope.net**
- **www.galaxyzoo.org**
- Is there anyone out there? Resource from ESERO-UK - **bit.ly/1a3e4jP**
- Dark Sky Discovery activities **www.darkskydiscovery.org.uk**
- Exoplanet activity using real data from the Royal Observatory Edinburgh - **bit.ly/12JAUCZ**
- Search **esa.int** for missions e.g. factsheets.
- World Space Week's Activity Guide for Teachers - **bit.ly/16GtNOx**

ABOUT ASDC AND STFC

ASDC brings together over 60 major science engagement organisations in the UK. Together we strive for a society where people of all ages and backgrounds have an opportunity to enjoy and explore science, and feel a sense of shared ownership over its direction. Each year our members engage over 20 million people with the wonders of science.

STFC is a world-leading multi-disciplinary science organisation, with the goal of delivering economic, societal, scientific and international benefits to the UK and its people – and more broadly to the world. Part of their function is to help ensure a future pipeline of skilled and enthusiastic young people by using the excitement of their sciences to encourage wider take-up of STEM (science, technology, engineering and mathematics) subjects in school and future life.

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For information of who has been awarded World Space Week grants, please refer to the ASDC website, **www.sciencecentres.org.uk/projects/world_space**.


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