

## **Research Space**

Online educational resource

**The Power of Light Zine 3 - Why do we explore the world around us? - an epistemically insightful way to explore the nature of science and research at Diamond Light Source, UK**

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Exploring ways we can investigate Big Questions about ourselves and the world around us

# Why do we explore the world around us?



Every autumn, Monarch butterflies travel from northern places in the USA to warmer places in Mexico, and return to the north in the Spring. Why might the butterflies migrate every year?

Let's Investigate by thinking about the ways we find out more about the world around us.

1 Humans and other animals travel. Sometimes their explorations of new or different places is due to curiosity. By exploring we can find out about new places and learn more about our own familiar place or 'territory'. Sometimes migration occurs when we need to try to find a place with better environmental conditions so that we can live more comfortably.

2 Humans continue to develop tools to help us to explore and investigate what is on and beyond Earth. The following tools are used to see things that are small or far away:

- Magnifying glass
- Spyglass
- Microscope
- Telescope
- Synchrotron

How might these tools help us understand more about the world around us?

3 When explorers arrive in new environments, they might observe how plants (flora) and animals (fauna) have adapted and can flourish. In each part of the Earth, we can observe evidence of unique relationships between sunlight, water, and soil that enables life to adapt and thrive.

4 Let's investigate by thinking about the ways we find out more about the world around us. How can we explore environments that we cannot yet personally experience, like deep into the core of the Earth, or on another planet, or into the future?

5 Sarah is a scientist at Diamond Light Source who is helping to research environments beyond Earth... without stepping into a spaceship!

6 Imagine you are an explorer, and you have arrived in a place that is new to you (or a place you do not yet know much about). What might you learn about this new place by observing some of the flora and/or fauna?

In this zine we will...

...be exploring the work of scientists who observe and seek to understand how the world around us 'works'

...find out how and why scientists at Diamond work with astronomers, geographers and others

...wonder about how and why it is important to investigate questions about the world around us

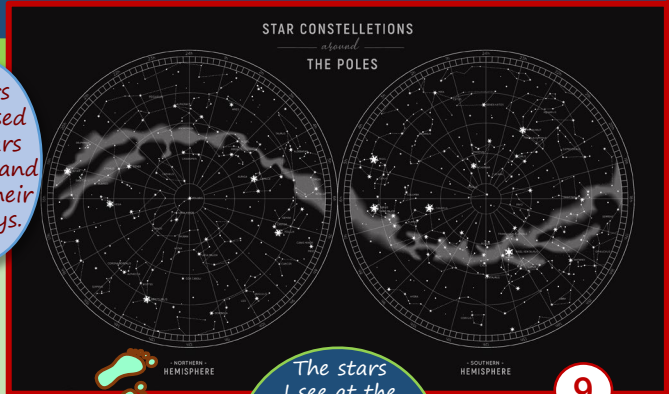




This is a map carved into a tablet made of clay. This map is on display in the British Museum, in London. Descriptions and place names are written in an ancient language, Akkadian. This map was carved about 3,000 years ago. It includes a city called Babylon, in a region now known as Iraq.

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Sailors have used the stars to map and guide their journeys.



The stars I see at the North Pole are different to the stars I see at the South Pole. Why?

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Maps are shared in stories, painted on cave walls, carved into clay, drawn and printed on paper, as well as created and stored digitally.

Maps can help travellers share a record of places where resources like water and food can be found. Maps are useful to record how the world (and our knowledge of it) changes.

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As humans discover more about our world, we use words and numbers to describe and share new knowledge

## EARTH

Our home planet is the largest of the eight planets in the solar system. It is also the largest of the four terrestrial planets.

Planetary Data		
Distance From Sun	Planet Diameter	Temperature
150 m km	12,756 km	20 °C
Planet Mass	Surface gravity	Planet Moons
$6 \cdot 10^{24}$ Kg	9.8 m/s <sup>2</sup>	1
Solar Orbital Period	Disastrous Period	
365 Days	24 Hrs	



## MARS

Mars is the fourth planet from the sun and the second smallest planet in the solar system; the reddish appearance of mars surface is caused by

Planetary Data		
Distance From Sun	Planet Diameter	Temperature
230 m km	6,794 km	-25 °C
Planet Mass	Surface gravity	Planet Moons
$6.4 \cdot 10^{23}$ Kg	3.7 m/s <sup>2</sup>	None
Solar Orbital Period	Rotational Period	
1.88 Year	25 Hrs	



If Fred weighs 88kg standing on Earth, his weight would be 33kg if he were standing on Mars!

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What is Mars like? Compare the numbers in these two images... then imagine you are standing on Mars! How might it be different to standing (and jumping!) on Earth? What might you observe around you?

### Key Words

**Particle** a very small piece of matter

**X-Ray** this form of light cannot be seen or felt – it is powerful enough to pass through most things, and is used to find out more about the structure of matter

**Synchrotron** works like a giant microscope, using the power of electrons to produce bright light (x-rays) that scientists can use to study anything from fossils to jet engines to viruses and vaccines

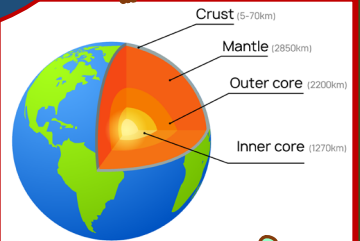
**Astronomer** a scholar who studies the origin and structure of the universe, including its stars, planets, galaxies and black holes

**Cartographer** a person who creates, draws or produces maps

**Sustainable** making choices that respect our environment so that natural systems can continue to function now and into the future

**Modelling** a scientific activity that tries to build our knowledge and understanding by using our observations of the world to create and test physical and technological simulations

the deepest parts of the oceans on Earth  
backwards into the past  
the centre of the Earth



11 Here are some examples of things and places we cannot travel to and experience (yet?)!

forwards into the future

Europa, one of Jupiter's moons

beyond the furthest star

How can we build our knowledge about places humans have never seen, or cannot yet safely travel to?

Sarah, Fred, Tina and other research scientists at Diamond Light Source use the synchrotron to model changes and environments





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When animals migrate, they tend to use routes that may have good places to eat and rest. Imagine you are preparing to travel in space... what might you need to think about when packing and preparing your spaceship?

Remember to think about what living beings need to have so that they can thrive like they would on Earth!



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The synchrotron is the machine that helps to generate the bright light used in experiments. Particles called electrons are fired into the machine, and made to travel at very high speeds (in accelerators) through a storage ring. Using powerful magnets, the energy of the electrons can be directed (as light) into experimental stations called beamlines. Scientists in these stations (laboratories) can observe, record and compare what happens to the light as it passes through, for example, some dust from a comet.

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Research taking place at Diamond Light Source helps us to investigate:

- storing, using and finding water in sustainable ways on Earth and in space
- making, storing and using energy cleanly and in sustainable ways on Earth and in space
- how galaxies have formed
- what conditions are important for life to exist on planets

Inside the storage ring... electrons travel around this for about half a day... an electron will complete about 2 billion laps!!

Magnets inside the storage ring



Storage Ring magnets - Copyright of Diamond Light Source LTD

Electrons inside travel so fast these could go around the Earth 7.5 times in one second!

### Observe, Compare, Record

Try these activities

Scientists like Sarah use models to observe the ways matter behaves, and these observations can help us to understand how the natural world works on Earth and in space.

**You will need:** a jar or glass, some water, some salt or granulated sugar or sand, a small spoon, and a torch.



Place the jar or glass on a dark surface.

**Method:** Partially fill the jar or glass with water. Hold the torch close to one side of the jar or glass, and shine the light through the water.

1) Observe what happens to the light when it has passed through the glass of water. What shapes are being made with the light?

2) Move the angle of the torch so that it shines from different sides and from above. Observe how the shapes made with the light change once it has passed through the water. Is the shape different when you shine the torch through the rim of the glass or jar, or from different angles?

3) Add a spoon of salt or sugar or sand to the water inside the jar or glass, and stir. Take the spoon out and shine the torch through the side of the glass. What is happening to the visible particles in the water? Shine the torch from above - what do you observe? (You could add some cooking oil and observe what happens to particles in the water.)

**For reflection:** Using light helps us to observe how particles behave in Earth's gravity. How might this experiment be different on Mars?

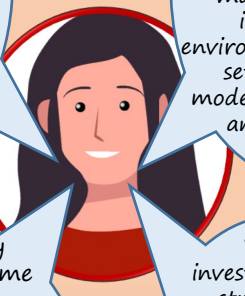
## Scientist Profile: Sarah

No one in my family had worked in science. When, as a teenager, I first looked through a telescope, I was amazed that there was so much that could be explored about space.

On my beamline I work with researchers including astronomers. We use the synchrotron to investigate how matter behaves in different environments. We can set controls to model temperatures and pressures in space.

My chemistry teacher helped me to investigate my questions about the relationships and changes that occur in matter. I watched films and read magazines and realised that scientists were like detectives trying to understand how pieces of a puzzle in this world fit together.

We are investigating the structure of molecules (e.g. water and gases) from the Earth's frozen Arctic, comets, Mars, and even deep in the oceans of one of Jupiter's moons (Europa). Using the synchrotron, I am also studying energy storage in batteries.



## 'Thinking like a scholar' Activity

This is a 'Discipline Wheel' – it includes some examples of 'ways of knowing' (disciplines). Viewing questions through different disciplinary lenses can help us think about how our actions can affect human life and the lives of other living beings. Investigate the Big Question in the middle through some of these different 'ways of knowing' (disciplines)?



**a** Fred and Sarah work with teams of research scientists who are trying to solve the puzzle – how can humans make, store and use forms of energy that are clean and sustainable?



SOLAR



WIND



HYDRO



GEOTHERMAL



BIOMASS



NUCLEAR



GAS



COAL

Fred uses scientific modelling to develop and test ways we can store radioactive waste. He wants to keep living organisms safe from harm now, and for thousands of years into the future.

**b** When exploring the world around us, scientists and other scholars often find their discoveries lead to more 'what', 'how?' and 'why?' questions about the world around us.

**c** Why do the explorations of space by scientists (astronomers, physicists, chemists, biologists) help us understand more about our world? What examples can you give?

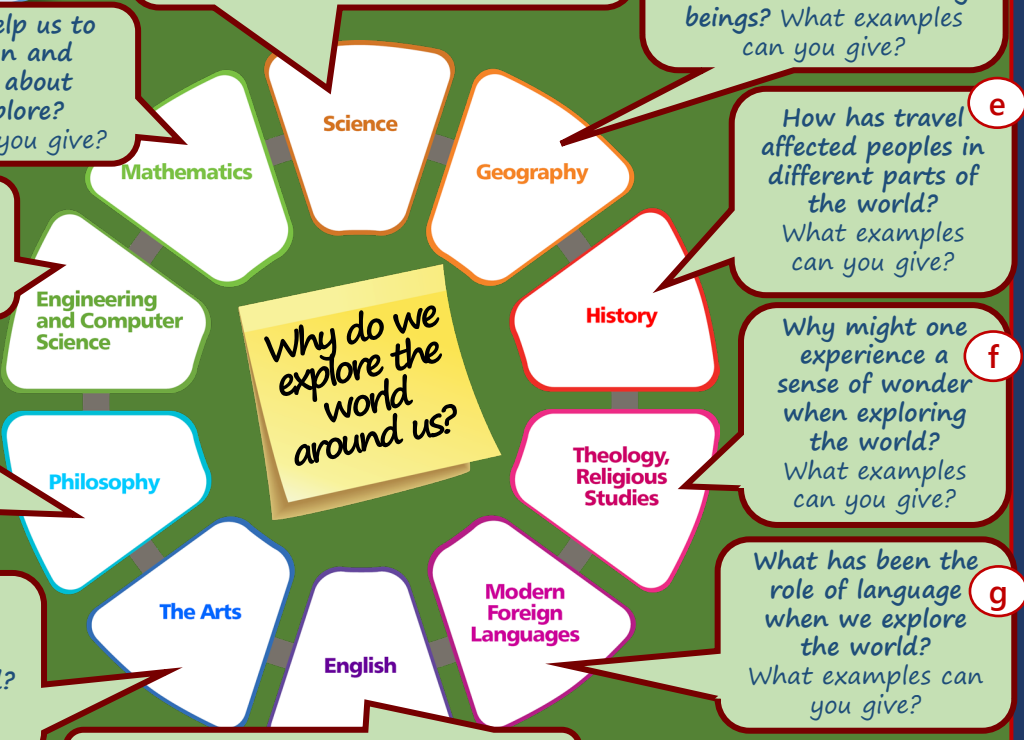
**d** How has travelling helped us to understand the relationships between natural environments and living beings? What examples can you give?

**l** How do numbers help us to record information and understand more about the places we explore? What examples can you give?

**k** What tools help us explore the world? What examples can you give?

**j** How does exploration change and build our knowledge? What examples can you give?

**i** What roles might art and music have when we explore cultures in the world? What examples can you give?



**e** How has travel affected peoples in different parts of the world? What examples can you give?

**f** Why might one experience a sense of wonder when exploring the world? What examples can you give?

**g** What has been the role of language when we explore the world? What examples can you give?

**h** What stories do people share about exploring the world? What examples can you give?

**Big Questions** are questions that explore being human and the world around us

When exploring Big Questions, science can help us answer precise, smaller questions. Investigating the world through different disciplinary lenses enables us build and use our knowledge in creative and sustainable ways. Give some examples of Big Questions that this zine has brought to your attention?

Find out more about how Diamond Light Source has helped to research questions raised by the Mars rover missions, other planets and galaxies... and about research taking place to support sustainable ways to produce and store energy. Visit [www.diamond.ac.uk](http://www.diamond.ac.uk) and search for 'science' then 'research'

For more info contact [lasar@canterbury.ac.uk](mailto:lasar@canterbury.ac.uk)

Epistemic Insight



The Power of Light

a UKRI funded project

co-creating resources

with schools, scientists and CCCU

This zine has been co-created with the help of STFC, Diamond Light Source, primary school teachers, the Epistemic Insight team at the Lasar Centre, and Canterbury Christ Church University, including images from NASA and Diamond Light Source (2022)