

# SPACE

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The universe is enormous. It includes absolutely everything, from the tiniest atoms to sprawling galaxies full of bright stars. Scientists still don't know how big the universe is, but they guess it contains about 2,000 billion galaxies! This immeasurable space is full of amazing sights and mysteries yet to be discovered...

Turn the pages and lift the flaps to explore the wonders of space, revealing layer after layer of incredible facts.



**Dark skies**  
It's best to look at the stars when it's very dark and clear, and away from city lights.

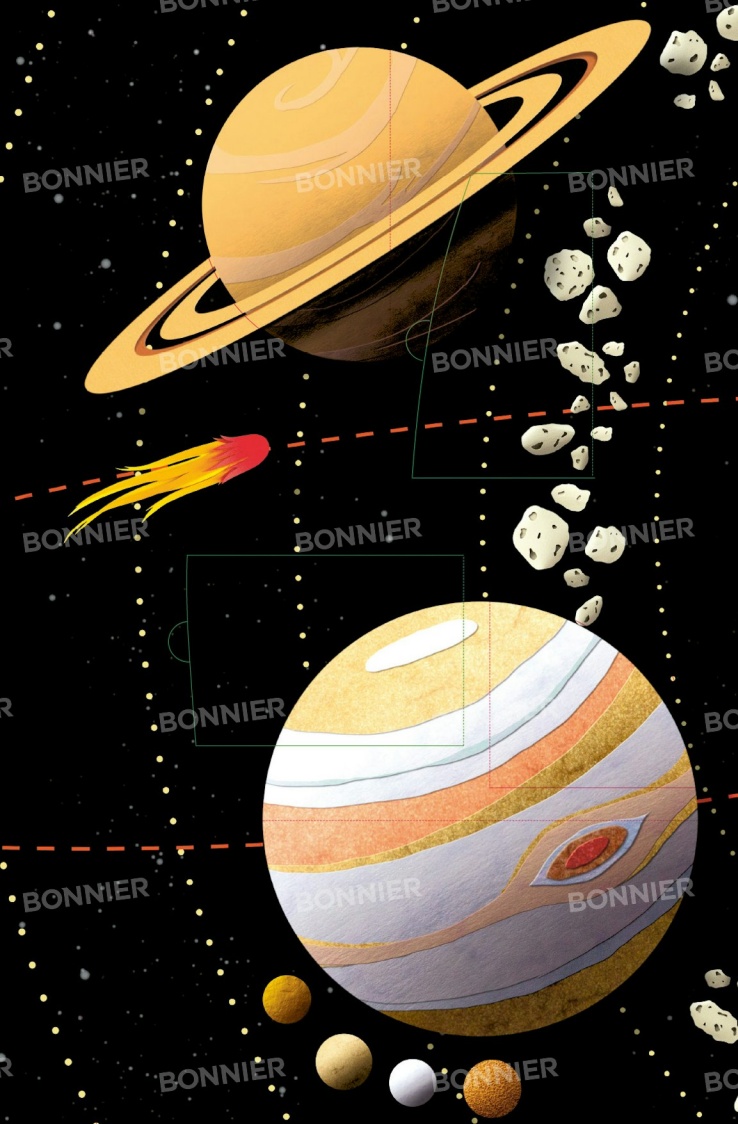
**Milky way**  
On a clear night, we can see part of the Milky Way – the galaxy we live in.

**Constellations**  
Some stars are clustered in groups called constellations. Many can be seen all over the world, but others can only be seen in the northern or southern hemisphere.

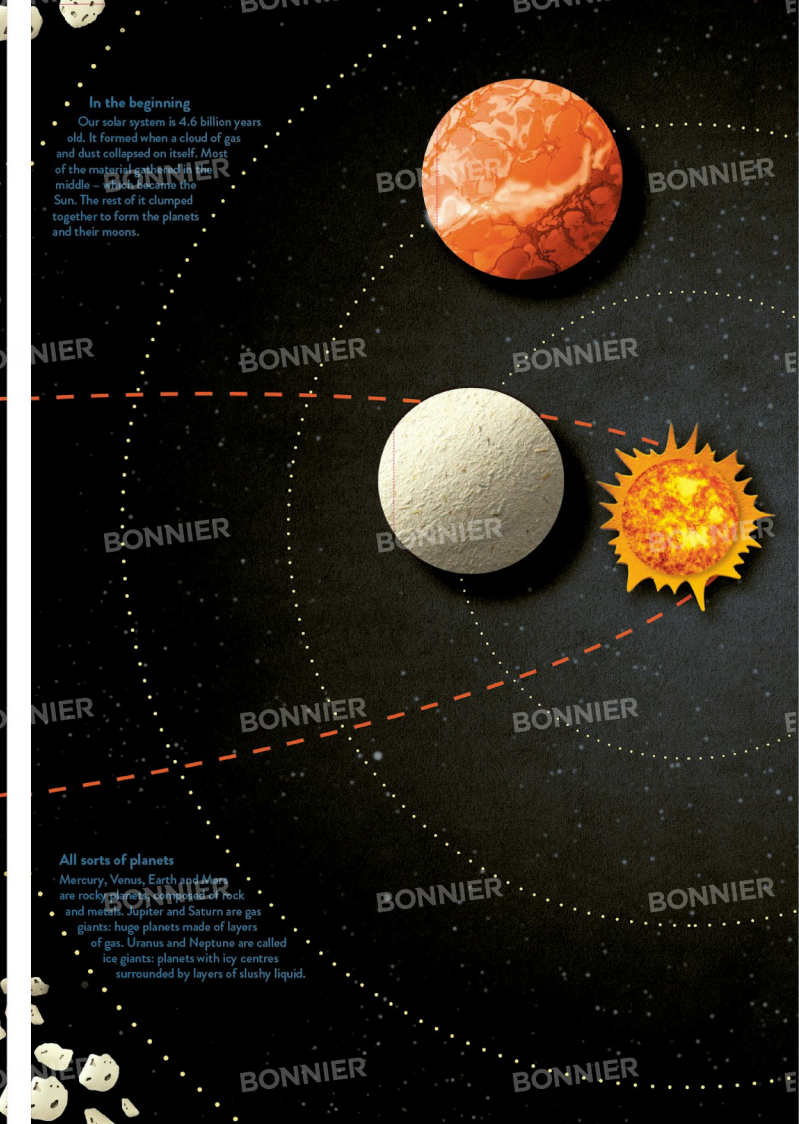
**Star colours**  
If you look closely, you can see some stars have colours. The hottest ones look blue; colder ones look red.

**Astronomers**  
Scientists who study space are called astronomers. The earliest astronomers lived in Babylonia, ancient Egypt and Rome. Many of our planets are still named after Roman gods – Jupiter is named after the king of the gods.

**On the move**  
Our planet Earth is constantly moving. It spins on its axis, giving us day and night. It also circles the Sun, giving us our seasons. Altogether that means we're travelling through space at more than 107,000 km/h!

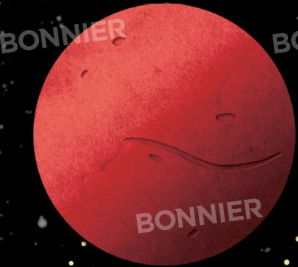


**In the beginning**  
Our solar system is 4.6 billion years old. It formed when a cloud of gas and dust collapsed on itself. Most of the material gathered in the middle - which became the Sun. The rest of it clumped together to form the planets and their moons.



**All sorts of planets**  
Mercury, Venus, Earth and Mars are rocky planets composed of rock and metals. Jupiter and Saturn are gas giants: huge planets made of layers of gas. Uranus and Neptune are called ice giants: planets with icy centres surrounded by layers of slushy liquid.





**Asteroid belt**  
Huge lumps of rocks, called asteroids, circle the Sun between Mars and Jupiter. This region is known as the asteroid belt. Sometimes an asteroid will get knocked off course and may even crash into a planet!

**Distant planets**  
There are eight planets in our solar system, but they aren't the only planets in the universe. Planets orbiting other stars are known as 'exoplanets'. There may even be life on some of these distant worlds!



# THE SUN

A huge, hot ball of glowing gas, the Sun is in fact our closest star. It is so huge that Earth could fit inside it over 1 million times!

The Sun's immense power comes from reactions deep inside its core. Here, intense pressure makes hydrogen atoms fuse together to make the gas helium, releasing huge amounts of energy. The Sun has been shining for 4.6 billion years and will keep shining as long as it has hydrogen in its core. However, one day this fuel will run out. When this happens, the Sun will expand into a red giant star, then collapse to make a dead star called a white dwarf. There's no need to worry, though – that won't happen for another 7 billion years or so!



**Parker Solar Probe**  
NASA's Parker Solar Probe launched in 2018 and will be the first probe to 'touch' the Sun.

## Warning!

The Sun's light is so bright that it can harm your eyes – even through sunglasses! It's advisable to never look directly at it.

## Sunspot

Sunspots are dark areas on the surface of the Sun, which are cooler than the region around them. They occur where the Sun's magnetic field is especially strong.

## Prominence

A prominence is a loop of gas above the Sun's surface. Some are as long as the distance from Earth to the Moon.

## Solar flare

A solar flare is an explosion of energy on the Sun's surface. Some are so intense that they can interfere with radio communications on Earth!

## Sun weather

Sometimes the Sun's surface is calm, and other times it is very active. This Sun weather, called the solar cycle, peaks every 11 years.



# THE MOON

Our planet has just one moon. A quarter of the Earth's size, and around 380,000 km away from us, the Moon takes just under a month to orbit Earth. It takes exactly the same length of time to spin once on its axis, meaning we only ever see one side of its surface. The other side is known as the far side of the Moon.

After the Sun, the Moon is the brightest object in our skies. However, it doesn't truly shine.

In fact, it works a bit like a huge mirror, reflecting the Sun's light back at us. The amount of the Moon visible to us depends on the angle at which the Sun's light hits the Moon's surface.

## Formation of the Moon

The Moon probably formed when a huge object collided with Earth, scattering debris which clumped together to make the Moon.

## Apollo 11

Several space crafts have visited the Moon, but NASA's Apollo missions were the first to send people there. In 1969, Apollo 11 landed the first humans on the Moon's surface.

The craft was launched by a Saturn V rocket and had three parts: the command module (seen here) was the only part to return to Earth; the other two parts fell away when they weren't needed.

## Lunar plains

Wide, dark lunar plains were made by ancient volcanic eruptions. They are called 'maria', meaning 'seas' in Latin – as people once thought there were oceans on the Moon!

## Cratered surface

The Moon's dry, dusty surface is covered in valleys and craters, caused by asteroid impacts.

## Atmosphere

The Moon has no atmosphere, so it can't trap or reflect any of the Sun's heat. This means temperatures in the day soar to 130°C, then drop to -110°C at night.



### Asteroids

Asteroids are lumps of metal and rock with a clumpy, potato-like shape.

### Meteorite or meteoroid?

Around 200 tons of dust and rock enters Earth's atmosphere every day. Most burns up on entry, showing as a bright streak of light in the sky. If objects hit the ground they are called meteorites. In outer space, they are known as meteoroids.

# ASTEROIDS AND COMETS

Floating between the planets are billions of lumps of rock and ice. They are the leftovers from the formation of the solar system. Some are nearly as big as planets themselves, while others are little more than dust drifting through space. They can all be split into three different groups – asteroids, comets and dwarf planets according to their shape and composition.

Most asteroids and comets orbit the Sun, but sometimes events in space can send them hurtling off course and even crashing into a planet or moon.

### Comets

A comet is a ball of ice and dust orbiting the Sun. As it approaches the Sun, its icy centre starts to melt, and gas and dust trail behind it in a long tail. These are often so bright they can be seen from Earth!

### Asteroid belt

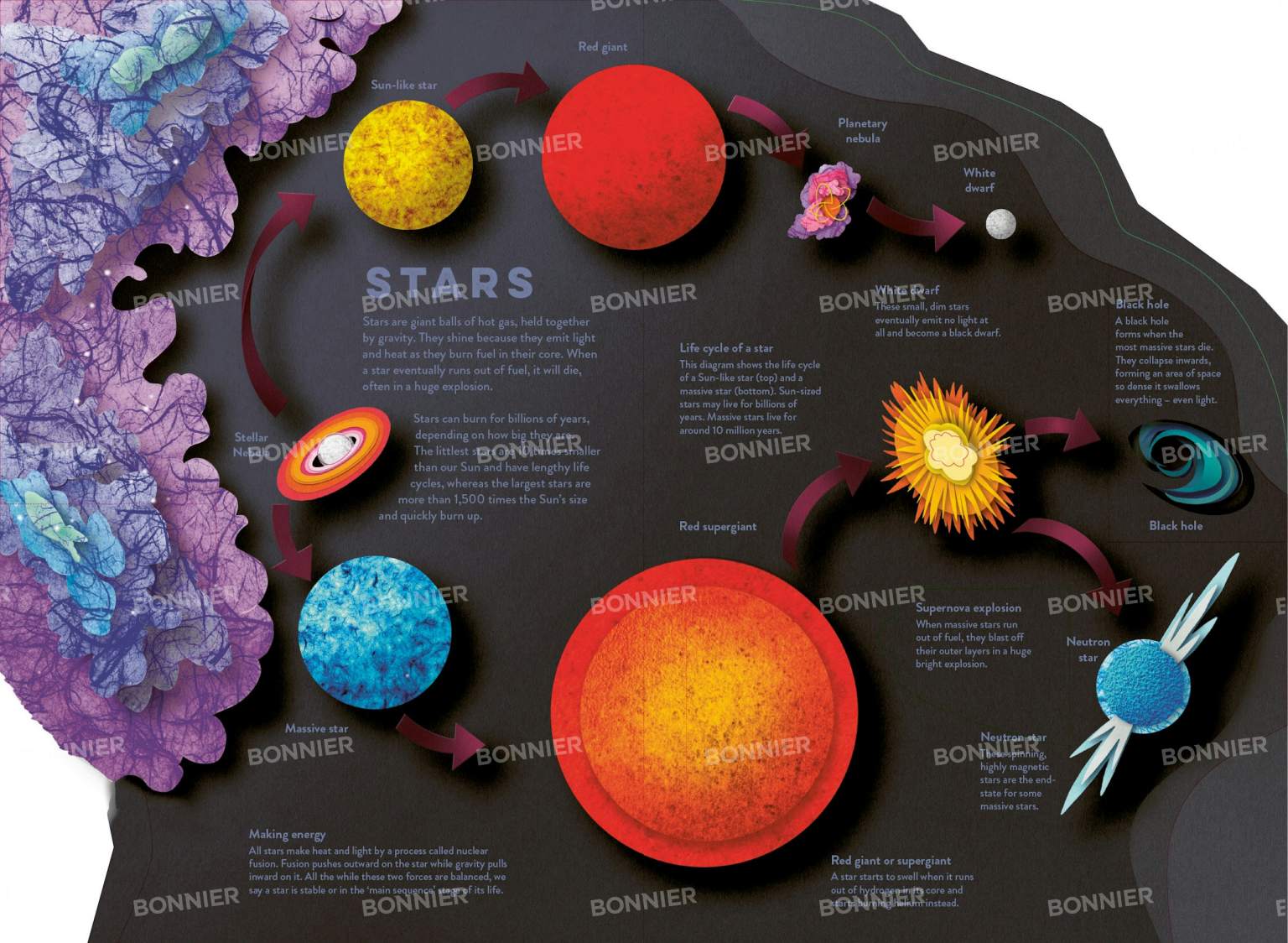
The biggest asteroids in the solar system all occur in a ring between Mars and Jupiter and orbit the Sun, forming something known as the asteroid belt.

### Stardust

In 2004, the Stardust probe flew close to a comet and brought back some of its dust to study on Earth.









# GALAXIES

A galaxy is a huge group of stars, dust and gas, all held together by gravity. There are around 2,000 billion galaxies in the universe, which mostly fall into one of three different shapes: elliptical, spiral and irregular. The smallest have a few million stars, but the biggest have around a trillion!

Our spiral-shaped galaxy is called the Milky Way. On a clear night, we can see part of it from Earth, as a flat band of pearly white light. The Milky Way is at least 100,000 light years across and thought to contain 200 billion stars. Around three new stars are born inside it every year.

## Crash

Galaxies are not stationary: they are moving through space all the time. Sometimes they crash together, and merge to make an even bigger galaxy!

## Galaxy Clusters

Galaxies gather in clusters, held together by gravity. The cluster of galaxies around ours is known as the 'Local Group'.

## Irregular galaxy

Irregular galaxies don't have any obvious shape. They usually contain lots of gas and dust, and are the birthplace for many new stars.

## Spiral galaxy

Spiral galaxies have flat, pin-wheel shapes. At the centre is the bulge, surrounded by spiral structures called arms, where stars are constantly being born. Spirals are the most common type of galaxy.

## Elliptical galaxy

Elliptical galaxies have squashed, egg-like shapes. They are full of old stars, and have little gas and dust to form new stars.

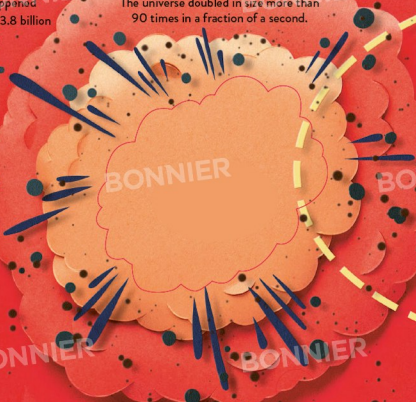
We are here!



# THE BIG BANG

The universe burst into existence around 13.8 billion years ago, in a moment called the Big Bang. In the blink of an eye, it expanded from smaller than a full stop to bigger than a city.

**1: The Big Bang**  
This happened around 13.8 billion years ago.



**2: The universe expands**  
The universe doubled in size more than 90 times in a fraction of a second.

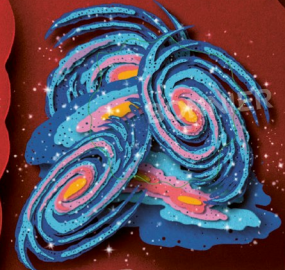
**3: The first atoms**  
After 380,000 years, electrons were sucked into orbit around neutrons and protons.



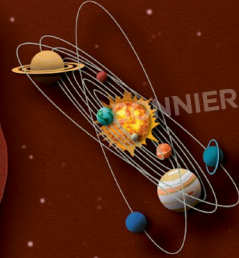
**4: The first stars**  
The first stars formed 200 million years after the Big Bang.



**5: The first galaxies**  
One billion years after the Big Bang, the first large galaxies appeared.



**6: The solar system forms**  
Nine billion years after the Big Bang, our Sun and solar system are born.



**The end of the universe**  
Nobody knows how the universe might end, but astronomers have predicted three very different possibilities for the future of our universe. Luckily, none of them will happen for billions of years.

**Our expanding universe**  
Ever since the Big Bang, the universe has been growing. Astronomers expected this expansion to slow down eventually, but that's not what is happening. Instead, the expansion seems to be speeding up! Astronomers think this is because of a kind of anti-gravity force called 'dark energy'.





### Drop pods

Thruster jets on backpacks attached to spacesuits can enable astronauts to fly back to safety should they drift away.

### Robot arms

Robot arms can control the station or move astronauts when they are on a space walk.

### Space stations

The first space station, Salyut 1, was launched in 1971 by Russia. The ISS was launched in 1998. Each of its parts had to be taken up in a spacecraft and fitted together by astronauts.

### Getting into space

Travelling into space requires a huge amount of energy to overcome Earth's gravitational pull. Rockets achieve this by burning fuel to make hot gases, which push the rocket upwards. At the top is the payload, containing the rocket's cargo, passengers and navigation systems.

### Space walk

Astronauts sometimes leave the space station to carry out experiments or repairs. These trips outside are called 'space walks'.

### Solar arrays

Solar cells collect the Sun's energy and turn it into electricity to power the station. 'Extra' energy is stored to be used when the ISS is not in direct sunlight.

# SPACE STATION

It's only been nearly 60 years since we sent the first people into space, but in that time we've landed humans on the Moon, sent probes to the most distant corners of the solar system and built entire laboratories in space. The International Space Station (ISS) is the largest of these space labs, orbiting Earth at a height of around 400 km and completing one orbit every 90 minutes.

The ISS is as big as a football field. Astronauts from 19 different nations have worked and lived there, usually spending around six months on board at a time. Experiments conducted on the ISS allow us to study how humans survive in space, and could provide valuable information for our future.



# MARS BASE

## Getting there

A journey from Earth to Mars would take around nine months. Astronauts might be put into a deep sleep for most of the journey.

The red planet Mars is more like Earth than any other planet in the solar system. It shares certain features with Earth, which mean that one day humans might be able to live on the rocky surface.

At the moment, we're a long way from having the technology we'd need to live on Mars. First off, we'd need special spacesuits to protect humans from the harsh conditions. Then, if we planned to stay for long, we'd need to find a way of making drinking water, growing food and producing enough oxygen to breathe. These are just some of the challenges scientists are working to solve.

Radiation danger  
Unlike Earth, Mars has no magnetic field, meaning it's exposed to high levels of radiation from the Sun.

## Olympus Mons

Mars has the largest volcano in the solar system. Called Olympus Mons, it is more than twice the size of Mount Everest on Earth.

## Harsh environment

Humans will have to live in protective structures to shelter from high radiation and extreme temperatures ranging from -140 to 30°C.

## Getting by

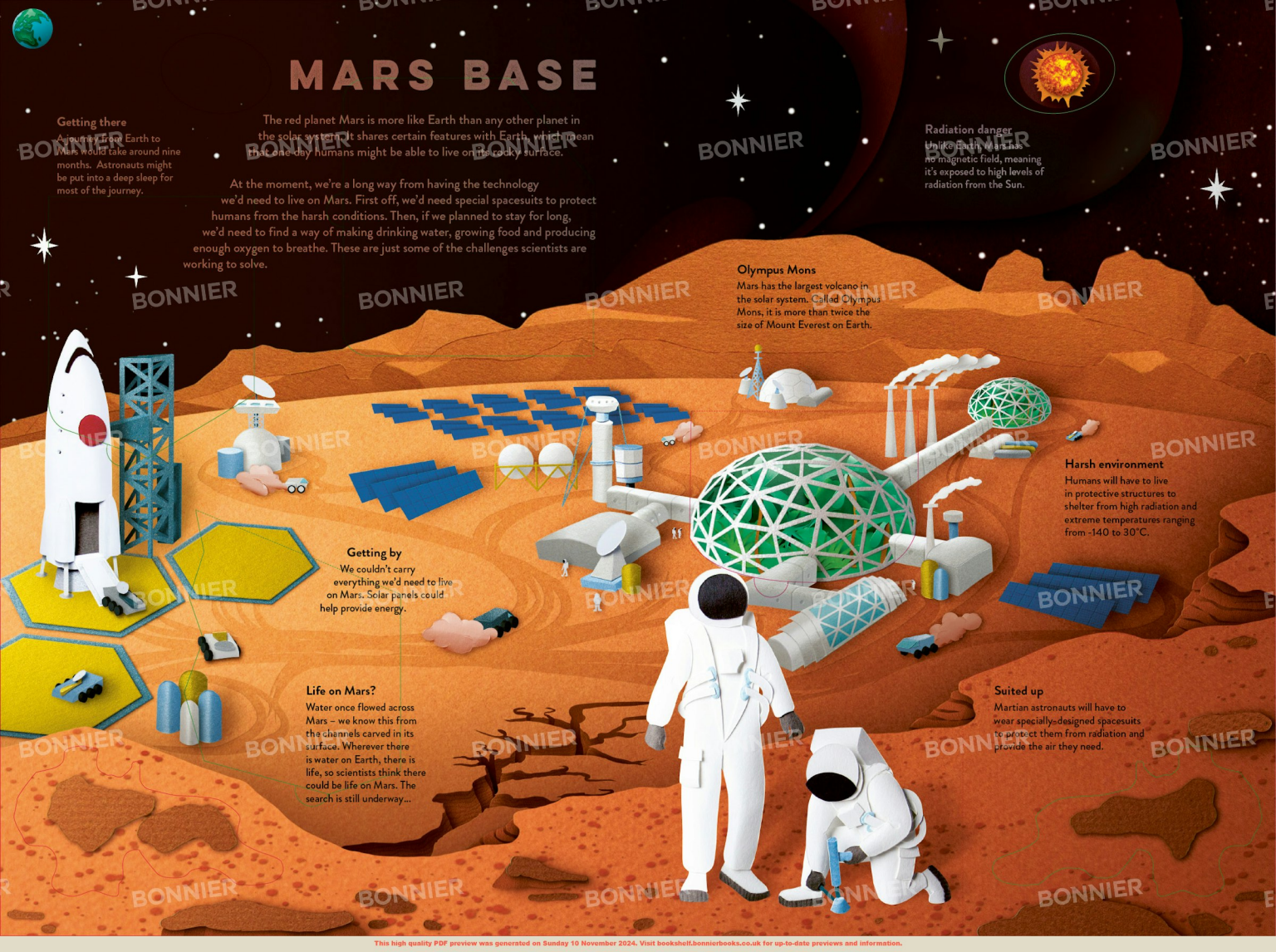
We couldn't carry everything we'd need to live on Mars. Solar panels could help provide energy.

## Life on Mars?

Water once flowed across Mars - we know this from the channels carved in its surface. Wherever there is water on Earth, there is life, so scientists think there could be life on Mars. The search is still underway...

## Suited up

Martian astronauts will have to wear specially-designed spacesuits to protect them from radiation and provide the air they need.





# GLOSSARY

## Atmosphere

A blanket of gases around Earth. It contains the air we breathe, keeps Earth warm and protects us from the Sun's harmful rays.

## Axis

An invisible line running through the middle of a planet, around which it rotates. The tilt in Earth's axis means the northern hemisphere tips towards the Sun, creating seasons.

## Black hole

A concentrated area where the force of gravity is so strong that nothing can escape it, not even light.

## Climate

The weather over a long period of time.

## Core

Earth's inner layer. The outer core is made of hot, molten iron. The inner core is a ball of solid iron at temperatures hotter than 6,000 °C.

## Environment

The surrounding conditions in which living things exist. This includes air, soil, water and climate, as well as plants and animals.

## Martian

The name for a fantasy creature or alien from the planet Mars.

## NASA

NASA is an acronym for National Aeronautics and Space Administration. Based in Washington D.C. in the United States, NASA conducts space research and organises space travel missions.

## Orbit

A curved path around a planet, star or moon.

## Probe

An unmanned spacecraft that explores space and sends information back to Earth for scientists to analyse.

## Radiation

A type of energy, such as heat or light that is transferred via waves.

## Satellite

An object in space that orbits a celestial body, such as a planet or star.

## Solar eclipse

A naturally-occurring event whereby the Moon partially obscures the Sun, creating a shadow over Earth.

## Spacecraft

A vehicle or type of machine designed to travel in space.

## Supernova

Created by a powerful stellar explosion, a supernova is a star that emits material, momentarily increasing the star's brightness.

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