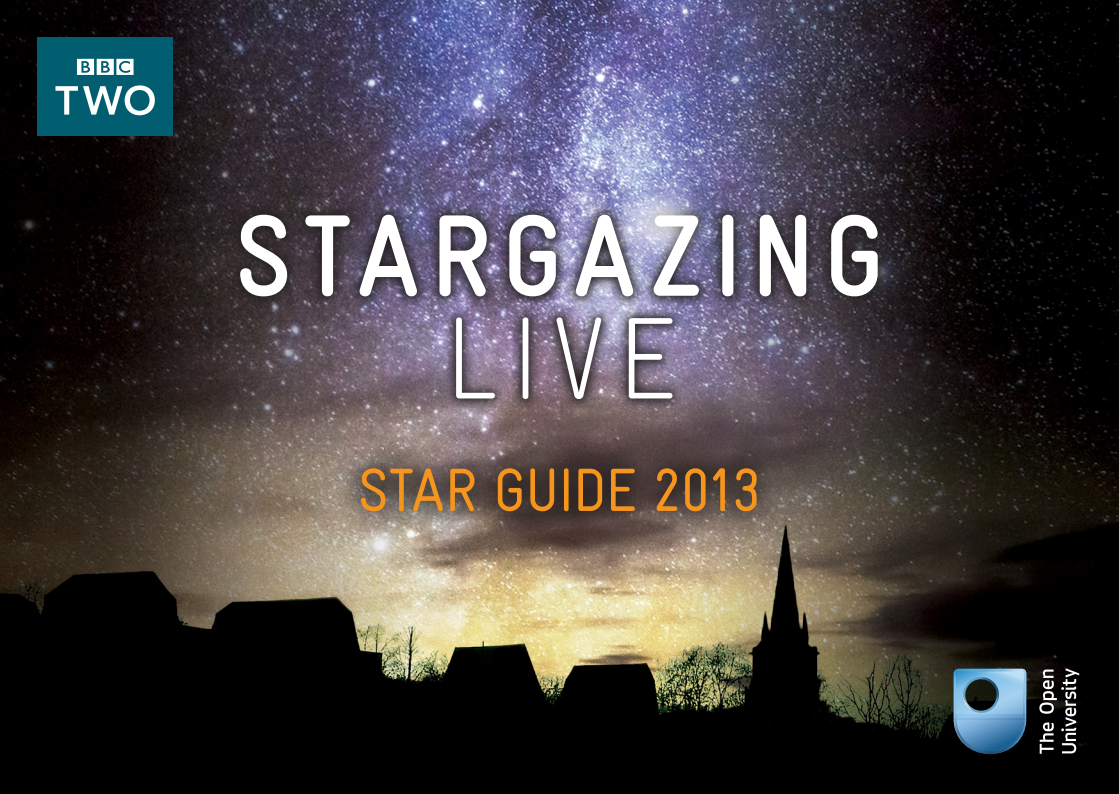
BBC TWO

STARGAZING LIVE

STAR GUIDE 2013



The Open University

WELCOME TO STARGAZING LIVE

Welcome to the 2013 Star Guide, designed to help you discover some amazing facts about the objects that you can see in the night sky.

If you've never tried stargazing before, this guide will help you find some of these objects as well as giving you useful background information about what they are.

When you're ready for the next step, there's more waiting for you at **bbc.co.uk/stargazing**, including audio guides to the night sky and how to stargaze on your smartphone or computer.

So what are you waiting for? There's a whole world of incredible wonders above your head. Isn't it time you looked up? Happy stargazing!

Professor Brian Cox

Dara O Briain

Liz Bonnin

Mark Thompson

BEFORE YOU HEAD OUT

You might like to gather the following items to help with your stargazing:

- **Binoculars/telescope:** to help you get a better view of objects in the night sky, although most of the stars in the guide can be seen without them.
- **A red torch:** so that you can still read your Star Guide without affecting your night vision. You could adapt a normal torch using red cellophane or use a rear bicycle light.
- **Apps:** there are many free apps available for mobile devices that utilise inbuilt GPS to help navigate the night sky.
- **A compass:** so you know which direction you're facing. We'll show you how to find north but bring a compass if you want to cheat!

For more information on using equipment and astronomy apps go to **bbc.co.uk/stargazing**

GETTING STARTED

1. Choose a clear night and find a safe outside space ideally away from tall buildings and bright lights. It could be anywhere from your back garden to a local park.

2. It will take at least 20 minutes for your eyes to properly adapt to the dim light. Light pollution can greatly affect what you can see in the night sky. Head to **bbc.co.uk/stargazing** and follow the link to Dark Sky Discovery to find out more about dark sky places near to where you live.

3. Our star maps face north or south. How many constellations can you find?

DID YOU KNOW?

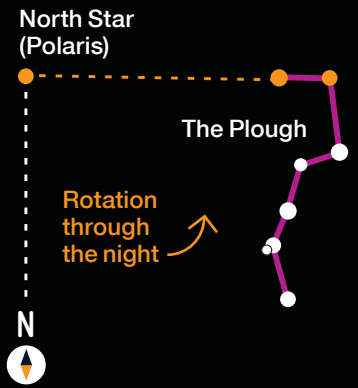
The sky is always changing – the stars you can see from a certain location change throughout the night as the Earth rotates. They also change throughout the seasons as the Earth orbits around the Sun and we move to a different position in space.

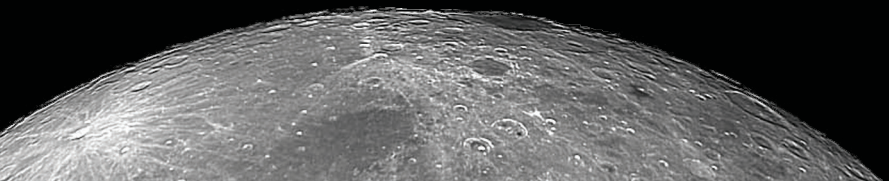
WHERE IS NORTH?

HOW TO FIND POLARIS

Polaris (the North Star) is positioned above the North Pole, so it seems to stay still in the night sky and the stars appear to rotate around it. As a result, it has been used for navigation for centuries.

It's easy to spot as two stars in the Plough (part of Ursa Major) point directly towards it, as shown here. If you drop a vertical line from Polaris to the horizon, this is due north. If you are looking north, east is to your right, west is to your left and south is directly behind you.





THE BASICS

THINGS TO SEE IN THE NIGHT SKY...

PLANETS

A planet in our Solar System is defined as a body that orbits the Sun, has enough gravitational pull to be nearly spherical and to clear its neighbourhood of debris. There are eight planets in our Solar System. If a planet orbits a star other than the Sun, it is known as an exoplanet.

MOON

The Moon is the Earth's only natural satellite. The other planets in the Solar System, with the exception of Mercury and Venus, also have moons. Jupiter and Saturn have over 60 moons each!

DEEP SKY OBJECTS

Deep sky objects lie outside the Solar System, nestled amongst the stars. Nebulae (glowing clouds of gas and dust), star clusters, globular clusters (ancient and densely packed clusters of stars that exist in a halo around a galaxy's core) and galaxies are known as deep sky objects. These are amazing things to look for. With a few notable exceptions, all of the objects, except galaxies, are located within our own Milky Way Galaxy.

There are many external galaxies to our own, each a collection of stars, gas and dust bound together by gravity. Our own Milky Way Galaxy contains several hundred billion stars.

METEORS

When small particles, known as meteoroids, collide with the Earth they pass through our atmosphere and vaporize. This results in a streak of light known as a meteor or shooting star. The particles are typically the size of a grain of sand but may occasionally be larger. Those that make it through the atmosphere intact to land on Earth are known as meteorites.

CONSTELLATIONS

Constellations are patterns of stars in the sky, historically named after objects, animals and mythological characters. There are 88 constellations of which roughly two thirds can be seen from the UK.

STARS

Stars are spheres of gas that emit energy, including light, through nuclear processes.

ASTEROIDS

Asteroids are small rocky or metallic bodies that orbit the Sun and mainly lie between the orbits of Mars and Jupiter.

Some do orbit outside of this zone and currently there are several thousand known to come in close proximity to the Earth.

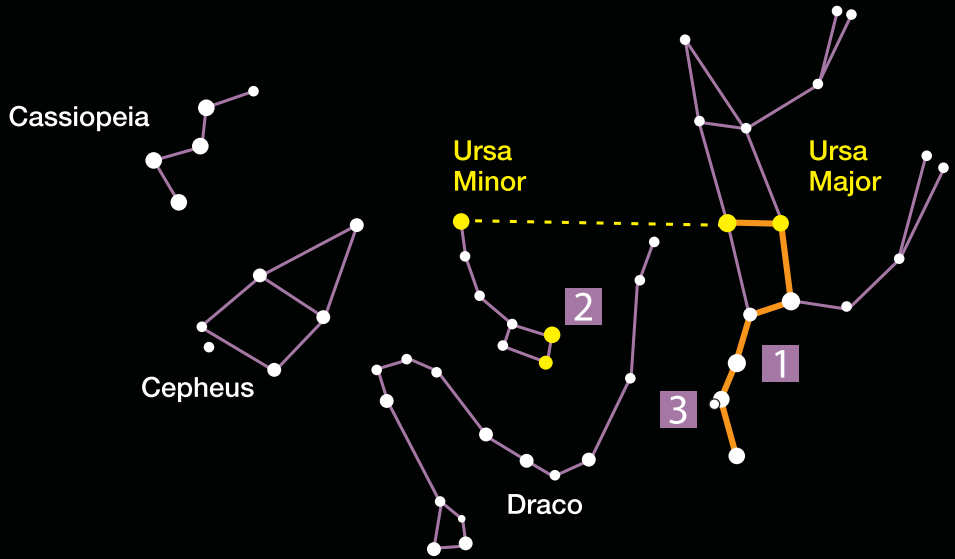
FIND OUT MORE

Do the galaxies, stars and planets spark your interest? Explore space with The Open University's Virtual Planisphere and other free online study material.

Go to **bbc.co.uk/stargazing** and follow the links.

STAR MAP

LOOKING NORTH



JANUARY-MARCH | LOOKING NORTH | EARLY EVENING

WHAT TO LOOK FOR

1. In the UK, this is called the Plough and is part of a larger constellation called Ursa Major (Latin for Great Bear). The Plough is also known as the Big Dipper or the Saucepan in other countries.

2. Use the Plough's 'pointer' stars to locate Polaris, the Pole Star, which marks the end of the tail of Ursa Minor, the Little Bear. The two stars at the other end of Ursa Minor (Kochab and Pherkad) are known as the Guardians of the Pole.

3. Using just your eyes, look carefully at the star in the middle of the Plough's handle, called Mizar, you should be able to make out its faint companion, known as Alcor.

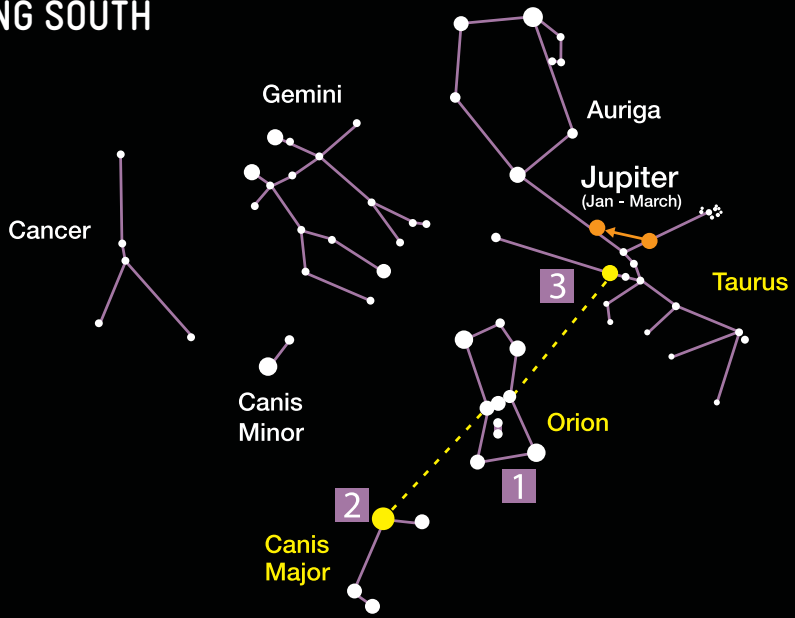
STAR CHARTS

Star maps showing you what to look out for in the night sky for the rest of 2013 are available to download from the website:

bbc.co.uk/stargazing

STAR MAP

LOOKING SOUTH



JANUARY-MARCH | LOOKING SOUTH | EARLY EVENING

WHAT TO LOOK FOR

1. Try and locate Orion's Sword, a line of faint stars below Orion's Belt. Looking at the sword through binoculars, see if you can pick out a misty region known as the Orion Nebula. This is a cloud of gas, or nebula, in which stars are forming.

2. Follow the line of Orion's Belt down and to the left to locate the brightest star in the night sky, known as Sirius.

3. Follow the line of Orion's Belt up and right to locate the orange star Aldebaran in Taurus. A v-shaped cluster of stars called the Hyades lies to the right of Aldebaran, with the Pleiades or Seven Sisters cluster to the upper right.

DID YOU KNOW?

The planets appear to wander through the constellations over time. Bright Jupiter can be seen close to the Hyades and Pleiades clusters in Taurus during the period from January to March 2013.

SATELLITE SPOTTING

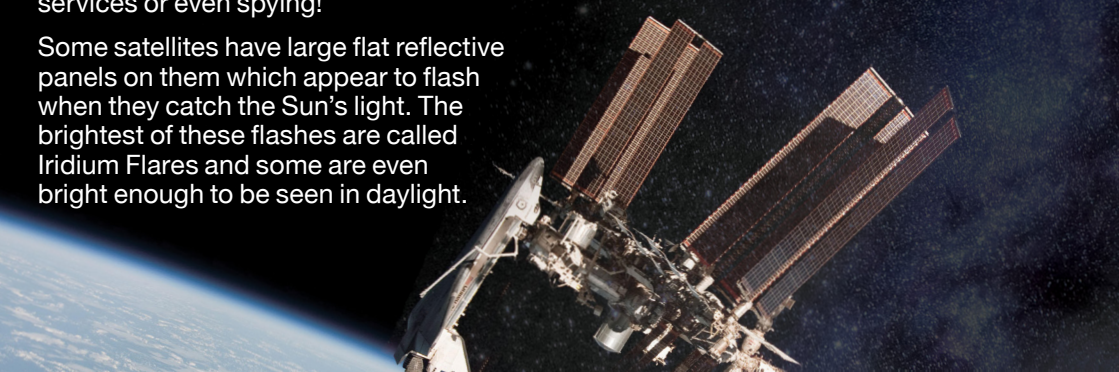
If you see a star appearing to move steadily across the night sky, you may be looking at an artificial satellite in orbit around the Earth. Due to reflected light from the Sun, many of these are visible throughout the course of a night.

Some are bits of space junk while others work hard sending back information about our weather, providing communication services or even spying!

Some satellites have large flat reflective panels on them which appear to flash when they catch the Sun's light. The brightest of these flashes are called Iridium Flares and some are even bright enough to be seen in daylight.

The International Space Station, or ISS, is one of the most impressive satellites. It appears very bright and obvious. The orbit of the ISS means that here in the UK we get to see it pass over for a number of nights at a time, then it isn't visible for a while.

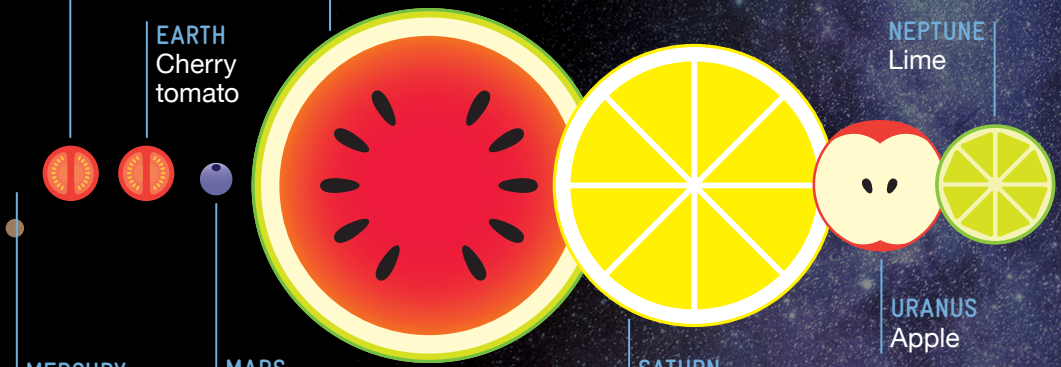
To check the visibility of the ISS from your location visit **www.nasa.gov**



SPACE STATS

HOW BIG ARE THE PLANETS?

Here are the relative sizes of the planets in our Solar System. The Sun is so enormous that you could fit over one million Earths inside it – which is why we couldn't fit it on this page!



PLANETS

The Solar System consists of the Sun, eight planets, five dwarf planets and many thousands of smaller bodies such as asteroids and comets.

Mercury is the closest planet to the Sun and is visible to the naked eye either low in the west after sunset or in the east before sunrise. So make sure the Sun is safely below the horizon when you're looking for it.

Next out is Venus, the most brilliant of the planets; so bright it is even able to cast shadows on Earth!

Both Mercury and Venus show a full range of phases when viewed through a telescope. This is due to their orbits being closer to the Sun than that of the Earth.

Mars is further from the Sun than Earth. Sometimes called the Red Planet, the surface of Mars appears orange-brown when seen through a telescope.

Bright polar caps may also be seen along with clouds in the atmosphere and dark regions of exposed rock on the surface.

Beyond Mars lies the gas giant Jupiter, the largest planet in the Solar System. Viewed through a telescope the planet's disc appears crossed by dark belts. A huge storm known as the Great Red Spot can also be seen. This is two to three times the size of the Earth and has raged for more than 200 years. If you have a pair of binoculars and a steady hand, see if you can spot up to four of Jupiter's largest moons.

Beyond Jupiter lies the magnificent ringed planet Saturn. A telescope is needed to look at the rings and will enable you to see a number of Saturn's brightest moons.

Uranus and Neptune are the outer planets of the Solar System. A small telescope will show them as tiny discs but they are so far away not much can be seen.

Planet	Type	Visible to naked eye & colour	Gravity (Earth = 1)	Distance from Sun (Earth = 1)	Surface temperature (°C)	Interesting facts	Best time to see in 2013
Mercury	Rocky	Yes / white	0.38	0.39	-200 to +400	Rotates 3 times for every 2 orbits	After sunset: mid-February & early-June Before Sunrise: early August & mid November
Venus	Rocky	Yes / white	0.91	0.72	+460	Atmospheric pressure is almost 100 x that of Earth	From late October through to the end of the year
Earth	Rocky		1.00	1.00	-90 to +60	Unofficially Earth and Moon considered a double planet	
Mars	Rocky	Yes / orange-pink	0.38	1.52	-140 to +30	Enough ice at south pole to cover the surface with water to a depth of 10m	At the end of the year passing from Leo into Virgo
Jupiter	Gas giant	Yes / white	2.36	5.20	-150	Has at least 67 moons, 4 of which are similar in size to or larger than Earth's Moon	At the start of 2013 in Taurus, and at the end of the year in Gemini
Saturn	Gas giant	Yes / yellowish	0.92	9.58	-170	Ring system is 240,000km wide but only 1km thick	At the end of April, low down in Libra
Uranus	Ice giant	Just / pale-green*	0.89	19.20	-200	Uranus is tilted on its side	Start of October in Pisces
Neptune	Ice giant	No / pale-blue*	1.12	30.10	-210	Has measured sustained wind speeds of 2,100km per hour, the strongest in the Solar System	End of August in Aquarius

*A telescope is required to see the colours of Uranus and Neptune

COMETS, METEORS AND ASTEROIDS

COMETS

Comets are small objects composed of ice, dust and frozen gas. The main part of a comet is known as the nucleus and typically measures just a few kilometres across. If a comet's orbit takes it close to the Sun, the energy it receives may release dust and gas from the nucleus.

An envelope of dust and gas wraps around the nucleus forming the head of the comet. Radiation pressure pushes dust out of the comet's head away from the Sun, forming a wide curving dust tail. Electrically charged particles sweep back in the opposite direction to the Sun forming a thin straight ion or gas tail.

NOTABLE COMETS IN 2013

Comet C/2011 L4 Panstarrs may be seen with the naked eye during March, visible low in the west after sunset.

Comet C/2012 S1 ISON may become bright but just how bright is difficult to predict. During November it might become visible to the naked eye, low in the southeast, visible before sunrise until the middle of the month. It then swings quickly past the Sun re-emerging in the evening possibly becoming visible after sunset, low in the west. It may then remain visible for the rest of the year.

METEORS

If the Earth passes through the orbit of a comet, it may encounter dust left along the comet's path. If this dust passes through our atmosphere it can vaporize producing a streak of light known as a meteor trail. If this happens, the meteors seen are said to belong to a meteor shower and all the trails point back to a single point in the sky known as the shower radiant.

FAVOURABLE METEOR SHOWERS IN 2013

Quadrantids, peaks on January 3rd
Perseids, peaks on August 12th

ASTEROIDS

An asteroid is a small rocky or metallic body in orbit around the Sun. Most are located between the orbits of Mars and Jupiter and are known as main-belt asteroids. Asteroid Ceres, at nearly 1,000km across, was reclassified in 2006 as a dwarf planet. The remaining asteroids are significantly smaller and only 140 of those in the main-belt have diameters over 120km. Vesta, the brightest asteroid, can occasionally be seen with the naked eye. A number of asteroids have their own moons.

On 15 February, 2013 the 50m asteroid 2012 DA14 will sweep past Earth, at a distance of just 35,000km.

STARS

The mass of stars like our Sun, together with most normal matter in the Universe, is typically made from three parts hydrogen and one part helium. The core of a star is a giant nuclear furnace, inside which atoms of hydrogen and helium are fused to make heavier elements.

When a star dies, its heavier elements are released into space. Known to astronomers as 'dust', this is the stuff that planets eventually form from.

THE COLOUR OF STARS

A star's colour is an indication of its temperature; red being coolest and blue hottest. A star's spectral type is a way of classifying a star's colour and temperature.

Spectral Type	Temperature (K)*
O	30,000+
B	10,000-30,000
A	7,500-10,000
F	6,000-7,500
G	5,000-6,000
K	3,500-5,000
M	Less than 3,500

*K is short for Kelvin, a temperature scale similar to Celsius (^{o}C) but with a different starting point. 0 K is equal to - 273.15^{o}C

The most spectacular way a star can die is in a supernova explosion. It's within such an event that heavier elements are formed and spread throughout space. The iron in your blood has come from such an explosion!

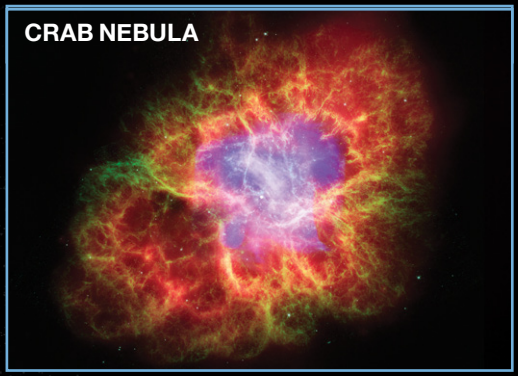
A supernova was observed by ancient Chinese, Japanese and Arabic astronomers in 1054 AD.

This was so bright that it could be seen in daylight for 23 days.

The remains of this star can still be seen today as an object called the Crab Nebula.

The core of a massive star that explodes is compacted into a super-dense object known as a neutron star. This has a mass greater than the Sun typically compacted into a sphere the size of a city.

A cup of neutron star material would outweigh the largest mountain on Earth!



Credit: NASA, ESA, CXC, JPL-Caltech, J. Hester and A. Loll (Arizona State Univ.), R. Gehrz (Univ. Minn.), and STScI

The Crab Nebula's neutron star sends out an energetic beam of radiation and spins 30 times every second. This type of object is known as a pulsar. On Earth we can see a pulse every time the beam spins past our line of sight.

HOW BIG IS SPACE?

- The distance between the Sun and the Earth is defined as one astronomical unit or AU.
- Average distance from the Sun to Neptune is 30 AU.
- The Voyager 1 spacecraft, launched in 1977, is at the edge of the Solar System. At the start of 2013, it was 123 AU from Earth, the furthest distance any man-made object has ever travelled.

- Our galaxy, the Milky Way, is approximately 6,300,000,000 AU across.
- Our next nearest star, Proxima Centauri, is 271,000 AU away from the Sun. It is a dim red dwarf in a triple star system called Alpha Centauri. Proxima Centauri can't be seen from the UK as it never rises above the horizon.

LIGHT YEAR

Despite its name, a light year is a measure of distance, not time. It represents the distance light travels in a year, travelling at the incredible speed of 300,000 kilometres a second. At that speed, it's possible to travel around the circumference of the Earth 7.5 times in one second!

One light year measures just under 10 million, million kilometres. On average it takes light 8.3 minutes to travel from the Sun to the Earth. The nearest star is 4.2 light years away and the Andromeda Galaxy, the nearest large galaxy outside our own, is about 2.5 million light years away. The Andromeda Galaxy can be seen from the UK and appears as an elongated fuzzy blob to the naked eye.

The most distant object so far detected by the Hubble Telescope is estimated to be 13.2 billion light years away. In the time it's taken for its light to reach us, the original object, a compact mini galaxy, has long since ceased to exist.

ANDROMEDA GALAXY

Credit: GALEX, JPL-Caltech, NASA

THE OBSERVABLE UNIVERSE

As we look beyond the confines of our Milky Way Galaxy, we see yet more galaxies. The Milky Way belongs to a collection of galaxies called the Local Group. A galaxy 'group' typically contains around 50 members.

On an even larger scale, galaxy clusters may contain several thousand galaxies.

Galaxy clusters themselves can belong to larger collections called super clusters.

Super clusters and clusters are part of the large scale structure of the universe forming filaments, walls and sheets. Together these are known as the Cosmic Web.

This massive galaxy cluster's gravitational field not only magnifies the images of hidden galaxies, but also distorts them into long, thin arcs (see picture below).

GALAXY CLUSTER

Credit: NASA, ESA, and Johan Richard (Caltech, USA)
Acknowledgement: Davide de Martin & James Long (ESA/Hubble)

LEARN MORE ABOUT ASTRONOMY WITH THE OPEN UNIVERSITY

If you're keen to learn more about astronomy, why not study with The Open University? You can explore free learning resources on OpenLearn: **open.edu/openlearn/stargazing**

The OU offers a range of introductory-level courses, perfect for new learners, and designed to help you find out what it's like to study with the OU, learn about a topic just for interest and try out an area of study before committing to a qualification.

Learn about galaxies, stars and planets (SG077) is an introductory level, online course covering the exploration of our Solar System; the discovery of planets orbiting other stars; the birth, life and violent death of stars; and the creation of the Universe itself. Find out more: **openuniversity.co.uk/stargazing**

The OU also offers a number of degree courses. If you are keen on astronomy, you may be interested in the **BSc (Honours) Natural Sciences: Astronomy & Planetary Sciences pathway.**

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