Astronomy for Curious Kids

By Giles Sparrow

How to be an Astronomer

THINK DIGITAL ACADEMY

How to be an Astronomer

People have been looking up to the skies and discovering the amazing secrets of the Universe since prehistoric times, before they could write and long before the invention of telescopes. Even today, you can begin you journey into astronomy with just your eyes and a curious mind.

In this chapter, we'll show you how to find your way across the night sky, choosing the best conditions to stargaze, what to see with just your eyes, and what to view with binoculars and telescopes. Then, you will find out how to hop from star to star to see the most wonderful sights in the heavens.

Watching the skies

On a clear night, once the Sun has set and its light has faded from the western sky, it's a great time to get out and get to know the wonders of the Universe.

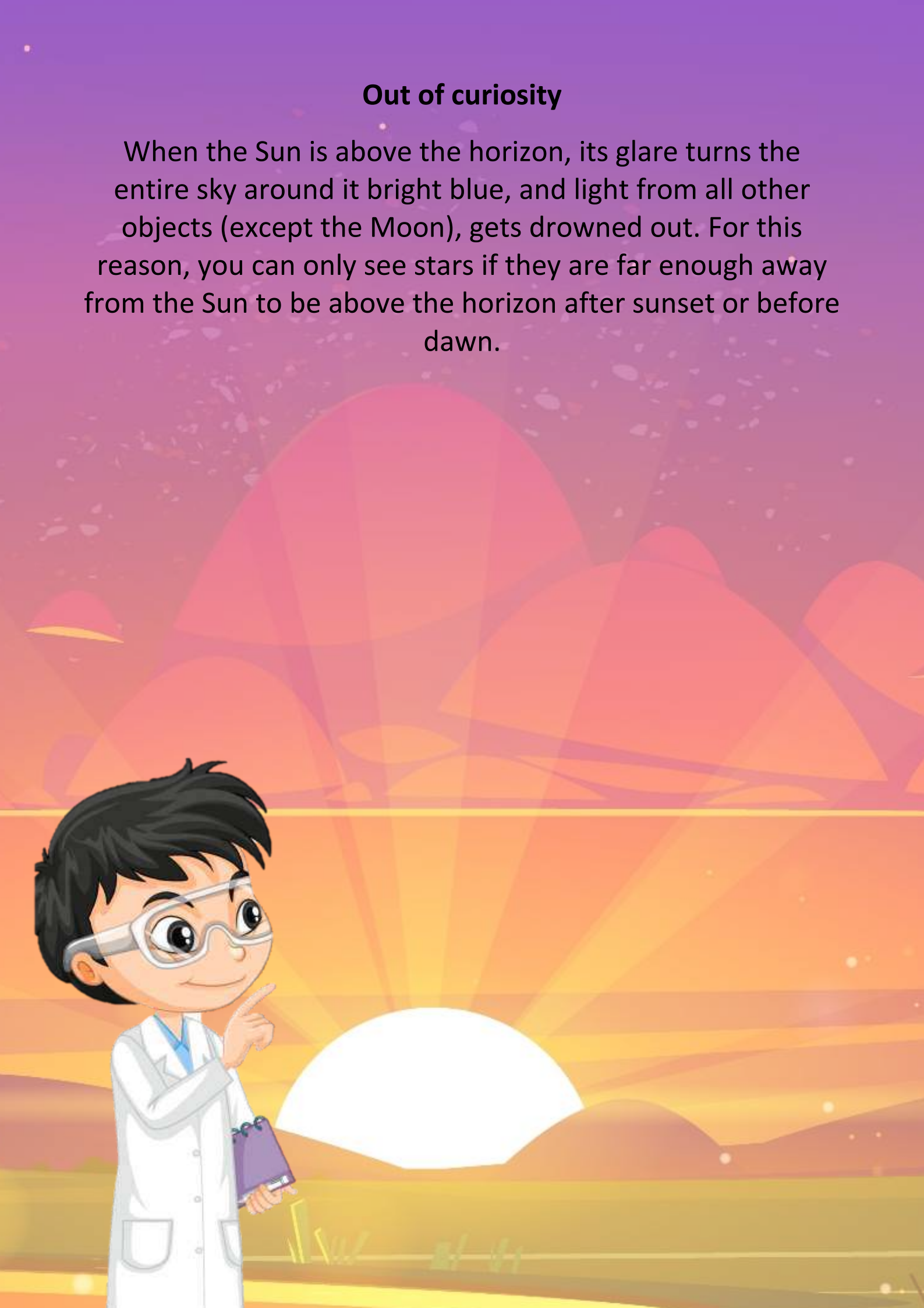
Learn the names of the brightest stars.

Follow the changing face of the moon from night to night.

Spot the faint light of distant galaxies.

Out of curiosity

When the Sun is above the horizon, its glare turns the entire sky around it bright blue, and light from all other objects (except the Moon), gets drowned out. For this reason, you can only see stars if they are far enough away from the Sun to be above the horizon after sunset or before dawn.



Golden Rules

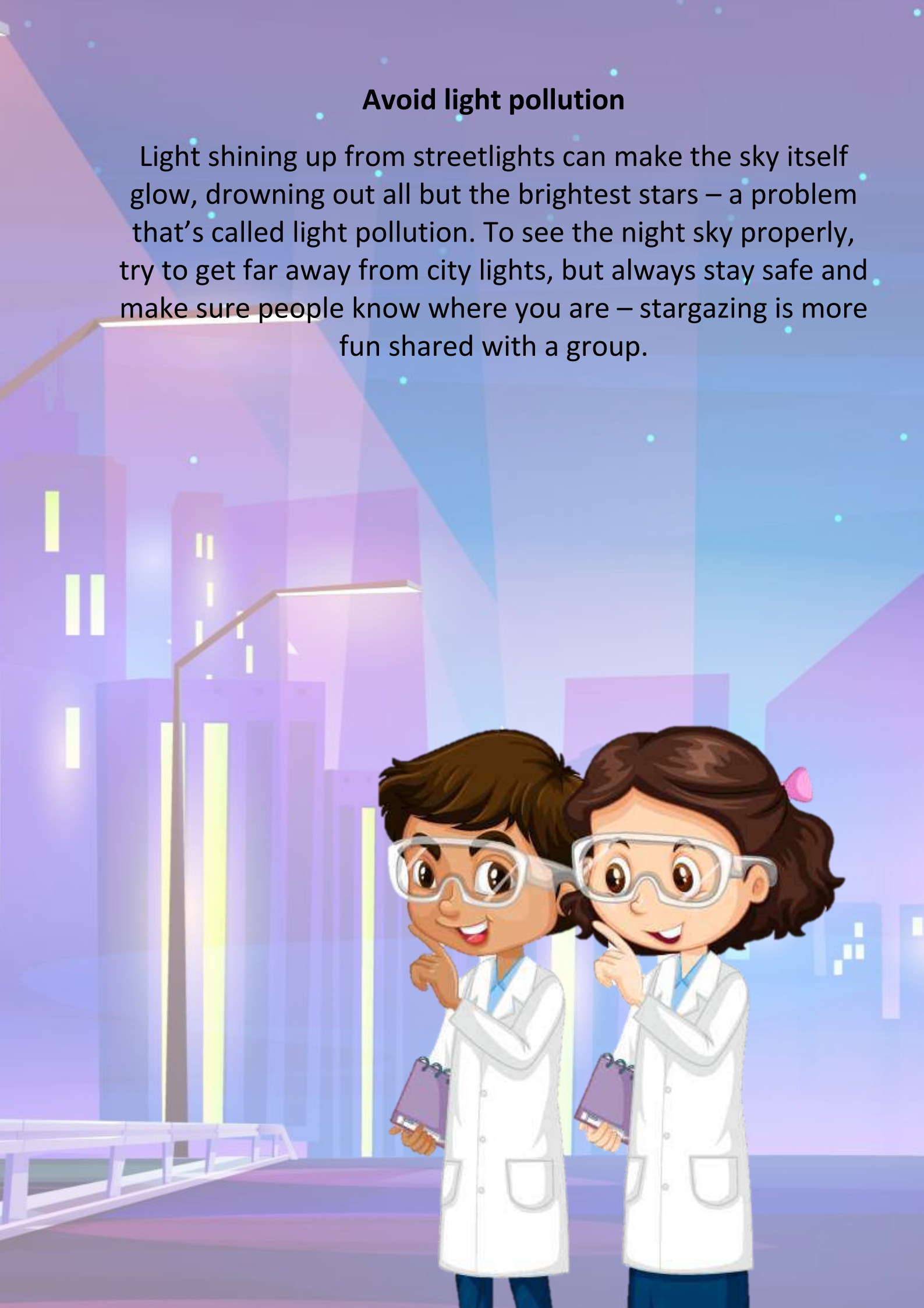
To get the most out of an evening's stargazing, here are a few things to keep in mind …

Wait for the darkness

After the Sun sets, the sky will be light for a fairly long period known as twilight. The farther the Sun is below the horizon, the darker the sky will be, and the stars will stand out better against it. serious stargazers may wait for up to two hours for the sky to become fully dark.

Avoid light pollution

Light shining up from streetlights can make the sky itself glow, drowning out all but the brightest stars – a problem that's called light pollution. To see the night sky properly, try to get far away from city lights, but always stay safe and make sure people know where you are – stargazing is more fun shared with a group.



Beware of the ripples

When days are warm but nights are cold, warm air rising off the and can cause apparently clear skies to ripple. This deflects the paths to light rays, so that bright stars twinkle and faint ones may be even fainter. Windy weather can have the same effect.

Your amazing eyes

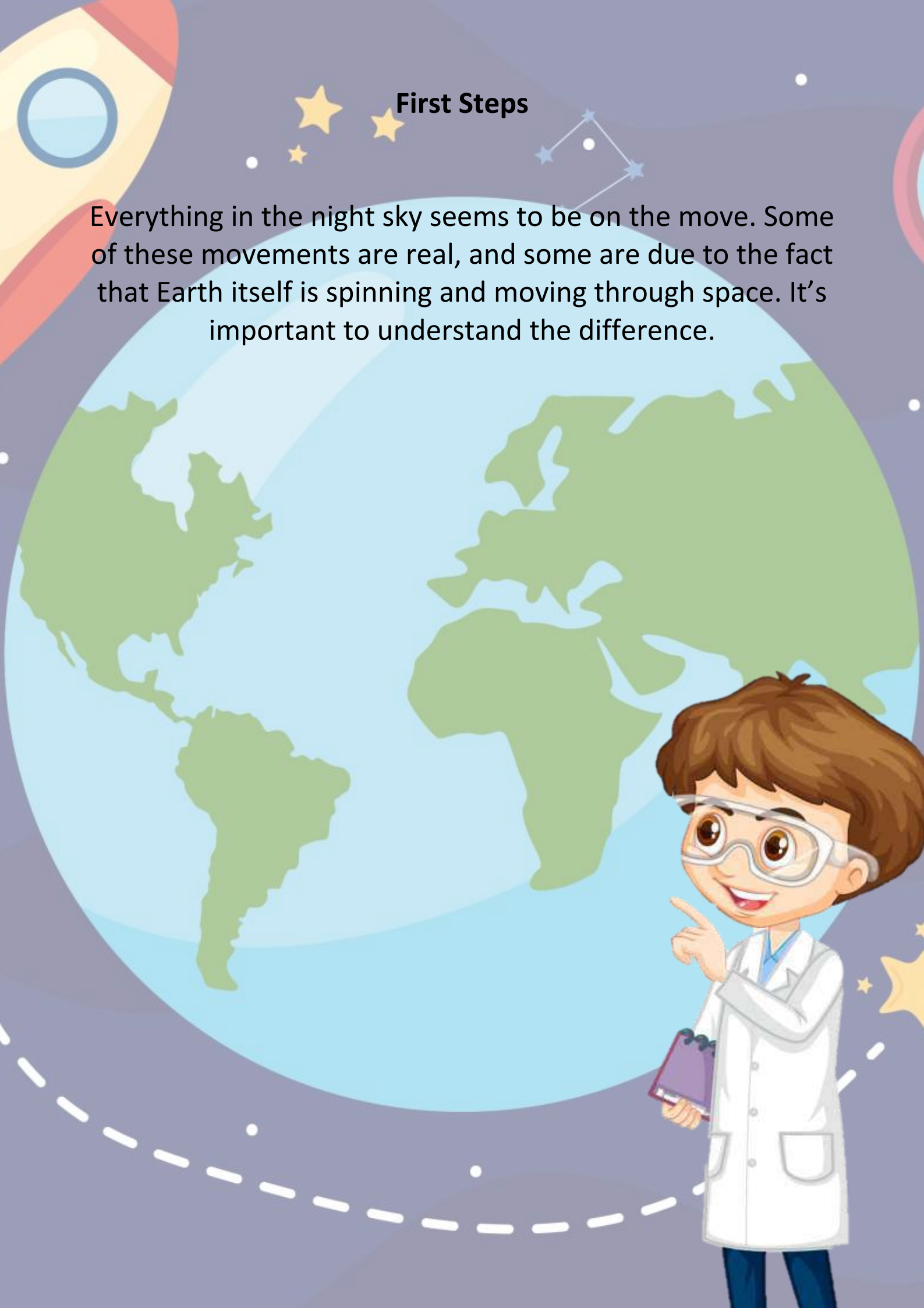
Your eyes are natural cameras. Light enters through the black central pupil and is detected by light-sensitive cells at the back of the eye, or retina. The pupil usually stays small to control the light getting in, but it gets wider in the dark, while the retina cells become more sensitive. An average person's eyesight will let them see around 3000 stars on a clear night, and the farthest thing most people can see is the Andromeda Galaxy, 2.5 million light years away.

Night vision

It can take an hour or more for your eyes to adjust properly to darkness and just a moment to undo that good work. For this reason, even if you can’t avoid light pollution in the sky, try to find an observing spot that protects you from the direct glare of streetlights, car headlights, and other bright lights.

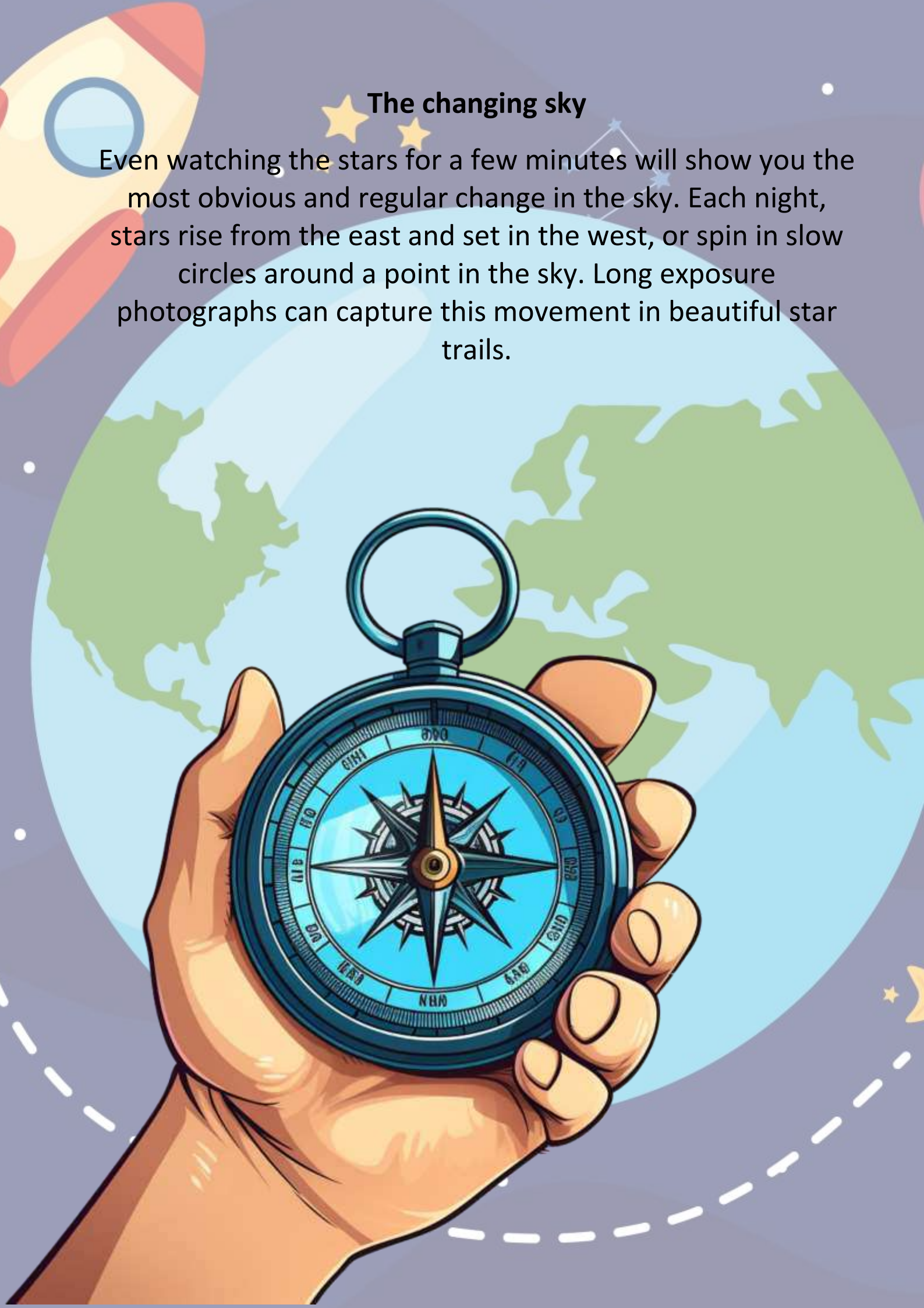
First Steps

Everything in the night sky seems to be on the move. Some of these movements are real, and some are due to the fact that Earth itself is spinning and moving through space. It's important to understand the difference.



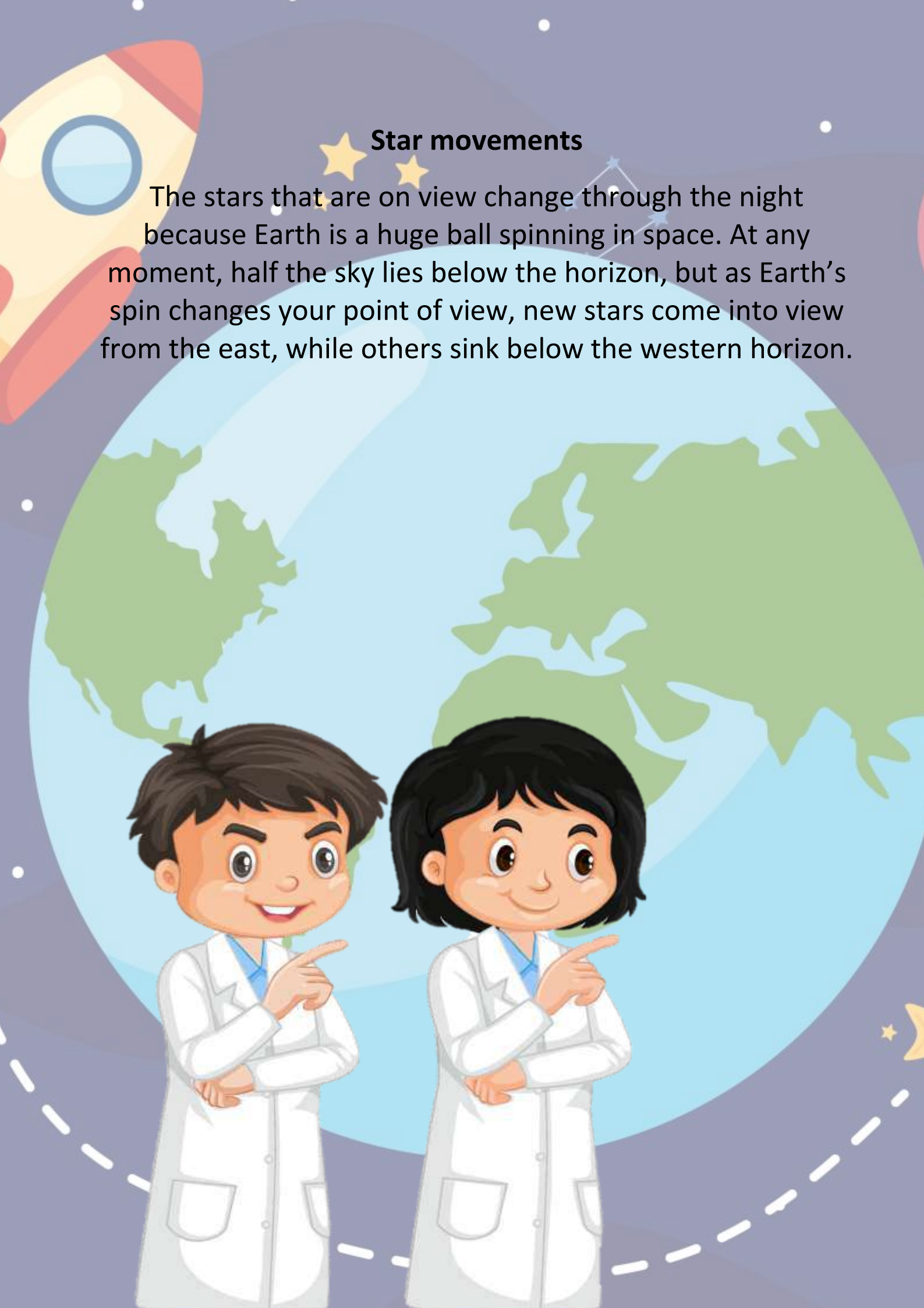
The changing sky

Even watching the stars for a few minutes will show you the most obvious and regular change in the sky. Each night, stars rise from the east and set in the west, or spin in slow circles around a point in the sky. Long exposure photographs can capture this movement in beautiful star trails.



Star movements

The stars that are on view change through the night because Earth is a huge ball spinning in space. At any moment, half the sky lies below the horizon, but as Earth's spin changes your point of view, new stars come into view from the east, while others sink below the western horizon.



The Sun’s glare drowns out the light of the stars closest to it, but that, too, changes. Earth is orbiting the Sun, and so the Sun’s direction shifts from day to day, moving against the background stars, so that different ones are hidden by the glare at different times of the year.

Aside from effects linked to Earth’s spin and orbit, the stars move only very slowly. They are so far away that their actual movement through space appears tiny, and star patterns stay the same for thousands of years.

Solar system wanderers

The Moon, planets and other objects lie within our own solar system behave differently from the spinning stars outside it. These objects are close enough for us to see their movements as they orbit the Sun at different speeds and appear against different background stars. What's more, this motion is complicated by the fact that our viewpoint on Earth is also circling the Sun once every year.

Basic equipment

If you want to track sky changes from night to night, and season to season, spot the wandering planets and learn the patterns of the stars, some basic equipment will help you get more out of your stargazing.

A magnetic compass (or smartphone compass app), will help you learn the different directions from your observing spot and quickly get your bearings. Use a notepad and pencil to record what you see. Sketch the patterns of the bright stars that are overhead when it's completely dark and then again, an hour later to see how they've changed. A flashlight with red plastic taped over the beam will help you see your way in the dark without ruining your night vision.

Finding your way

If you have a smartphone, there are plenty of apps that show what you can see in the night sky, but a simple device called a planisphere (also known as a star wheel), may give you a better understanding of what's going on. The planisphere has two disks – when you rotate the upper one so that the time of day around the edge matches the correct date on the lower disk, the clear window shows you a map of which stars are currently over the horizon

Binoculars and the telescopes

Your eyes can see a lot on their own, but you'll see even more of the Universe with binoculars or a telescope. Both of these optical instruments capture more light and create magnified views of the sky that reveal more detail

Binocular stargazing

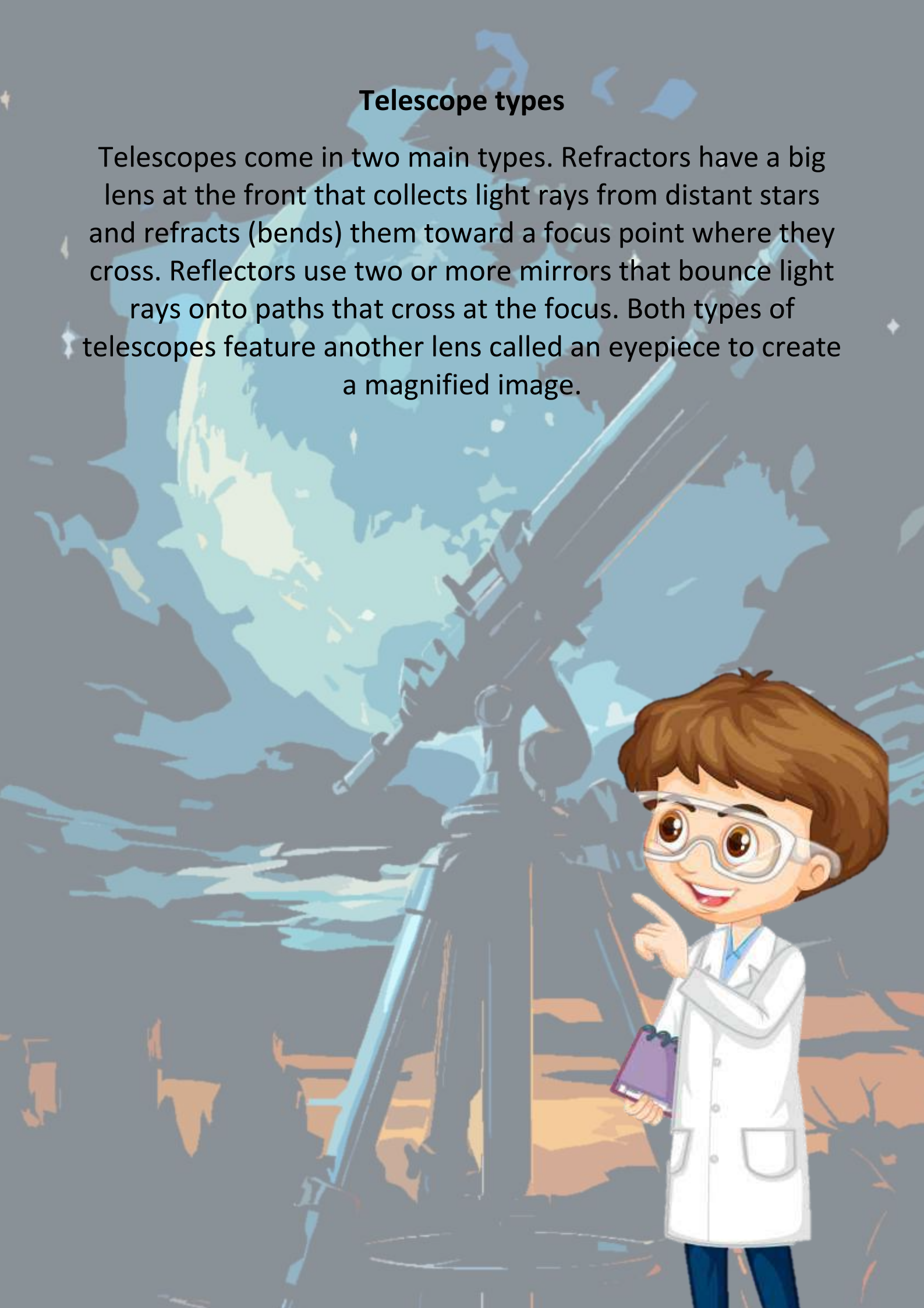
Binoculars are great for sweeping large area of sky. Their big lenses direct more light to your eyes, making stars appear brighter, and they reveal objects that are too faint to spot with your eyes alone. Most binoculars don’t magnify much, though – this mean that things look only a few times bigger. However, they are easy to point and hold steady.

Telescopic astronomy

A small telescope may capture only a little more light than binoculars, but because it magnifies the view much more, it will make things appear much bigger and reveal greater detail in objects such as planets. Telescopes also magnify small motions (including your hands shaking), so they're usually mounted on a tripod.

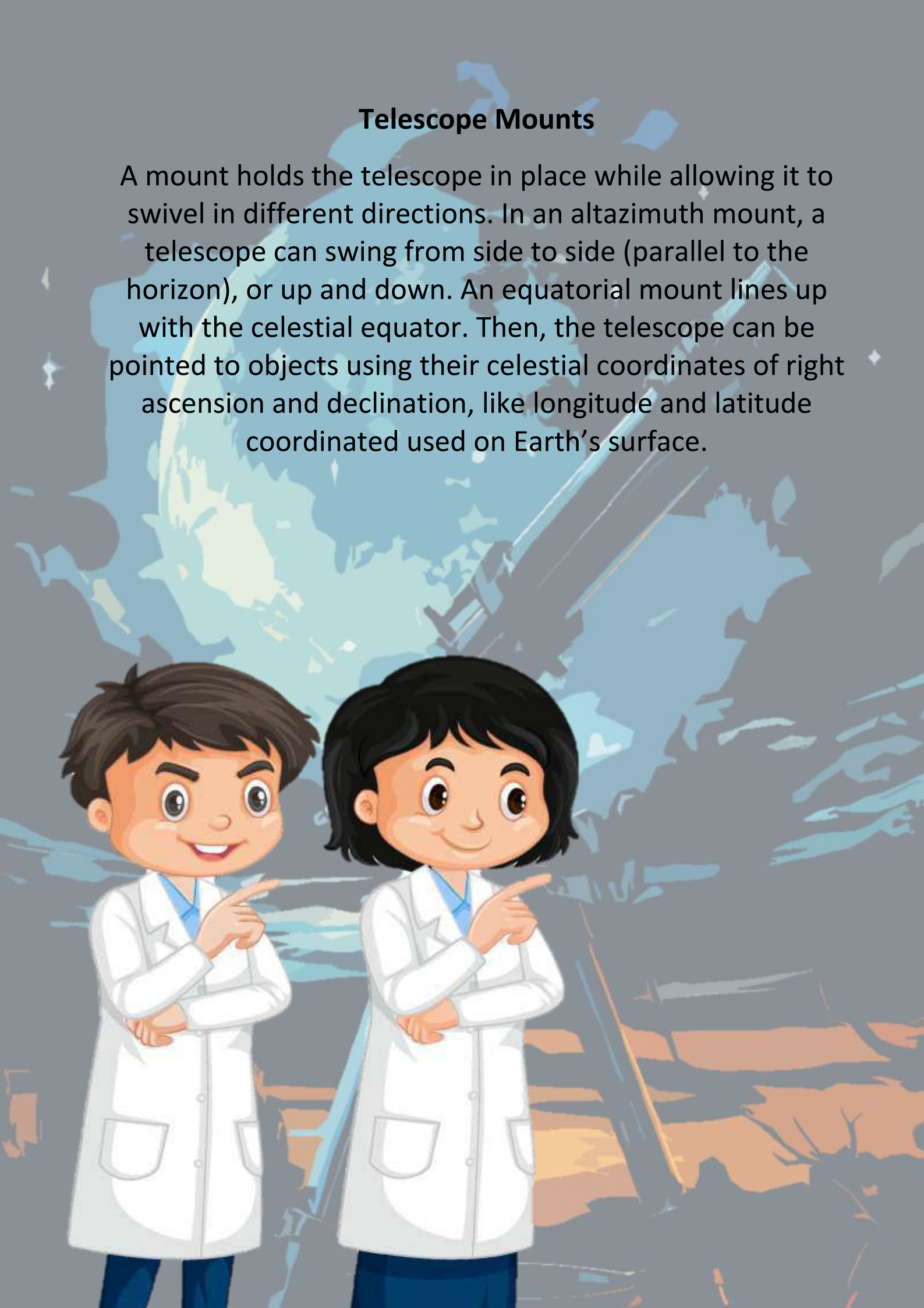
Telescope types

Telescopes come in two main types. Refractors have a big lens at the front that collects light rays from distant stars and refracts (bends) them toward a focus point where they cross. Reflectors use two or more mirrors that bounce light rays onto paths that cross at the focus. Both types of telescopes feature another lens called an eyepiece to create a magnified image.



Telescope Mounts

A mount holds the telescope in place while allowing it to swivel in different directions. In an altazimuth mount, a telescope can swing from side to side (parallel to the horizon), or up and down. An equatorial mount lines up with the celestial equator. Then, the telescope can be pointed to objects using their celestial coordinates of right ascension and declination, like longitude and latitude coordinated used on Earth's surface.



Out of curiosity

Because light rays in a telescope cross over at the focus point, the image you see in the eyepiece is flipped left to right and upside down.

Constellations

How can you make sense of all the lights in the nights sky? Over many centuries, people have made patterns from the bright star called constellations. These are a useful way of finding your way around the sky.

The first constellations

Most constellation started out as groups of stars that people connected with imaginary lines to make pictures in the sky. Some look very much like the figure or object they're supposed to represent, while others take a lot of imagination. Taurus, the bull, is one of the most obvious patterns in the sky and dates back to at least 15000 BCE – it's even found in cave paintings.

What makes a constellation?

Constellations started out as figures drawn by linking stars in the sky, but once telescopes were invented, astronomers began to question which constellation each newly discovered star or other object should belong to. For this reason, today's constellation's are defined as areas of the sky that fit together like a jigsaw puzzle, so it's clear where any newfound object belongs

Changing Definitions

Most constellations are made of stars that lie in the same direction as seen from Earth- they're not necessarily close together in space. For example, the brightest objects in Orion the Hunter, are separated by vast distances.

- Rigel – knee – 860 light years away
- Belelgeuse – right shoulder – 548 light years away
- Bellatrix – left shoulder – 200 light years away
- Orion's belt (Mintaka, Alnilam, Alnitak), 1200, 2000 and 1260 light years away
- Orion Nebula – sword – 1400 light years away

Naming Stars

Many stars have names that were invented by Islamic astronomers more than a thousand years ago, but rather than memorizing these, you can use an easier system that uses the letters of the Greek alphabet. Each bright star in a constellation has a Greek letter applied to it that indicates its rank in the constellation, beginning with alpha and ending at omega for the twenty-fourth brightest star (since there are 24 letters in the Greek alphabet). This is written with a special form of the constellation name to indicate that it belongs in that particular star pattern. So, for example, Alpha Centauri is the brightest star in Centaurus, while Zeta Tauri is the sixth-brightest star in Taurus.

The Modern Constellations

Today, there are 88 official constellations. Of these, 48 are ancient European and Middle Eastern star patterns that were listed by the Greek-Egyptian astronomer, Ptolemy around 150 CE. The others were invented by various astronomers from the late 1400s to the 1700s, either to fill gaps between Ptolemy's constellations or to divide up parts of the far southern sky that ancient Eurasian astronomers never saw.

1 = α = Alpha

2 = β = Beta

3 = γ = Gamma

4 = δ = Delta

5 = ε = Epsilon

6 = ζ = Zeta

7 = η = Eta

8 = θ = Theta

9 = ι = Iota

10 = κ = Kappa

11 = λ = Lamba

12 = μ = Mu

13 = ν – Nu

14 = ξ = Xi

15 = ο = Omicron

16 = π = Pi

17 = ρ = Rho

18 = σ = Sigma

19 = τ = Tau

20 = υ = Upsilon

21 = ϕ = Phi

22 = χ = Chi

23 = ψ = Psi

24 = ω = Omega

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The Celestial Sphere

To help explain the relationship between Earth and the sky, the celestial sphere copies many of Earth's own features. It spins around two fixed points called the north and south celestial poles (NCP and SCP), which lie directly above Earth's own north and south poles. It rotates from east to west once each day (reflecting what is really Earth's own west-to-east rotation), and a celestial equator midway between northern and southern hemispheres, just like Earth.

Positions on the Celestial Sphere

Astronomers usually measure the locations of objects on the celestial sphere with a system that's similar to the longitude and latitude used on Earth. Objects have a declination between 0 and 90 degrees, which indicates how far north or south of the celestial equator they lie (+ 90° is the NCP, -90° is the SCP). They also have a right ascension, which indicates how far east or west they are from a fixed point called the First Point of Aries. This is measured in hours, minutes and seconds, rather than degrees. It indicates how far the object lags behind the First Point in its daily rotation around the sky.

What Can You See?

At any location on Earth, you can always see the celestial pole that matches your own hemisphere, lying in the direction of the nearest pole of Earth itself. This means that stargazers in the northern hemisphere see the NCP due north and those in the southern hemisphere see the SCP due south.

The height of the pole above the horizon depends on your latitude. At Earth's own poles above the horizon on your latitude. At Earth's own poles the celestial poles are directly overhead at the Zenith point, but they sink steadily farther toward the horizon as you get closer to the equator. The sky spins around the celestial pole you can see, with stars rising from the east and sinking to the west. Stars close enough to the celestial pole never actually disappear but make circles in the sky and are called circumpolar.

In the course of a year, all the stars in your own celestial hemisphere will eventually come into view. However, the closer you get to the equator, the higher the line of the celestial equator rises up in the sky in the opposite direction to the celestial pole. Beneath it, you can see stars that lie in the opposite celestial hemisphere.

Stars that set completely are at their highest in the sky when they cross a line called the Meridian, which runs north to south across the sky through the zenith.

Angles in the Sky

Angles in the sky are generally measured in degrees. There are 360 degrees in a full circle and 90 degrees in a quarter circle (for instance, from the horizon to the zenith). The full moon is about half a degree across. Held at arm's length, your hand can provide a handy guide for estimating the size of different angles.

Little finger = 1°

Three middle fingers = 5°

Bunched fist = 10°

Index and little fingers stretched apart = 15°

Thumb and little fingers stretched apar = 25°

Star-Hopping

The quickest way to find your way around the sky is to use a trick called star-hopping. Where you follow imaginary lines between stars to find your way to other stars and interesting points in the sky.

The Far North

For northern-hemisphere stargazers, the sky seems to rotate around the pole star Polaris, the brightest star in Ursa Minor, the Little Bear (or Little Dipper). To find it, follow a line from the two “pointer” stars on the end of the Big Dipper or Plough (a pattern made by the seven brightest stars in Ursa Major, the Great Bear).

A Milky Way Triangle

Around August and September, three bright stars mark out a large triangle in the southern sky for stargazers in the northern hemisphere. Deneb is the brightest star in Cygnus the Swan, Vega is the brightest in Lyra the Lyre and Altair is the brightest in Aquila the Eagle. The same pattern appears upside down in the north for southern-hemisphere skywatchers.

Scan the middle of the triangle with binoculars to see pale clouds of distant stars, compact star clusters and other beautiful sighs in the Milky Way, then follow the outstretched neck of Cygnus south to reach Scorpius the Scorpion, Sagittarius the Archer and the centre of our galaxy.

Orion and the Nearby Stars

The distinctive constellations of Orion the Hunter lies near the celestial equator and is at its best in both hemispheres on evenings from December through to March. Northern hemisphere observers can see it over the southern horizon, while southern stargazers should look for it upside down in the northern sky.

Various stars in Orion point to other interesting objects. A line southeast from its belt points to Sirius, the brightest star in the sky, in the constellation of Canis Major, the Great Dog. A line northeast from the belt leads to Aldebaran (the eyes of Taurus the Bull) and beyond it to the beautiful Pleiades star cluster. A line from the middle of the belt past brilliant-red Betelgeuse on Orion's shoulder leads to Castor and Pollux, the bright twin stars that give the constellation Gemini its name. You can also imagine equilateral triangle connecting Sirius, Betelgeuse and Procyon – the brightest star of Canis Minor, the Lesser Dog.

The Southern Cross and Beyond

Unlike Polaris at the North Celestial Pole, there's no bright star to mark the South Celestial Pole (SCP). Southern-hemisphere stargazers can best locate it using the small but brilliant constellation of Crux, the Southern Cross.

Look east along the shorter bar of Crux to find another pair of bright stars, Beta and Alpha Centauri, then imagine that they form the short bar of a similar cross. Follow imaginary lines down the long bars of these two crosses and they'll meet very close to the SCP, with the faint star Sigma Octantis lying nearby. Extend the lines past the pole to find the Small and Large Magellanic Couds, two satellite galaxies of our Milky Way.


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