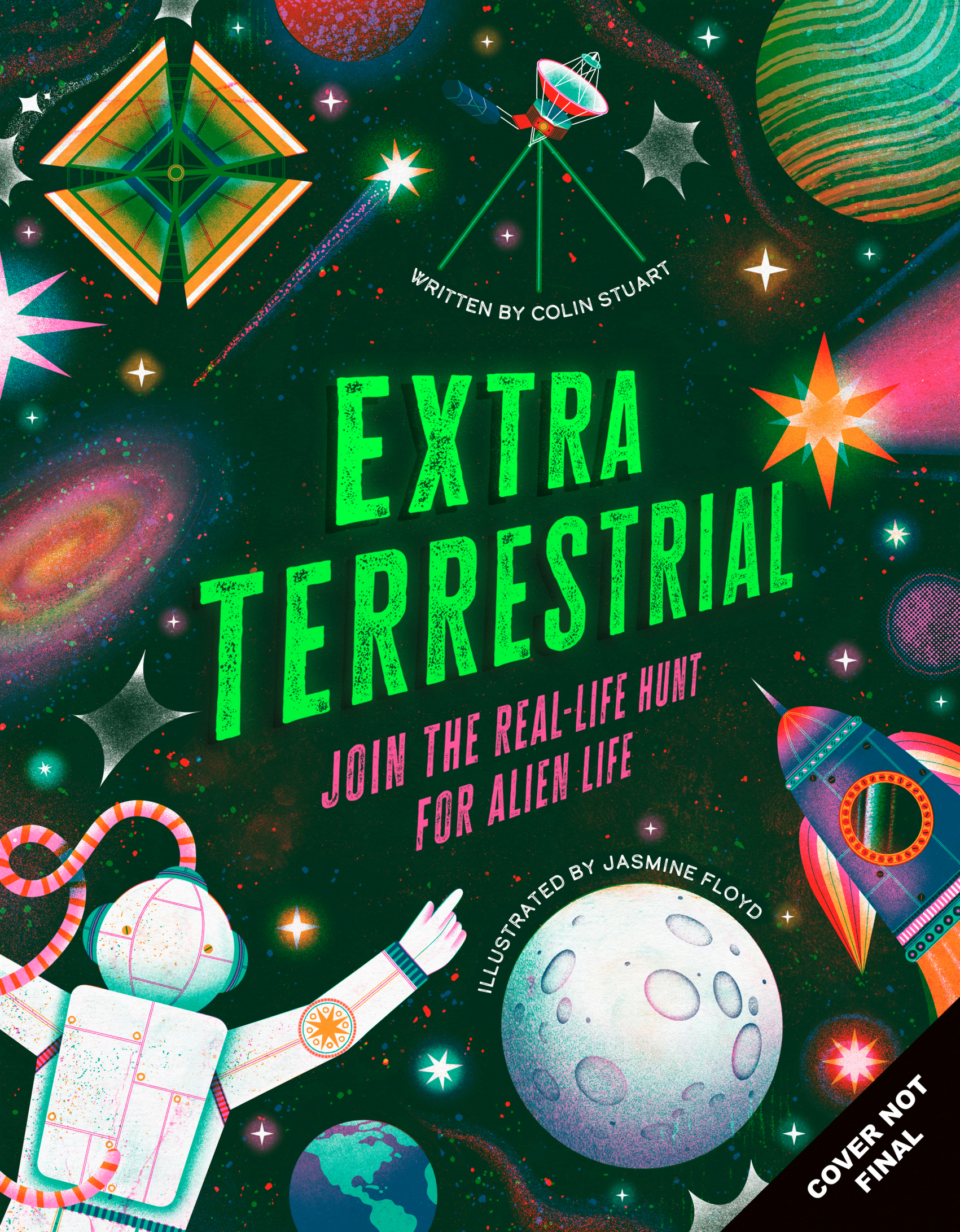
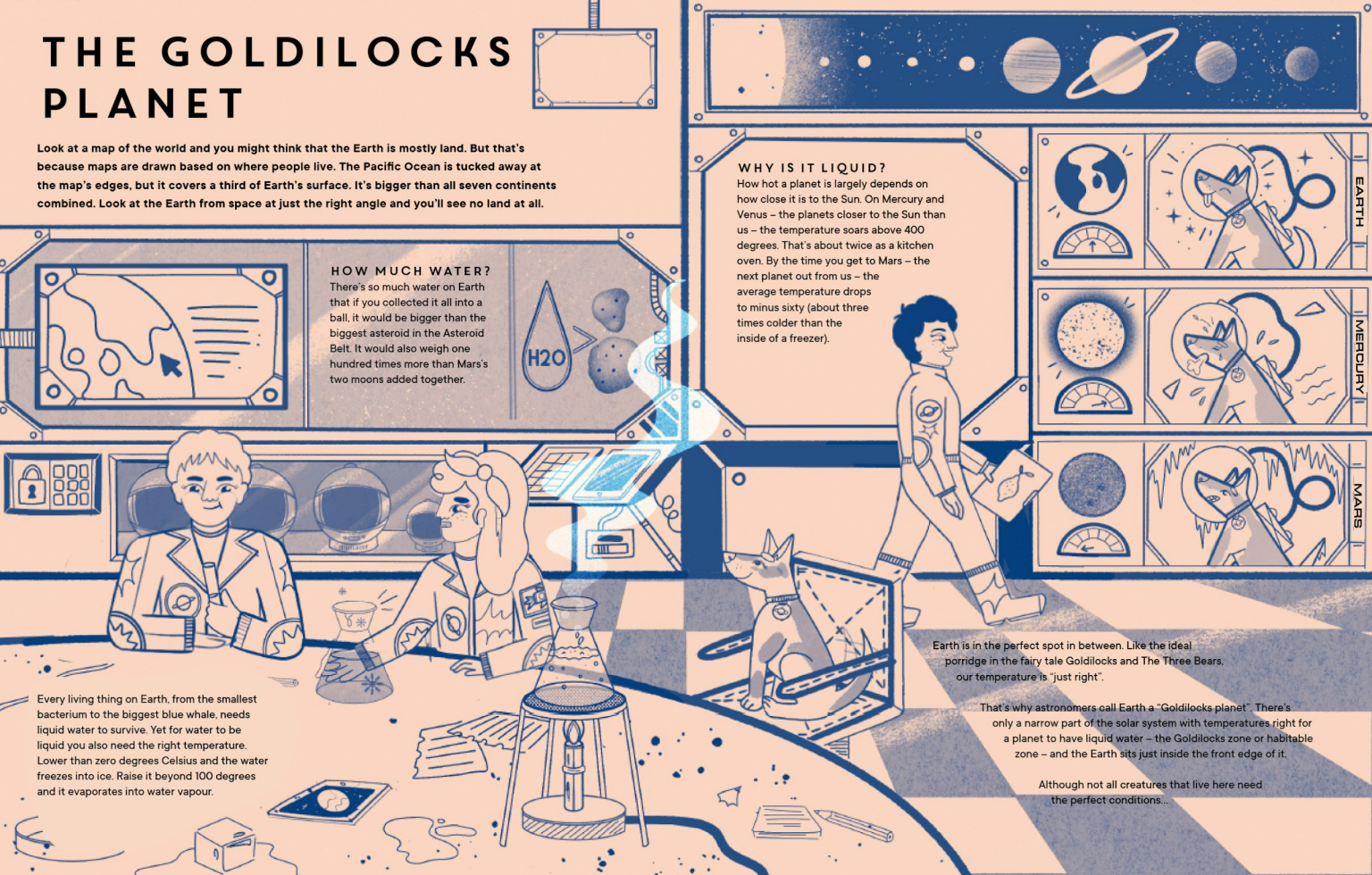

WRITTEN BY COLIN STUART
EXTRA TERRESTRIAL
JOIN THE REAL-LIFE HUNT FOR ALIEN LIFE
ILLUSTRATED BY JASMINE FLOYD
COVER NOT FINAL

THE GOLDILOCKS PLANET

Look at a map of the world and you might think that the Earth is mostly land. But that's because maps are drawn based on where people live. The Pacific Ocean is tucked away at the map's edges, but it covers a third of Earth's surface. It's bigger than all seven continents combined. Look at the Earth from space at just the right angle and you'll see no land at all.



Every living thing on Earth, from the smallest bacterium to the biggest blue whale, needs liquid water to survive. Yet for water to be liquid you also need the right temperature. Lower than zero degrees Celsius and the water freezes into ice. Raise it beyond 100 degrees and it evaporates into water vapour.

Earth is in the perfect spot in between. Like the ideal porridge in the fairy tale Goldilocks and The Three Bears, our temperature is "just right".

That's why astronomers call Earth a "Goldilocks planet". There's only a narrow part of the solar system with temperatures right for a planet to have liquid water – the Goldilocks zone or habitable zone – and the Earth sits just inside the front edge of it.

Although not all creatures that live here need the perfect conditions...

WATER, WATER, EVERYWHERE...

You're flying over a craggy ice sheet when suddenly you see it rising over the horizon. You're stunned into complete silence and can't look away. Saturn and its majestic rings appear almost 150 times wider than the Full Moon does in our night sky.

You are searching for life on Enceladus, one of Saturn's 117 known moons. Beneath its cracked, icy surface is an ocean of liquid water that's almost as big as the Arctic Ocean here on Earth.

OUTSIDE THE GOLDILOCKS ZONE

Enceladus is a long way from the Sun, more than five times farther than the outer edge of the solar system's habitable zone. And yet there's plenty of liquid water here despite Enceladus's surface temperature of minus 200 degrees Celsius.

How can this be? The secret is tidal heating. Enceladus orbits around Saturn in just 33 hours, meaning it's very close to the planet. During this orbit Enceladus gets severely stretched and squeezed by Saturn's strong gravity. This constant flexing warms up the inside of the moon, which is enough to keep the water liquid under its surface ice.

With its global ocean and internal heat, Enceladus could be a good contender for alien life.

A robotic spacecraft called Cassini discovered Saturn's ocean during a 13-year space mission.

Jets of icy particles and explosions of water and chemicals continuously spurt into space from its surface.

A TRIP TO JUPITER

The same thing is happening on Jupiter's moon Europa which NASA estimates has a sub-surface ocean containing twice the amount of water in Earth's oceans. Future missions such as NASA's Europa Clipper, scheduled for arrival in 2030, could help us work out if the conditions there are right for life.

Under its thick crust of ice, Europa's oceans or salty liquid reservoirs could be habitable.

One rover discovered a type of silica which exists in hot springs on Earth. These sorts of springs might have been home to ancient microbes.

THE RED PLANET

Even our next-door neighbour, Mars, could be a living planet. Data from our Mars rovers tell us that the Red Planet, which today is cold and dry, used to be a lot more like Earth with oceans, lakes and rivers. If life got started when liquid water was everywhere on Mars, extremophiles could still be clinging on to this day in hard-to-reach places like underground caves. Imagine Martian snottite!

ANOTHER EARTH

Despite these possibilities, Earth remains the only place we've ever found life. There's only one planet like ours around the Sun, so to find another Earth we may have to widen the search. It's time we looked towards the other stars twinkling away in the night sky!

EXOPLANET TOOLKIT: WINKS

All of a sudden, the temperature drops and the sky darkens – even though it's lunchtime. An eerie silence descends as birds stop tweeting, tricked into thinking night is falling. You're witnessing a spectacular solar eclipse, where the Moon temporarily blocks out the Sun.

TRANSITING METHOD

Astronomers call an event like this a transit. The Moon is passing in front of – or transiting across – the Sun. Distant exoplanets often transit in front of their stars, too. The planet is too small and dim to be seen directly, but during the transit it blocks out some of the star's light. You'll see the star get temporarily dimmer, like it's winking at you.

ORBIT TIME

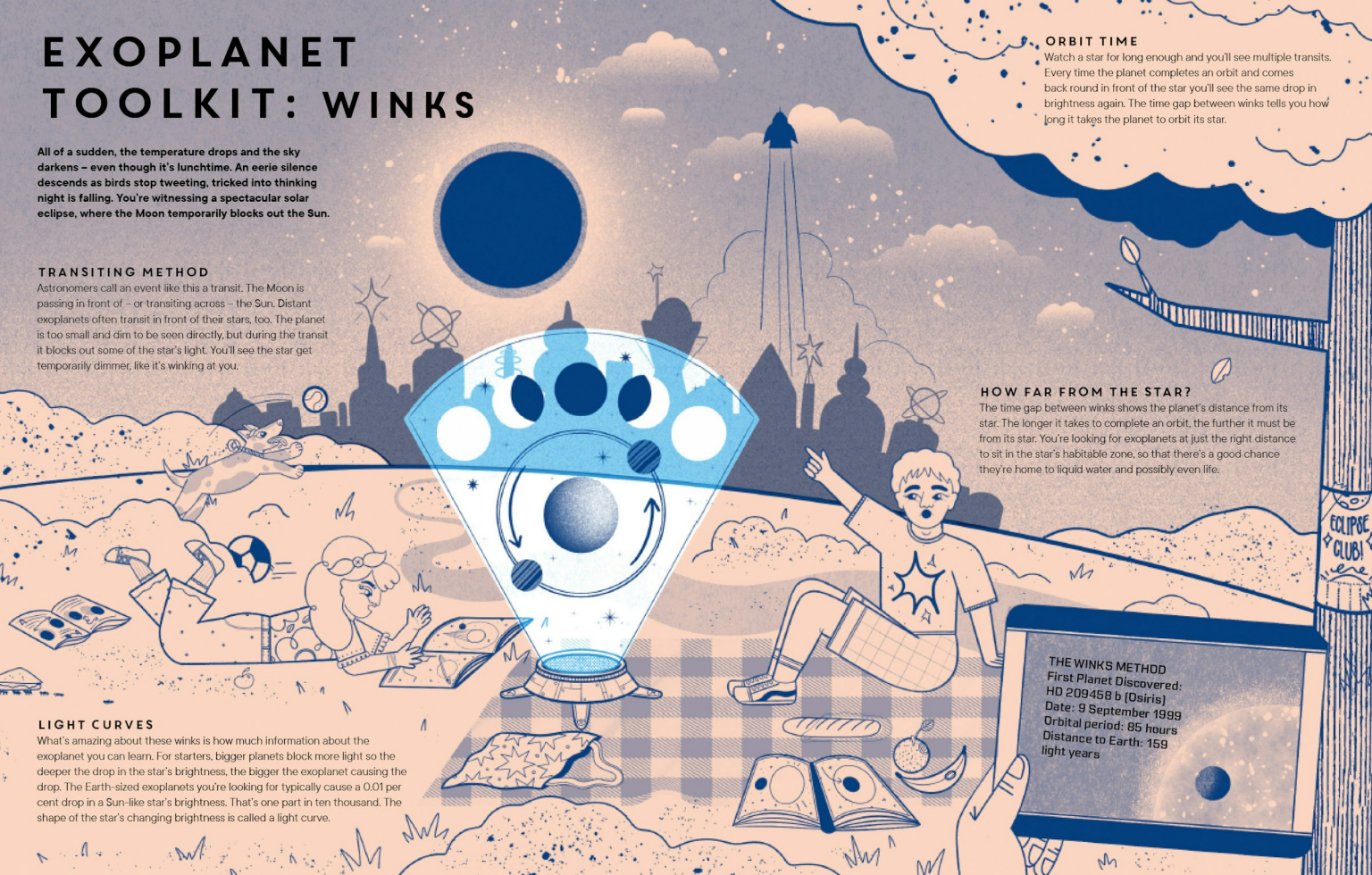
Watch a star for long enough and you'll see multiple transits. Every time the planet completes an orbit and comes back round in front of the star you'll see the same drop in brightness again. The time gap between winks tells you how long it takes the planet to orbit its star.

HOW FAR FROM THE STAR?

The time gap between winks shows the planet's distance from its star. The longer it takes to complete an orbit, the further it must be from its star. You're looking for exoplanets at just the right distance to sit in the star's habitable zone, so that there's a good chance they're home to liquid water and possibly even life.

LIGHT CURVES

What's amazing about these winks is how much information about the exoplanet you can learn. For starters, bigger planets block more light so the deeper the drop in the star's brightness, the bigger the exoplanet causing the drop. The Earth-sized exoplanets you're looking for typically cause a 0.01 per cent drop in a Sun-like star's brightness. That's one part in ten thousand. The shape of the star's changing brightness is called a light curve.



EXOPLANET TOOLKIT: BLIPS

Albert Einstein is arguably the most famous scientist of all-time. Along with the equation E=mc2, he changed the way we think about gravity forever and gave us a new way to hunt down exoplanets.

GRAVITY WELL

Imagine taking the sheet off your bed and roping in some friends to hold each corner. You then put a basketball in the middle, which creates a dip in the centre of the sheet. Next you take a tennis ball and roll it rapidly around the rim of the dip. In other words, you make the tennis ball orbit the basketball.

Now, let's pretend the basketball is the Sun and the tennis ball is the Earth. The tennis ball isn't orbiting the basketball because it is being pulled around by it. What happens is that the basketball changes the shape of the sheet and the tennis ball is simply follows that shape. This is Einstein's explanation of gravity and the dip is a called a gravity well.

NEUTRON STARS

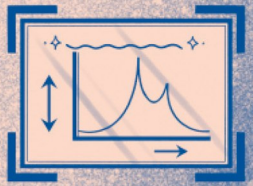
Scientists use gravity wells to see if distant stars have exoplanets using a technique called gravitational microlensing. Here's how:

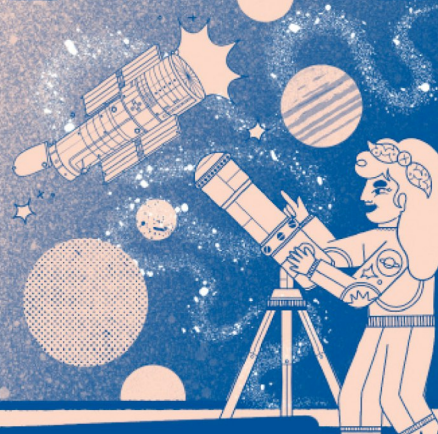
Wait for a nearby star to pass directly in front of a more distant star.

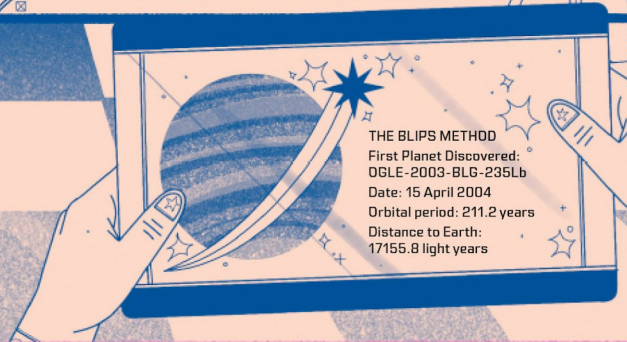
As the light from the distant star approaches the star in front, it encounters its gravity well.

The distant star's light curves around the rim of that well before hitting your telescope.

The effect of this is that you'll see the distant star's light get temporarily brighter as if the front star is acting like the lens of a magnifying glass. If the front star has an exoplanet then you'll also see a small extra 'blip' where the planet's own gravity well has added in some extra magnification.







THE BLIPS METHOD

First Planet Discovered:
OGLE-2003-BLG-235Lb

Date: 15 April 2004

Orbital period: 211.2 years

Distance to Earth:
17155.8 light years