



ABCs of Exoplanets Flash Card Downloads

The image shows a two-page spread of a flash card download. The left page features the NASA logo at the top left, the text "National Aeronautics and Space Administration" below it, and a large, stylized title "THE ABCS OF EXOPLANETS" in yellow and orange. Below the title is the subtitle "A PAINTED EXPLORATION OF THE WHATS AND WHYS OF STAR-ORBITING PLANETS OUTSIDE OUR SOLAR SYSTEM" and the website "www.nasa.gov" at the bottom. The right page has the title "ABCs of Exoplanets" at the top, followed by a paragraph: "Learn about planets outside our solar system with our flash cards, colorful reading book, and interactive e-book!". Below this is another paragraph: "Follow along on the search for new worlds with NASA's next exoplanet mission, the exciting Transiting Exoplanet Survey Satellite (TESS) mission. TESS is the first space mission to search nearly the entire sky for exoplanets. This will allow it to find many different kinds of exoplanets around many different stars!". At the bottom right of the right page is a QR code and the text "NP-2018-3-185-GSFC".

Directions:

Print each page on 8.5x11 inch sheet of paper (regular or cardstock). After printing each sheet, cut the flash cards out (dotted lines only provided for light colored cards). Fold each card in half after cutting them out. Tape or glue the two halves together to create finished flash cards. You will end up with a stack of 28 flash cards total when you are finished.

National Aeronautics and
Space Administration



THE ABCs OF EXOPLANETS

A PAINTED EXPLORATION OF THE WHATS AND WHYS OF
STAR-ORBITING PLANETS OUTSIDE OUR SOLAR SYSTEM

www.nasa.gov

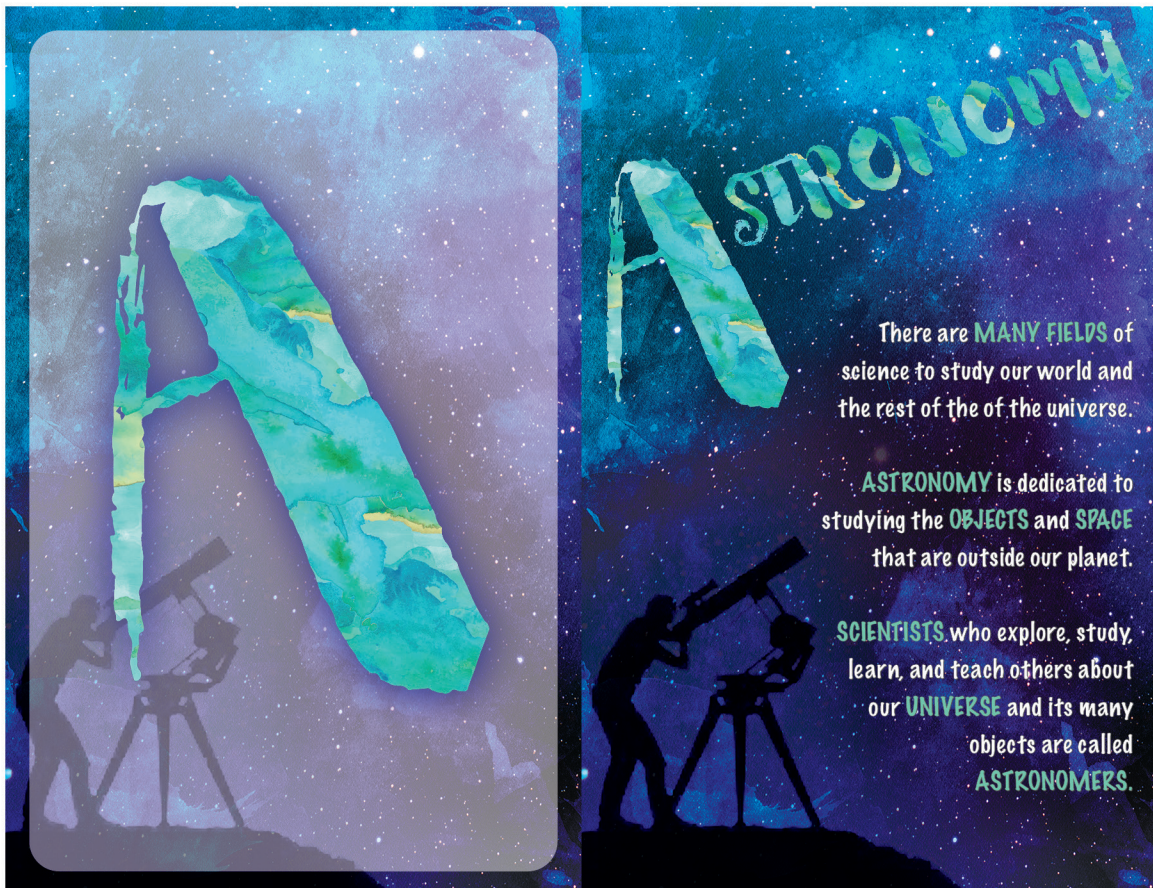
ABCs of Exoplanets

Learn about planets outside our solar system with
our flash cards, colorful reading book, and
interactive e-book!

Follow along on the search for new worlds with
NASA's next exoplanet mission, the exciting
Transiting Exoplanet Survey Satellite (TESS)
mission. TESS is the first space mission to search
nearly the entire sky for exoplanets. This will
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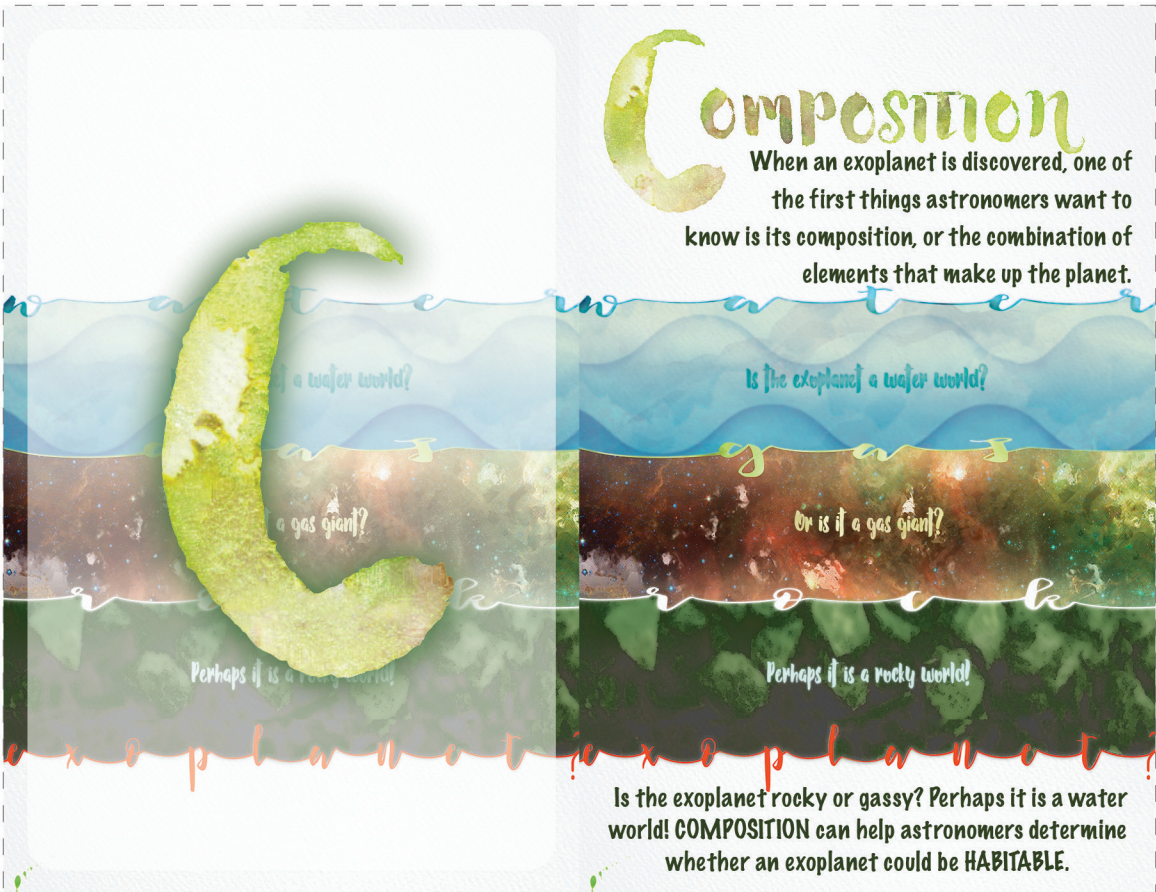
NP-2018-3-185-GSFC





A binary star system is a **GROUP OF TWO STARS** that orbit each other or the same central point. Astronomers believe at least **HALF OF THE STARS** in our galaxy are part of **BINARY SYSTEMS!** An exoplanet orbiting a binary star system could have **MULTIPLE SUNRISES** and **SUNSETS!**

BINARY STAR SYSTEM

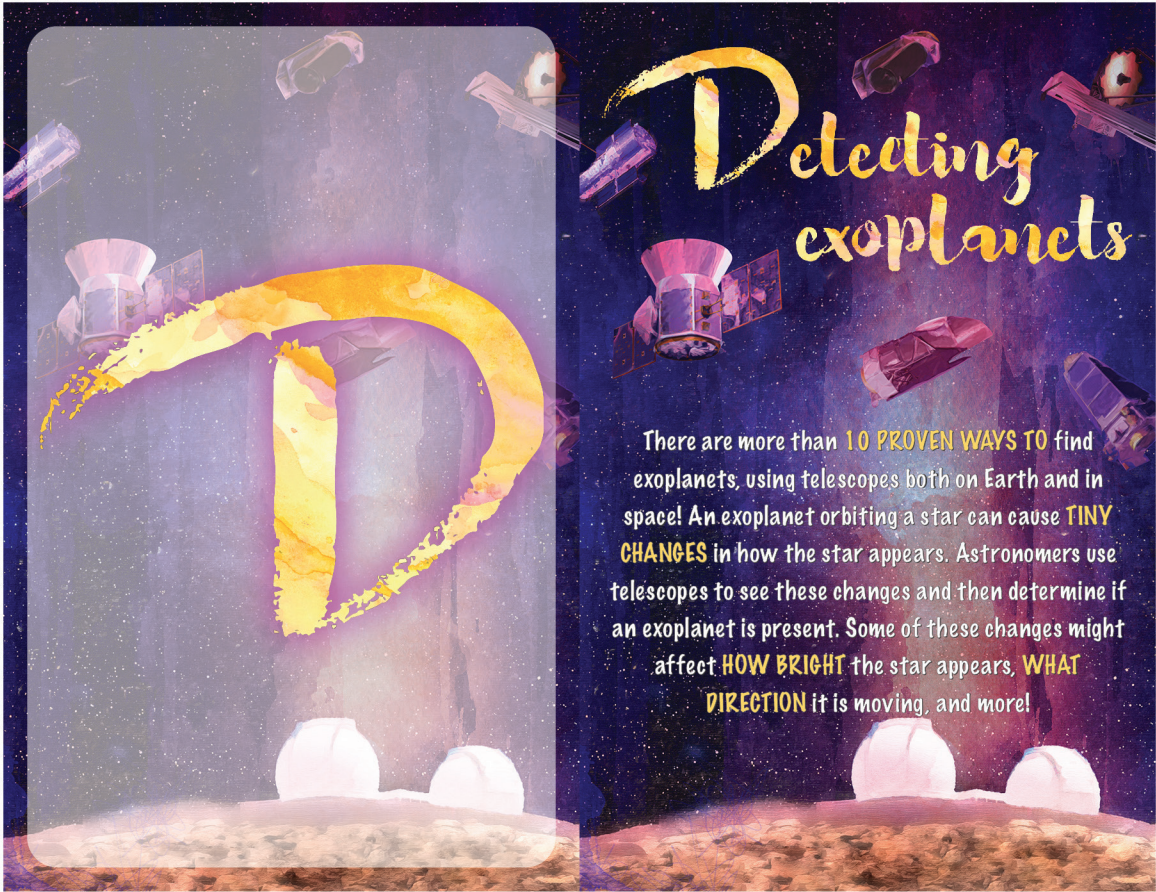


Composition

When an exoplanet is discovered, one of the first things astronomers want to know is its composition, or the combination of elements that make up the planet.

water
 Is the exoplanet a water world?
gas giants
 Or is it a gas giant?
rocky
 Perhaps it is a rocky world!

Is the exoplanet rocky or gassy? Perhaps it is a water world! **COMPOSITION** can help astronomers determine whether an exoplanet could be **HABITABLE**.



Detecting exoplanets

There are more than **10 PROVEN WAYS TO** find exoplanets, using telescopes both on Earth and in space! An exoplanet orbiting a star can cause **TINY CHANGES** in how the star appears. Astronomers use telescopes to see these changes and then determine if an exoplanet is present. Some of these changes might affect **HOW BRIGHT** the star appears, **WHAT DIRECTION** it is moving, and more!



Exoplanets

On a clear dark night, you can see **THOUSANDS OF STARS** in the night sky. Each of those stars may have planets orbiting it, called **EXOPLANETS!** Exoplanets do not belong to our solar system. Some may be similar to our solar system's planets, but some may be **VERY DIFFERENT.**



Free Floating Planet

Not every **EXOPLANET** can be bound to orbiting a **STAR**. If an exoplanet is ejected from its star system, that planet **FLOATS FREELY** in space; these exoplanets are also sometimes called **ROGUE PLANETS!** Scientists estimate there could be hundreds of billions of **FREE-FLOATING** planets in the Milky Way.



GAS GIANTS

GAS GIANTS are huge planets that are made mostly of gases and do not have a surface made of rocky materials and metals. These planets are **MUCH LARGER** than rocky worlds like our Earth. We have four gas giants in our solar system!



Host Star

Exoplanets orbit their own **SPECIAL STAR**, called a host star. Host stars can come in all different colors, sizes and temperatures. Sometimes **EXOPLANETS** even orbit around more than one star in a system! **HOW FAR AWAY** an exoplanet is from its **HOST STAR** helps determine whether the exoplanet can be **HABITABLE**.



Infinite WORLDS

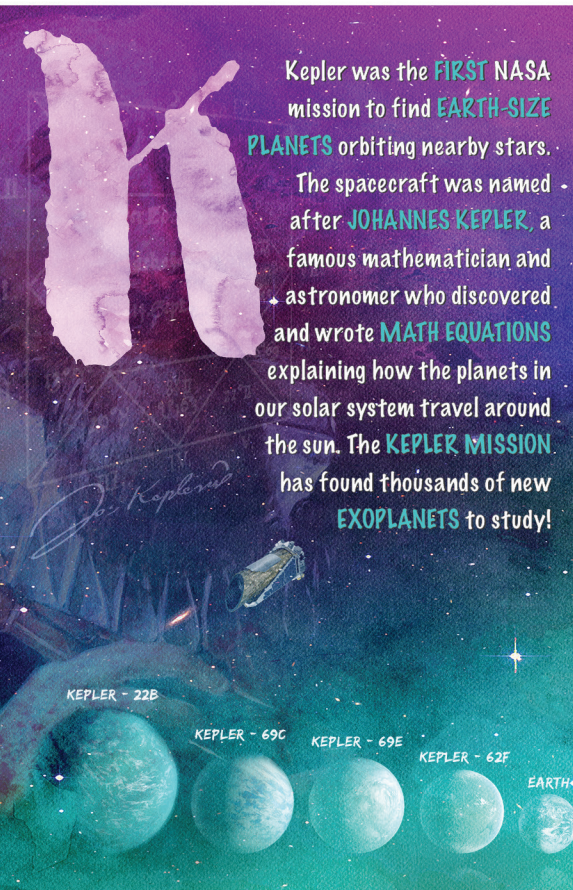
THERE ARE MANY MANY GALAXIES in our universe. In each galaxy, stars are forming ALL THE TIME! Planets could be forming around these new stars, too! With so many stars to study and observe, the number of exoplanets is ENDLESS!



HOT JUPITER

Hot Jupiters are **HUGE GAS GIANT EXOPLANETS** that are very close to their host star! They may be too close for life to form, and their atmospheres may even be **BOILING AWAY** from the heat! They have very **FAST ORBITS** because they are so close to their star.

ONE HOT JUPITER HAS AN ORBIT OF JUST FOUR DAYS!



Kepler was the **FIRST** NASA mission to find **EARTH-SIZE PLANETS** orbiting nearby stars.

The spacecraft was named after **JOHANNES KEPLER**, a famous mathematician and astronomer who discovered and wrote **MATH EQUATIONS** explaining how the planets in our solar system travel around the sun. The **KEPLER MISSION** has found thousands of new **EXOPLANETS** to study!



LIGHT YEARS

Here on Earth, we have many **DIFFERENTLY SIZED UNITS** to measure how far away something may be or how big something is. Astronomers commonly use the **LIGHT-YEAR**, the distance light travels in one year.

ONE LIGHT-YEAR is equal to about **5878499810000 MILES!** One of the **CLOSEST** known exoplanets to Earth is **4.22 LIGHT-YEARS AWAY.**

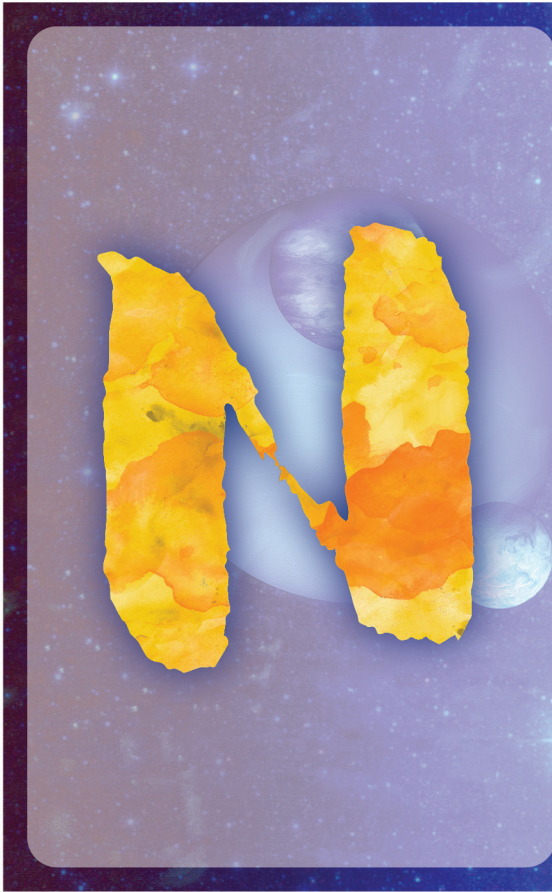


exo MOONS

Many planets in our solar system have moons. Astronomers believe exoplanets might have moons, too!

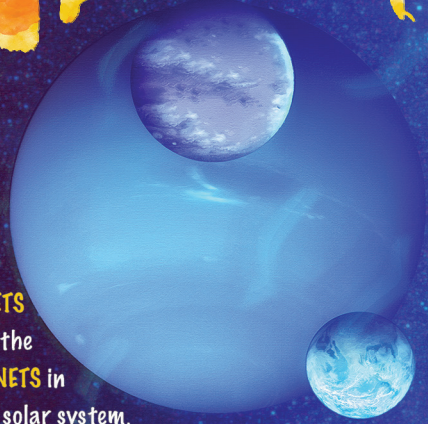
They would be called exomoons and are very difficult to find because they are smaller than planets and **DO NOT PRODUCE THEIR OWN LIGHT.**

Astronomers are developing new techniques to help make finding them easier.



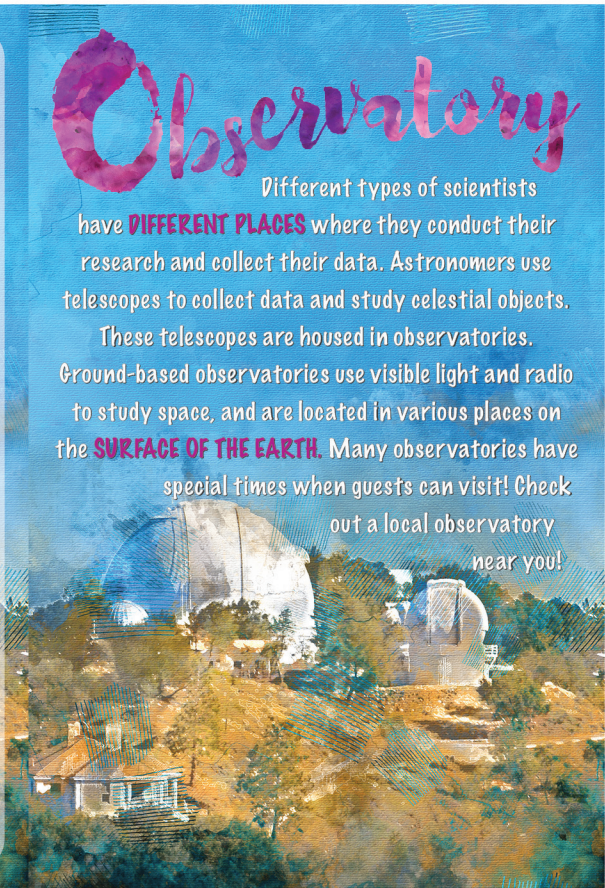
mini NEPTUNE


Some **EXOPLANETS** resemble the **GAS PLANETS** in our own solar system, but they're **MUCH SMALLER!** These planets are called **MINI-NEPTUNES**. They are closer in size to Earth than Neptune, but astronomers can tell they're gas planets because they are much **LESS DENSE** than a rocky world.



Observatory

Different types of scientists have **DIFFERENT PLACES** where they conduct their research and collect their data. Astronomers use telescopes to collect data and study celestial objects. These telescopes are housed in observatories. Ground-based observatories use visible light and radio to study space, and are located in various places on the **SURFACE OF THE EARTH**. Many observatories have special times when guests can visit! Check out a local observatory near you!





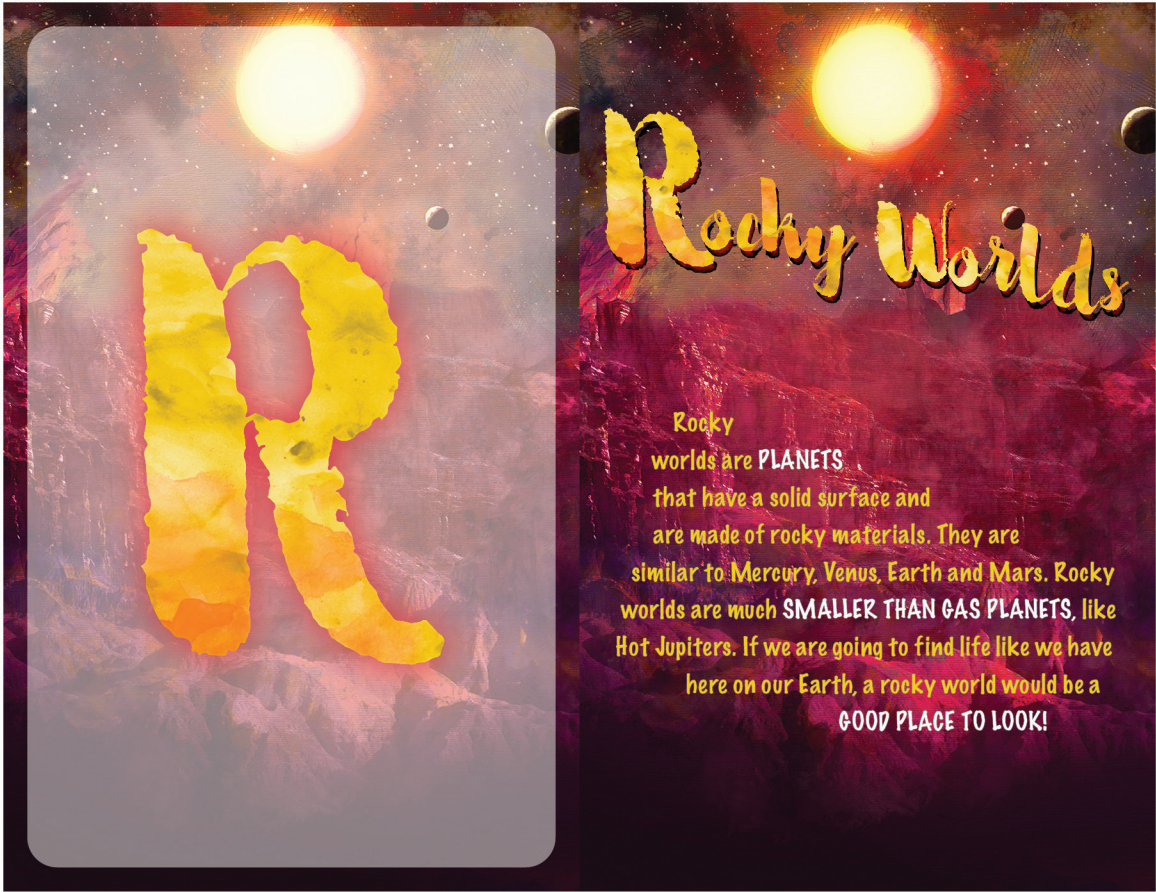
Proxima Centauri b

The closest exoplanet to Earth orbits the star Proxima Centauri. It's called **PROXIMA CENTAURI B**, and it is only a little over **FOUR LIGHT-YEARS AWAY!** It would take many years to travel to this exoplanet because we cannot move as **FAST AS LIGHT**, but **IMAGINE** what new information we could **DISCOVER!**



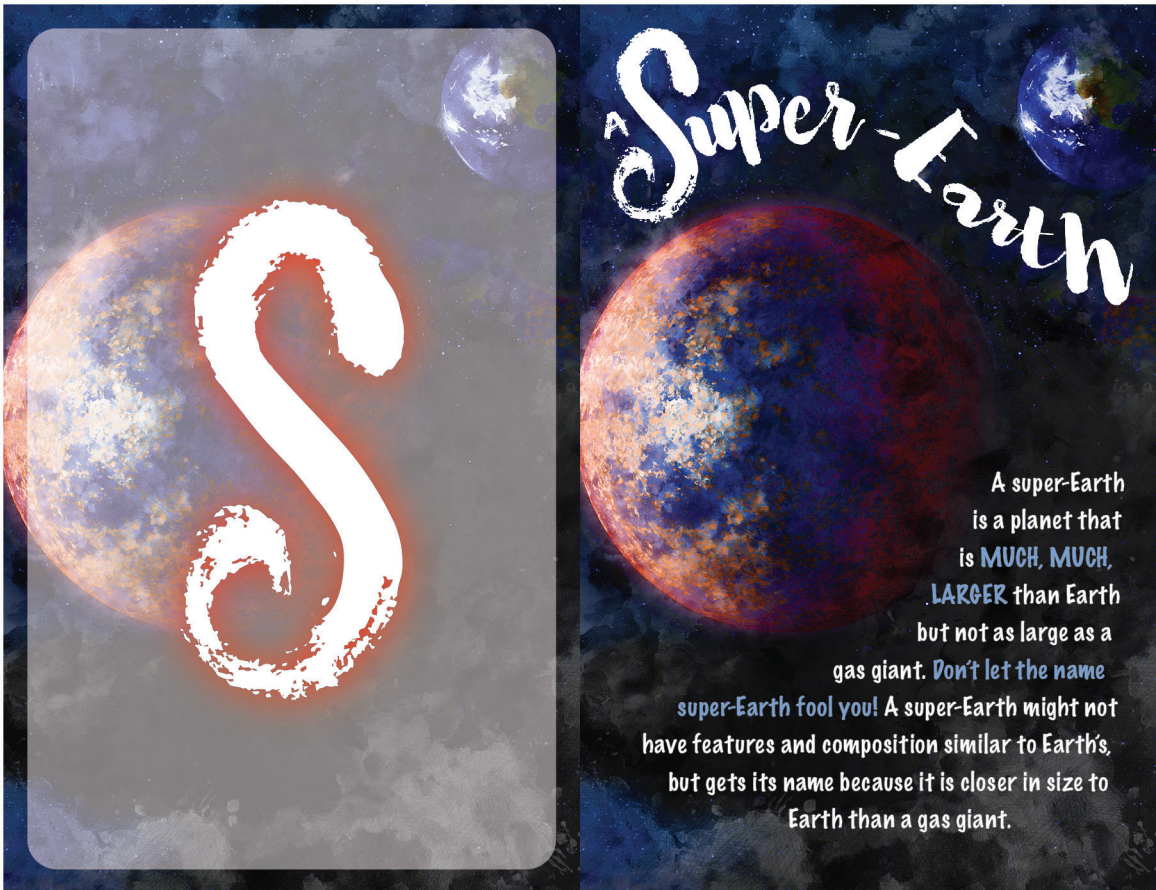
Questions

With astronomers discovering **NEW WAYS** to find exoplanets and new observatories being built, the quest for **NEW WORLDS** is just beginning! Many questions are being asked, scientists are studying data and new missions are being designed to help find **ANSWERS.**



Rocky Worlds

Rocky worlds are **PLANETS** that have a solid surface and are made of rocky materials. They are similar to Mercury, Venus, Earth and Mars. Rocky worlds are much **SMALLER THAN GAS PLANETS**, like Hot Jupiters. If we are going to find life like we have here on our Earth, a rocky world would be a **GOOD PLACE TO LOOK!**



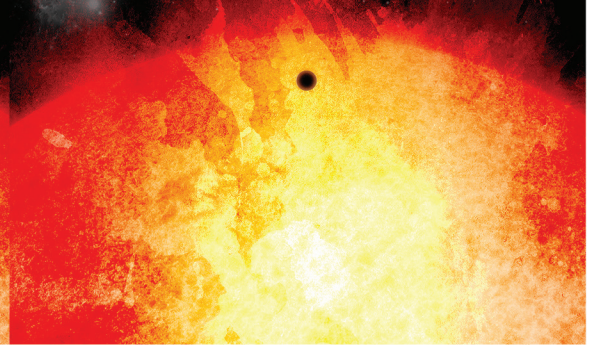
Super-Earth

A super-Earth is a planet that is **MUCH, MUCH, LARGER** than Earth but not as large as a gas giant. **Don't let the name super-Earth fool you!** A super-Earth might not have features and composition similar to Earth's, but gets its name because it is closer in size to Earth than a gas giant.



Transit

When an exoplanet orbits in front of its **HOST STAR**, it **BLOCKS** some of the **LIGHT**. Astronomers call this a transit. Each transit will block a different amount of light because exoplanets can be **DIFFERENT SIZES** and **DIFFERENT DISTANCES** from their host star. This is one way for astronomers to find new **EXOPLANETS**.



Uni

Everything we know that exists is located in the **UNIVERSE**. The universe is the term astronomers use to describe all of space. Astronomers believe it is **GROWING AND GROWING!** **HOW BIG WILL THE UNIVERSE GET?** Our galaxy, the Milky Way, is one part of the universe. How many exoplanets are in our galaxy?

verse



radial Velocity

One of the ways astronomers **DISCOVER** exoplanets is called **RADIAL VELOCITY**. **STARS** aren't completely still in space when an exoplanet is orbiting them. The planet **TUGS** on the star ever so **SLIGHTLY**, causing it to move in a small circle. These movements affect a star's **LIGHT SPECTRUM**. When the planet is moving **TOWARD US**, the **COLORS** will appear **SHIFTED** toward the color **BLUE**. When moving **AWAY** from us, the color spectrum is **SHIFTED** toward **RED**. These shifts can be measured and show a planet is in **ORBIT**.



WATER WORLD

A **WATER WORLD**, or an ocean planet, is a planet that astronomers think could be entirely **COVERED BY WATER**. With all of that water, it may be hard to have **LAND-BASED** life forms.

However, if the planet could have life, imagine all of the new types of **WATER LIFE** that could be discovered!



Astronomers call the light we see with our eyes "**VISIBLE LIGHT**," but visible light only makes up a small portion of all the light in the **UNIVERSE!** X-rays are a special type of light astronomers use to observe exoplanets transiting their host star. **X-RAYS** provide **DIFFERENT INFORMATION** than visible light.



Y

EAR

The time it takes for a planet to **ORBIT** around its star is called a year, or an **ORBITAL PERIOD**. Different planets have **DIFFERENT** year **LENGTHS**. The length of the planet's year depends on how close it is to its **HOST STAR**. The closer the planet is to its host star, the **SHORTER** its **YEAR** will be.



Habitable



Every star has three **SPECIAL ZONES** surrounding it. These zones are divided by **TEMPERATURE**. Just like in Goldilocks, there is a zone that's **TOO HOT** for life, a zone that's **TOO COLD**, and one that is **JUST RIGHT!** The middle zone is the "just right" zone, called the **HABITABLE ZONE**. Planets there are the most likely to support life!



TESS

NASA's Transiting Exoplanet Survey Satellite (TESS) will **DISCOVER** thousands of **EXOPLANETS** in orbit around the brightest stars in the sky. TESS is the first space mission to search nearly the entire sky for exoplanets. In a **TWO-YEAR ALL-SKY SURVEY**, it will monitor more than **200,000 STARS** for short drops in brightness caused by exoplanets passing in front of them, called **TRANSITS**.

WHAT NEW WORLDS WILL IT FIND?

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