National Aeronautics and Space Administration

NASA Helio Club

Session 6
Beyond the Heliosphere

NASA Heliophysics Education Activation Team

Materials Needed for this Session

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Basics
- ❑ Writing tools (pens or pencils)
- ❑ Art supplies (markers or crayons)
- ❑ (1) pair of scissors
- ❑ (1) roll of tape

Prior Knowledge/Evaluate
- ❑ (1) Handout_KWL_Session 6

Engage
- ❑ (1) Handout_NASA's Science Fleet

Explore: Activity 1
- ❑ (1) Handout_Life Cycle of Stars
- ❑ (1) Haandout_Modeling a Supernova
- ❑ (1) Tennis ball
- ❑ (1) Ping Pong ball

Explain: Activity 2
- ❑ Digital Resources
- ❑ (optional) Poster Paper

Extend: Activity 3
- ❑ Set of Extremophile Cards

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Youth Guide Page 81

Use a notebook or the extra paper in the Helio Club Youth Guide to record observations, collect data, and organize ideas.

Session 6: Notes

What do you already know about space weather?

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Session 6: KWL		
K - what do we already know?	**W- what do we wonder about?**	**L- what did we learn?**
What do we already know about other star systems? Are other stars like our Sun?	**Record questions you have about other star systems in this column.**	**Record what you learned about other star systems in this column.**

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NASA's Science Fleet

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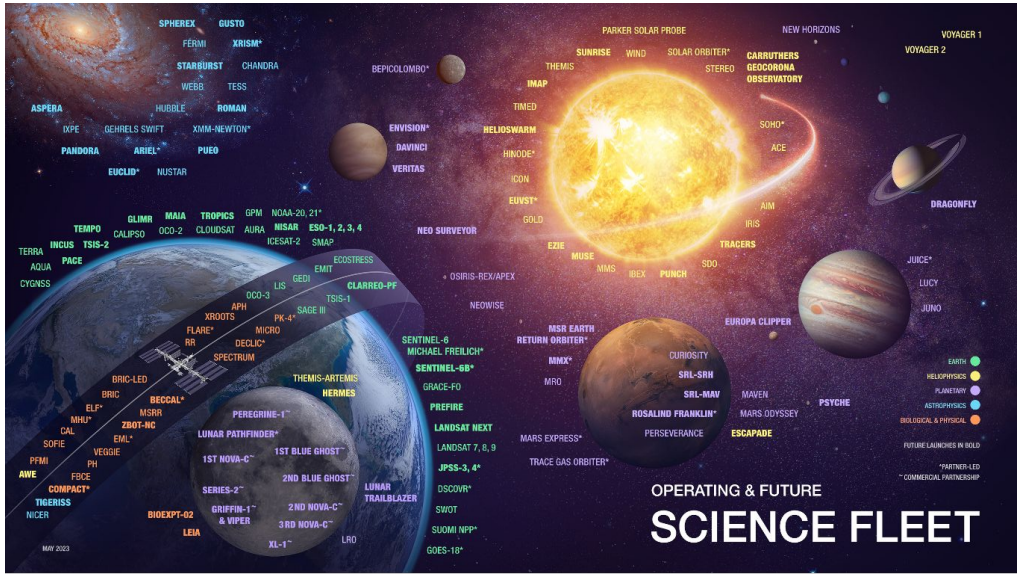
Can you find all of the missions we have learned about during Club Sessions 1-5?

- What types of missions have we explored so far during the club?
  - Earth Science in green
  - Heliophysics in yellow
  - Planetary Science in purple
  - Astrophysics in blue
  - Biological & Physical Sciences in orange

- Which of the missions we explored were most interesting to you? Why?



Operating and Future NASA Missions
Credit: NASA

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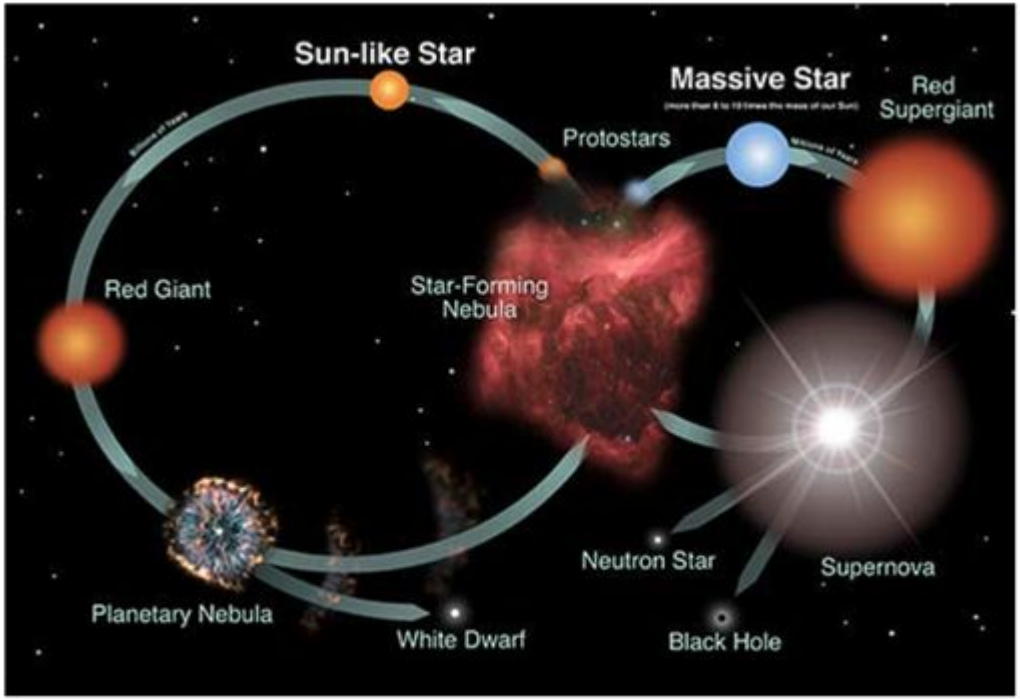
What is your favorite Hubble image?

Hubble Space Telescope
Credit: NASA/Hubble

[NASA/ESA Top 100 Images Site]

The Lives of Stars

Youth Guide Page 78-79



The life cycle of a Sun-like star and a massive star, 8-10 times larger than the Sun.
Credit: NASA / Night Sky Network

- How do both low-mass stars and massive stars begin their life?
- Why is this process considered a cycle?
- What are the similarities and the differences between the red giant phase of a low-mass star and the red supergiant phase of a massive star?
- While a Sun-like (low-mass) star will slowly lose its material through the planetary nebula stage, eventually becoming a white dwarf - how will a massive star lose its material and what will it become?

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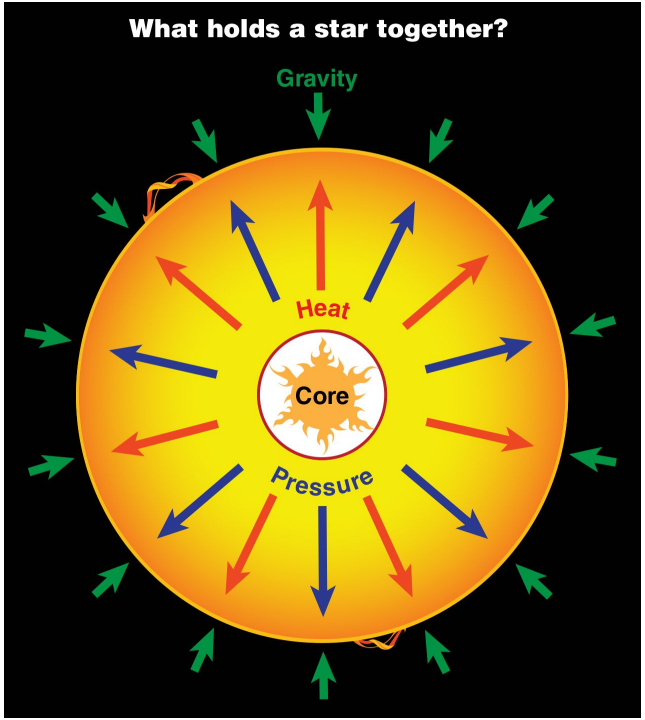
Supernova Explosion

Supernova remnant captured by NASA's Chandra Mission ***Credit: NASA Chandra***



What holds a star together?
Credit: NASA Space Place

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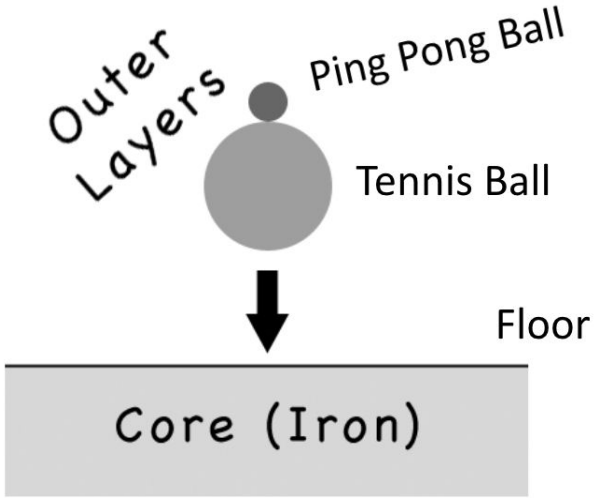
Modeling a Supernova Explosion

Drop the balls at the same time, with the balls in contact with one another.



Credit: NASA Afterschool Universe

Make a prediction!

What will happen to each ball when they hit the floor?

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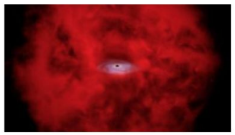
Chandra Stories Scavenger Hunt

Chandra Stories



NASA Connects Little Red Dots with Chandra, Webb

4 MIN READ

A newly discovered object may be a key to unlocking the true nature of a mysterious class of sources that astronomers have found in the early universe in recent years. A “X-ray dot” found by NASA’s Chandra X-ray Observatory could...

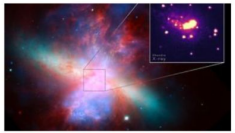
ARTICLE

NASA Finds Young Stars Dim in X-rays Surprisingly Quickly

5 MIN READ

Scientists have found that young stellar cousins of our Sun are calming down and dimming more quickly in their X-ray output than previously thought, according to a new study using NASA’s Chandra X-ray Observatory. A paper describing the results published...

ARTICLE



NASA-JAXA’s XRISM Telescope Clocks Hot Wind of Galaxy M82

5 MIN READ

For the first time, astronomers have directly measured the speed of superheated gas billowing from a cauldron of stellar activity at the heart of M82.

ARTICLE

Scavenger Hunt Items:

- ❑ Spiral Galaxy
- ❑ Supernova Remnant
- ❑ Black Hole
- ❑ Nebula

X-ray telescopes allow us to see really hot objects, like exploding stars and black holes.

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Multi-Mission Images

Galaxy M74

Credits: X-ray: Chandra: NASA/CXC/SAO, XMM: ESA/XMM-Newton; IR: JWST: NASA/ESA/CSA/STScI, Spitzer: NASA/JPL/CalTech; Optical: Hubble: NASA/ESA/STScI, ESO; Image Processing: L. Frattare, J. Major, and K. Arcand

Viewing objects in multiple wavelengths of light can give scientists more information about the object.

This image is a combination of images taken from multiple missions:

- **Chandra** data spotlights high-energy activity from stars at **X-ray** wavelengths (purple)
- **JWST** outlines gas and dust in the **infrared** (green, yellow, red, magenta)
- **Hubble** optical data showcases additional stars and dust along the dust lanes (orange, cyan, blue)

These cosmic wonders and details are made available by mapping the data to colors that humans can perceive.

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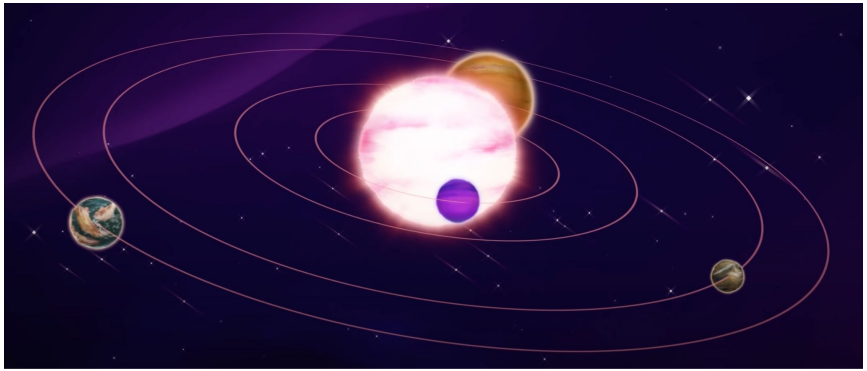
Exoplanet Videos

Exoplanets: Weird and Wondrous
Credit: NASA/JPL-Caltech



Exoplanet Types: Worlds Beyond our Solar System ***Credit: NASA/JPL-Caltech***

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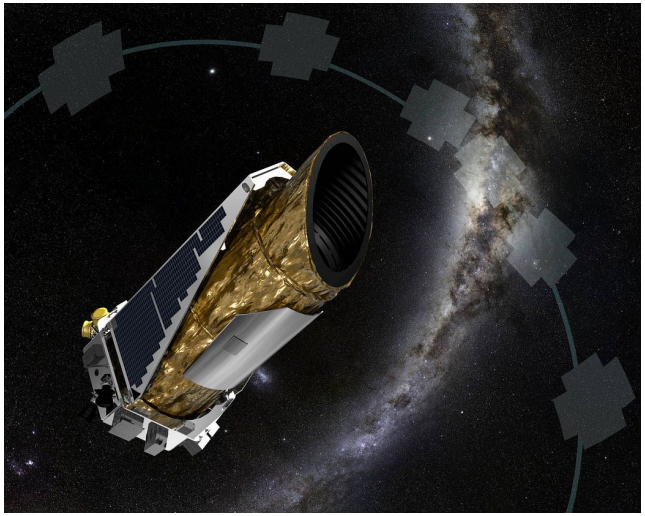
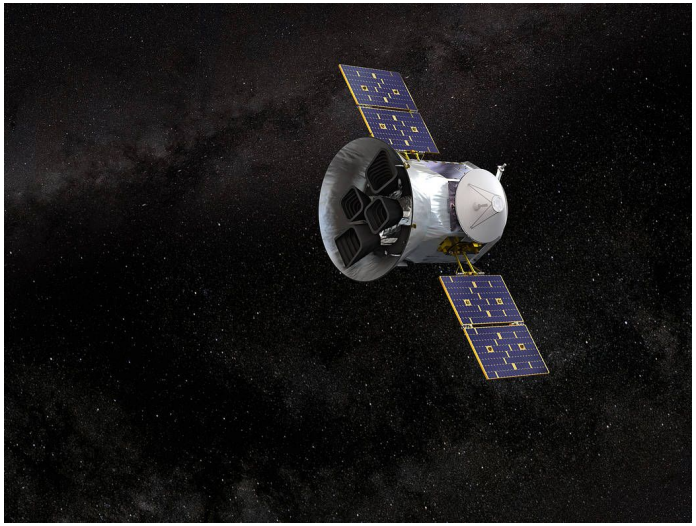
2 NASA Missions that search for Exoplanets

Kepler and K2



The Kepler Mission is specifically designed to survey our region of the Milky Way galaxy to discover hundreds of Earth-size and smaller planets in or near the habitable zone and determine the fraction of the hundreds of billions of stars in our galaxy that might have such planets. ***Credit: NASA***

TESS
(Transiting Exoplanet Survey Satellite)



TESS will survey 200,000 of the brightest stars near the Sun to search for transiting exoplanets.
Credit: NASA

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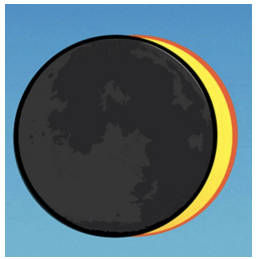
NASA Space Place: Transits

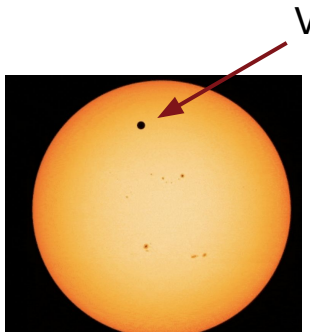
NASA Space Place: Transits

*A **transit** is when an object passes between a star and its observer. More **exoplanets** are discovered this way than any other method.*

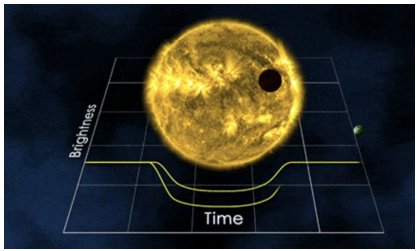
An eclipse is a type of transit. The Moon passes between the Sun and the Earth.



Graphic 1: Solar Eclipse
Credit: NASA/JPL-CalTech



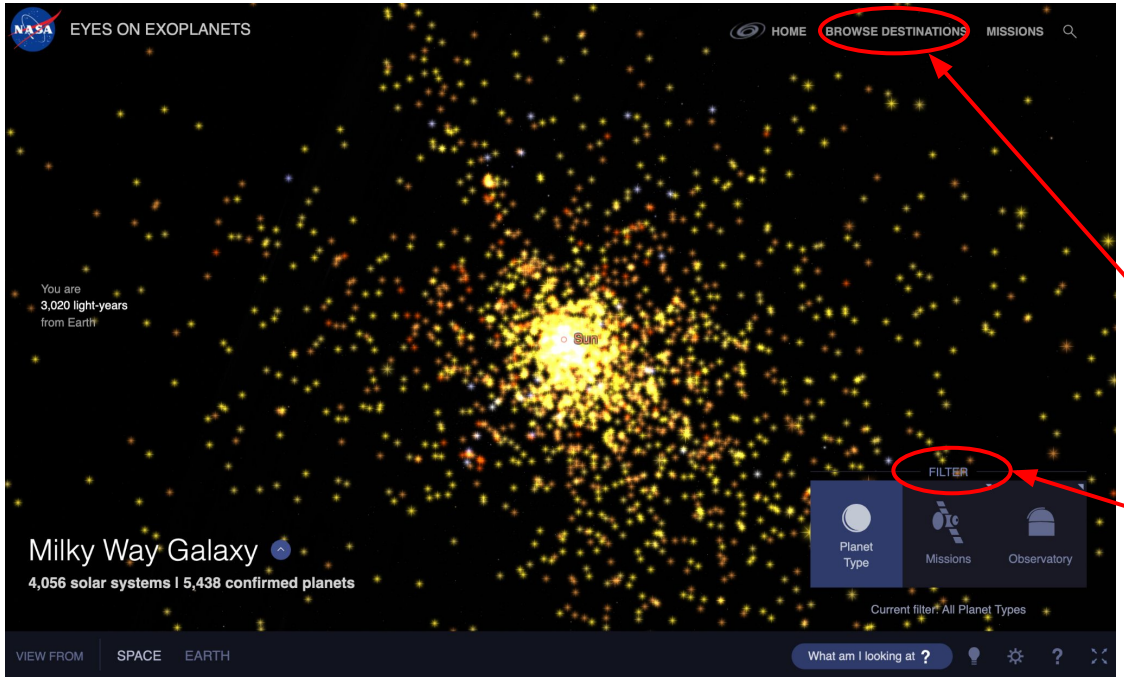
Graphic 2: Venus Transit
Credit: NASA



Graphic 3: Brightness vs. Time
Credit: NASA GSFC

5000+ NASA Confirmed Exoplanets

NASA's Eye on Exoplanets



Each plot on the screen is a star where an **exoplanet** has been discovered.

When you click on a data plot it zooms in on the star and shows the **exoplanets** orbiting around the star.

Select **"Browse Destinations"** to see featured discoveries, weirdest planets, types of planets and more!

You can **filter** by planet-type or by the mission or observatory that discovered the planet.

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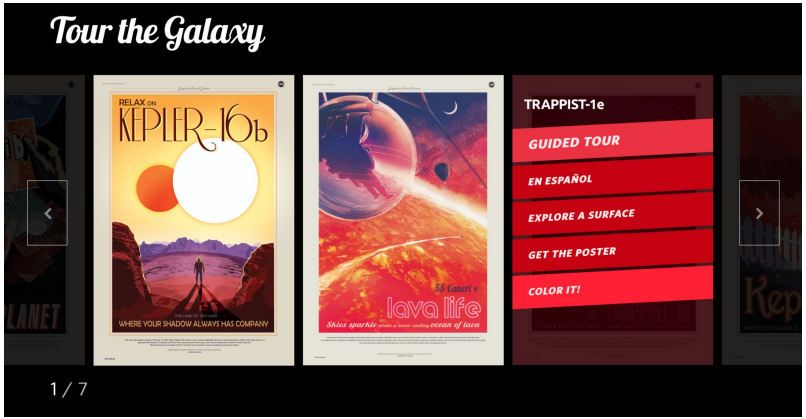
Exoplanet Travel Bureau



Exoplanet Travel Bureau
Credit: NASA

Where science meets art!

Artist, Tyler Nordgren, uses scientific data from NASA missions to make illustrations about what exoplanets might look like.

Exoplanet Travel Bureau Poster
Credit: Tyler Nordgren

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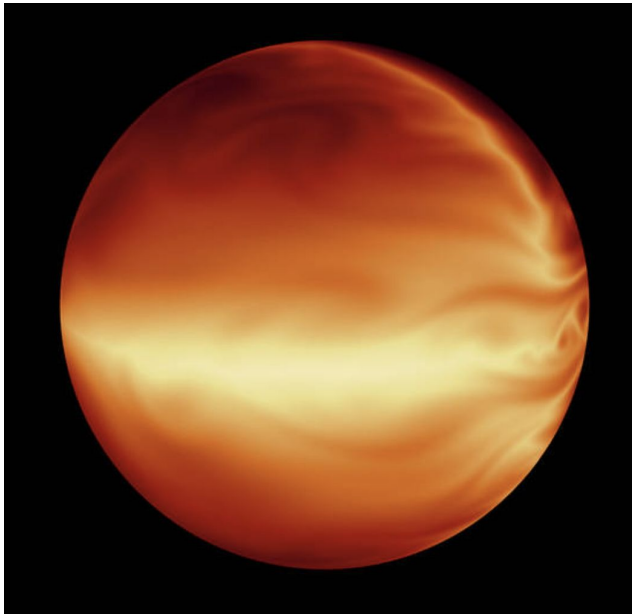
NASA's Spitzer Mission Also Finds Exoplanets

Discover Planet HD 80606b with Spitzer Space Telescope!

The turbulent atmosphere of a hot, gaseous planet known as **HD 80606b** is shown in this simulation based on data from NASA's Spitzer Space Telescope.

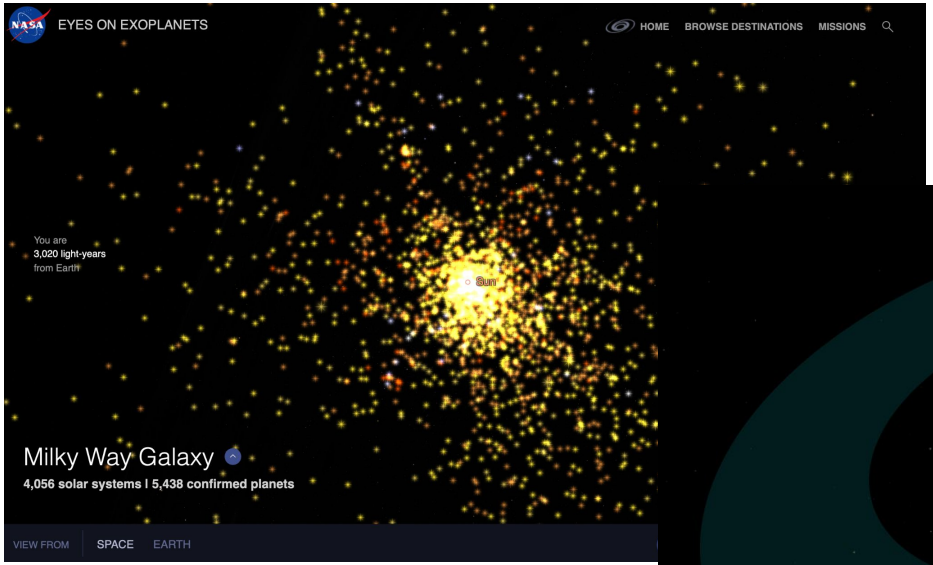
The planet spends most of its time far away from its star, but every 111 days, it swings extremely close to the star, experiencing a massive burst of heat.

Spitzer measured the whole heating cycle of this planet, determining its coolest (less than 400 degrees Fahrenheit) and hottest (2,000 degrees Fahrenheit) temperatures.



Planet HD 80606b
Credit: NASA/JPL-CalTech

Habitable Zone



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Extremophile Cards

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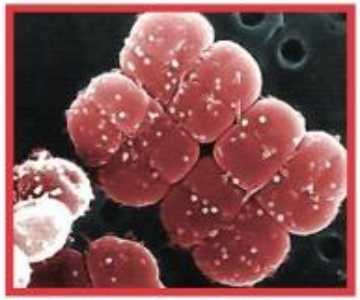
CONAN THE BACTERIUM

Deinococcus radiodurans



Peggy A. O'Cain and Margaret C. Hanik, Louisiana State University

the "terrible grain"

Conan the Bacterium Environment

Conan is so tough, it can even survive high levels of radiation.

	Range	Low	High
Temperature	← Range →	Low	High
Sunlight		Low	High
Pressure		Low	High
Water Need		Low	High
Acidity		Not acidic	Very acidic

Can be found

Fun Fact

Deinococcus radiodurans is listed as the world's toughest bacterium in The Guinness Book Of World Records.

www.nasa.gov

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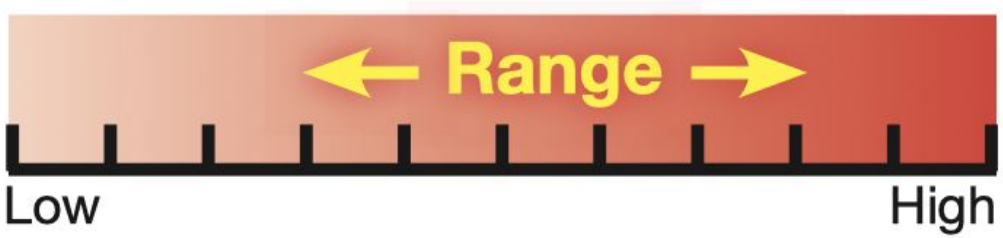
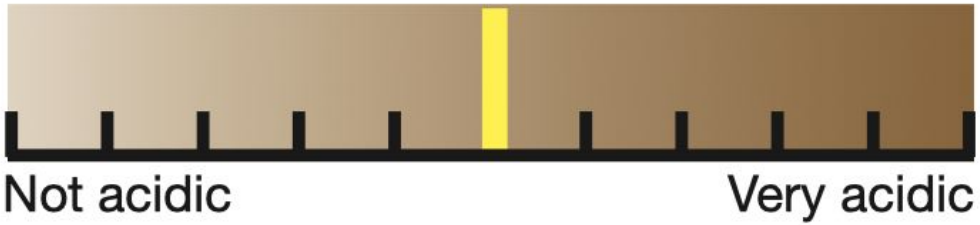
Temperature

Temperature



pH

Acidity

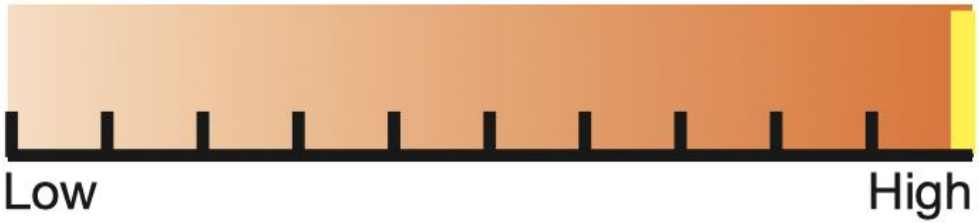


Pressure

Pressure

Sunlight

Sunlight



Little Water

Water Need

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What did you learn about other stars?

Session 6: KWL		
K - what do we already know?	**W- what do we wonder about?**	**L- what did we learn?**
What do we already know about other star systems? Are other stars like our Sun?	**Record questions you have about other star systems in this column.**	**Record what you learned about other star systems in this column.**

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Session 6 Major Concepts

- ★ Stars come in different sizes; the Sun is an average-sized, very mild-mannered star.
- ★ Stars are born in a **stellar nebula,** which is made of mostly hydrogen and dust.
- ★ The **main-sequence** phase of the life cycle of a star is when the star is actively making energy through **nuclear fusion**.
- ★ Our Sun is currently in the **main-sequence** phase of its life and will continue to burn fuel for about 5 billion more years.
- ★ Sun-like stars end their lives as a **white dwarf;** massive stars end their lives either as a **neutron star** or a **black hole**, depending on the size of the star.
- ★ A star is in balance between two opposite forces: The outward pressure caused by nuclear fusion and the inward pressure of gravity. A **supernova** explosion occurs when the star runs out of fuel and the force of gravity causes the star to collapse in on itself.
- ★ The Sun will not become a **supernova**.
- ★ **Extrasolar planets,** or **exoplanets**, are planets found outside of the Solar System, usually orbiting around other stars.

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Session 6 Major Concepts

- ★ There are multiple methods that scientists use to find exoplanets. NASA does not confirm an exoplanet find until it has been confirmed by at least two different methods. As of 2022, NASA missions have discovered more than 5,000 **exoplanets**!
- ★ The Kepler and TESS missions use a specific method to discover exoplanets by looking for **transits**. A **transit** is when an object passes between a star and its observer. More planets are discovered this way than any other method.
- ★ Sun-like stars have conditions that can host planets where there could be potential for biological life. These conditions include long life cycles and temperatures similar to the Sun.
- ★ When scientists find Sun-like stars, they look around the star in an area called the **habitable zone**, or the **Goldilocks Zone**, which is the distance from a star that a planet could exist with liquid water on the surface.
- ★ Organisms that can survive in extreme environments are known as **extremophiles**. These extreme environments include boiling pools of acid, underwater thermal vents, inside of glaciers, or in the deepest rocks on Earth. If we discover extraterrestrial life, they most likely will be a type of **extremophile**.