Jet Propulsion Laboratory
California Institute of Technology

Education

π IN THE SKY 5

Can you size up this faraway planet not with your eyes but with math?
A slice of pi will help you reveal this mystery like a NASA space explorer.

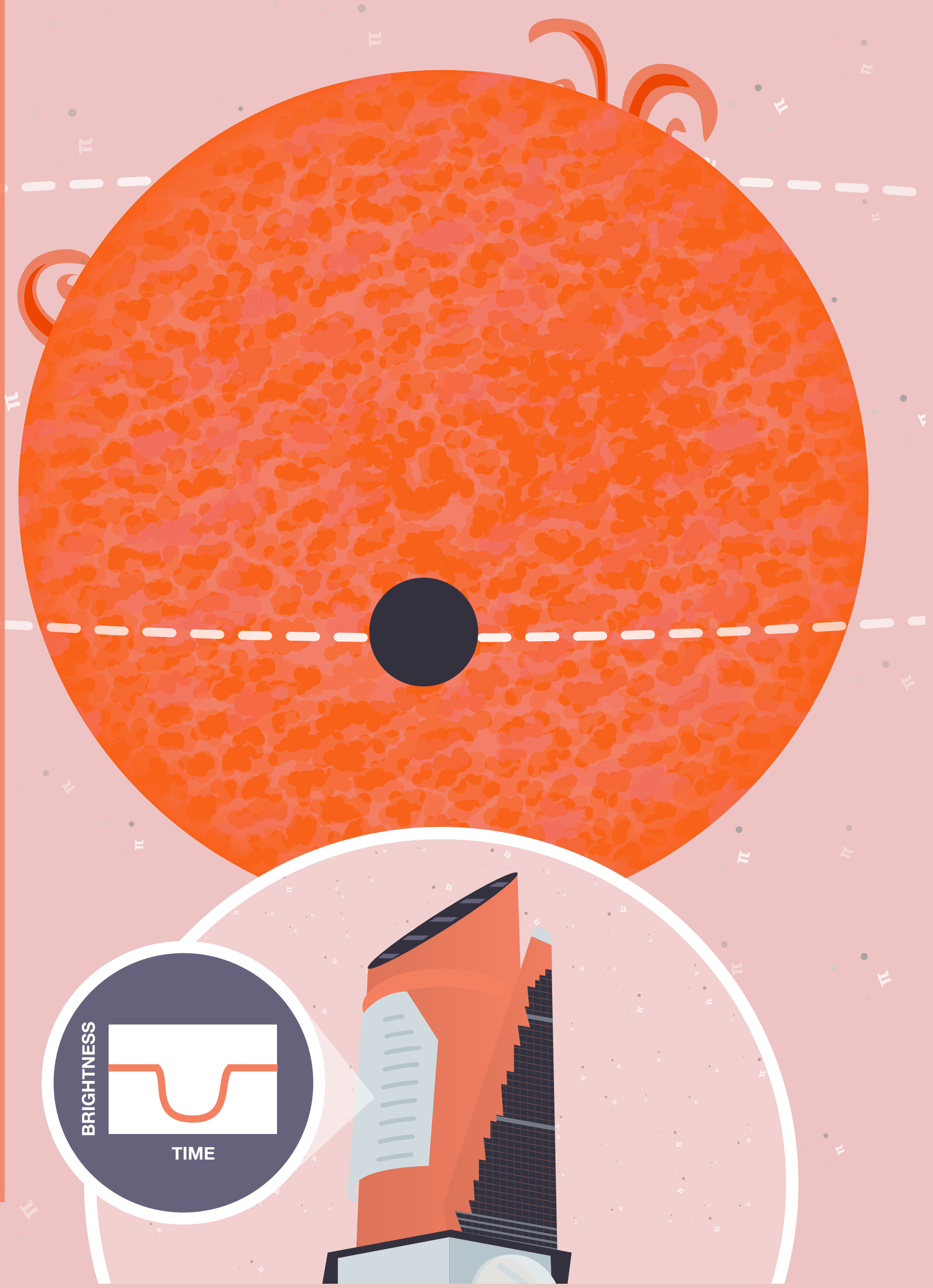
Explore the full NASA Pi Day Challenge at:
jpl.nasa.gov/edu/nasapidaychallenge

SOLAR SLEUTH

Exoplanets are worlds that orbit other stars. Using the Kepler Space Telescope, scientists can study distant stars and search for the exoplanets around them. When Kepler measures repeated dips in the brightness of a star, it can mean that an exoplanet is passing in front of that star from Kepler's point of view. Scientists can then determine the size of the exoplanet based on how much the star's light dipped when the planet passed in front of it.

This dip in brightness detected by Kepler is expressed as a percentage of the star's light that is blocked by the planet – with large planets blocking out more of the star's light and small, Earth-size planets blocking less. This percentage equals the ratio of the area of the planet's disk to the area of the star's disk. If Kepler detects a 0.042% drop in brightness from the star Kepler-186, which has a disk area of 416,000,000,000 km^2, **what is the radius of the exoplanet, known as Kepler-186f?**

LEARN MORE
exoplanets.nasa.gov



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Can you figure out what's disappearing inside Jupiter?
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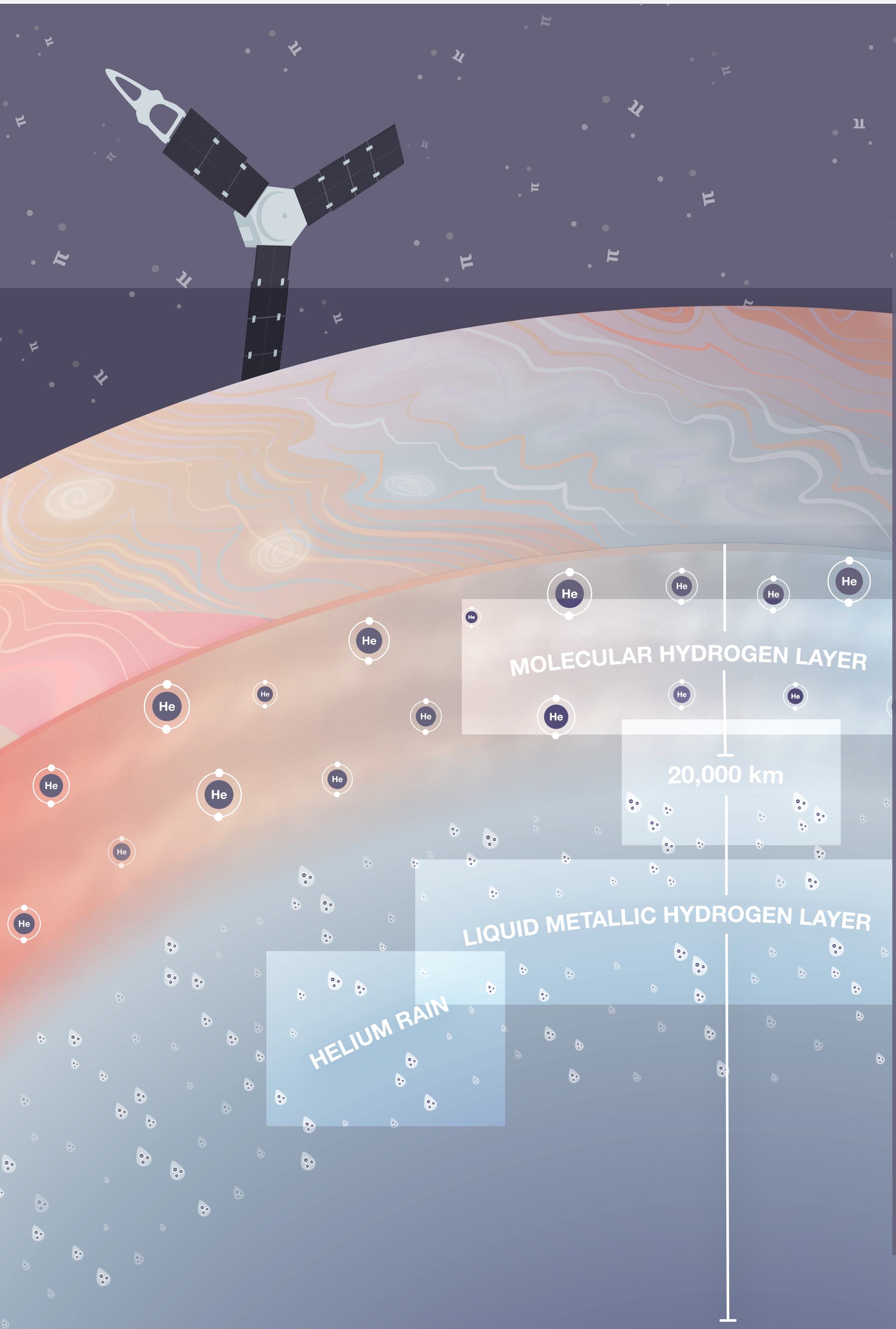

HELIUM HEIST

With a radius of 70,000 km, Jupiter is our solar system's most massive planet. About 10% of the volume from Jupiter's cloud tops to 20,000 km below is helium, with the rest being mostly hydrogen. Circulation in this molecular hydrogen layer causes some of that helium to be depleted as it moves into the liquid metallic hydrogen layer beneath. The tremendous pressure inside Jupiter condenses helium into droplets that fall like rain through the less dense liquid metallic hydrogen. The presence of helium rain inside Jupiter helps explain why scientists observe less helium in the clouds than expected.

If 10% of the helium volume in Jupiter's molecular hydrogen layer has been rained out since the planet formed, what is the volume in cubic km that has rained out?

Given that Earth's radius is 6,371 km, about how many Earth-size spheres of helium have been rained out?

LEARN MORE
solarsystem.nasa.gov/planets/jupiter

π IN THE SKY 5

Can you determine what – or rather where – is shaking on Mars?
A slice of pi will help you reveal this mystery like a NASA space explorer.

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QUAKE QUANDARY

During a seismic event on Mars, or a "marsquake," a type of seismic wave called surface waves travel outward from the epicenter, across the planet in all directions. Scientists expect these surface waves to arrive at NASA's InSight lander, designed to study the quakes, at three different times: R_1, when the first wave arrives, having traveled the shortest distance from the epicenter to the lander; R_2, when the second wave arrives, having traveled the other way around Mars; and R_3, when the first wave again impacts the lander, having traveled all the way around Mars.

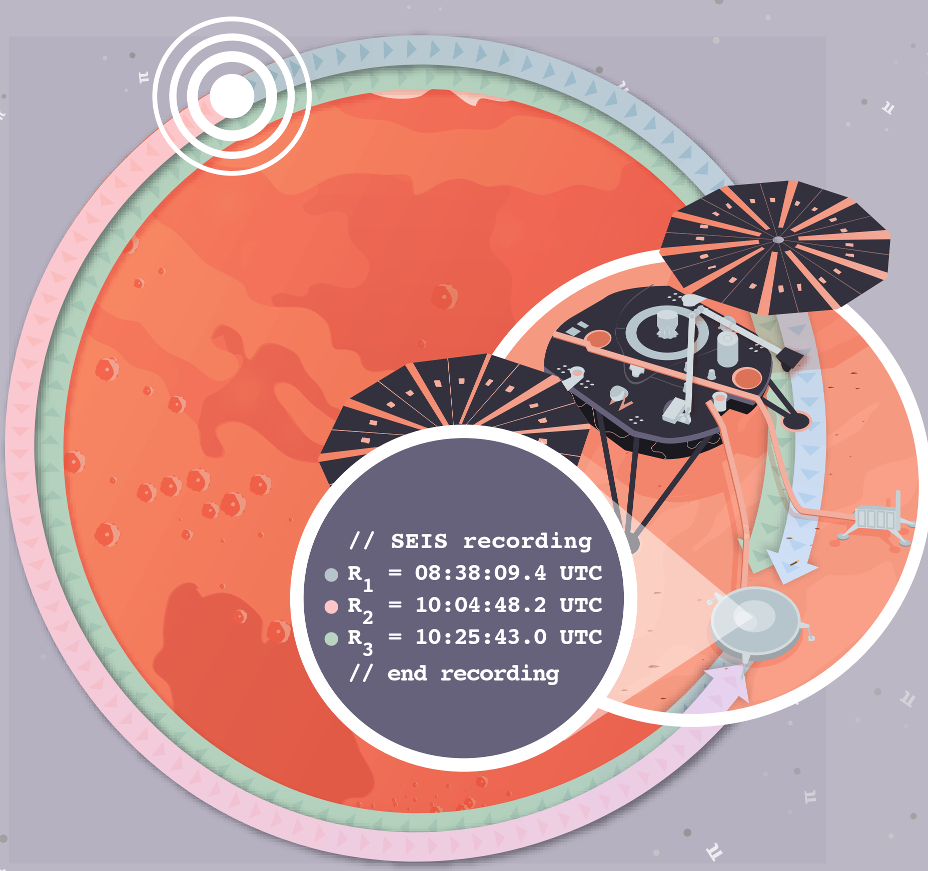
Let's imagine InSight records marsquake waves at the Earth times shown on the graphic. **What is the velocity (U) in rad/s of the surface wave, the distance in radians on the sphere from InSight to the epicenter (Δ), and the time the marsquake occurred (t_0)?**

$$U = \frac{2\pi}{(R_3 - R_1)}$$

$$\Delta = \pi - \frac{U(R_2 - R_1)}{2}$$

$$t_0 = R_1 - \frac{\Delta}{U}$$

LEARN MORE
mars.nasa.gov/insight



* Marsquake wave times are in UTC, which is written in hh:mm:ss format.

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**Can you solve the case of this topsy-turvy visitor from another solar system?
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ASTEROID ACE

Asteroid 'Oumuamua is a uniquely-shaped interstellar object discovered in October 2017. It's the first visitor from outside our solar system to be detected. Preliminary analyses indicate that 'Oumuamua is quite elongated, about 10 times as long as it is wide. It was first detected after it had passed Earth at a high speed on its journey out of our solar system, traveling at about 85,700 miles per hour.

So scientists could make detailed observations of the interstellar visitor before it sped too far away, they had to quickly re-plan their schedules. By monitoring how the brightness of the asteroid fluctuated as it spun on its axis, scientists estimate that 'Oumuamua rotates once every 7.3 hours.

Given these findings, what's the angular rotation rate of asteroid 'Oumuamua in rad/s?

How does this compare with Earth's rotation rate?

LEARN MORE
jpl.nasa.gov/asteroidwatch