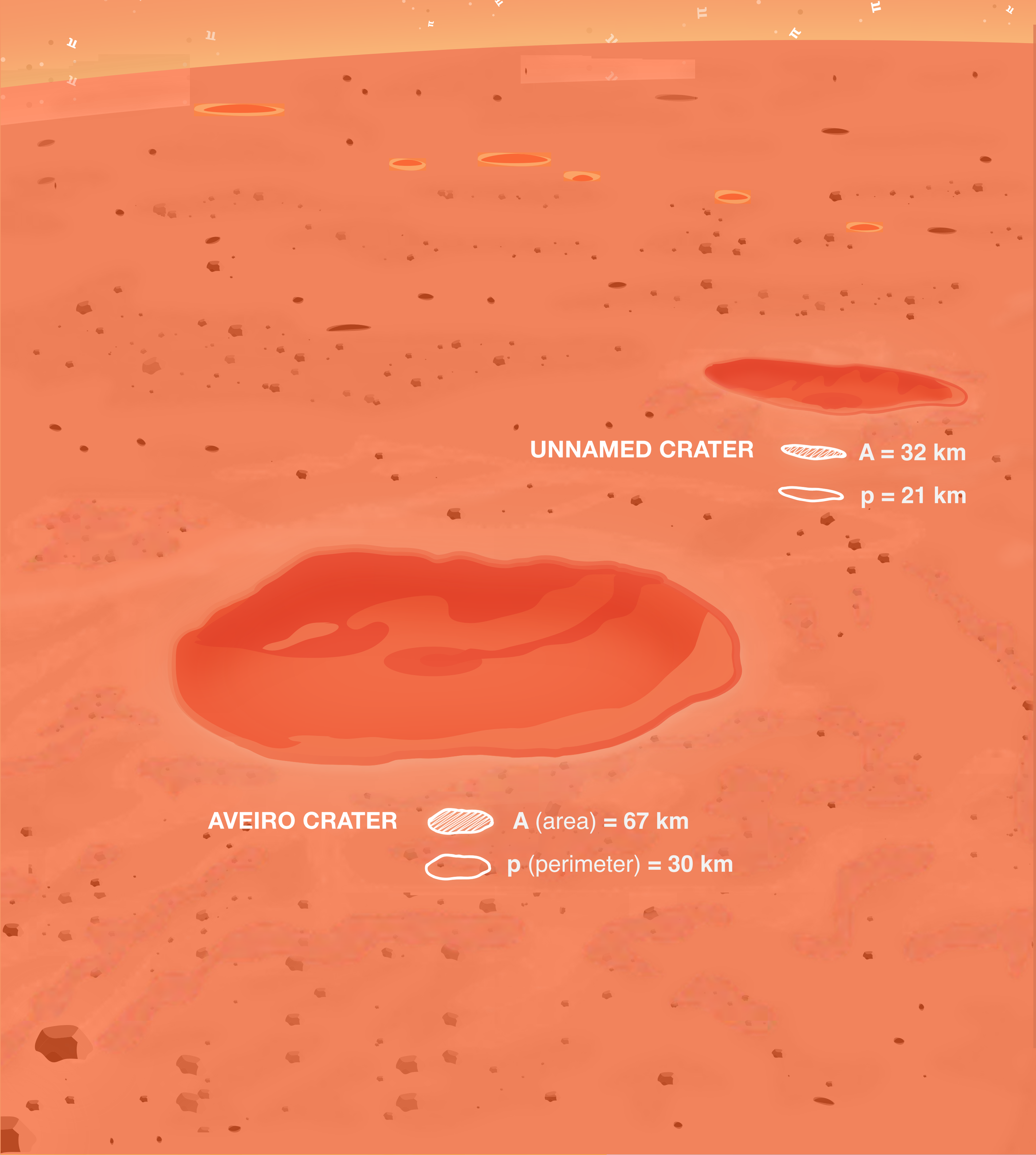
Jet Propulsion Laboratory
California Institute of Technology

π IN THE SKY 4

Solve a Martian crater mystery, measure the size of the moon's shadow during a total solar eclipse, send a spacecraft on a daring orbit around Saturn, and discover potentially habitable worlds beyond our solar system. You don't have to be a NASA rocket scientist to do stellar math with pi.



CRATER CURIOSITY

Craters form when an object hits the surface of a planet or other body. The impact creates a round impression surrounded by material, called ejecta, that gets blasted out of the crater. Scientists study ejecta because it contains clues about what's below a planet's surface. When an object hits Mars at an angle under 20 degrees, the crater is less circular and the ejecta settles in a butterfly shape. Some areas around the crater contain no blast material. Finding craters that formed this way can help scientists understand how meteor impacts change the surface of a planet. To do this, they measure a crater's circularity ratio. If the ratio is less than 0.925, it suggests that an object impacted at an angle under 20 degrees and created a butterfly ejecta pattern.

Using the circularity ratio formula, $\frac{4\pi A}{P^2}$, determine which of the craters shown here would have the butterfly ejecta pattern.

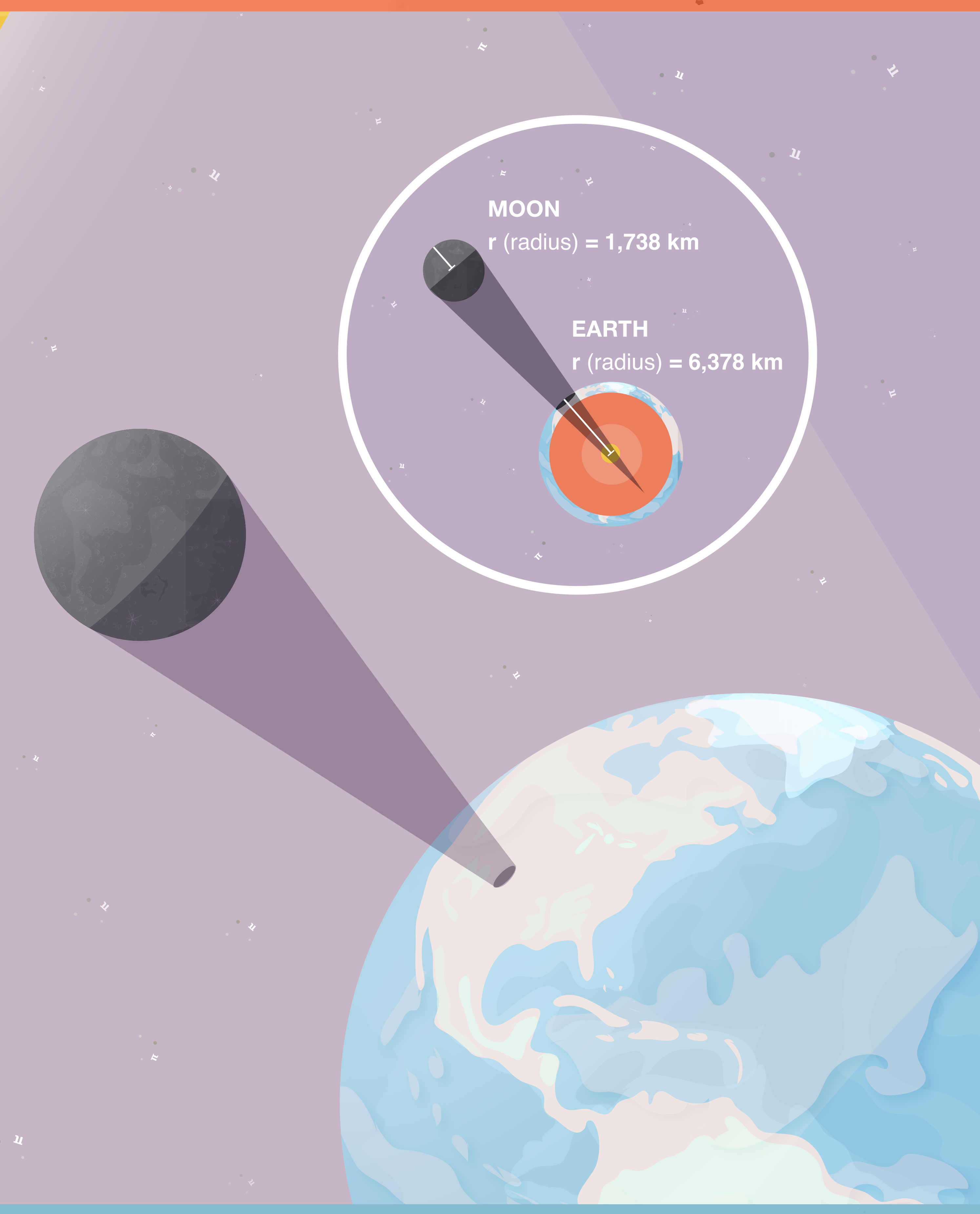
LEARN MORE ABOUT MARS CRATERS
bit.ly/marscraters

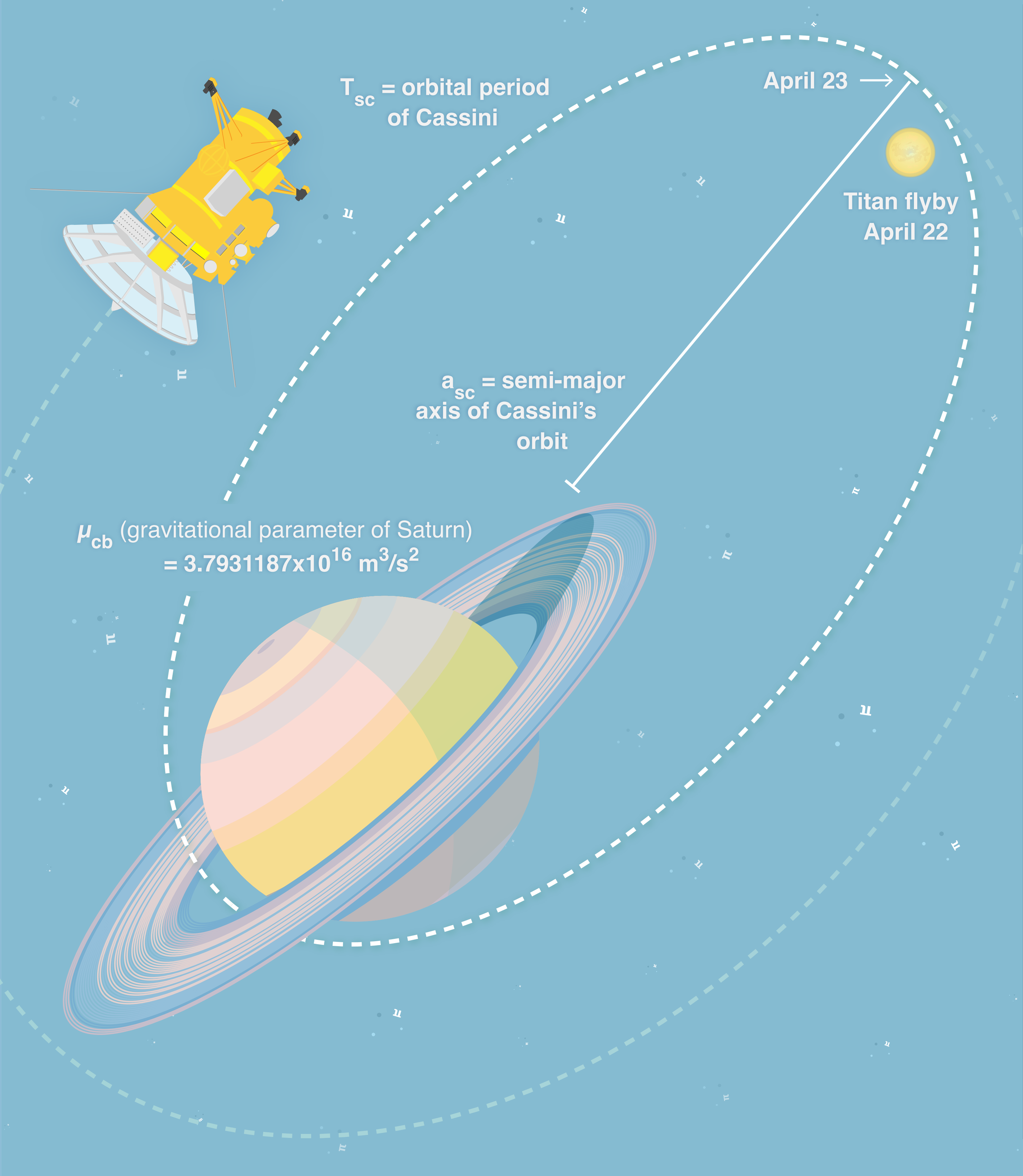
EPIC ECLIPSE

When sunlight hits the moon, a cone-shaped shadow is created. During the total solar eclipse on August 21, 2017, the distance from the center of the moon to the center of Earth will be 372,027 km. On that day, if the moon's shadow were not intersected by the surface of Earth, it would extend 377,700 km from the moon to its vertex.

Viewers on Earth who want to witness the eclipse will have to be at a location inside this shadow as it passes over Earth to see the eclipse at totality. **What is the approximate surface area of Earth that will be covered by the disc of the moon's shadow at any one time during the eclipse?**

LEARN MORE ABOUT THE 2017 ECLIPSE
eclipse2017.nasa.gov





FINALE FANFARE

In 2017, after more than 12 years at Saturn, the Cassini mission will come to an end with a plunge into Saturn. The finale is designed to keep Cassini from impacting and possibly contaminating any of Saturn's scientifically intriguing moons. First, mission operators have planned a daring series of orbits that will take Cassini closer to Saturn than ever before. Cassini will use the gravity of Saturn's moon Titan to alter its trajectory and fly into the gap between Saturn and its rings. It all begins with a flyby of Titan on April 22, putting Cassini on a new orbital path whose first apoapsis is on April 23. Then, it will complete 22 elliptical orbits with an average periapsis altitude of 63,022 km and an average apoapsis altitude of 1,274,828 km. A final flyby of Titan will place Cassini on a half-orbit trajectory for Saturn impact.

Use Kepler's third law below to find approximately how many days each orbit will take. Approximately what day will Cassini dive into Saturn's atmosphere?

$$a_{sc}^3 = \mu_{cb}\left(\frac{T_{sc}}{2\pi}\right)^2$$

LEARN MORE ABOUT CASSINI
saturn.jpl.nasa.gov

HABITABLE HUNT

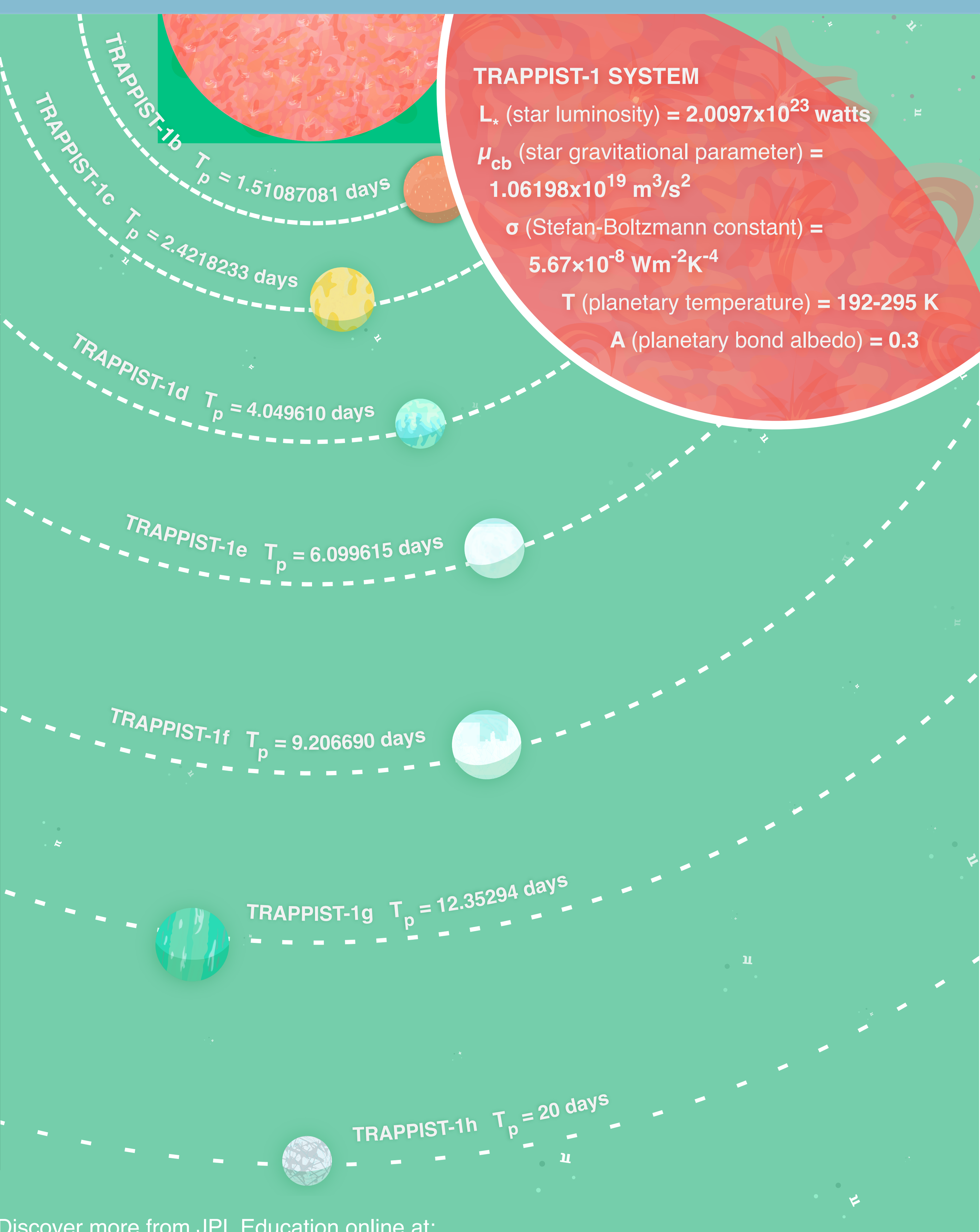
Scientists can learn a lot about planets beyond our solar system by studying their stars. They can calculate an exoplanet's orbital period by measuring how often its star dims as the planet passes by. They can even find potentially habitable worlds with a few key details. The star's temperature and luminosity, which are related to its mass, define its habitable zone, the area where liquid water can exist. And the bond albedo, or percentage of light reflected by the exoplanet, helps estimate its temperature. Scientists recently discovered seven Earth-like planets orbiting the star TRAPPIST-1. **Given TRAPPIST-1's measurements, what are the inner and outer radii (r), in AU, of its habitable zone?** Use the formula below.

$$r = \sqrt{\frac{(1-A)L_*}{16\pi\sigma T^4}}$$

Given the orbital periods (T_p), for TRAPPIST-1's planets, which are in the habitable zone? Use Kepler's third law to find the semi-major axis of each orbit (a_p).

$$a_p^3 = \mu_{cb}\left(\frac{T_p}{2\pi}\right)^2$$

LEARN MORE ABOUT EXOPLANETS
exoplanets.nasa.gov



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