

B E A M D R I P

References & Field Guide

K2-141b — Magma Exoplanet

Every fact in the game's K2-141b world and the sources behind them
— for curious minds!

11

FACTS

202

LIGHT-YEARS

6.7h

ORBIT

A note on how this was built

This game is not only intended to be fun, but also to build real knowledge. The facts are meant to pique real scientific curiosity, and to reward learners as they play. Each of the 11 facts in this world was checked against a live source. Peer-reviewed papers were preferred where they exist, then NASA's own catalogue, then science outreach. No blogs, no content farms.

K2-141b is different from the game's other two worlds in that its facts are based on models. Earth's water cycle can be measured directly, and Titan had a spacecraft land on it. K2-141b has had neither. The planet was discovered in 2018, 202 light-years away, with a mass and orbit measured to several decimal places, but we haven't gotten close enough to get real data or photograph its surface. What we have instead is a computer model! Scientists feed in the measured mass, radius, orbit and starlight, apply known physics, and see what kind of weather comes out. That is where the magma ocean, the supersonic winds and the rock rain come from.

These models use the same approach that we use to forecast weather on Earth. For this guide, anything that is extrapolation rather than measurement is marked with a $\triangle$.

Start here

Foundational reference links.

The study behind this world

Almost everything here traces to one piece of work: a 2020 modelling study of K2-141b's weather, led by Tue Giang Nguyen at York University with Nicolas Cowan at McGill.

[Nguyen et al., MNRAS \(2020\)](#) [Plain-language summary](#)

NASA Exoplanet Archive

The authoritative catalogue entry — mass, radius, orbit, distance, and the papers behind each measurement.

[K2-141 b](#)

The discovery papers

Two teams confirmed K2-141b independently in 2018 and pinned down its mass — for a time the shortest-period planet with a precisely measured one.

[Barragán et al., A&A](#) [Malavolta et al., AJ](#)

Looking for the atmosphere

A 2022 analysis of K2 and Spitzer phase curves found hints of the thin rock-vapour atmosphere the models predicted.

[Zieba et al., A&A \(2022\)](#)

Readable coverage

For the story rather than the equations.

[EarthSky](#) [Sci.News](#) [CNN](#)

The 11 Facts and Source Links

FACT 1

Rock does what water does

DID YOU KNOW?

On Earth, water cycles between ice, liquid, and vapor — but on K2-141b, rock does the exact same thing!

WHERE THIS COMES FROM

The whole world runs on one idea: swap water for rock. The modelling study behind this planet describes sodium, silicon monoxide and silicon dioxide evaporating, rising, condensing and falling back as rain — the same loop Earth runs on water.

WORTH NOTING

This is what makes K2-141b such a good companion to the Water Cycle world. Nothing about the *process* changes; only the substance and the temperature do. Learn the shape of a cycle once and you can recognise it on a planet where the rain is molten stone.

SOURCE LINKS

Nguyen et al. · MNRAS, 2020 (open preprint) · ScienceDaily · Supersonic winds, rocky rains forecasted

FACT 2

Hot enough to boil stone

DID YOU KNOW?

It takes more than 5,000°F (3,000°C) to boil stone — over twice the heat of Earth's hottest lava. At that temperature K2-141b vaporizes silicon dioxide: the same mineral as beach sand and window glass.

WHERE THIS COMES FROM

The dayside sits near 3,000 °C (about 3,270 K). That is past melting and into boiling for silicate rock — the planet does not merely have lava, it has rock vapour.

WORTH NOTING

For scale: Earth's hottest lava tops out around **1,200 °C**, so K2-141b's dayside runs roughly **two and a half times hotter**. And the mineral doing the cycling, silicon dioxide, is not exotic at all — it is quartz. The same stuff as beach sand and window glass, boiled into an atmosphere.

SOURCE LINKS

NASA Exoplanet Archive · K2-141 b · EarthSky · The hell planet with a magma ocean

FACT 3

An ocean of magma

DID YOU KNOW?

Entire mountains evaporate directly into gas, creating vast oceans of liquid magma that feed a sky filled with vaporized minerals.

WHERE THIS COMES FROM

Beneath that vapour lies a magma ocean roughly 100 km (62 miles) deep, continuously fed by rock evaporating on the star-facing side and raining back down.

WORTH NOTING

Depth is the part that surprises people. The Pacific's deepest trench is about **11 km**; this magma ocean is close to **nine times deeper** than that, and it is molten all the way down. Because evaporation never stops on the dayside, the ocean is not a leftover from the planet's formation — it is actively resupplied, every hour of every 6.7-hour day.

SOURCE LINKS

Nguyen et al. · MNRAS, 2020 (open preprint) · Sci.News · Rock rains and supersonic winds

FACT 4

One face, always

DID YOU KNOW?

K2-141b is tidally locked: it takes the exact same amount of time to spin once on its axis as it does to orbit its star, so the same face of the planet permanently points toward the star.

WHERE THIS COMES FROM

K2-141b is tidally locked: its rotation period exactly matches its orbital period, so the same hemisphere faces the star permanently. Earth's Moon does the same thing to us.

WORTH NOTING

Tidal locking is common for worlds orbiting this close, and it is the root cause of nearly everything else in this guide. Without it there would be no permanent dayside to boil, no permanent nightside to freeze, and therefore no wind, no rain and no cycle. One orbital quirk generates the entire weather system.

SOURCE LINKS

NASA Exoplanet Archive · K2-141 b · EarthSky · The hell planet with a magma ocean

FACT 5

Winds past 5,000 km/h

DID YOU KNOW?

The extreme temperature difference between the sunlit side and the frozen dark side drives supersonic winds over 3,000 mph (5,000 km/h) — about five times the speed of sound.

WHERE THIS COMES FROM

The temperature gap between the two hemispheres drives winds modelled at over 5,000 km/h (about 3,100 mph) — several times the speed of sound.

WORTH NOTING

The fastest wind ever recorded on Earth was about **408 km/h (253 mph)**, in a tropical cyclone. K2-141b's winds are more than **twelve times** that. They are what carry the rock vapour from the boiling dayside to the freezing nightside, which is precisely why the rain falls where it does.

SOURCE LINKS

Nguyen et al. · MNRAS, 2020 (open preprint) · ScienceDaily · Supersonic winds, rocky rains forecasted

FACT 6

Rain made of molten rock

DID YOU KNOW?

As rock vapor races toward the cooler side of the planet, it condenses into dense clouds — not water droplets, but liquid stone! Molten lava falls from dark, ashy stone clouds in heavy, glowing rainstorms.

WHERE THIS COMES FROM

As mineral vapour is swept toward the cold side, it condenses and falls — rock rain, returning to the magma ocean. The 2020 study modelled this cycle in detail.

WORTH NOTING

It is worth pausing on how strange the sky must be. The clouds are not water vapour but vaporised minerals, and what falls from them is molten stone. The study's authors point out that this weather is, in principle, *detectable from Earth* — the mineral vapour leaves a fingerprint in the light passing through the atmosphere.

SOURCE LINKS

Nguyen et al. · MNRAS, 2020 (open preprint) · CNN · A magma ocean and 'rocky' weather

FACT 7

Glass on the night side

DID YOU KNOW?

Near the twilight zone — the border between endless day and endless night — temperatures plunge far below freezing. Lava rain is thought to freeze mid-air into sharp obsidian and quartz "snow," building glassy formations on the planet's dark side.

WHERE THIS COMES FROM

Near the terminator — the boundary between endless day and endless night — temperatures collapse to below -200°C , cold enough to freeze mineral rain solid.

WORTH NOTING

△ **This one is extrapolation, not measurement.** The freezing nightside and the mineral rain are both modelled results; the specific picture of obsidian and quartz “snow” building glassy formations is a reasonable extension of that chemistry rather than a published finding. Nobody has seen the night side of this planet. It is a good example of where science ends and informed imagination begins — and knowing which is which is part of the fun.

SOURCE LINKS

[NASA Exoplanet Archive · K2-141 b](#) [Nguyen et al. · MNRAS, 2020 \(open preprint\)](#)

FACT 8

Found in 2018, 202 light-years away

DID YOU KNOW?

K2-141b was discovered in 2018 by NASA's Kepler space telescope. It's about 200 light-years away in the constellation Pisces — close enough that telescopes like Kepler and the James Webb Space Telescope (JWST) can study the light passing through its atmosphere.

WHERE THIS COMES FROM

K2-141b was discovered in 2018 during Campaign 12 of NASA's K2 mission — the Kepler space telescope's second life — and confirmed with the HARPS-N spectrograph. It sits about 202 light-years away, orbiting an orange K-dwarf star.

WORTH NOTING

Its transit signal is unusually easy to catch: a 6.7-hour orbit means the planet crosses its star roughly **3.6 times every Earth day**, so observations pile up fast. That is why so much is known about a rocky world 202 light-years off — and why **two independent teams** confirmed it in the same year, Barragán's and Malavolta's, working separately and agreeing on the answer. That kind of duplicate check is how a measurement earns trust. The Spitzer and K2 phase curves later hinted at the thin rock-vapour atmosphere the models predicted.

SOURCE LINKS

[Barragán et al. · A&A, 2018 \(discovery\)](#) [Malavolta et al. · AJ, 2018 \(independent confirmation\)](#) [NASA Exoplanet Archive · K2-141 b](#) [Zieba et al. · A&A, 2022 \(phase curves\)](#)

FACT 9

A lava-bow instead of a rainbow

DID YOU KNOW?

Liquid stone bends light very differently than water — so instead of a rainbow, imagine a "lava-bow": starlight shining through lava droplets in a tight, glowing arch of neon gold, deep orange, and crimson red.

WHERE THIS COMES FROM

Rainbows come from light refracting through droplets. Titan's would be infrared because methane bends light differently than water; K2-141b's droplets would be molten rock, different again.

WORTH NOTING

△ **Imaginative, and flagged as such in the game.** No study has modelled an optical bow on K2-141b. The underlying physics is sound — any transparent droplet refracts light, and the refractive index sets the arc's angle and colours — but the glowing gold-and-crimson “lava-bow” is a thought experiment built on real principles, not a prediction.

SOURCE LINKS

[EarthSky](#) · [The hell planet with a magma ocean](#)

FACT 10

A sky of vaporised metal

DID YOU KNOW?

The atmosphere is packed with vaporized sodium, silicon monoxide, and silicon dioxide, giving the entire sky a thick, glowing metallic haze.

WHERE THIS COMES FROM

The modelled atmosphere is made of sodium, silicon monoxide and silicon dioxide — rock vapour rather than gas in any familiar sense.

WORTH NOTING

A conventional atmosphere is nitrogen and oxygen; this one is evaporated crust. Sodium is the giveaway: it is easy to spot spectroscopically, which is part of how an atmosphere on a world this far away can be studied at all. The 2022 phase-curve analysis found signs consistent with exactly this kind of tenuous rock-vapour envelope.

SOURCE LINKS

[Zieba et al. · A&A, 2022 \(phase curves\)](#) [Nguyen et al. · MNRAS, 2020 \(open preprint\)](#)

A year that lasts 6.7 hours

DID YOU KNOW?

K2-141b completes a full orbit around its star in just 6.7 hours. Tidally locked, one half of the planet is trapped in perpetual, blinding daylight, while the other half faces eternal, freezing darkness.

WHERE THIS COMES FROM

K2-141b completes an orbit in 6.727 hours — one of the shortest orbital periods known. Its measured period is 0.2803244 days.

WORTH NOTING

A birthday every **6.7 hours**: someone living there would pass a thousand years in under a single Earth year. The planet orbits so close that its star fills a huge portion of the sky and never moves — because it is tidally locked, the star hangs in exactly the same spot forever, neither rising nor setting.

SOURCE LINKS

NASA Exoplanet Archive · K2-141 b · Barragán et al. · *A&A*, 2018 (discovery)