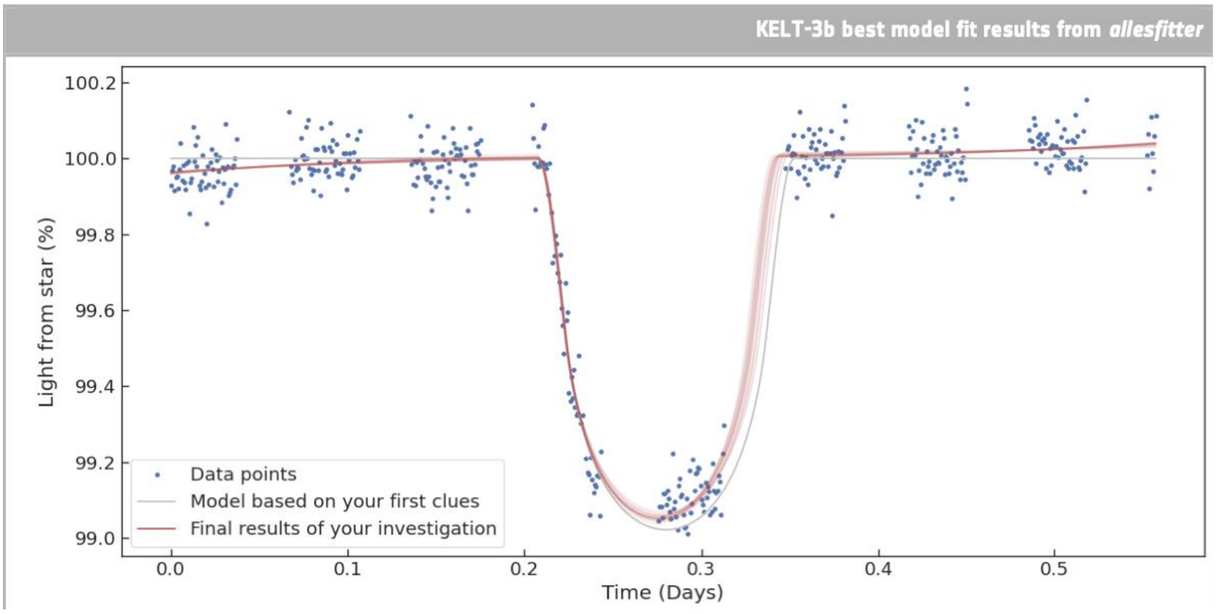
JOURNAL TEMPLATE: KELT-3b

ABSTRACT

On January 22, 2023, at 23:20 CET, the satellite Cheops captured the exoplanet KELT-3b. This latter had already been discovered by the KELT survey nine years earlier in 2012. Since exoplanets are outside the solar system, it makes it more difficult to find them. Therefore, for this experience, we relied on transit photometry as one of the methods to detect them. We referred to the exoplanet transit known as the measurement of "dimming in the light coming from the star when the exoplanet passes in between the star and the telescope". Based on these data represented by a light curve, we could determine the size of KELT-3b as well as its orbital period, its orbital distance, its temperature, and its composition to compare them to the Earth and the other planets in the solar system. These answers were to complete the missing information in the KELT-3b case file. The understanding of KELT-3b will be helpful for the search for habitable planets or living species outside of the Earth.

ANALYSIS AND RESULTS

Regarding the light curve below, we considered the mid-transit time as the best fit model parameter. Indeed, the difference between the upper and lower errors is null, meaning that this parameter is the most trustworthy.



We then measured the size of KELT-3b. Having approximated the transit depth to 0.9 %, we used this equation.

$$R_p = \sqrt{{R_s}^2 \text{x} \frac{\text{transit depth}}{100}} = \sqrt{1.70^2 \text{x} \frac{0.9}{100}} = 0.161 R_{\text{Sun}}$$

In this case, R_p *designates the exoplanet's radius and* R_s the stellar radius.

We converted it to Earth radii units.

$$R_p = 0.161 \text{ x } 109 = 17.5 R_{\text{Earth}}.$$

According to Cheops observations, the radius of the planet (in units of Earth radii) had a median value of 16.82 R_{Earth} with 0.16 as a lower error and 0.19 as an upper error, which is different but close to the found result 17.5 R_{Earth}. We then calculated its orbital period and distance using this equation.

$$d = \sqrt[3]{\frac{GM_s}{4\pi^2}T^2} = \sqrt[3]{\frac{6.67430x10^{-11}x3.90x10^{30}}{4\pi^2}233573^2} = 7.112 \text{ x } 10^9 \text{ m} = \mathbf{0.048\ au}$$

We noted that KELT-3b has a shorter orbital period (approximately 2.70 days) than Mercury, the closest planet to the Sun in our Solar System, and Neptune, the farthest one. Figure 1 below demonstrates that KELT-3b is not habitable for humans at least since its surface temperature is 1543 °C.

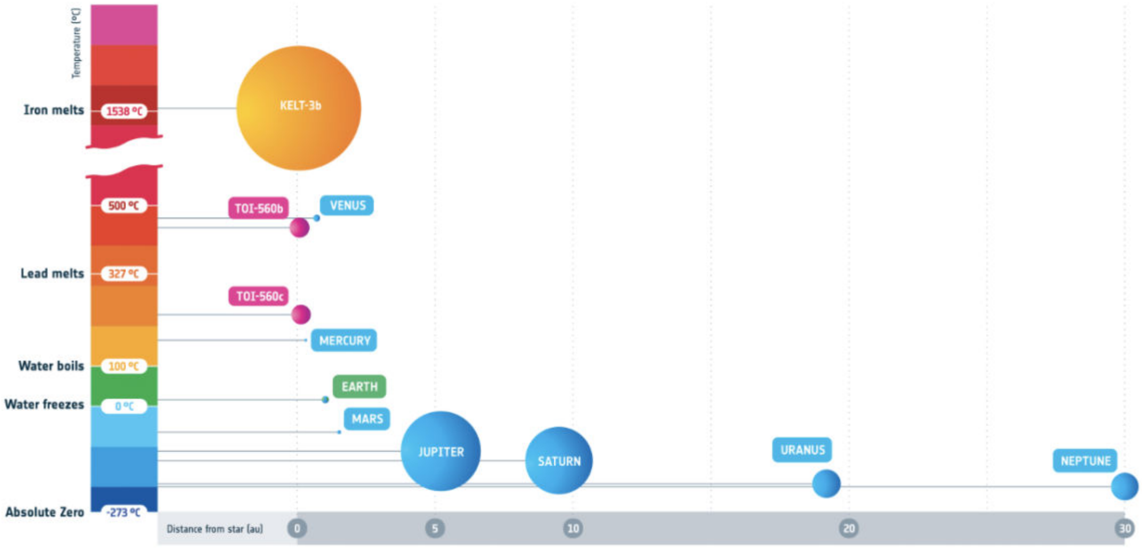


Diagram presenting some of the planet's characteristics (size, temperature, and distance to host stars)

In this environment, iron and lead are likely to melt and water to boil. Consequently, KELT-3b is not located in the habitable zone of its host star. Lastly, we analyzed the composition of KELT-3b. According to the KELT-3b case file, its mass is 617 M_{Earth}. We then calculated its density.

$$V = \frac{4}{3}\pi R^3$$

$$M_p = 617\ M_{Earth} = 3.685 \text{ x } 10^{30} \text{ g}$$

$$R_p {*}= 17.5\ R_{Earth} = 1.116 \text{ x } 10^{10} \text{ cm}$$

$$\rho = \frac{M}{V} = 0.63 \text{ g cm}^{-3}$$

It amounts to 0.63 g/cm^{-3} meaning that it is smaller than the mean density of Jupiter (1.33 g/cm^{-3}).

CONCLUSION

The exoplanet KELT-3b discovered in 2012 by the KELT survey is a type of Hot Jupiter weighing 617 M_{Earth} because of a 17.5 R_{Earth} radius. Its orbital and distance period are respectively 2.70 days and 0.048 au. Its density is estimated at 0.63 g/cm^{-3}. Knowing that its surface temperature is 1543 °C, we infer that it is puffy and gaseous.