

= Kepler @-@ 11d =

Kepler @-@ 11d is an exoplanet discovered in the orbit of the sun @-@ like star Kepler @-@ 11 . It is named for the telescope that discovered it , a NASA spacecraft named Kepler that is designed to detect Earth @-@ like planets by measuring small dips in the brightness of their host stars as the planets cross in front . This process , known as the transit method , was used to note the presence of six planets in orbit around Kepler @-@ 11 , of which Kepler @-@ 11d is the third from its star . Kepler @-@ 11d orbits Kepler @-@ 11 well within the orbit of Mercury approximately every 23 days . The planet is approximately six times more massive than the Earth , and has a radius that is three and a half times larger than that of Earth 's . It is , however , far hotter than Earth is . Its low density , comparable to that of Saturn , suggests that Kepler @-@ 11d has a large hydrogen ? helium atmosphere . Kepler @-@ 11d was announced with its five sister planets on February 2 , 2011 after extensive follow @-@ up studies .

= = Name and discovery = =

As with all exoplanets , Kepler @-@ 11d is named first for its host star , Kepler @-@ 11 . Because Kepler @-@ 11d was announced at the same time as the five other planets in the system , their names are sorted by their distances from the host star ; thus , because Kepler @-@ 11d is the third planet from Kepler @-@ 11 , it was given the designation d . Kepler @-@ 11 was named for the Kepler spacecraft , a NASA Earth @-@ trailing satellite purposed with discovering Earth @-@ like planets in a small area of the sky between the constellations Cygnus and Lyra by observing planets that transit , or cross in front of , their host stars with respect to Earth . The transit causes the star 's brightness to dim slightly and at a regular rate , a phenomenon that the Kepler satellite notes till future study can prove or disprove the existence of a planetary body . Kepler @-@ 11d was flagged by Kepler @-@ 11 , given the designation KOI @-@ 157 .

Required follow @-@ up observations were conducted at the Hale and Shane telescopes in California ; the W.M. Keck Observatory 's Keck I telescope in Hawaii ; telescopes at the WIYN , Whipple , and MMT observatories in Arizona ; and the Hobby @-@ Eberly and Harlan J. Smith telescopes of west Texas . Additionally , the Spitzer Space Telescope was used . Kepler @-@ 11d , along with its five sister planets , were announced to the public on February 2 , 2011 . Its discovery paper was published in the journal Nature the next day .

= = Host star = =

Kepler @-@ 11 is a G @-@ type star in the Cygnus constellation . With a mass of .95 Msun , a radius of 1 @-@ 1 R_{sun} , a measured metallicity of 0 , and an effective temperature of 5680 K , Kepler @-@ 11 is near in mass (95 % of Sun) , radius (110 % of Sun) , and iron content as the Sun . Metallicity has been observed to play a major role determining the type of planet a star forms . As metal @-@ rich gas clouds tend to cause planetary cores to aggregate to a gravitationally prominent size while primordial gases still exist in the system , gas giants tend to form under such conditions . It is also slightly cooler than the Sun . However , it is estimated to be eight (± two) billion years old , far older than the Sun is . Kepler @-@ 11 is host to five other planets other than Kepler @-@ 11d : Kepler @-@ 11b , Kepler @-@ 11c , Kepler @-@ 11e , Kepler @-@ 11f , and Kepler @-@ 11g . The first five planets in the system have orbits that would collectively fit inside the orbit of planet Mercury , while Kepler @-@ 11g orbits at a considerably further distance in relation to the orbits of its inner counterparts .

At a distance of 613 parsecs , Kepler @-@ 11d has an apparent magnitude of 14 @-@ 2 . It is , thus , not visible with the naked eye .

= = Characteristics = =

Kepler @-@ 11d has a mass of 6 @-@ 1 M_E and a radius of 3 @-@ 43 R_E , making it some six

times more massive than Earth with nearly three and a half times the radius . With a density of $.9 \text{ grams / cm}^3$, Kepler @-@ 11d 's density is less than that of water and comparable to that of the gas giant Saturn . This suggests that , unlike its sister planets Kepler @-@ 11b and Kepler @-@ 11c , which are closer to their host star , Kepler @-@ 11d has maintained a large atmosphere that is most likely composed to hydrogen and helium . Kepler @-@ 11d has an equilibrium temperature of 692 K , nearly $2 \text{ @.@ } 7$ times the equilibrium temperature of Earth . Kepler @-@ 11d orbits at a mean distance of $.159 \text{ AU}$ from its host star and completes an orbit every $22 \text{ @.@ } 68719$ days , making it the third planet from Kepler @-@ 11 . In comparison , planet Mercury orbits the Sun every $87 \text{ @.@ } 97$ days at a distance of $.387 \text{ AU}$. Kepler @-@ 11d has an orbital inclination of $89 \text{ @.@ } 3^\circ$. Thus , Kepler @-@ 11d is almost exactly edge on with respect to Earth .

The presence of large quantities of hydrogen and helium on Kepler @-@ 11d , Kepler @-@ 11e , and Kepler @-@ 11f suggest that these planets formed within the first few million years of the system 's existence , when gas could still be captured from the forming protoplanetary disc .