Eccentric Planets : what's interesting?

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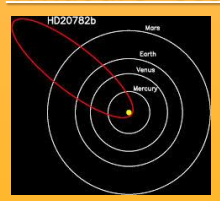
About "eccentric planets"

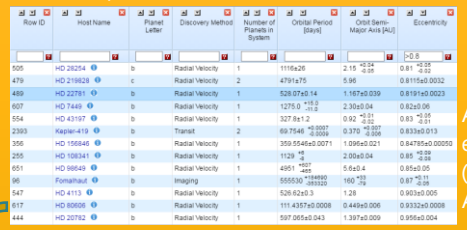
What are "eccentric planets"?



The orbit of HD20782b, whose orbit has the biggest eccentricity, 0.956!

They are planets with an eccentric orbit. Differing from circular orbiting planets, they have various speed in their orbit. So they may have some interesting properties.

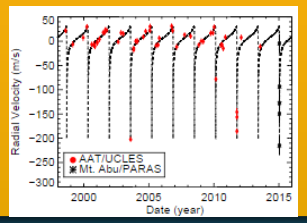
How were they detected?



Row ID	Host Name	Planet Letter	Discovery Method	Number of Planets in System	Orbital Period [days]	Orbit Semi-Major Axis [AU]	Eccentricity
							>0.8
505	HD 28254	b	Radial Velocity	1	1116±26	2.15 +0.04 -0.05	0.81 +0.05 -0.02
479	HD 219828	c	Radial Velocity	2	4791±75	5.96	0.8115±0.0032
489	HD 22781	b	Radial Velocity	1	528.07±0.14	1.167±0.039	0.8191±0.0023
607	HD 7449	b	Radial Velocity	1	1275.0 +16.5 -11.0	2.30±0.04	0.82±0.06
554	HD 43197	b	Radial Velocity	1	327.8±1.2	0.92 +0.01 -0.02	0.83 +0.05 -0.01
2393	Kepler-419	b	Transit	2	69.7546 +0.0007 -0.0009	0.370 +0.007 -0.006	0.833±0.013
356	HD 156846	b	Radial Velocity	1	359.5546±0.0071	1.096±0.021	0.84785±0.00050
255	HD 108341	b	Radial Velocity	1	1129 +6 -4	2.00±0.04	0.85 +0.09 -0.08
651	HD 98649	b	Radial Velocity	1	4951 +507 -455	5.6±0.4	0.85±0.05
96	Fomalhaut	b	Imaging	1	555530 +184990 -389320	160 +33 -79	0.87 +0.11 -0.09
547	HD 4113	b	Radial Velocity	1	526.62±0.3	1.28	0.903±0.005
617	HD 80606	b	Radial Velocity	1	111.4367±0.0008	0.449±0.006	0.9332±0.0008
444	HD 20782	b	Radial Velocity	1	597.066±0.043	1.397±0.009	0.956±0.004

A list of planets with eccentricity larger than 0.8. (NASA's Exoplanet Archive)

More than 80% of planets with eccentricity larger than 0.8 were detected by Radial Velocity method.

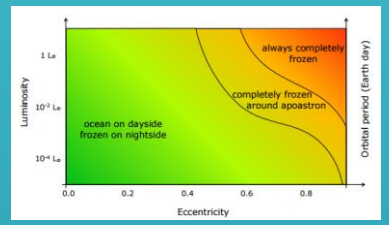


Radial velocity of HD20782. The shape differs greatly from sine curve.

Possible properties

Holding water

They have "four seasons" caused by their orbit. This big change of temperature makes the environment very hard. Especially, the most eccentric planet, HD20782b passes closer than the Mercury orbiting the Sun at the closest point. However, it is said that they could hold liquid water under an appropriate environment. In addition, they may be not tidally locked because of their orbit. This means they may be spinning, and this leads to atmospheric circulation. So, their temperature may be stable than tidally-locked model.



Liquid water coverage map of tidally locked ocean-covered planets

Help discovering second planet

If the system has a second planet, the gravitational interaction could be more complicated by the perturbation. Indirect methods such as transit timing variation(TTV) may be able to detect it.

Image of HD20782b passing its host star in the closest point

Origin of Hot Jupiters

It's very difficult to explain how Hot Jupiters were formed. In recent studies, such "strange" Jupiters are said to be formed from eccentric planets. If there are more than 3 Jupiter-sized planets in a system, their orbit could be eccentric by the gravitational instability, and then their ellipse orbit become circle by the tidal effect.

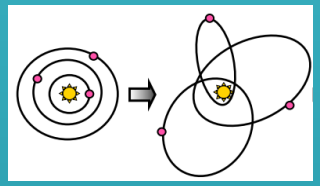


Image of the evolution from circular orbit to elliptic. This model is called "Jumping Jupiter".

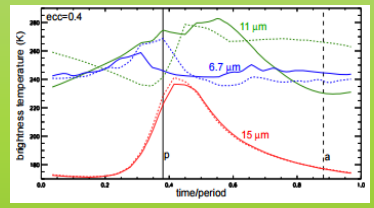
Future expectation

Effect on predict transit observations

Changing the speed of planet caused by its eccentric orbit may lead to the difference between Ingress and egress slope of transit. To distinguish this difference is very difficult, but JWST potentially can do that. We will get the information of eccentricity from not only fitting radial velocity but also transit light curve.

Detection of atmosphere

An elliptic orbit leads to a big change of the distance between the planet and the host star. This enables us to detect changing the brightness of planet caused by varying temperature. From this comet-like "flash", we may determine its atmosphere.



Thermal phase curve of eccentric planets

Reference

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E. Bolmont et al. 2016, A&A, 591A, 106A
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NASA's Exoplanet Archive (http://exoplanetarchive.ipac.caltech.edu/index.html)
SF State News "Most eccentric planet known flashes astronomers with reflected light" (https://news.sfsu.edu/news-story/most-eccentric-planet-known-flashes-astronomers-reflected-light)