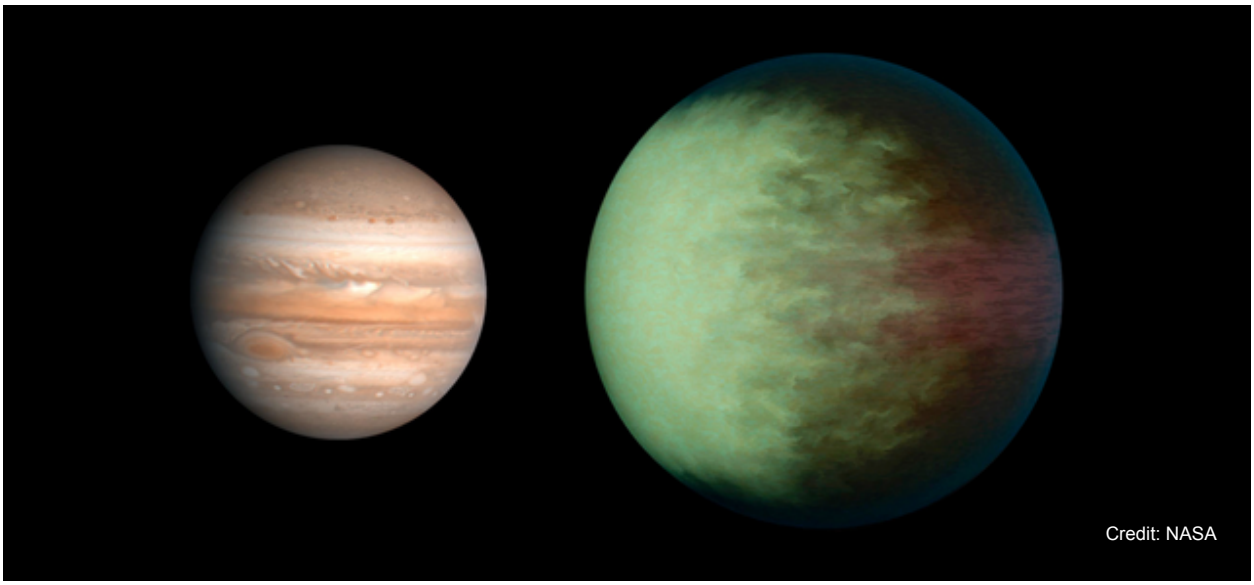
The analogy of the nebulae with the system of stars in which we find ourselves … is in perfect agreement with the concept that these elliptical objects are just island universes - in other words, Milky Ways...

Immanuel Kant
Universal Natural History and Theory of the Heavens, 1755

Absence Of Evidence Is Not Evidence Of Absence

Hello AST 111. Holy smokes Batman! The prediction by Kant above, that the Milky Way was just one or many galaxies, was stunningly bold given he had no evidence to support it. He also happened, in the end, to be correct. In this module we'll explore some of the surprising characteristics of the exoplanets discovered to date and check if our model of solar system formation needs tweaking.

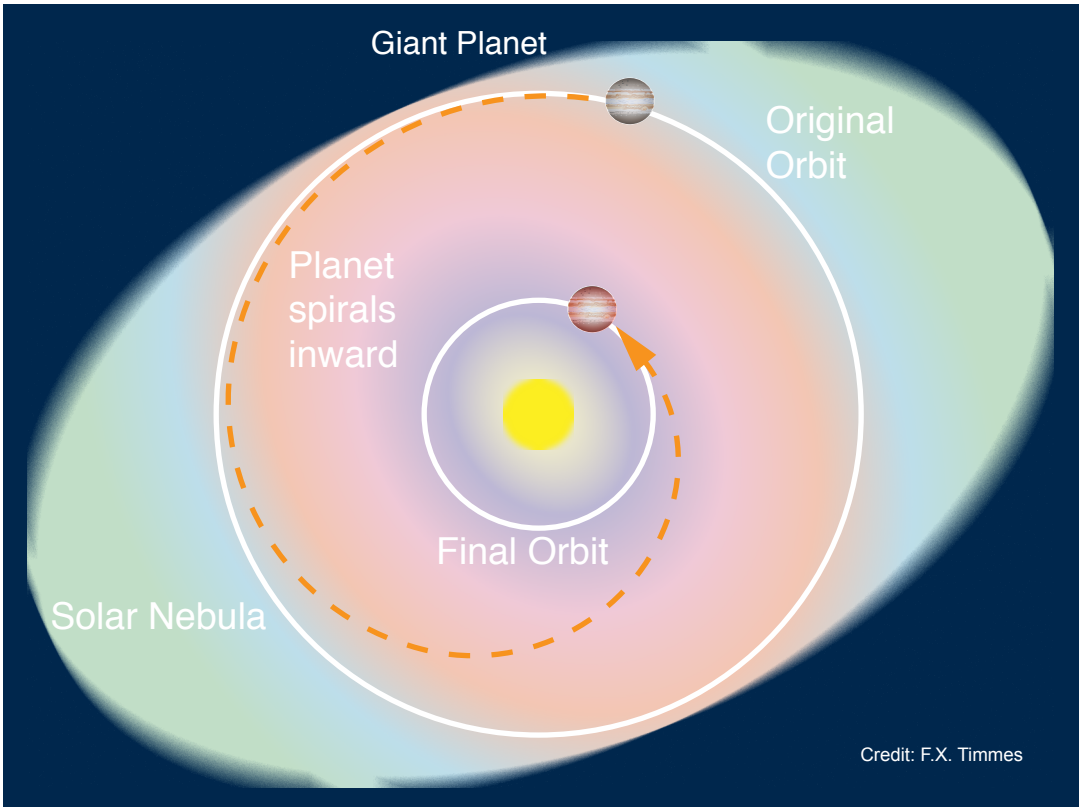


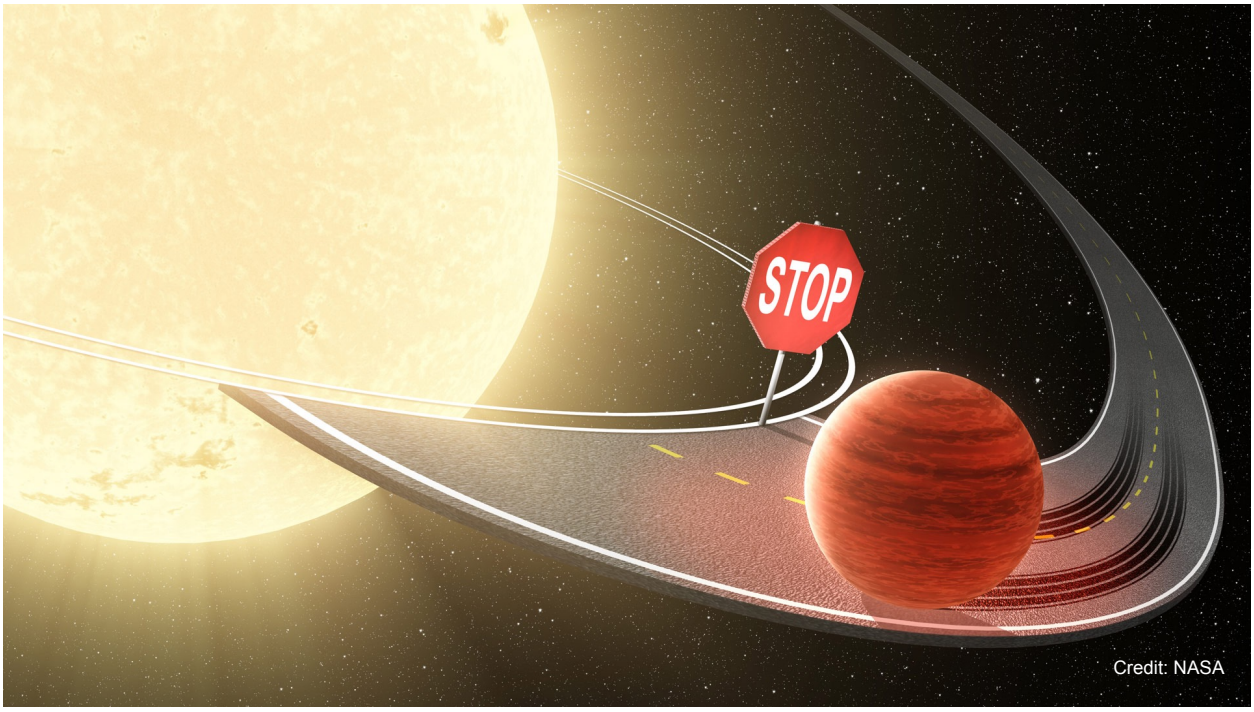
Name: Jupiter
Mass: 1 Jupiter
Distance: 5 AU
Period: 12 years
Cloudtops: 130 K
Density: 1.33 g/cm^3

Name: Kepler-7 b
Mass: 0.2 - 2 Jupiter
Distance: as close at 0.03 AU
Period: as short as 1.2 days
Cloudtops: 1300 K
Density: as low as 0.2 g/cm^3

Most of the known exoplanets are Jovian-like. Those that obit close to their parent starts have higher temperatures that puff up their hydrogen and helium gases - the Hot Jupiters. As a result of being swollen by their temperature, they have a lower average density that Saturn.

How did Jovian-like planets get there? Well, they were probably born beyond the frost line just like our Gas Giant planets. Several effects could have changes their orbits - caution, science at the bleeding edge follows! They could have interactions with waves that are set up in the disk from which they formed. They could have had orbital resonances with another exoplanet. They could have experienced a larger drag force. They could have had gravitational encounters with other objects. The net effect, of any of these possibilities, as suggested by the illustration below, is that the planet migrates inward from where they were born to where they are now.





Hot Jupiters, despite their close-in orbits, appear not to be eaten by their stars. The Hot Jupiters seem to know when to stop migrating inwards, as illustrated above. Instead, the planets appear to remain in fairly stable orbits for billions of years, until the day comes when they may ultimately get eaten as the parent star begins to die. Tidal forces seem to circularize and stabilize a planet's orbit. When its orbit finally become nearly circular, the migration inwards ceases, putting the planetary brakes so to speak.

Credit:Wikipedia
Creative Commons

The overall situation with exoplanets is unlike what we find in our solar system. However, caution is prudent in over-interpreting the current situation for several reasons:

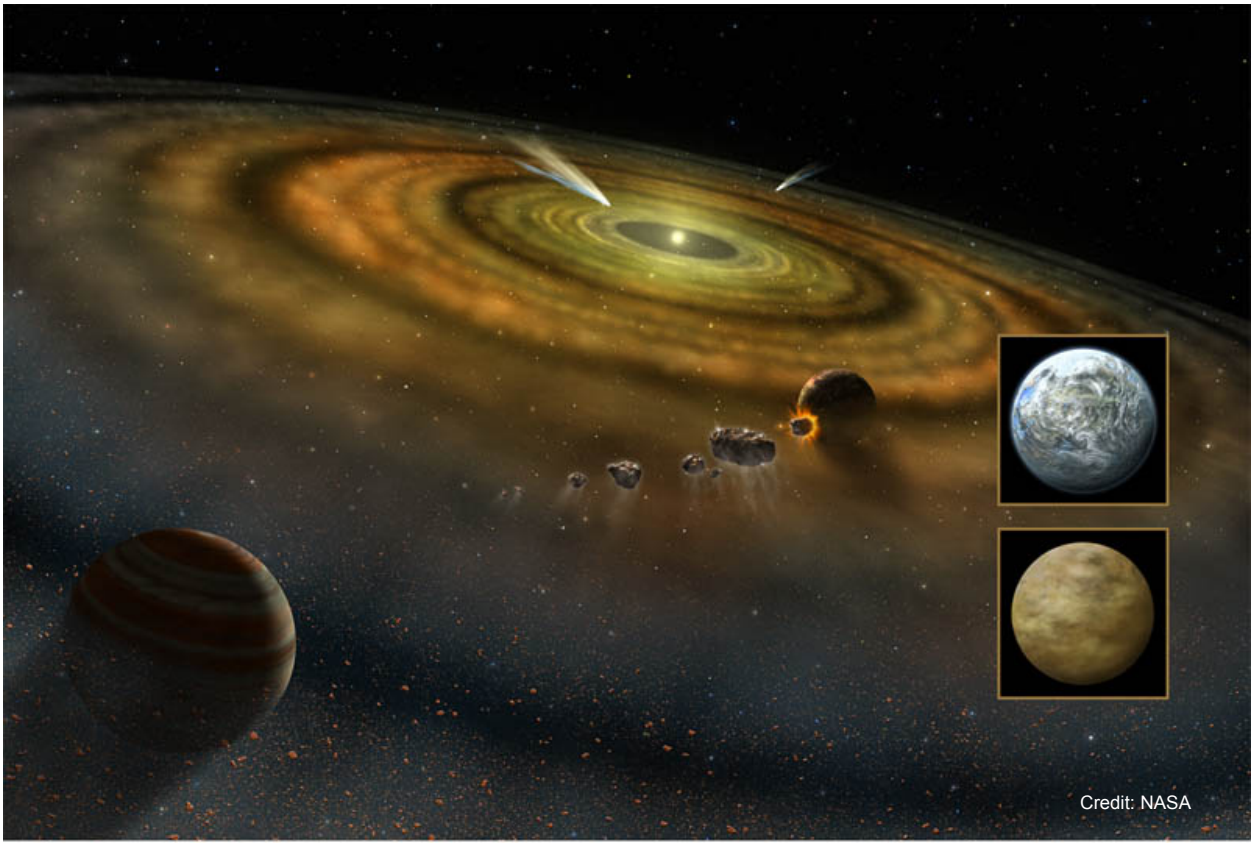
First, our sample size is relatively small, less than 10,000 solar system. This might seem like a lot, but its tiny compared to the 100 billion stars in the Milky Way.

Second, our search programs have been operating for about 20 years. Jupiter has an orbital period of about 12 years, so twice that, 24 years, to get a periodic signal. Saturn and orbital period of 29 years, so 58 years to get a periodic signal. If we were on another star looking at our solar system, Jupiter would not be detected. We just have not been looking long enough!

Credit: Wikipedia
Creative Commons

An analogy. Its like walking into the jungle shown above and claiming that there are no animals in the jungle because you don't immediately see them. The animals are there, you just need patience to look carefully and longer. As the saying goes, absence of evidence is not evidence of absence.

It could be that the search techniques we are using are good at detecting the proverbial tip of the iceberg,. After all, we've yet to find many Earth-sized planets. If we do end up finding many Earth-sized planets in 10, 20 or even 50 years, they might even out the overall distribution to be more in line with our own solar system.



While our basic model of solar system formation, summarized by the illustration above, seems to be pretty sound, we will have to modify it to account for planet migration. No harm, no foul in doing that. This is science. You have a model and you refine that model, or throw it away for a better mode, as you discover more evidence.

Thanks! Bye Bye