Our sun may have eaten a super-Earth for breakfast

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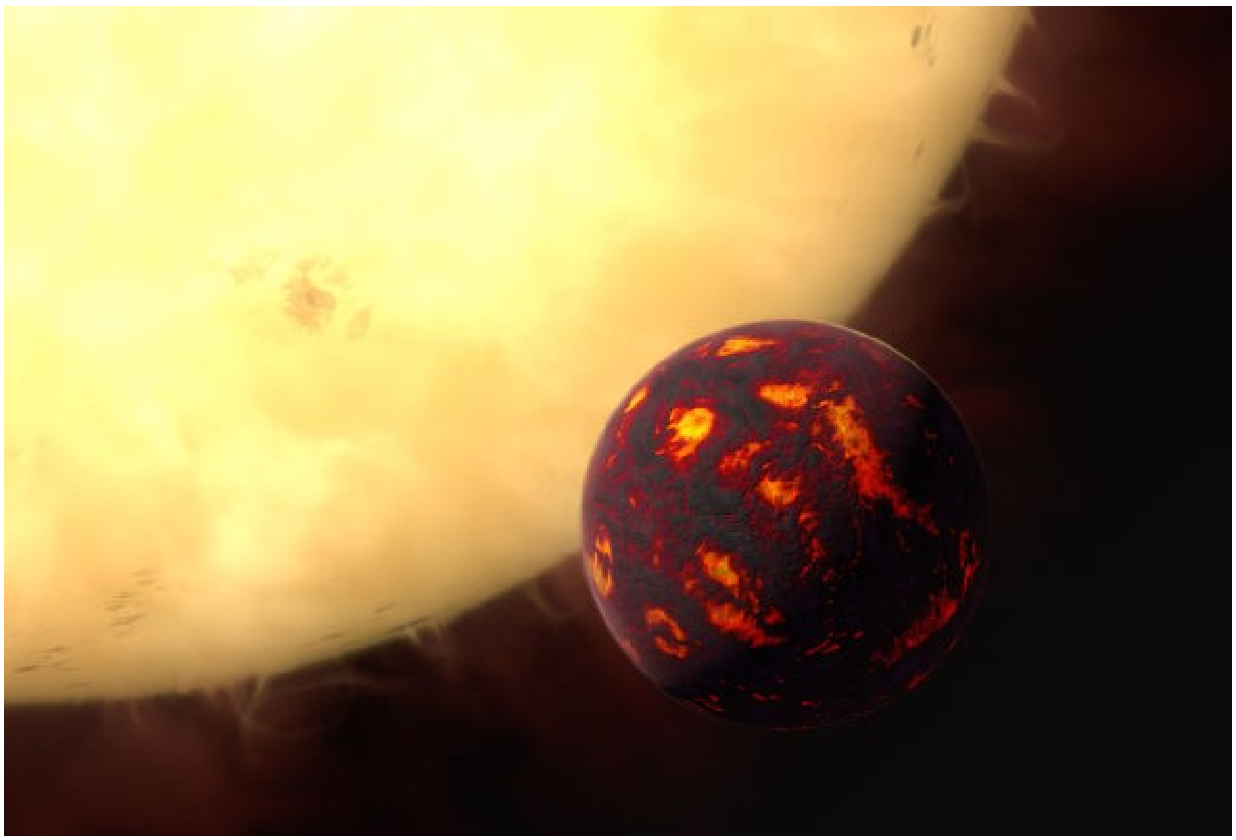

A new paper says that a super-Earth may have formed in our solar system and been swallowed by the sun. Credit: ESA/Hubble, M. Kornmesser

Our solar system sure seems like an orderly place. The orbits of the planets are predictable enough that we can send spacecraft on multi-year journeys to them and they will reliably reach their destinations. But we've only been looking at the solar system for the blink of an eye, cosmically speaking.

The young solar system was a much different place. Things were much more chaotic before the planets settled into the orbital stability that they now enjoy. There were crashings and smashings aplenty in the early days, as in the case of Theia, the planet that crashed into Earth, creating the moon.

Now, a new paper from Rebecca G. Martin and Mario Livio at the University of Nevada, Las Vegas, says that our solar system may have once had an additional planet that perished when it plunged into the sun. Strangely enough, the evidence for the formation and existence of this planet may be the lack of evidence itself. The planet, which may have been what's called a super-Earth, would have formed quite close to the sun, and then been destroyed when it was drawn into the sun by gravity.

In the early days of our solar system, the sun would have formed in the centre of a mass of gas and dust. Eventually, when it gained enough mass, it came to life in a burst of atomic fusion. Surrounding the sun was a protoplanetary disk of gas and dust, out of which the planets formed.

What's missing in our solar system is any bodies, or even rocky debris in the zone between Mercury and the sun. This may seem normal, but the Kepler mission tells us it's not. In over half of the other solar systems it's looked at, Kepler has found planets in the same zone where our solar system has none.

A key part of this idea is that planets don't always form in situ. That is, they don't always form at the place where they eventually reach orbital stability. Depending on a number of factors, planets can migrate inward towards their star or outwards away from their star.

Martin and Livio, the authors of the study, think that our solar system did form a super-Earth, and rather than it migrating outward, it fell into the sun. According to them, the super-Earth most probably formed in the inner regions of our solar system, on the inside of Mercury's orbit. The fact that there are no objects there, and no debris of any kind, suggests that the super-Earth formed close to the sun, and that its formation cleared that area of any debris. Then, once formed, it fell into the sun, removing all evidence of its existence.

The authors also note another possible cause for the super-Earth to have fallen into the sun. They propose that Jupiter may have migrated inward to about 1.5 AUs from the sun. At that point, it got locked into resonance with Saturn. Then, both gas giants migrated outward to their current orbits. This process would have shepherded a super-Earth into the sun, destroying it.

Some of the thinking behind this whole theory involves the size of the inner terrestrial planets in our solar system. They're very small in comparison to other systems studied by the Kepler Mission. If a super-Earth had formed in the inner part of our system, it would have dominated the accretion of available material, leaving Mercury, Venus, Earth and Mars starved for matter.

A key idea behind this study is what's known as a dead zone. In terms of a solar system and a protoplanetary disk, a dead zone is a zone of low turbulence which favors the formation of planets. A system with a dead zone would have enough material to allow super-Earths to form in-situ, and they would not have to migrate inward from further out in the system. However, since large planets like super-Earths take a long time to fully form, this dead zone would have to be long-lived.

If a protoplanetary disk lacks a dead zone, it is likely too turbulent for the formation of a super-Earth close to the star. A turbulent protoplanetary disk favors the formation of super-Earths further out, which would then migrate inwards towards the star. Also, a turbulent disk allows for quicker migration of planets, while a pronounced dead zone inhibits migration.

As the authors say in the conclusion of their study, "The lack of Super–Earths in our solar system is somewhat puzzling given that more than half of observed exoplanetary systems contain one. However, the fact that there is nothing

inside of Mercury's orbit may not be a coincidence." They go on to conclude that in our solar system, the likely scenario is the in situ formation of a super-Earth which subsequently fell into the sun.

There are a lot of variables that have to be fine-tuned for this scenario to happen. The young solar system would need a dead zone, the depth of the turbulence in the protoplanetary disk would have to be just right, and the disk would have to be the right temperature. The fact that these things have to be within a certain range may explain why we don't have a super-Earth in our system, while over half of the systems studied by Kepler do have one.

Source: Universe Today

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