Study on extrasolar planet orbits suggests that solar system structure is the norm

The analysis revealed that the orbits of other planetary systems are aligned, like in a disk, just like in our own solar system.

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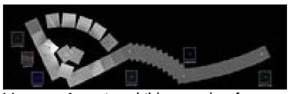

Voyager 1 captured this mosaic of our solar system at almost 13 billion miles (20 billion kilometers) from Earth and 32° degrees above the plane of the solar system. Although our system's organization is more often the exception than the rule, a recent study shows that the high degree of alignment of our system might well be the norm.
Photo by NASA/JPL

Recently, the HARPS spectrograph and the Kepler satellite made a census of the planetary population around stars like our own, revealing a bounty of planetary systems. A follow-up study lead by members of the EXOEarths team (Centro de Astrofísica da Universidade do Porto [CAUP]), in collaboration with Geneva University in Switzerland, did a joint analysis of the data that showed that the planetary orbits in a system are strongly aligned, like in a disk, just as we have in our own solar system.

The two most effective methods for detecting extrasolar planets are the radial-velocity method and the transit method. The radial-velocity method detects planets through the reflex motion induced by the planet on the star's velocity on the radial direction (hence the name). This velocity variation is detected through the Doppler effect, the same that leads to a pitch change in the sound of a traveling ambulance. On the other hand, a planetary transit is akin to a mini-eclipse. As a planet travels around the star, its orbit can locate it in front of the star, and the light we collect from the star is reduced because the planet blocks part of it (even though we cannot image the planet).

There is a significant difference when these two methods are applied to a planetary system. A planet can be detected in radial velocity even when the orbit's plane direction is tilted relative to the line of sight, and the same is true for a system of planets. However, for a planet to transit, the plane of its orbit has to be almost perfectly aligned with our line of sight, and the same is true for a system of two (or more planets) to transit. This means that if several planets in a system transit, they form necessarily a very small angle between them.

The group simulated planetary systems with frequencies as reported by the HARPS survey (that detects basically all the systems, independently of their inclination angle), and attributed to them different relative inclinations. The frequency of transiting systems was calculated and compared with the values reported by Kepler. The team showed that a match can be obtained for double-transiting systems only if they are very strongly aligned with a common plane (the system's plane). This alignment has to be close to 1°, and only reaches 5° on very extreme cases (extreme on the sense of the assumption on how a planetary mass translates to a radius).

These results show consistently that the planets' orbits are predominantly aligned, reinforcing the idea that planets form on a disk and suggesting for the first time that violent encounters between planets are not frequent. This provides a very important clue about the formation and evolution of exoplanets, a domain in which several open questions remain. Although the solar system's organization is more often the exception than the rule, this study shows that the high degree of alignment of our system might well be the norm.

Pedro Figueira of CAUP, the article's first author, stated: "These results show us that the way our solar system formed must be common. Its structure is the same as the other planetary systems we studied, with all planets orbiting roughly in the same plane."

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