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Title: Comparing HARPS and Kepler surveys: On the alignment of multiple-planet systems
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Abstract: The two most effective methods for detecting extrasolar planets are the radial-velocity method and the transit method. 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 lign-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.

We simulated planetary systems with frequencies as reported by HARPS radial-velocity survey (that detects basically all the systems, independently of their inclination angle), and attributed to them different relative inclinations. The frequency of expected transiting systems was then calculated and compared with the values reported by the Kepler mission. We 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 degree, and only reaches 5 degrees 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. Even though 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.