Two giant planets detected around an evolved intermediate-mass star

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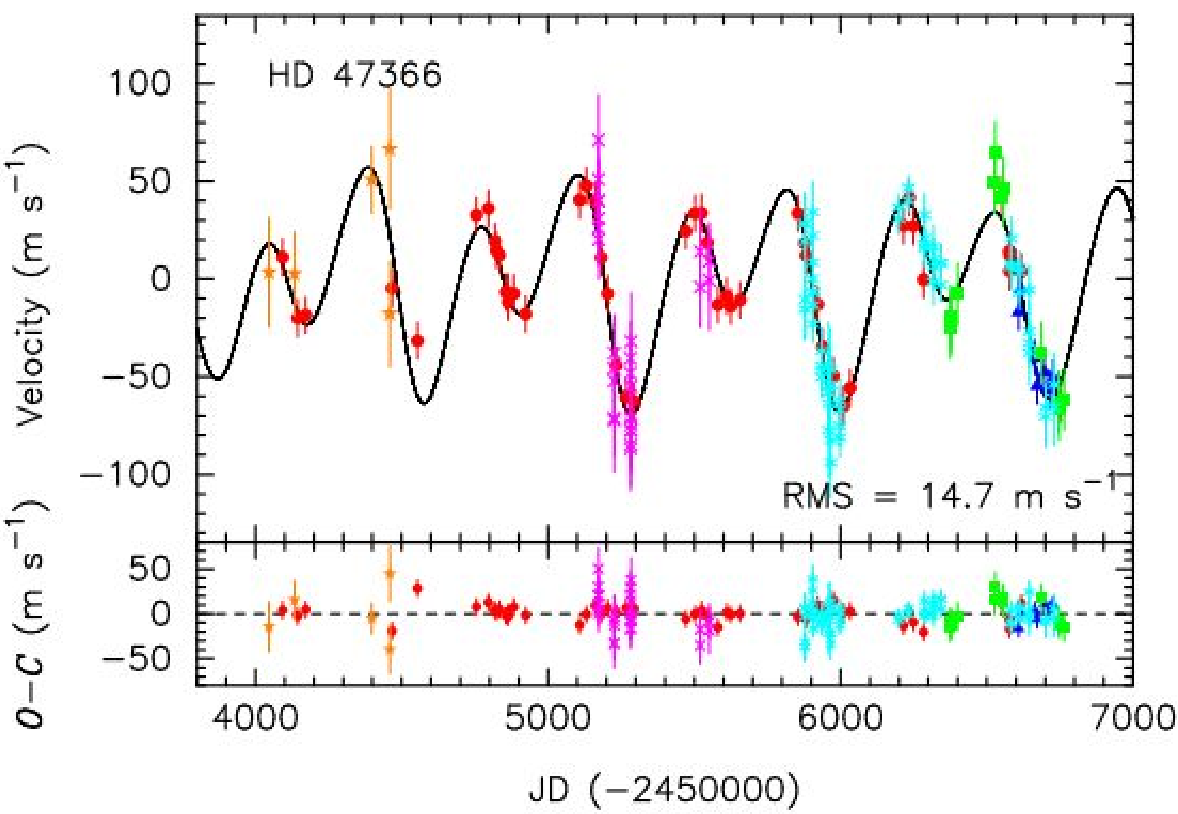

Upper: Radial velocities of HD 47366 obtained with HIDES-S (red), HIDES-F (blue), CES-O (brown), CES-N (magenta), HRS (cyan), and AAT (green). The error bar for each point includes the extra Gaussian noise. The double Keplerian model for the radial velocities is shown by the solid line. Bottom: Residuals to the Keplerian fit. Credit: arXiv:1601.04417 [astro-ph.EP]

(Phys.org)—HD 47366 is an evolved star almost twice as massive as our sun. Located about 260 light years from the Earth, the star is approximately 1.6 billion years old, and, as it turns out, hosts two giant planets with a mass nearly two times that of Jupiter's each. A research paper detailing the new findings was published online on Jan. 18 in the arXiv journal.

The planets were discovered by an international team of astronomers led by Bun'ei Sato of the Tokyo Institute of Technology. The researchers employed the Okayama Astrophysical Observatory (OAO) in Japan, the Xinglong Station in China and the Australian Astronomical Observatory (AAO) to observe HD 47366. The planets were detected by the radial velocity method, also known as Doppler spectroscopy, which uses gravity to detect exoworlds.

The astronomers were searching for any signs of wobbling when observing HD 47366, as planets exert a gravitational tug when they orbit their parent stars, causing them to wobble back and forth. Three powerful spectrographs were needed to detect this wobbling: the HIgh Dispersion Echelle Spectrograph (HIDES) at OAO, the Coude Echelle Spectrograph (CES) at Xinglong and the University College London Echelle Spectrograph (UCLES) at AAO.

Precise radial-velocity measurements using these spectrographs revealed the presence of two exoplanets orbiting HD 47366. By fitting a double Keplerian model to the obtained radial-velocity data, the researchers were able to determine the mass, semimajor axis and eccentricity of the newly discovered worlds. According to their computations, the inner and outer planet have minimum masses equal to 1.75 and 1.86 Jupiter masses, semimajor axes of 1.214 and 1.853 AU (astronomical units), and eccentricities of 0.089 and 0.278 respectively.

With relatively small orbital separations, this planetary system has immediately become very intriguing for the scientists.

"The planetary system is intriguing in the points that the best-fit Keplerian orbit is unstable, it is near but less likely in 2:1 mean-motion resonance, and could be stable if the orbits are nearly circular or in retrograde configuration," the researchers wrote in the paper.

To further investigate the orbital stability of the system and constrain orbital parameters, the astronomers performed dynamical analysis for the system. This analysis revealed that the best-fit orbits in prograde configuration are unstable. However, the scientists found that they are stable in the following cases: The two planets are in the 2:1 mean-motion resonance; the eccentricity of the outer planet is less than about 0.15; mutual inclination of two the planets is larger than 160 degrees.

The researchers also assume that the current orbital configuration could also be caused by a possible third planet in this system. However, no convincing evidence supporting this theory has yet been released.

According to the research team, it is still unknown why multi-giant-planet systems with small orbital separation are mostly found around evolved, intermediate-mass stars. The scientists have offered one possible explanation for this phenomenon.

"It may be a primordial property of planets around intermediate-mass stars that could be an outcome of planet formation or an acquired one as a result of orbital evolution caused by stellar evolution (stellar tide and mass loss) of central stars," the paper reads.

To this date, precise radial-velocity surveys have found about 120 substellar companions around evolved stars. The discovery made by Sato and his team is another important finding increasing the population of multi-giant-planet systems found with relatively small orbital separations around evolved intermediate-mass stars. Planets around these type of stars, especially consisting of giant exoplanets, could be crucial for our understanding of formation and evolution of planetary systems.

More information: A Pair of Giant Planets around the Evolved Intermediate-Mass Star HD 47366: Multiple Circular Orbits or a Mutually Retrograde Configuration, arXiv:1601.04417 [astro-ph.EP] arxiv.org/pdf/1601.04417.pdf

Abstract

We report the detection of a double planetary system around the evolved intermediate-mass star HD 47366 from precise radial-velocity measurements at Okayama Astrophysical Observatory, Xinglong Station, and Australian Astronomical Observatory. The star is a K1 giant with a mass of 1.81+-0.13M_sun, a radius of 7.30+-0.33R_sun, and solar metallicity. The planetary system is composed of two giant planets with minimum mass of 1.75^{+0.20}_{-0.17}Mjup and 1.86^{+0.16}_{-0.15}Mjup, orbital period of 363.3^{+2.5}_{-2.4} d and 684.7^{+5.0}_{-4.9} d, and eccentricity of 0.089^{+0.079}_{-0.060} and 0.278^{+0.067}_{-0.094}, respectively, which are derived by a double Keplerian orbital fit to the radial-velocity data. The system adds to the population of multi-giant-planet systems with relatively small orbital separations, which are preferentially found around evolved intermediate-mass stars. Dynamical stability analysis for the system revealed, however, that the best-fit orbits are unstable in the case of a prograde configuration. The system could be stable if the planets were in 2:1 mean-motion resonance, but this is less likely considering the observed period ratio and eccentricity. A present possible scenario for the system is that both of the planets have nearly circular orbits, namely the eccentricity of the outer planet is less than ~0.15, which is just within 1.4sigma of the best-fit value, or the planets are in a mutually retrograde configuration with a mutual orbital inclination larger than 160 degree.