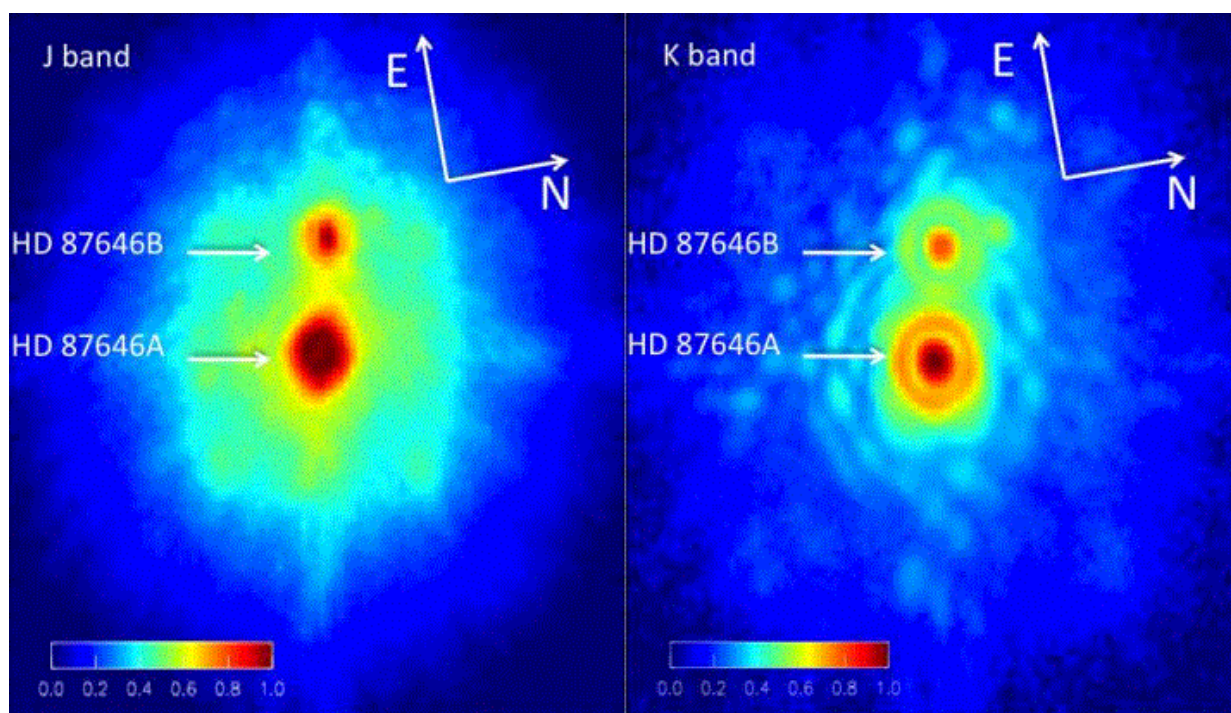


Giant planet and brown dwarf discovered in a close binary system HD 87646

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J and K band AO imaging of HD 87646 taken at Palomar observatory. Credit: Ma et al., 2016.

(Phys.org)—An international team of astronomers reports the discovery of a giant planet and a brown dwarf in a close binary system designated HD 87646. The findings, described in a paper published Aug. 11 on arXiv.org, reveal that HD 87646 is the first close binary system with

more than one substellar circum-primary companion known to date.

HD 87646, located around 240 light years away, is a bright G-type star with a fainter K-type stellar companion. The primary star in the system, HD 87646A, is about 12 percent more massive than the sun and has a radius of about 1.55 solar radii. The system has a separation of only 22 AU between the two stars.

A team of researchers, led by Bo Ma of the University of Florida, has been observing HD 87646 since 2006 using a set of telescopes. The scientists employed the W.M. Keck Exoplanet Tracker (KeckET), at the Sloan Digital Sky Survey (SDSS) 2.5m telescope, mounted on the Apache Point Observatory in New Mexico to reveal the presence of a new giant planet that received designation HD 87646b. KeckET is a new generation multiple object Doppler instrument, capable of simultaneously observing more than 50 stars.

The planetary status of HD 87646b was confirmed thanks to the radial velocity observations conducted by utilizing the Kitt Peak National Observatory (KPNO) in Arizona, the High-Resolution Spectrograph at the Hobby-Eberly Telescope (HET) in Texas, the "Classic" spectrograph at the Automatic Spectroscopic Telescope, mounted on the Fairborn Observatory in Arizona and the Multi-object APO Radial Velocity Exoplanet Large-area Survey (MARVELS) at SDSS. Moreover, these observations allowed the researchers to detect new even larger companion in the system – a brown dwarf designated HD 87646c.

"Our SDSS MARVELS pilot survey and additional observations at the HET, KPNO 2.1m telescope, and Fairborn Observatory confirm the detection of two massive substellar companions in a close [binary system](#) HD 87646," the team wrote in the paper.

According to the study, HD 87646b has a minimum mass of about 12.4

Jupiter masses and an orbital period of approximately 13.5 days. HD 87646c is much more massive, having 57 Jupiter masses and much longer orbital period, circling the star every 673 days.

The team also conducted dynamical simulations of the system, which allowed them to draw conclusions that HD 87646 is stable if it has a large binary semi-major axis and a relatively low binary eccentricity.

However, the question of how this system was formed still baffles the authors of the paper. Given the fact that HD 87646 is the first known system to have two massive substellar objects orbiting a star in a close binary and the masses of the two objects are close to the minimum masses for burning deuterium and hydrogen, these peculiarities raise questions about the system's formation and evolution.

"The large masses of these two substellar objects suggest that they could be formed as stars with their binary hosts: a large molecular cloud collapsed and fragmented into four pieces; the larger two successfully became stars and formed the HD 87646 binary, and the other smaller ones failed to form stars and became the substellar objects in this system. This scenario might be relevant for the binary stars but seems problematic for the two substellar objects on orbits within one AU because it is unclear whether fragmentation on such a small scale can occur," the paper reads.

Other hypothesis offered by the scientists is that the two newly discovered giant objects were formed like giant planet in a protoplanetary disk around HD 87646A. However, they added that such massive disks are rare in close binaries, and further investigation is needed to confirm this explanation.

More information: Very Low-Mass Stellar and Substellar Companions to Solar-like Stars From MARVELS VI: A Giant Planet

and a Brown Dwarf Candidate in a Close Binary System HD 87646 ,
arXiv:1608.03597 [astro-ph.EP] arxiv.org/abs/1608.03597

Abstract

We report the detections of a giant planet (MARVELS-7b) and a brown dwarf candidate (MARVELS-7c) around the primary star in the close binary system, HD 87646. It is the first close binary system with more than one substellar circum-primary companion discovered to the best of our knowledge. The detection of this giant planet was accomplished using the first multi-object Doppler instrument (KeckET) at the Sloan Digital Sky Survey (SDSS) telescope. Subsequent radial velocity observations using ET at Kitt Peak National Observatory, HRS at HET, the "Classic" spectrograph at the Automatic Spectroscopic Telescope at Fairborn Observatory, and MARVELS from SDSS-III confirmed this giant planet discovery and revealed the existence of a long-period brown dwarf in this binary. HD 87646 is a close binary with a separation of ~ 22 AU between the two stars, estimated using the Hipparcos catalogue and our newly acquired AO image from PALAO on the 200-inch Hale Telescope at Palomar. The primary star in the binary, HD 87646A, has $T_{\text{eff}} = 5770 \pm 80 \text{ K}$, $\log(g) = 4.1 \pm 0.1$ and $[\text{Fe}/\text{H}] = -0.17 \pm 0.08$. The derived minimum masses of the two substellar companions of HD 87646A are $12.4 \pm 0.7 M_{\text{Jup}}$ and $57.0 \pm 3.7 M_{\text{Jup}}$. The periods are 13.481 ± 0.001 days and 674 ± 4 days and the measured eccentricities are 0.05 ± 0.02 and 0.50 ± 0.02 respectively. Our dynamical simulations show the system is stable if the binary orbit has a large semi-major axis and a low eccentricity, which can be verified with future astrometry observations.

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