Astronomers discover a new 'warm Jupiter'

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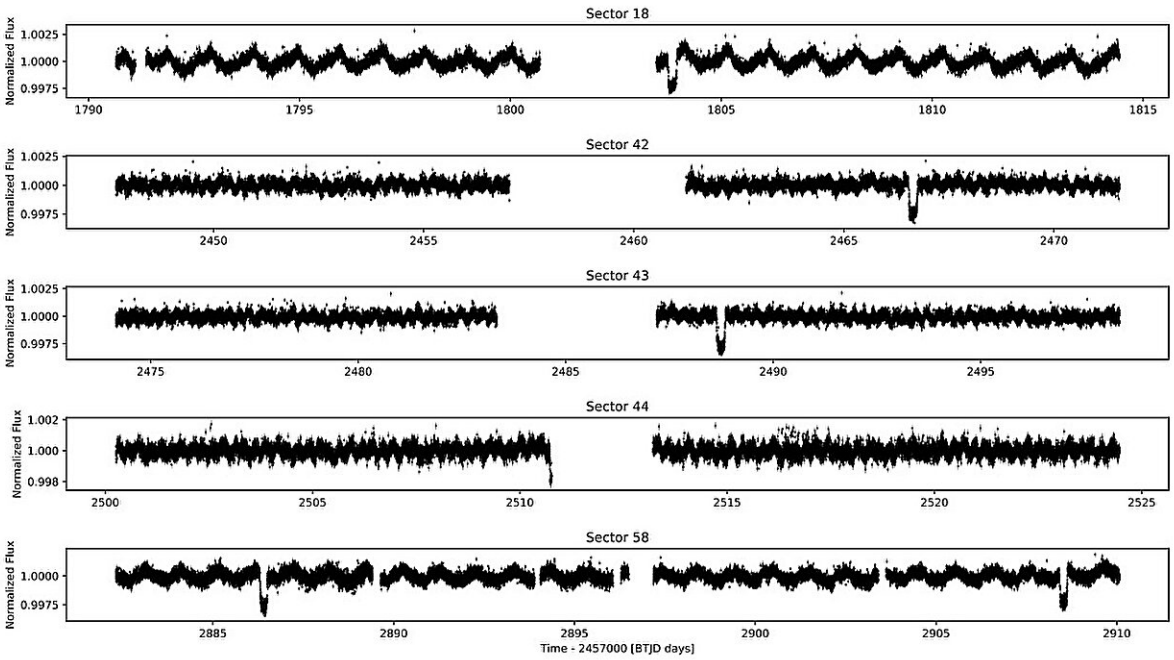

Per-sector Normalized TESS PDCSAP light curves for TOI-4641. Credit: *arXiv* (2023). DOI: 10.48550/arxiv.2312.03971

Astronomers from the Harvard–Smithsonian Center for Astrophysics (CfA) and elsewhere, report the discovery of a new 'warm Jupiter' exoplanet orbiting a rapidly rotating F-type star. The newfound alien world, designated TOI-4641 b could be nearly four times as massive as Jupiter. The finding was detailed in a paper published December 7 on the pre-print server *arXiv*.

In general, warm Jupiters are gas giant planets with orbital periods between 10 and 200 days. This makes them challenging targets for transit detection, and radial velocity follow-up studies, compared to their shorter-orbit counterparts known as hot Jupiters.

Now, a group of astronomers led by CfA's Allyson Bieryla has found a new exoplanet of this type. Using NASA's Transiting Exoplanet Survey Satellite (TESS), which is conducting an all-sky survey searching for transiting extrasolar worlds, they identified a transit signal in the light curve of TOI-4641—a bright and rapidly rotating F-star (with a projected rotational velocity of approximately 86.3 km/s). The planetary nature of this signal was confirmed by follow-up photometric and spectroscopic observations.

"A candidate exoplanet orbiting TOI-4641 with a period of 22.1d was identified in light curves including data through Sector 43 in both SPOC and QLP pipelines," the researchers wrote in the paper.

The newfound planet has a radius of about 0.73 Jupiter radii and its maximum mass was calculated to be 3.87 Jupiter masses. The observations indicate that TOI-4641 b orbits its host star every 22.09 days at a well-aligned orbit, at a distance of some 0.173 AU from it. TOI-4641 b is therefore among the longest period planets, to be thoroughly characterized, that orbits a hot rapidly rotating star.

The parent star TOI-4641 (also known as TIC 436873727), located some 286 light years away, has a radius of about 1.72 solar radii and is approximately 41% more massive than the sun. The star is estimated to be 2.69 billion years old, has a metallicity at a level of -0.09, and its effective temperature was found to be 6,560 K.

The authors of the paper underlined that long-period exoplanets like TOI-4641 b could be crucial for testing mechanisms that induce

primordial misalignment in planetary systems, given that at such orbital distances, star-planet tidal interactions are assumed to be too weak to modify the orbital obliquity.

"Testing these predictions motivate full characterizations of planets in long-period orbits about early-type stars," the scientists concluded.

All in all, Bieryla's team proposes a few mechanisms behind such misalignment, including chaotic accretion, magnetic warping, or changes to the spin axes of early-type stars, as well as stellar or planetary companions during the primordial phase of formation.

More information: Allyson Bieryla et al, TOI-4641b: An Aligned Warm Jupiter Orbiting a Bright (V=7.5) Rapidly Rotating F-star, *arXiv* (2023). DOI: 10.48550/arxiv.2312.03971