The Astrophysical Journal, 745:80 (9pp), 2012 January 20 doi:10.1088/0004-637X/745/1/80

HAT-P-25b: A HOT-JUPITER TRANSITING A MODERATELY FAINT G STAR*

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Received 2010 August 20; accepted 2011 November 4; published 2011 December 29

ABSTRACT

We report the discovery of HAT-P-25b, a transiting extrasolar planet orbiting the $V = 13.19$ G5 dwarf star GSC 1788-01237, with a period $P = 3.652836 \pm 0.000019$ days, transit epoch $T_c = 2455176.85173 \pm 0.00047$ (BJD—barycentric Julian dates throughout the paper are calculated from Coordinated Universal Time, UTC), and transit duration 0.1174 ± 0.0017 days. The host star has a mass of $1.01 \pm 0.03\ M_\odot$, radius of $0.96^{+0.05}_{-0.04}\ R_\odot$, effective temperature 5500 ± 80 K, and metallicity [Fe/H] $= +0.31 \pm 0.08$. The planetary companion has a mass of $0.567 \pm 0.022\ M_{\rm J}$ and radius of $1.190^{+0.081}_{-0.056}\ R_{\rm J}$ yielding a mean density of 0.42 ± 0.07 g cm^{-3}.

Key words: planetary systems – stars: individual (HAT-P-25, GSC 1788-01237) – techniques: photometric – techniques: spectroscopic

Online-only material: color figures, machine-readable table

1. INTRODUCTION

As more transiting extrasolar planets (TEPs) are discovered, statistics become significant enough to begin looking at bulk properties of exoplanet populations. By investigating relationships between stellar, planetary, and orbital characteristics (see, e.g., Hartman et al. 2011; Burrows et al. 2007; Enoch et al. 2011), we can probe the underlying astrophysics that dictates the properties we observe. In this paper, we present the discovery of HAT-P-25b, the 25th TEP found by the Hungarian-made Automated Telescope Network (HATNet; Bakos et al. 2004) survey, orbiting the star also known as GSC 1788-01237.

With $V = 13.19$, HAT-P-25 was the faintest transiting planet host star discovered by a wide-field, ground-based transit survey at the time of its discovery—the recently announced hot-Jupiter TrES-5b (Mandushev et al. 2011) orbits a $V = 13.72$ star. Traditionally wide-field surveys using small-aperture telescopes, such as HAT, WASP, XO, and TrES, have focused on stars with $V < 13$ mag while fainter stars have been the domain of space-based surveys and narrow-field ground-based surveys such as OGLE (e.g., OGLE-TR-56b, $V = 16.6$; Konacki et al. 2003), *CoRoT* (e.g., CoRoT-1b, $V = 13.3$; Barge et al. 2008), and *Kepler* (e.g., Kepler-5b, $V = 13.4$; Koch et al. 2010). As these latter surveys have shown, spectroscopically confirming planets around faint stars poses several challenges which are not present for brighter hosts (e.g., Pont et al. 2008).

HATNet has been one of the main contributors to the discovery of TEPs. In operation since 2003, it has now covered approximately 14% of the sky, searching for TEPs around bright stars ($8 \lesssim I \lesssim 14.0$). HATNet operates six wide-field instruments: four at the Fred Lawrence Whipple Observatory (FLWO) in Arizona and two on the roof of the hangar housing the Smithsonian Astrophysical Observatory's Submillimeter Array, in Hawaii.

The layout of the paper is as follows. In Section 2, we report the detection of the photometric signal and the follow-up spectroscopic and photometric observations of HAT-P-25. In Section 3, we describe the analysis of the data, beginning with the determination of the stellar parameters, continuing with a discussion of the methods used to rule out non-planetary, false positive scenarios which could mimic the photometric and spectroscopic observations, and finishing with a description of our global modeling of the photometry and radial velocities. Our findings are discussed in Section 4.

2. OBSERVATIONS

2.1. Photometric Detection

The transits of HAT-P-25b were detected with the HAT-10 telescope in Arizona and the HAT-9 telescope in Hawaii. The region around GSC 1788-01237, a field internally labeled as 259, was observed on a nightly basis between 2008 September 15 and 2009 March 16, whenever weather conditions permitted. We gathered 6786 exposures of 5 minutes at a 5.5 minute cadence. Each image contained approximately 36,000 stars down to Sloan $r \sim 14.5$. For the brightest stars in the field, we achieved a per-image photometric precision of 4 mmag.

The calibration of the HATNet frames was carried out using standard photometric procedures. The calibrated images were then subjected to star detection and astrometry, as described

* Based in part on observations obtained at the W. M. Keck Observatory, which is operated by the University of California and the California Institute of Technology. Keck time has been granted by NOAO (A201Hr), NASA (N018Hr and N167Hr), and the NASA Gemini-Keck time-exchange program (G329Hr). Based in part on observations made with the Nordic Optical Telescope, operated on the island of La Palma jointly by Denmark, Finland, Iceland, Norway, and Sweden, in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofisica de Canarias.

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