NGTS-2b: An inflated hot-Jupiter transiting a bright F-dwarf

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ABSTRACT

NGTS-2b is an inflated hot-Jupiter transiting a bright F5V star \((T_{\text{eff}} = 6479 \pm 90 \text{ K})\), discovered by the Next Generation Transit Survey (NGTS). The planet is in a \(P = 4.51 \text{ day}\) orbit with mass \(0.74 \pm 0.13 M_J\), radius \(1.595 \pm 0.046 R_J\) and density \(0.226 \pm 0.039 \text{ gcm}^{-3}\); therefore one of the lowest density exoplanets currently known. With a relatively deep 1.0% transit around a bright \(V = 10.96\) host star, NGTS-2b is a prime target for probing giant planet composition via atmospheric transmission spectroscopy. The rapid rotation \((v\sin i = 15.2 \pm 0.8 \text{ km s}^{-1})\) also makes this system an excellent candidate for Rossiter-McLaughlin follow-up observations, to measure the sky-projected stellar obliquity. NGTS-2b was confirmed without the need for follow-up photometry, due to the high precision of the NGTS photometry.

BACKGROUND

Hot-Jupiters (HJs) are giant exoplanets \((m \sin i \gtrsim 0.5 M_J)\) orbiting close to their parent stars \(P \lesssim 10 \text{ days}\). The radii of many HJs exceed that predicted by evolutionary models¹² and HJs with bulk densities as low as \(\sim 0.1 \text{ gcm}^{-3}\) have been discovered³⁴. HJs transiting bright stars present the finest opportunities for robust exoplanet atmospheric characterisation⁵. HJs almost certainly formed at larger orbital separation but the importance of disc-driven and tidal-driven migration is still unclear⁶. Further detections of HJs transiting bright stars is crucial to further our understanding of the formation and evolution of these planets and their atmospheres.

NGTS PHOTOMETRY

NGTS is a wide-field, transit survey located at Paranal, Chile⁷. It comprises an array of 12 fully automated, 20cm telescopes. The primary goal of NGTS is to discover Neptune sized exoplanets orbiting bright \((V<13)\), K and early M-dwarfs – suitable for atmospheric follow-up studies.

NGTS-2b was detected from 12 individual transits in \(~200,000\), 10s NGTS images, taken between January and August 2017. A full description of the NGTS pipelines can be found in ⁷. The individual transits of NGTS-2 are shown in Fig. 1, while the full light curve is shown in Fig. 2.

Fig. 1: Individual transits of NGTS-2 detected in the NGTS light curve. Black points represent photometric data binned to 10-minute cadence. The red line and pink shaded regions show the median and 1 & 2 \(\sigma\) confidence intervals of the posterior model using GP-EBO³, before detrending for the Gaussian process component. The robust detection of NGTS-2b in individual transits \((\text{RMS} \sim 2.4 \text{ mmag})\) demonstrates the high photometric precision of NGTS.

HARPS RADIAL VELOCITIES

Radial velocities of NGTS-2 were derived from 16 spectra taken with HARPS⁸ on the ESO 3.6m telescope, between July 2017 and March 2018. The radial velocities are plotted in Fig. 3.

Fig. 2: Transit of NGTS-2, phase-folded on the best fitting period as determined from our global modelling. Black points represent photometric data binned to 10 minute cadence. Error bars and 1 and 2\(\sigma\) confidence regions are plotted as in Fig. 1. The light curve has been detrended for the Gaussian process component. Residuals are shown below with RMS \(~1.3\) mmag.

Fig. 3: HARPS radial velocity curve of NGTS-2, phase-folded to the best-fitting period as determined from the global modelling. Black points represent HARPS/HAM data points whereas black triangles show HARPS/EGGS mode data. The red line and pink shaded regions show the median and 1 & 2 \(\sigma\) confidence intervals of the posterior model. Residuals are shown below with RMS 2% and 3% for HAM and EGGS respectively.

REFERENCES