

Observations of transiting exoplanets around host stars with near-by companions

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Abstract

We report the detection of three possible transiting exoplanets around the star EPIC 246239135, which has a near-by companion star in its field of view designated as EPIC 246239053. The two stars which are separated by approximately 6 arcseconds are likely to be a binary system of K-type stars. Initial observations from the K2 mission showed multiple transits, although the photometry was conducted with an aperture that covered both stars. We used custom apertures to do a pixel by pixel analysis of the Target Pixel File (TPF) of this system in order to determine which of the stars host the planet candidates. After removing the systematic effects inherent to K2 light curves and fitting transit models to the observed data, we found preliminary parameters for the planet candidates in this system.

1. Introduction

Exoplanet host stars with close companions in their field of view, whether bound or not, can significantly affect the characterization process of observed planet candidates. The cumulative flux from two stars can lead to an under-estimate of planetary radii, and sometimes even present false positives as true positives^[1]. In this paper we discuss our preliminary results of the analysis of photometric data from the stellar pair of EPIC 246239135/246239053, where we attempt to measure the parameters of the planet candidates as accurately as possible.

2. Photometry and transit analysis

The light curve and TPF for our target was obtained from the K2 archives hosted by the Mikulski Archive for Space Telescopes (MAST). Due to the proximity between EPIC 246239135 and 246239053, the default aperture used by the K2 science team and the optimized aperture used in accordance with

Vanderburg & Johnson (2014)^[2] includes both stars when extracting a photometric light curve. As this would lead to a flawed analysis where we would get incorrect measurements of the planet radii, we used custom apertures over different regions of the stellar pair in the TPF. Each aperture was placed over a given star in such a way that it would exclude as much flux as possible from the companion star. By measuring the variation in transit depth and precision of the planet candidates between apertures, we determined that they are most likely to be hosted by EPIC 246239135. Using an aperture over just the host star, we re-extracted a new light curve and removed its systematic trends using the K2SC^[3] reduction pipeline. Using broadband photometric observations from Gaia DR2, 2MASS, Pan-STARRS1, the Sloan Digital Sky Survey and AllWISE, we measured the stellar parameters for each host star using a spectral energy distribution fitting. We utilized the VOSA/SED tool for this purpose as well as the ISOCHRONES package to arrive at a final set of stellar parameters. EPIC 246239135 was found to be 0.81 solar radii with an effective temperature of 5111 K, and EPIC 246239053 to be 0.92 solar radii with an effective temperature of 5460 K. The observed transits were fitted with a Monte Carlo Markov Chain (MCMC). We used the *emcee* package (Foreman-Mackay et al. 2013) to fit the model light curves produced by the *PyTransit* package (Parviainen et al 2015), which utilizes the Mandel & Agol algorithm. Our initial estimates for the planet parameters yielded orbital periods of 8.1, 12.7 and 19.3 days with radii of $1.6 \pm 0.04 R_{\text{earth}}$, $1.8 \pm 0.02 R_{\text{earth}}$ and $2.1 \pm 0.06 R_{\text{earth}}$ respectively. The planet sizes indicate that these are possible super-Earth type exoplanets.

3. Figures

References

- [1] Ciardi D. R., Beichman C. A., Horch E. P., & Howell S. B., 2015, accepted to ApJ, arXiv:1503.03516
- [2] Vanderburg A. & Johnson J. A., 2014, PASP, 126, 948
- [3] Aigrain S., Parviainen H., Pope B. J. S., 2016, MNRAS, Vol. 000, pp. 1-14

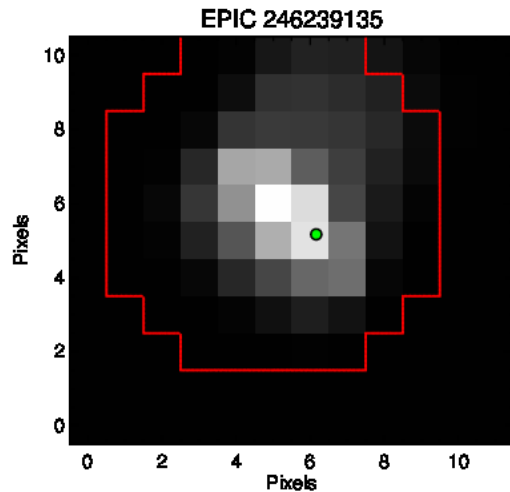


Figure 1: The EPIC 246239135 & EPIC 246239053 pair with the optimized photometric aperture (Vanderburg & Johnson 2014) overlaid in red.

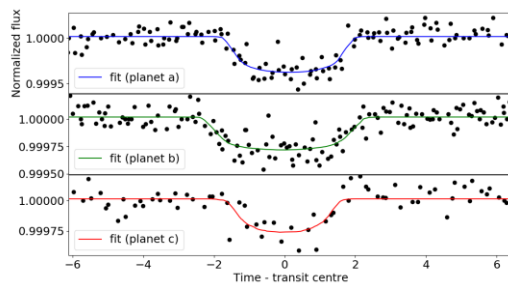


Figure 2: The best fit curves with the observed data for each planet in this system. Planet a (blue) with 8.1 days, Planet b (Green) with 12.7 days and planet c (red) with 19.3 days.

4. Summary and Conclusions

We have provided observational evidence for three transiting planets around the probable binary system EPIC 246239135/246239053 separated by 6 arcseconds (Gaia DR2 parallax measurements). We used custom apertures to analyze the K2 TPF in order to determine the exact host star for these planet candidates and to make accurate measurements of their planetary radii.