

TRANSITING EXOCOMETES DETECTED IN BROADBAND LIGHT BY *TESS* IN THE β PICTORIS SYSTEM

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Abstract. We present the first broadband detections of exocomets crossing the disk of β Pictoris. We use photometric data obtained by the *TESS* satellite over a time-base of 105 days, and pre-whiten the 54 identified δ Scuti p -modes of the star. The residual photometric time-series show three distinct dipping events. These dips have depths from 0.5 to 2 millimag, durations of up to 2 days for the largest dip, and are asymmetric in nature. This detection complements the predictions made 20 years earlier. Furthermore they confirm the spectroscopic detection of exocomets in Calcium II H and K lines that have been seen in high-resolution spectroscopy.

Keywords: Comets: general, stars: planetary systems, individual: β Pictoris, Techniques: photometric, circumstellar matter

β Pictoris (HD 39060) is a bright ($m_V = 3.86$), close (19.76 pc; Brown et al. 2018) and young (~ 23 Myr; Mamajek & Bell 2014) exoplanet host star showing δ Scuti pulsations. Ferlet et al. (1987) detected absorption features in the spectrum of the star that changed with time, and which have been attributed to Falling Evaporating Bodies (FEBs, also known as exocomets). Similar signatures have been detected around other stars, such as HD 172555 (Kiefer et al. 2014). The first exocomets to be seen photometrically were discovered in *Kepler* data by Rappaport et al. (2018) around the two stars KIC 3542116 and KIC 11084727. Kennedy et al. (2019) developed an algorithm to search for asymmetric, exocomet-like dips in light-curves, retrieving those two events and finding a third around HD 182952. The deep and irregular dimming events seen in KIC 8462852 (Boyajian’s star or Tabby’s star) have also been interpreted as having a cometary origin (Boyajian et al. 2016; Wyatt et al. 2018).

Zieba et al. (2019) presented observations of β Pictoris from *TESS*, and showed that the duration and depth of a dipping event in Sector 6 (see Fig. 1) are consistent with the transit of an exocomet, and also agree with the predictions made by Lecavelier Des Etangs et al. (1999). Two smaller dips in Sector 5 are visible (see Fig. 1) after the subtraction of 54 identified δ Scuti p -modes of the star (see Fig. 2 and 3).

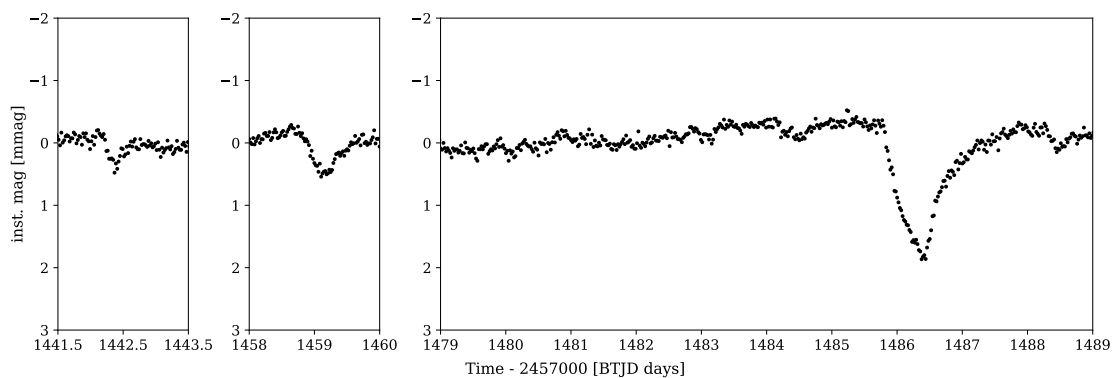


Fig. 1. Enlargement of the three events in the 30-min binned light-curve, after subtraction of the pulsational signal. The two smaller dips in the left and middle panels occurred in *TESS* Sector 5. The bigger event in the right panel was in Sector 6.

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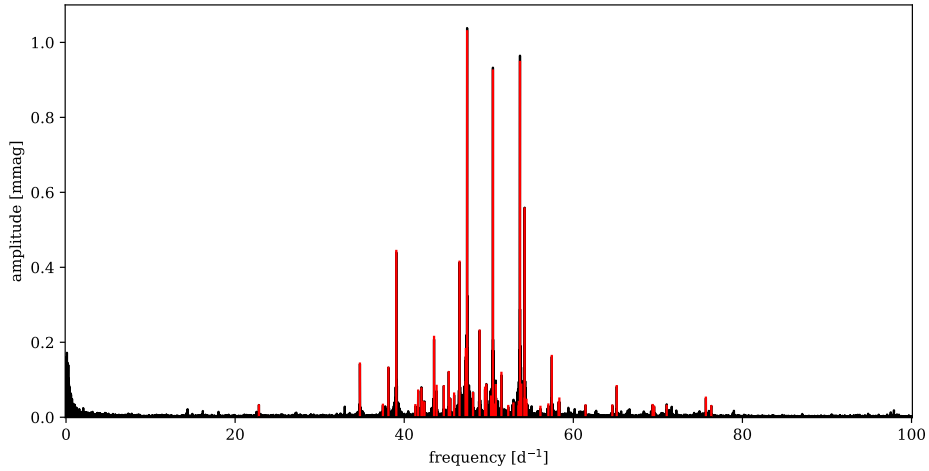


Fig. 2. Original amplitude spectrum of the full β Pictoris light-curve collected by *TESS* in black, and the 54 identified δ Scuti pulsations in red.

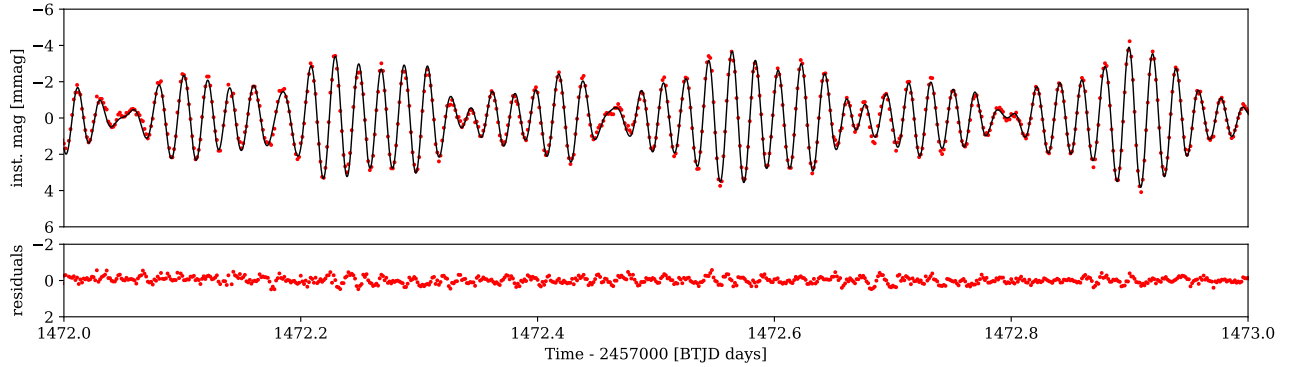


Fig. 3. One-day enlargement of the β Pictoris light-curve. *Upper panel:* *TESS* photometric time-series (red points) and multi-sine fit, using the 54 identified δ Scuti frequencies (black line). *Lower panel:* Residual time-series after subtracting the multi-sine fit using all 54 identified pulsation frequencies.

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