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A dance with dragons: *TESS* reveals α Draconis is a detached eclipsing binary

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Detached eclipsing binaries allow stellar masses and radii to be measured with unrivalled accuracy (Andersen 1991; Torres et al. 2010). While inspecting light curves obtained with the *Transiting Exoplanet Survey Satellite* (*TESS*; Ricker et al. 2015), we noticed that the A0 III star α Dra shows clear and well-separated primary and secondary eclipses. With a V magnitude of 3.68, α Dra is brighter than most previously known detached eclipsing binaries (Malkov et al. 2006; Zasche et al. 2009; Avvakumova et al. 2013), with the only brighter systems apparently being γ Per (Griffin 2007) and δ Vel A (Pribulla et al. 2011).

The star α Dra (Thuban; HR 5291; HD 123299; HIP 68756) is a well-studied single-lined spectroscopic binary, with a period of 51.5 d and an eccentricity of 0.43 (e.g., Harper 1907; Elst & Nelles 1983; Budovicová et al. 2004; Bischoff et al. 2017). The currently available *TESS* observations for α Dra cover two 27-d sectors[1]. The light curve (Fig. 1) shows a primary eclipse in Sector 14 and a secondary eclipse in Sector 15, separated in time by 38.5 d. Optical interferometry shows that the angular separation is a few milliarcsec and the magnitude difference at 700 nm is 1.83 ± 0.07 (Hutter et al. 2016). This flux ratio implies that a total eclipse would have a depth of 16%. The two *TESS* eclipses have depths of 9% and 2%, indicating that the eclipses are partial and the inclination is slightly less than 90°.

The star lies close to, but not inside, the *TESS* continuous viewing zone (CVZ) and further observations will be available from Sectors 16, 21 and 22[2]. We expect the next primary eclipse to occur at BJD 2458747.4, which falls within Sector 16. Another secondary eclipse will fall in Sector 21 and another primary eclipse will fall in Sector 22.

Spectroscopically, α Dra is used as the MK standard for spectral type A0 III (Gray & Garrison 1987; Gray & Corbally 2009). Although α Dra has been reported as a λ Bootis star (showing surface chemical abundances that imply accretion from circumstellar material), it is not a member of this class (Murphy et al. 2015). Its projected rotation velocity is quite low for this spectral type ($v \sin i \sim 26\,\mathrm{km\,s^{-1}}$; Gray 2014). Now that we know the system is eclipsing, the assumption of reasonable alignment between the rotation and orbital axes implies that the primary is indeed a slow rotator (rather than being a rapid rotator seen pole-on, like the A0 V star, Vega; Hill et al. 2010).

Kallinger et al. (2004) suggested that α Dra is photometrically variable, with a period of about 53 min and an amplitude of 1–2 mmag. They speculated that α Dra could belong to the unconfirmed class of so-called Maia variables (for recent discussions, see Balona et al. 2015; Szewczuk & Daszyńska-Daszkiewicz 2017; White et al. 2017). It was this possibility led us to examine the *TESS* light curve for this star. However, apart from the eclipses, the light curve shows no evidence for variability and we can rule out variability on timescales shorter than 8 hr at the level of 10 ppm (parts per million).

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[1] https://mast.stsci.edu/portal/Mashup/Clients/Mast/Portal.html
[2] https://heasarc.gsfc.nasa.gov/cgi-bin/tess/webtess/wtv.py

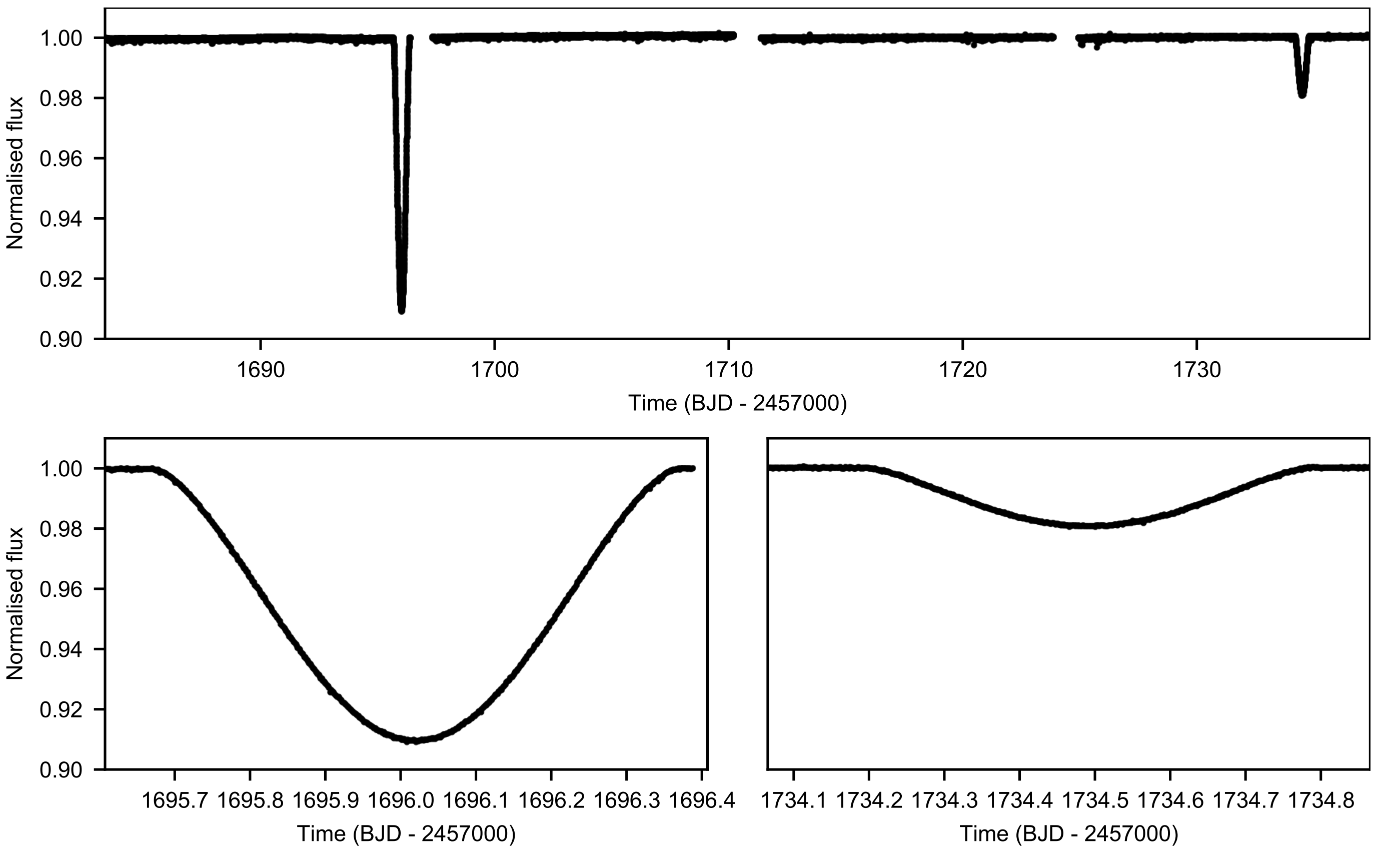

Figure 1. *TESS* light curve of α Dra at 2-minute cadence using the Simple Aperture Photometry (SAP) flux, show the primary and secondary eclipses. The bottom panels show close-up views (both 0.8 d wide) of the primary and secondary eclipses (left and right, respectively).

Facility: TESS

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