

Measuring the masses of challenging TESS planets: Single transits and DS Tuc Ab

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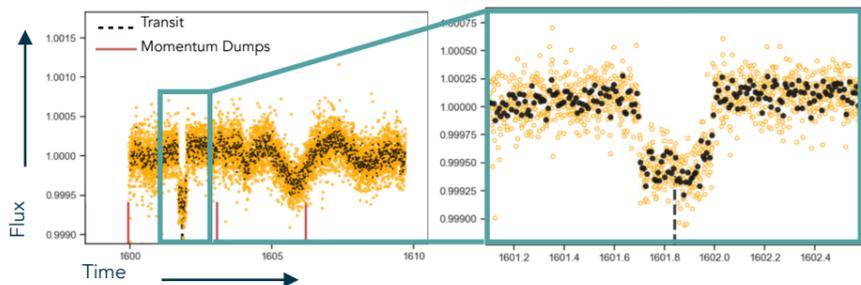
The Goal: Constraining photoevaporation

Single transit planet candidates are on longer period and experience lower levels of irradiation from their host star, thus probing the lower limits of photoevaporation.

DS Tuc Ab is a planet probing the higher end of photoevaporation test cases due to its short period (high irradiance), and the youth of its host star (high XUV flux).

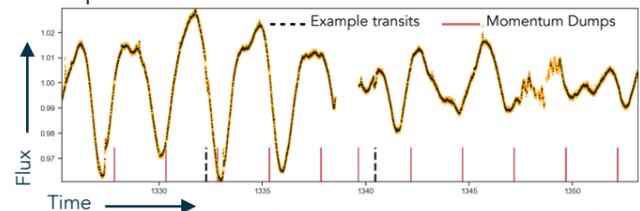
The Challenge: not ideal radial velocity targets...

Single transit planets are **harder to find**, as they are not picked up by the TESS pipeline. Candidates observed here have been found by the Planet Hunters TESS citizen science project, and the TESS Single Transits Working Group automated pipeline. This example light curve shows a single transit discovered by Planet Hunters TESS:

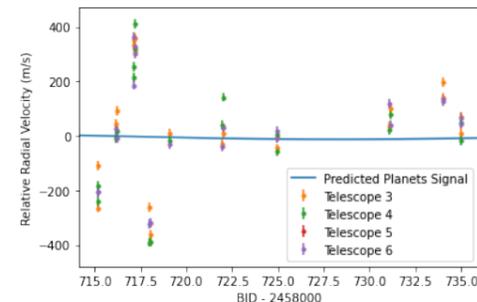


The unknown period and ephemeris, and likely smaller signal amplitude of these planet candidates makes them **harder to follow-up** with radial velocity.

DS Tuc A is young and **very active**, resulting in spatial and temporal variations in surface brightness. This is clearly seen in the TESS light curve, where the variations obscure many of the transits of the P~8.14 d planet.



This **activity induces large radial velocity variations** that mask the signal of the orbiting planet. This is demonstrated in this plot of MINERVA-Australis radial velocities observed in August-Sep 2019, plotted alongside the predicted planets signal:



Challenge Accepted: Observing programmes with the MINERVA-Australis Telescope Facility

The **MINERVA-Australis telescope facility**, (located in South East Queensland, Australia; pictured below!) combines an array of 0.7m telescopes and a fibre-fed precision spectrograph, dedicated to follow-up of TESS targets. Within this is a program **dedicated to follow-up of single transit planet candidates**.



Follow up of tens of candidates thus far have revealed a number of spectroscopic binaries (there are lots of binaries out there...), and a handful of promising candidates that are currently being observed on a 5 night cadence.

MINERVA-Australis is currently undertaking an **intensive observing programme** of DS Tuc with the goal of observing DS Tuc every night for several months to closely monitor the activity signal in the radial velocity measurements. This activity can then be modelled and removed using **Gaussian Processes (GP)**, allowing the detection of DS Tuc Ab.

These plots show the **predicted GP model and recovered RVs** of DS Tuc from **simulated MINERVA-Aus. data based on the observations** from Aug. - Sep. 2019 plotted above, giving a realistic estimate of the activity signal and instrumental behaviour.

