ÖAW IWF

TOI-396
Planetary characterisation

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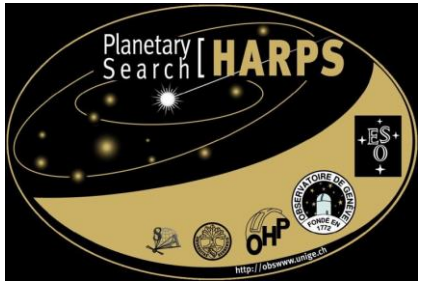
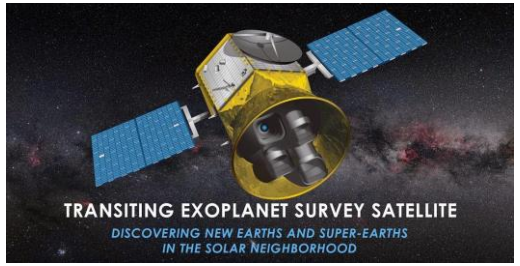
The scientific case

Fundamental planetary parameters

Radial velocity method ← **Mass** — **Radius** → Transit method





Density

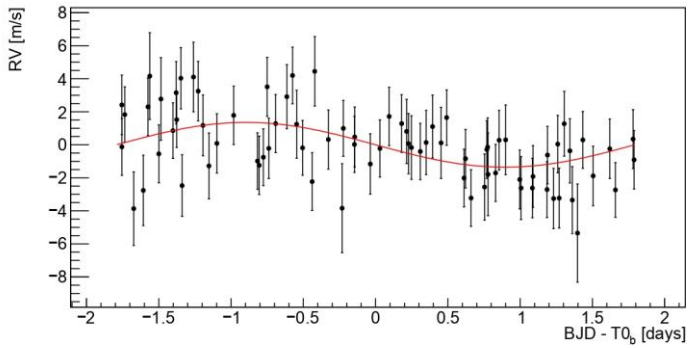
Composition
Internal structure
Formation and evolution

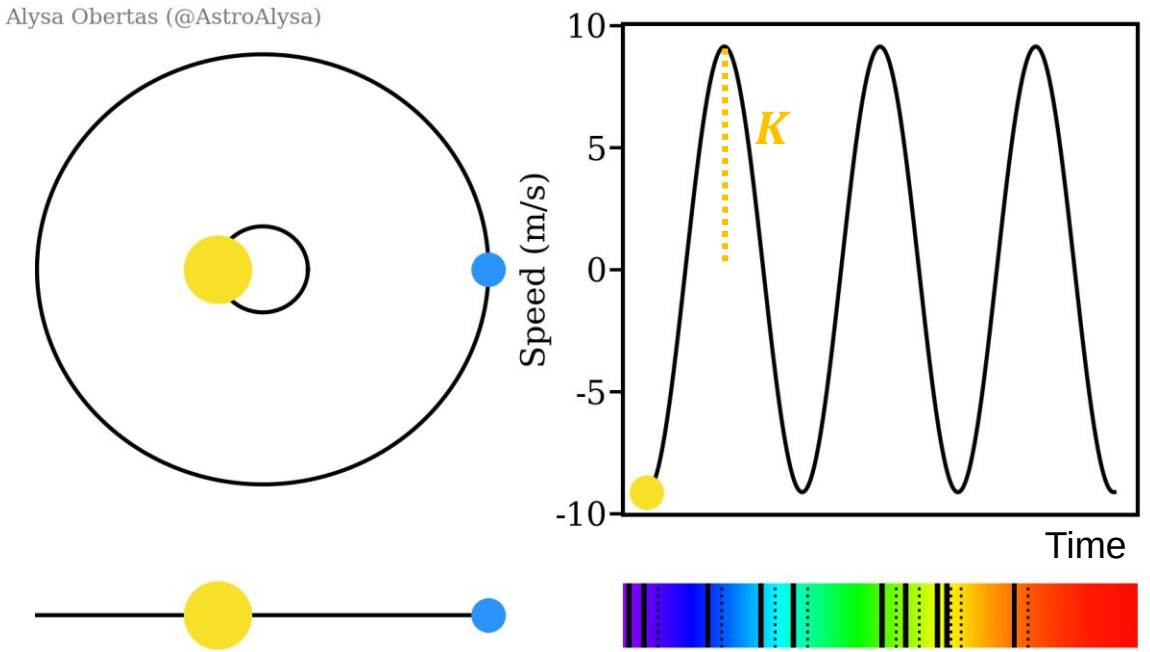
Radial Velocity Method

78 HARPS spectra

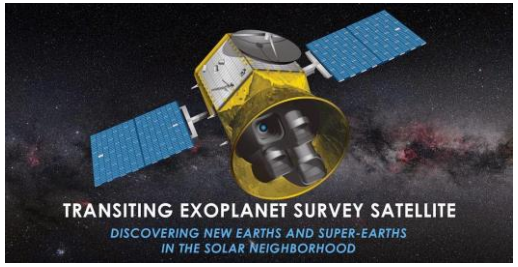
Radial velocity time series

Planetary mass determination





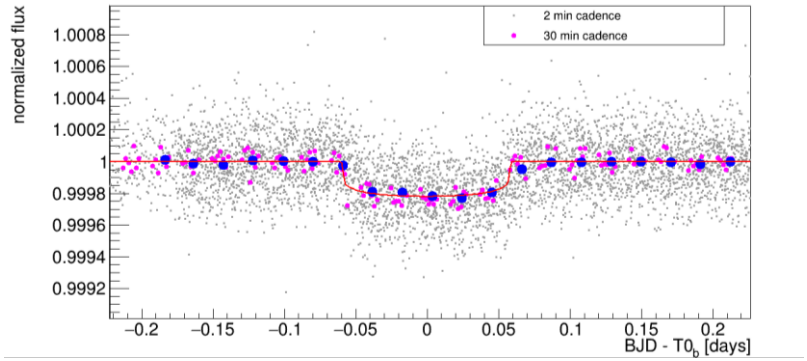
Transit Method

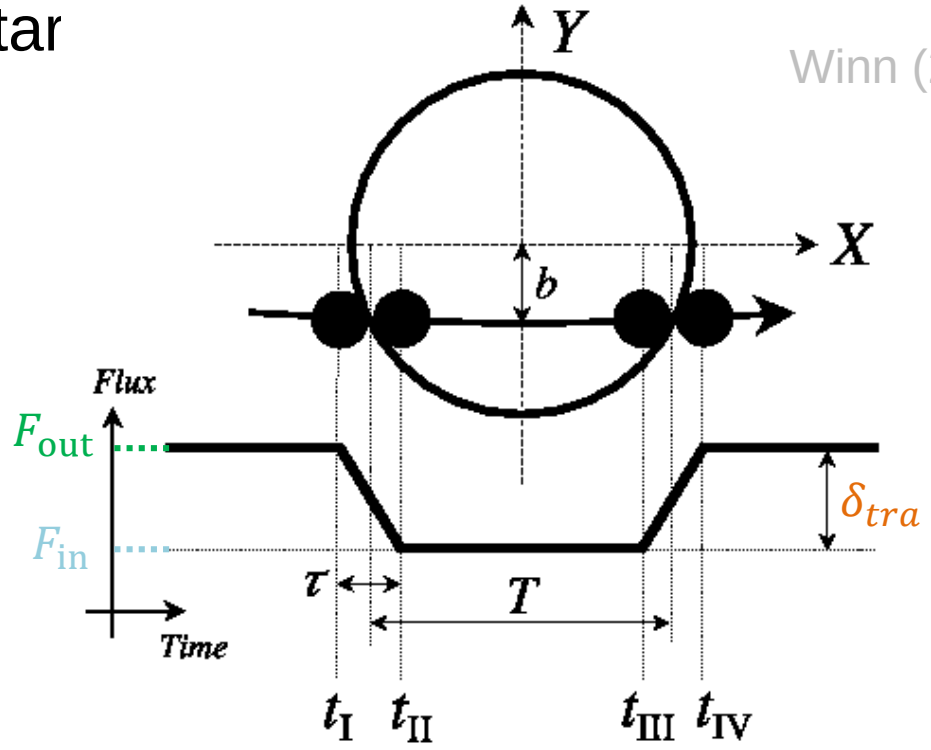


Periodic dimming of the brightness of the star as the orbiting planet transits in front of it

TESS transit observations

Planetary radius determination





Winn (2010)

Stellar Activity

Star spots, flares, faculae

↓

Correlation with stellar rotational period

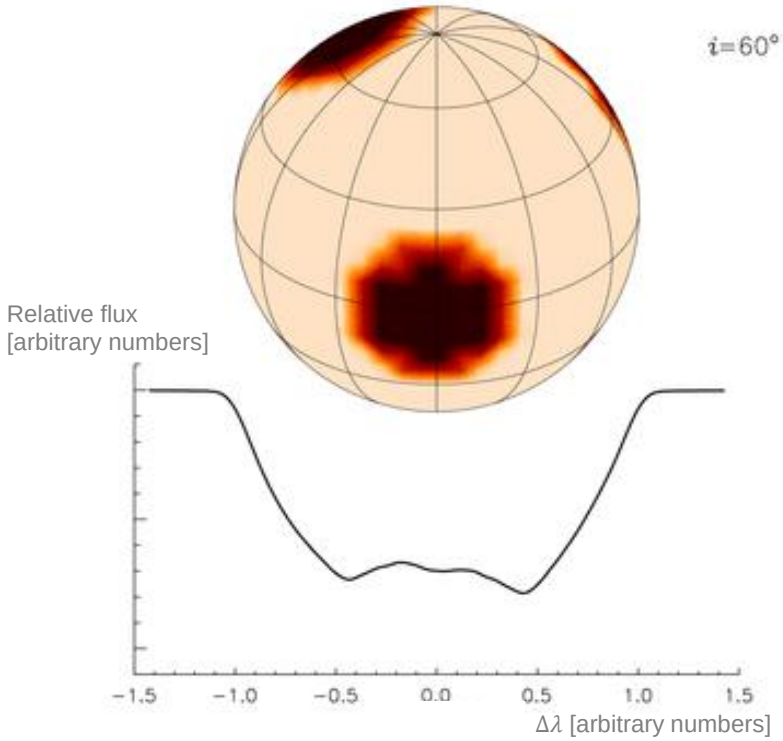
↓

Potentially masking a planetary signal

↓

RV detrending using break-point method

→ Stellar activity is not stationary



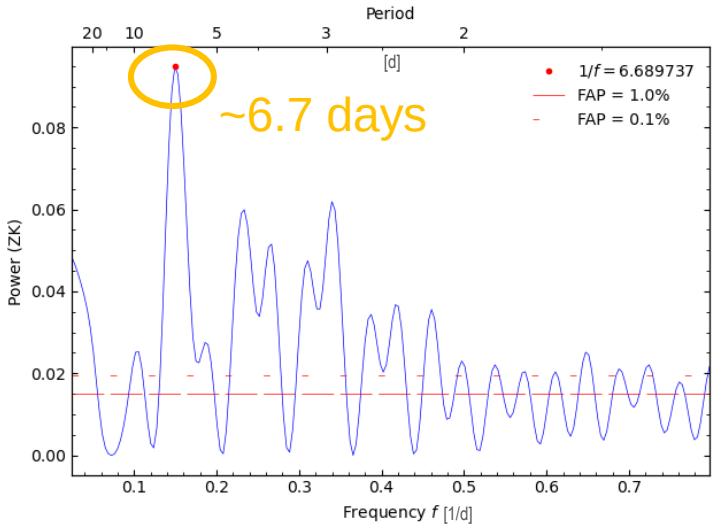
Axel Hahlin et al. (2018)

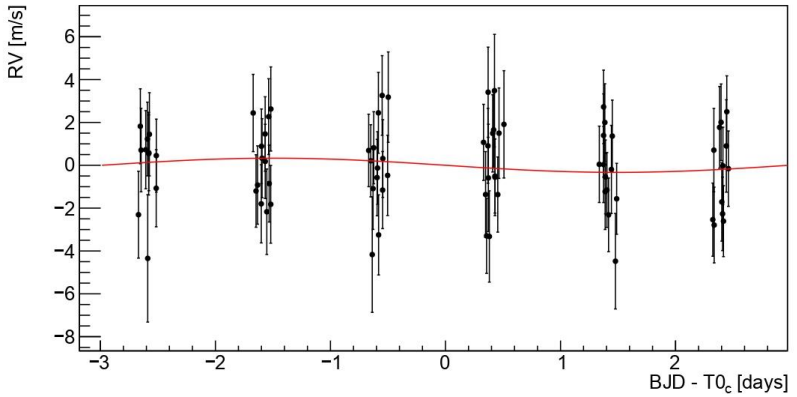
Stellar Activity

TOI-396 c RV signal is not statistically detected

Hypothesis: $P_{rot} \approx P_c$

Periodograms of activity indicators





Stellar activity covered the RV signal generated by TOI-396 c

Results

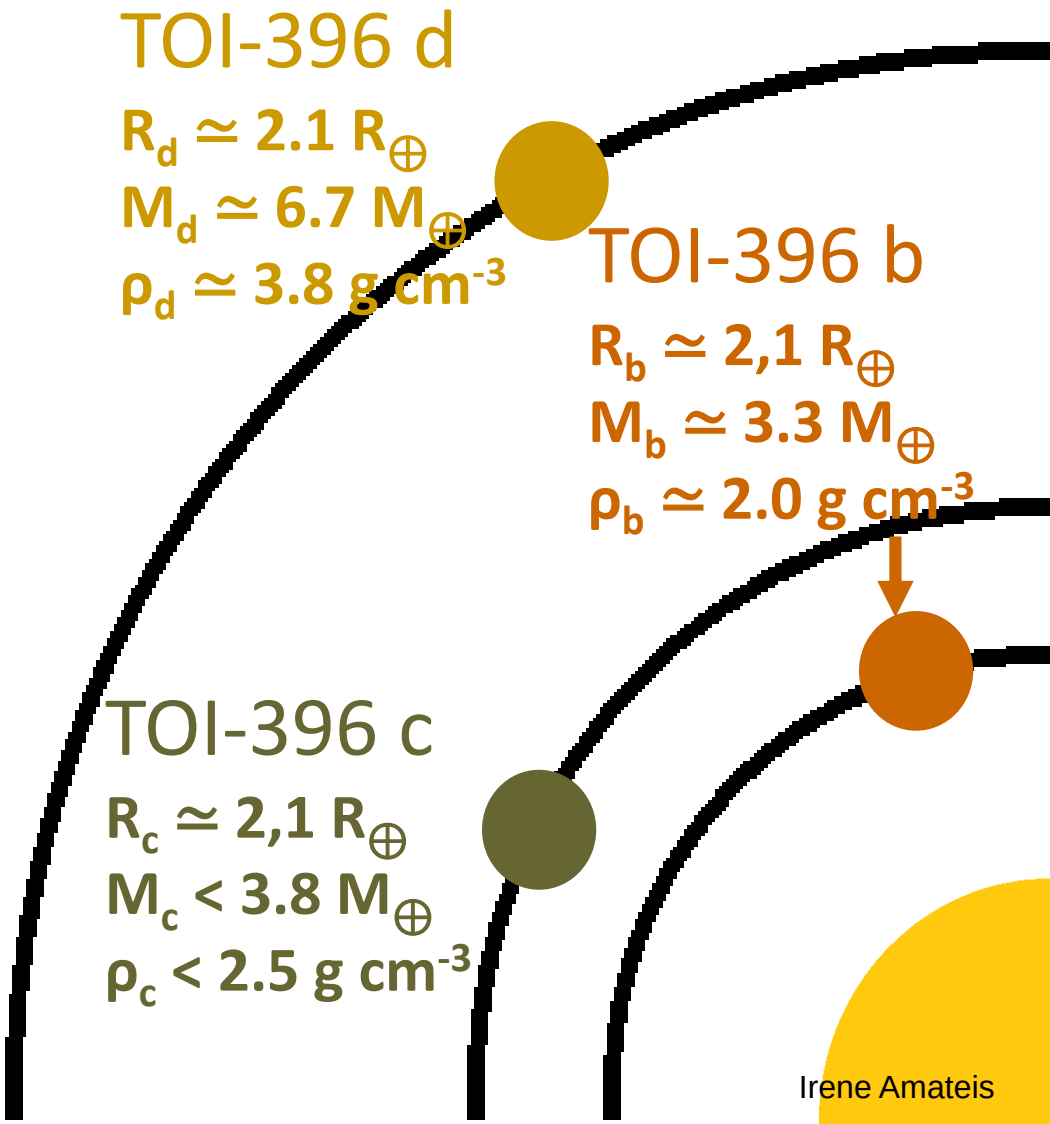
- Discovery paper: Vanderburg (2019)
  - ➡ Radii determination using transit method

- My work: Joint analysis of RV time series and transits using a Markov Chain Monte Carlo code (Bonfanti & Gillon, 2020)
  - ➡ Masses and radii determination

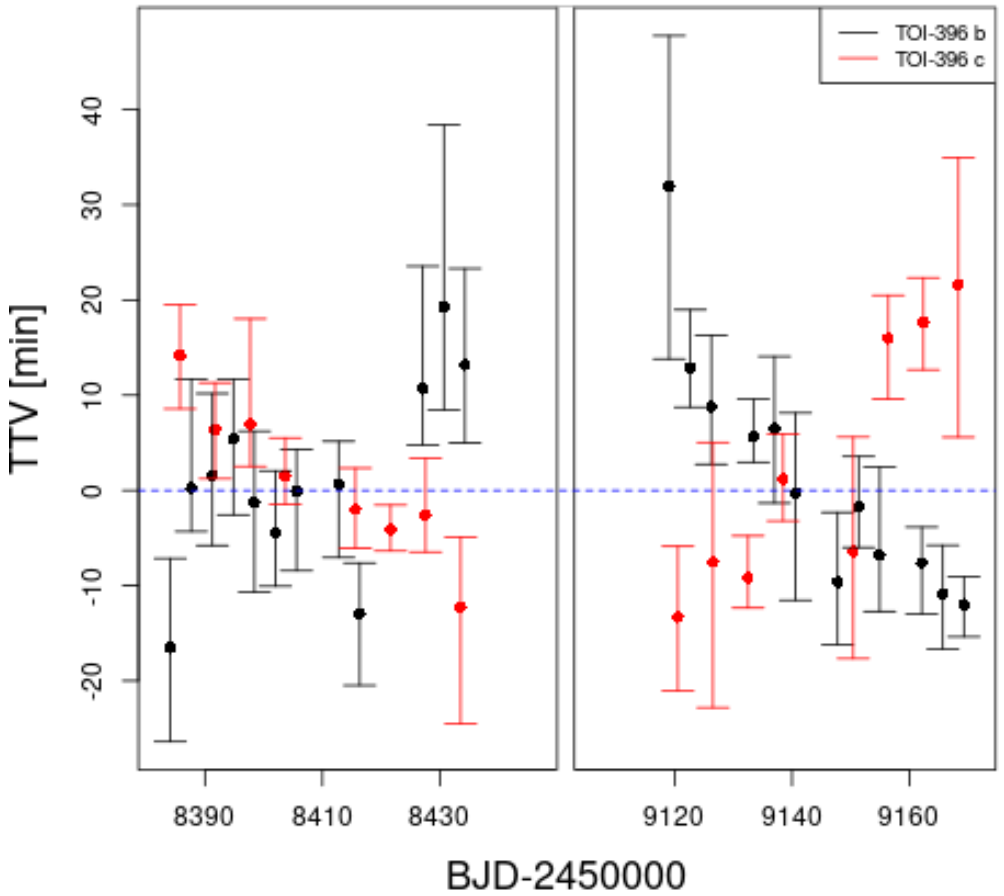
The Astrophysical Journal Letters, 881:L19 (11pp), 2019 August 10 https://doi.org/10.3847/2041-8213/ab322d

TESS Spots a Compact System of Super-Earths around the Naked-eye Star HR 858

Andrew Vanderburg[1,27], Chelsea X. Huang[2,28], Joseph E. Rodriguez[3,29], Juliette C. Becker[4,30,31], George R. Ricker[2], Roland K. Vanderspek[2], David W. Latham[3], Sara Seager[2,5], Joshua N. Winn[6], Jon M. Jenkins[7], Brett Addison[8],



Transit timing variations (TTV)



Anti-correlation pattern in TTV of TOI-396 b and c

Mean motion resonance

$$\frac{P_c}{P_b} \cong 1{,}666213 \approx 5:3$$

Proof that TOI-396 c orbits around TOI-396

Un unusual system

Atmospheric characterization needed

A paper on this thesis is the process of being submitted