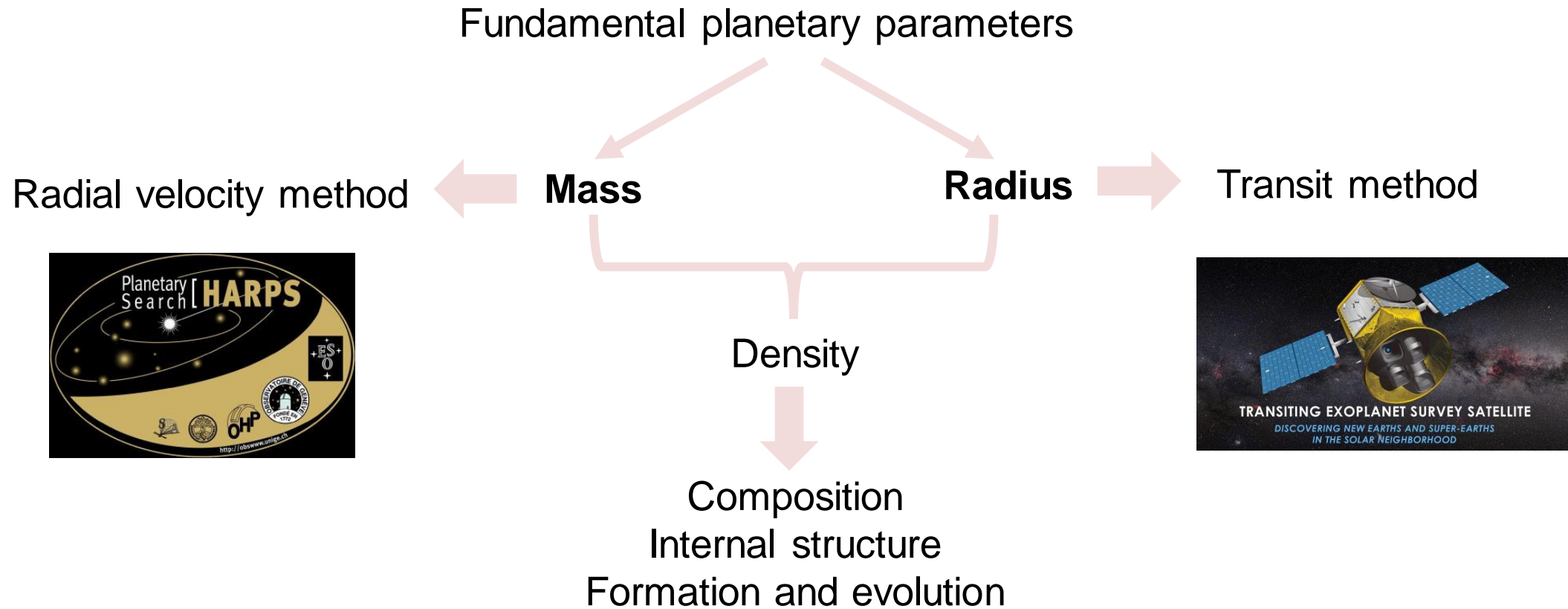


Planetary characterization in the presence of stellar activity. The case of TOI-396.

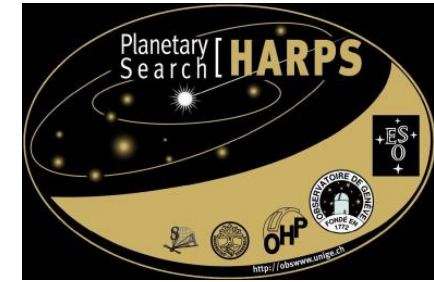
Irene Amateis

Master Degree in Astrophysics at University of Turin (Italy)
Master Thesis at The Space Research Institute in Graz (Austria)

The scientific case



Radial Velocity Method



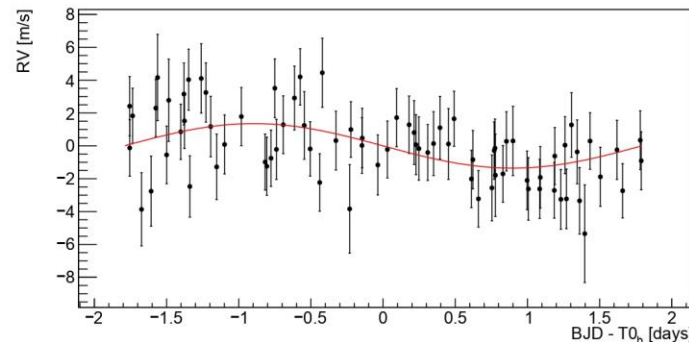
78 HARPS spectra



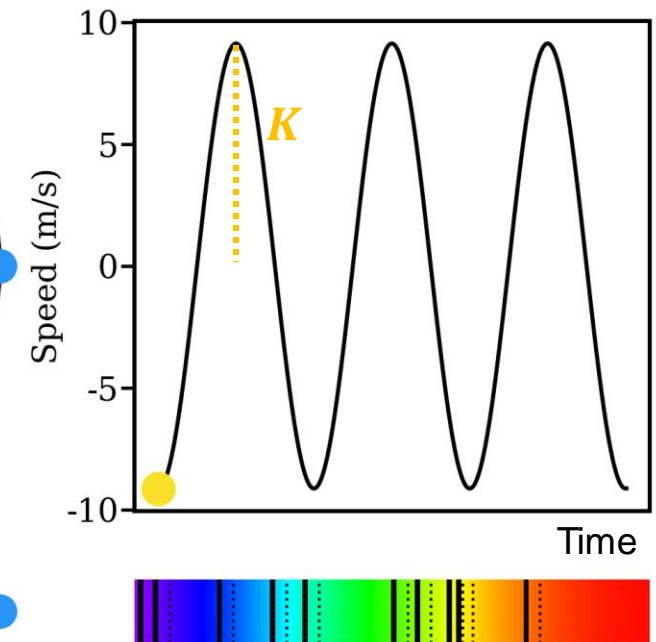
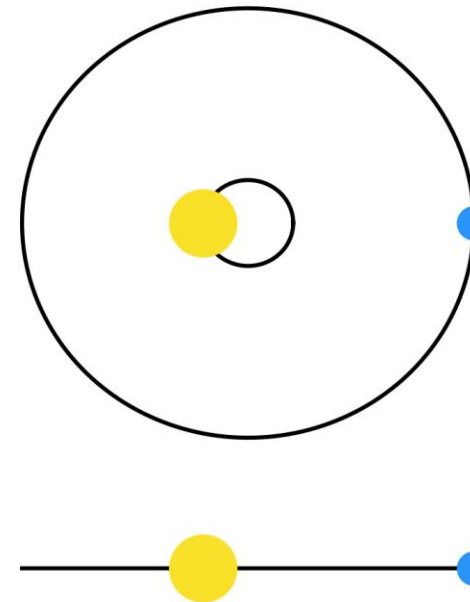
Radial velocity time series



Planetary mass determination



Alysa Obertas (@AstroAlysa)



Transit Method



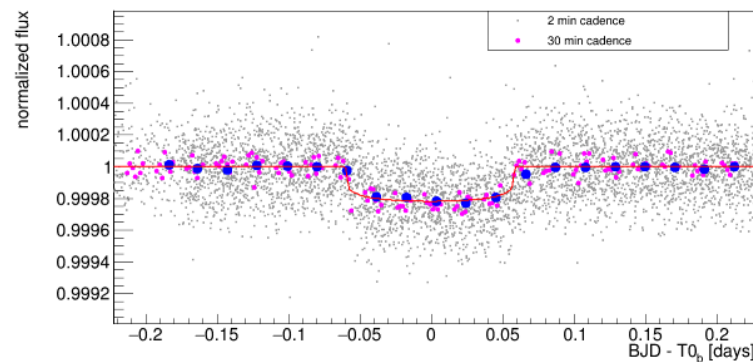
TESS transit observations



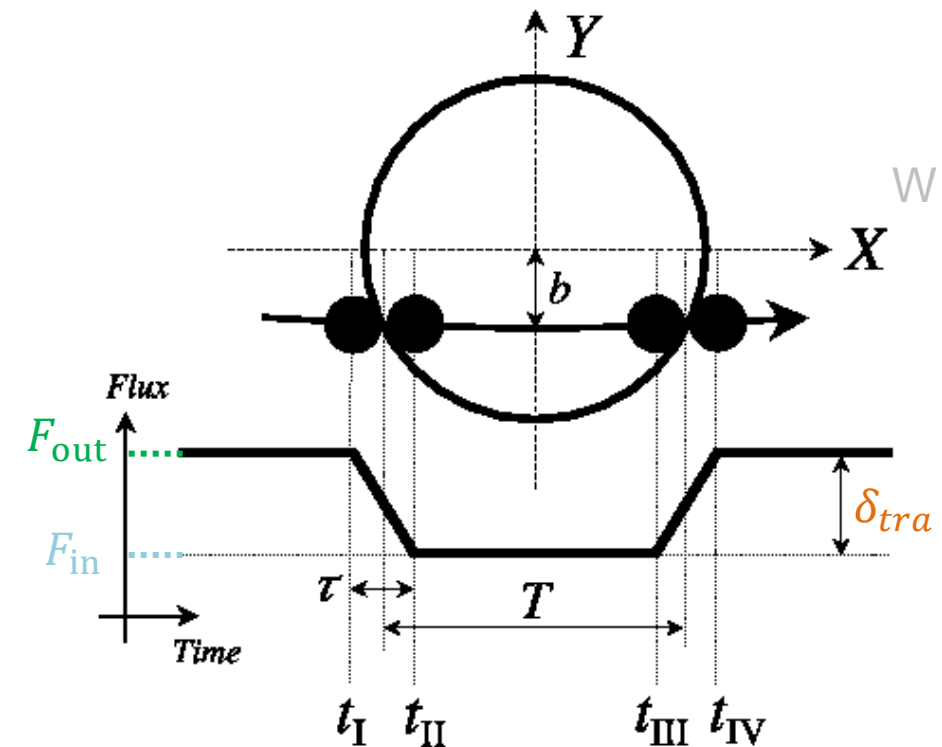
Light curves



Planetary radius determination



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



Winn (2010)

Stellar Activity

Star spots, flares, faculae



Correlation with stellar rotational period



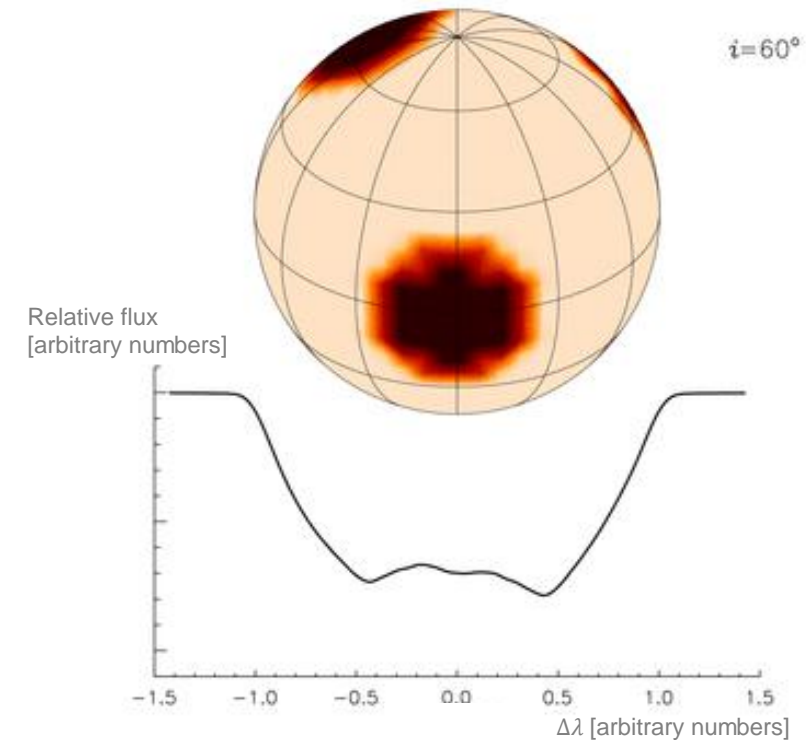
Potentially masking a planetary signal



RV detrending using break-point method



Stellar activity is not stationary



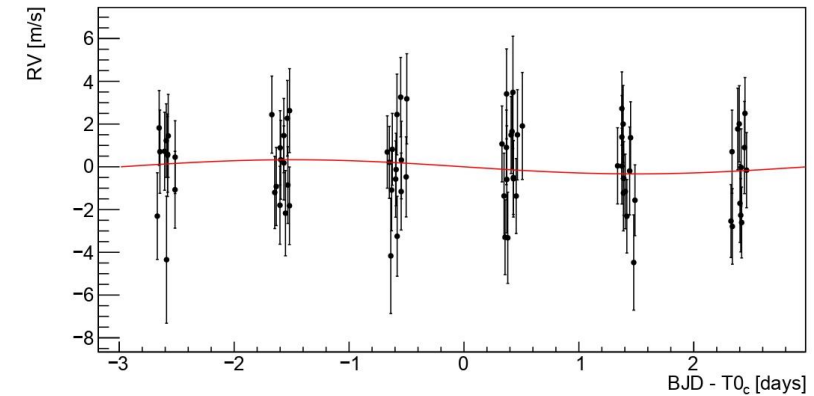
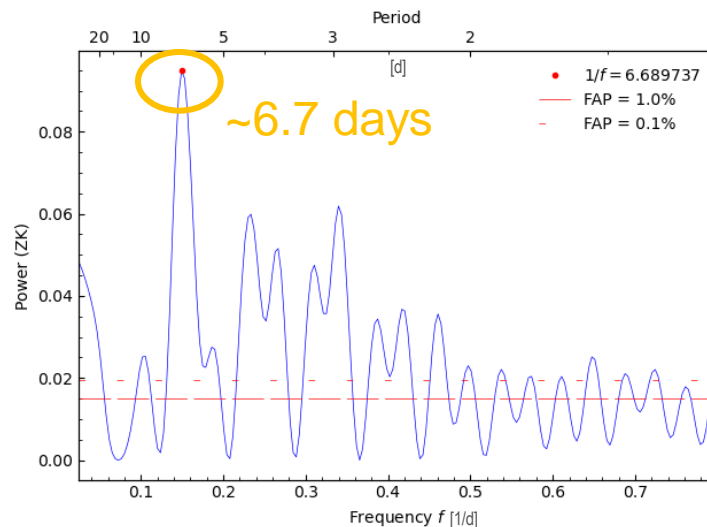
Axel Hahlin et al. (2018)

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

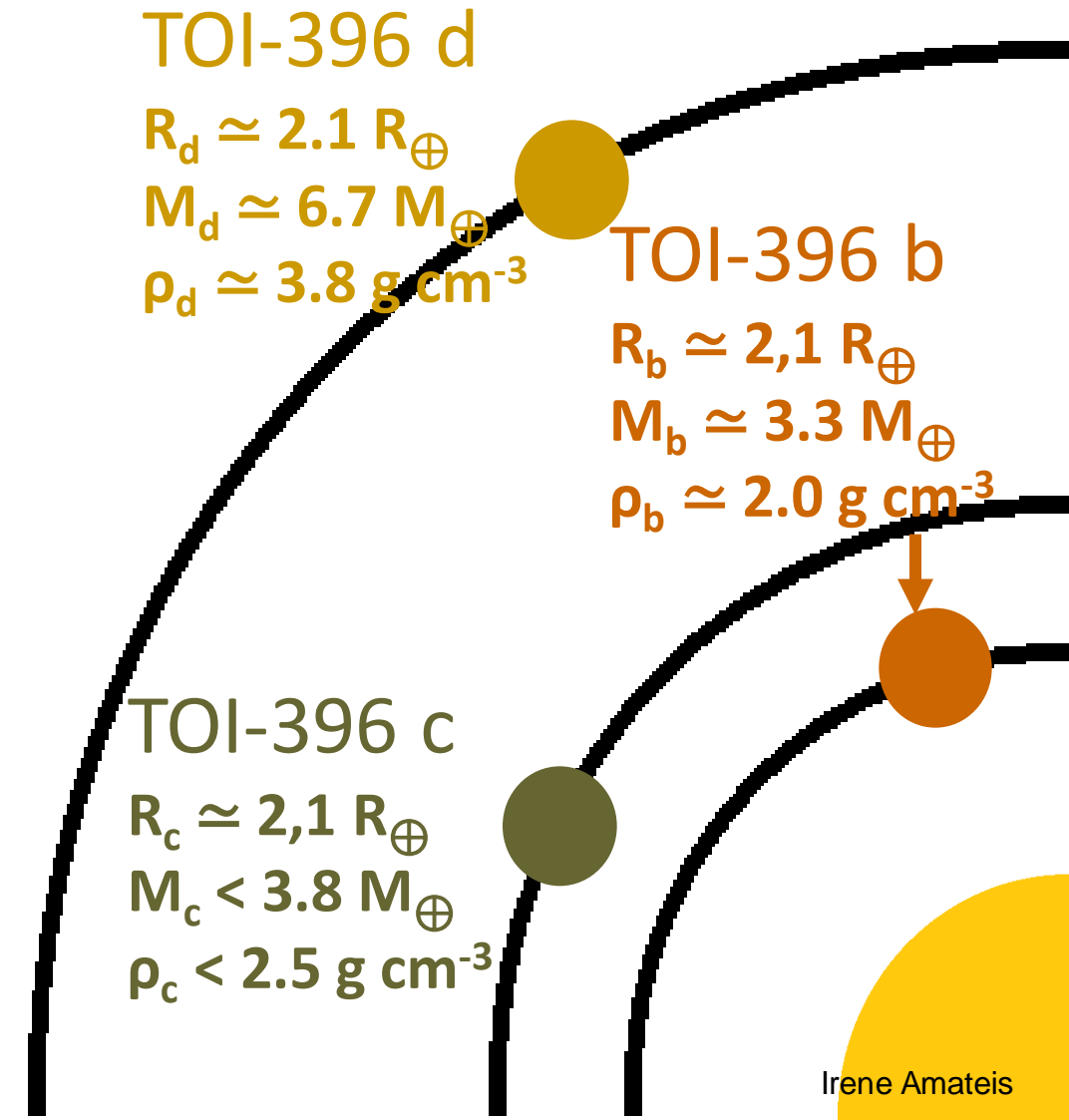
THE ASTROPHYSICAL JOURNAL LETTERS, 881:L19 (11pp), 2019 August 10
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<https://doi.org/10.3847/2041-8213/ab322d>

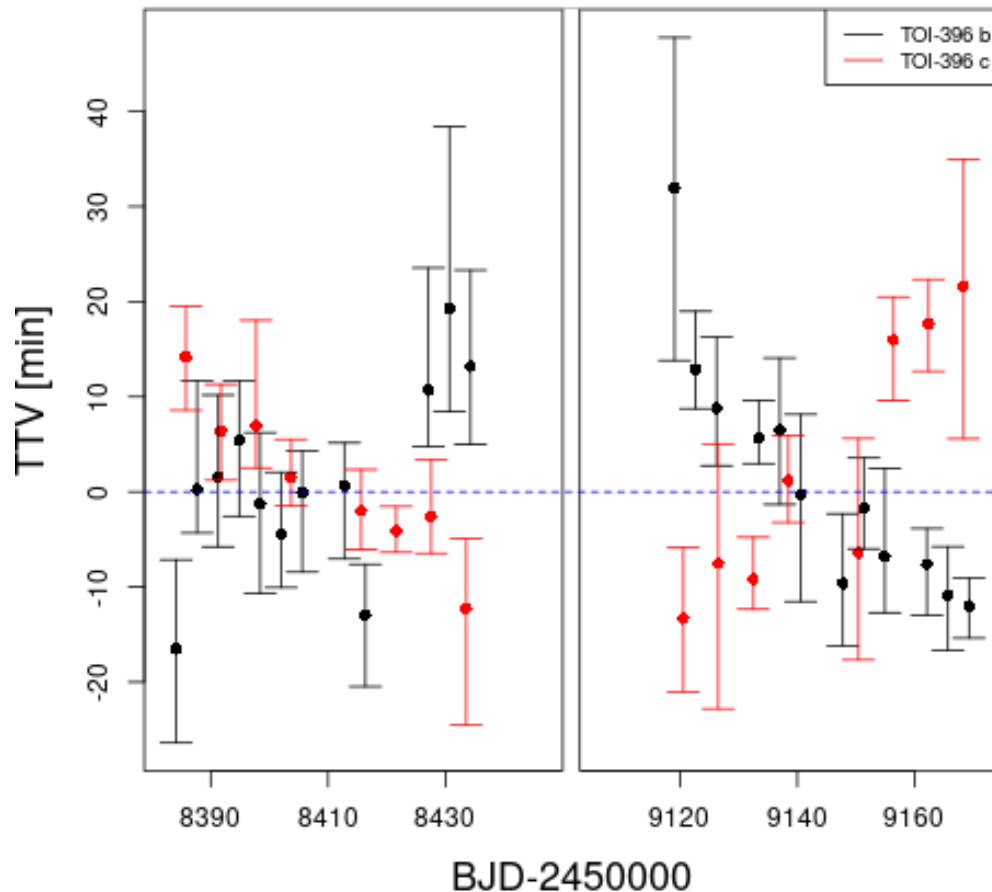


TESS Spots a Compact System of Super-Earths around the Naked-eye Star HR 858

Andrew Vanderburg^{1,27} , Chelsea X. Huang^{2,28} , Joseph E. Rodriguez^{3,29}, Juliette C. Becker^{4,30,31} , George R. Ricker², Roland K. Vanderspek², David W. Latham³ , Sara Seager^{2,5}, Joshua N. Winn⁶ , Jon M. Jenkins⁷ , Brett Addison⁸,



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

Comparison with known systems

The outer planet is denser than the inner planet

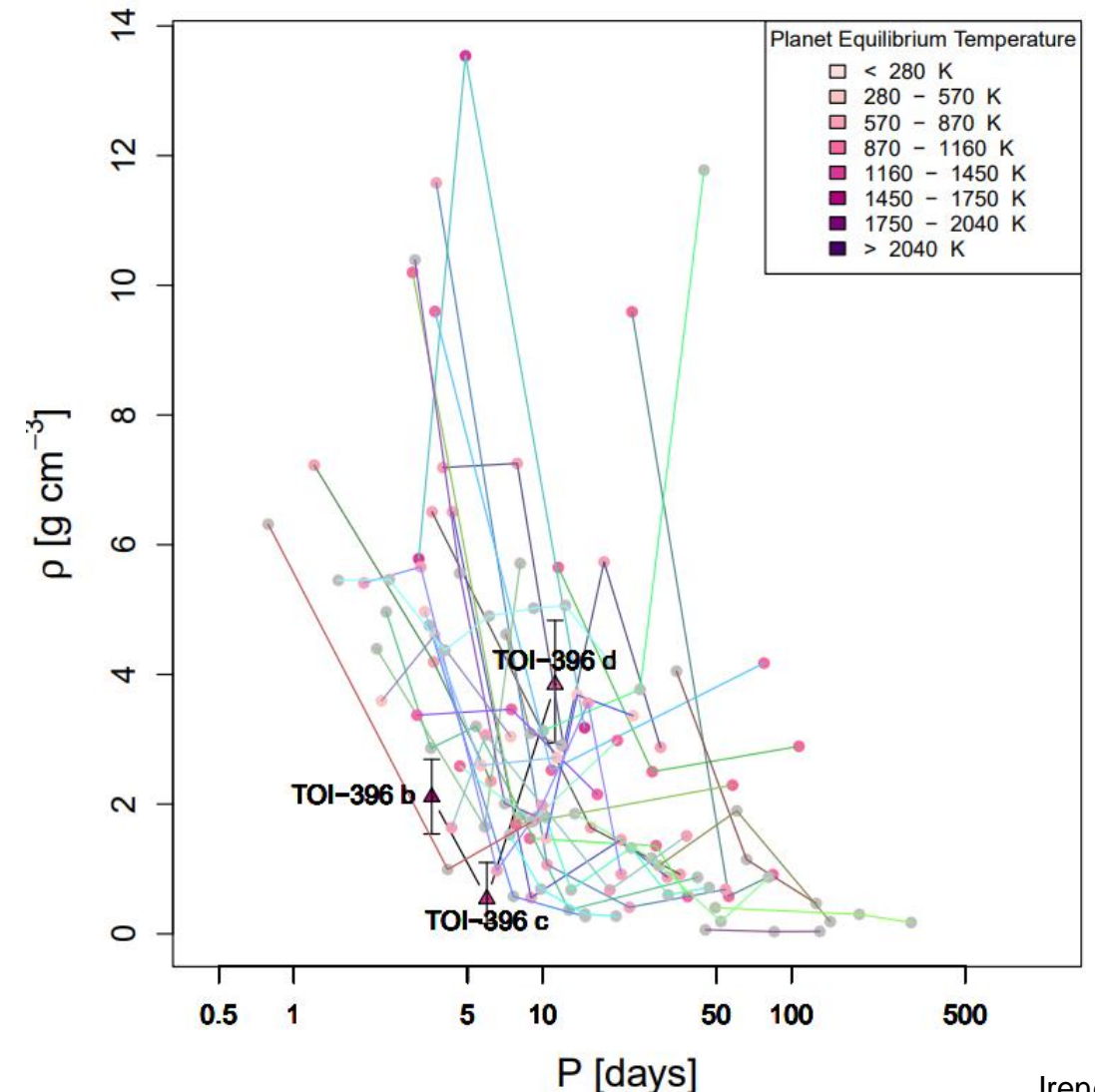


Unusual system



Atmospheric characterization needed

A paper on this thesis is the process of being submitted



Relevant Studies

“Element of Eliophysics and Space Weather” elective class

“Physics of the Matter in Fluids and Plasma state” elective class

Ground and space-based data analysis

Object-oriented programming in C++, Root (Cern)

R, Python

Experience in working in a research group