1. What is STOKED with TESS?

The Study Of Known Exoplanet re-Discoveries (STOKED) with TESS is a project aimed at the study of known transiting exoplanets observed by TESS. The project aims to perform a systematic study of known exoplanets observed by the mission in order to extract and interpret stellar and planetary atmospheric and bulk properties, along with updated ephemerides for the systems. The project is being led by Nestor Espinoza (MPIA) & Max Guenther (MIT).

2. What’s with limb-darkening and TESS?

Suppose you had to fit a transit lightcurve from TESS: how would you treat limb-darkening? Typically one parametrizes the effect through so-called limb-darkening “laws”, with the quadratic law (parametrized via two coefficients, \( u_1 \) and \( u_2 \)) being the most popular. Here you have to options: you either believe stellar model atmospheres and fix the coefficients to theoretical predictions or you fit those parameters directly along with the other transit parameters (see, e.g., Cizmadia et al., 2013; Espinoza & Jordan, 2015, 2016). Here fitted the limb-darkening coefficients for 70+ known exoplanetary systems observed by TESS and compared them to theoretical predictions obtained from ATLAS and PHOENIX model atmospheres. The results for the most precise data in our sample (for exoplanets that have data for multiple sectors) are already very interesting:

Empirical limb-darkening coefficients are consistent between sectors for exoplanets observed in multiple sectors (see e.g., WASP-126b in Figure 2). Results for a handful of the most precisely characterized systems in this work (which are targets with multi-sector data) already show an offset between theoretical and observed limb-darkening coefficients at least for PHOENIX model atmospheres (Figure 3).

3. Results for the 70+ analyzed systems?

Observed TESS limb-darkening coefficients are not well predicted by PHOENIX models (Claret 2017, below). Offsets exist, but are smaller for ATLAS models (Claret 2017, below).

4. What magic did you use to fit these TESS lightcurves?

Glad that you asked! We used juliet (Espinoza et al., 2018). This allowed us to take systematics present in TESS data into account in the errorbars of our retrieved transit parameters, as Gaussian Processes were simultaneously fit to the transit lightcurves along with the transit model. To check out the code, use the QR code below or check the project’s Github (http://www.github.com/nespinoza/juliet)!

References