Seismology and modeling of the bright, wide eclipsing binary, γ Persei

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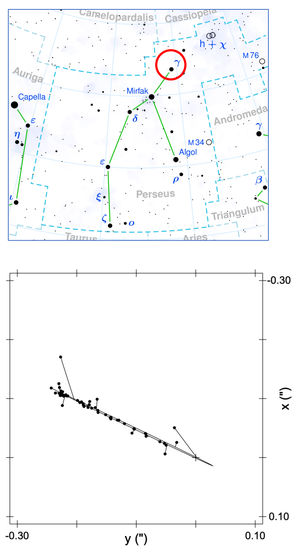
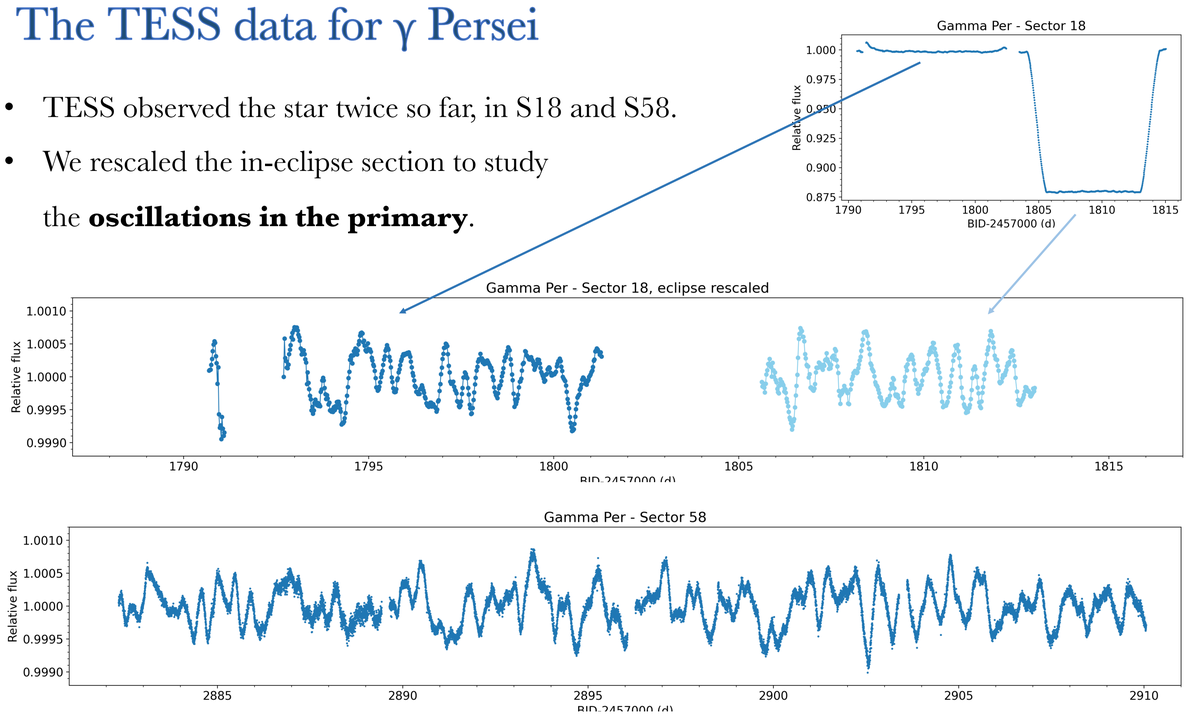
The γ Persei system

- 4th brithtest star in Perseus, V = 2.9 mag
- Visual + spectroscopic + eclipsing binary
- G9 giant + A3 dwarf with a period of **14.59 years**
- So far only two primary eclipses have been observed, one in 1990 and one in 2019. The 2005 eclipse was not observed.
- **Primary might be a merger product?**
  - Indications based on isochrone fitting
- Visual orbit by Pourbaix (1999):

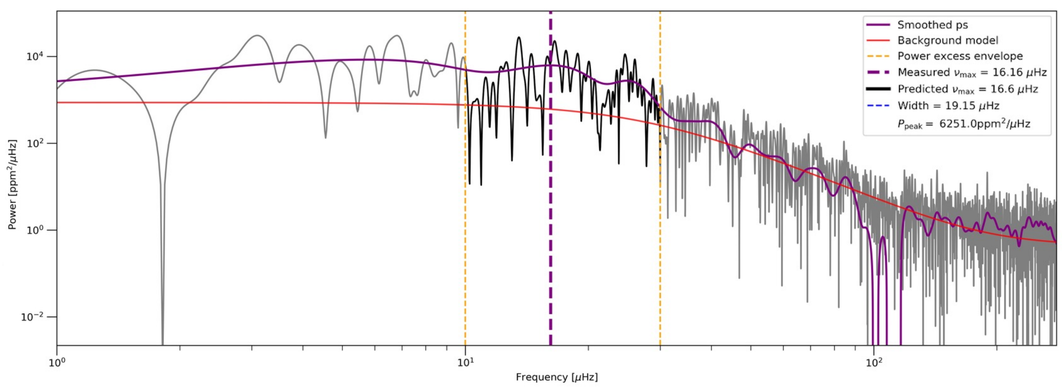


The TESS data for γ Persei

- TESS observed the star twice so far, in S18 and S58.
- We rescaled the in-eclipse section to study the **oscillations in the primary**.

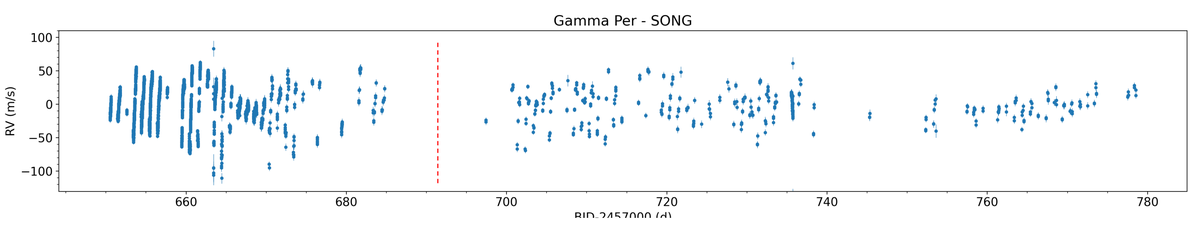


- We used pyMON, a modified version of pySYD, written by Madeline Howell (Monash University) to estimate ν_{max} from the S58 data.
- **ν_{max} ≈ 16.6 μHz, which gives a mass estimate of 2.5 ± 0.2 M_{Sun}**
- However, the lightcurve is very short, and these values might be too low (relative to the binary model), influenced by long mode lifetimes.



The SONG data for γ Persei

- The star was observed with the SONG telescope between October 2016 – January 2017 from Tenerife. The first month of data is densely sampled, the rest is sparse, with few RV points per night.
- The first part of the data is dominated by a beating pattern. We think that this is caused by **two nearby modes excited temporarily simultaneously to high amplitudes**.



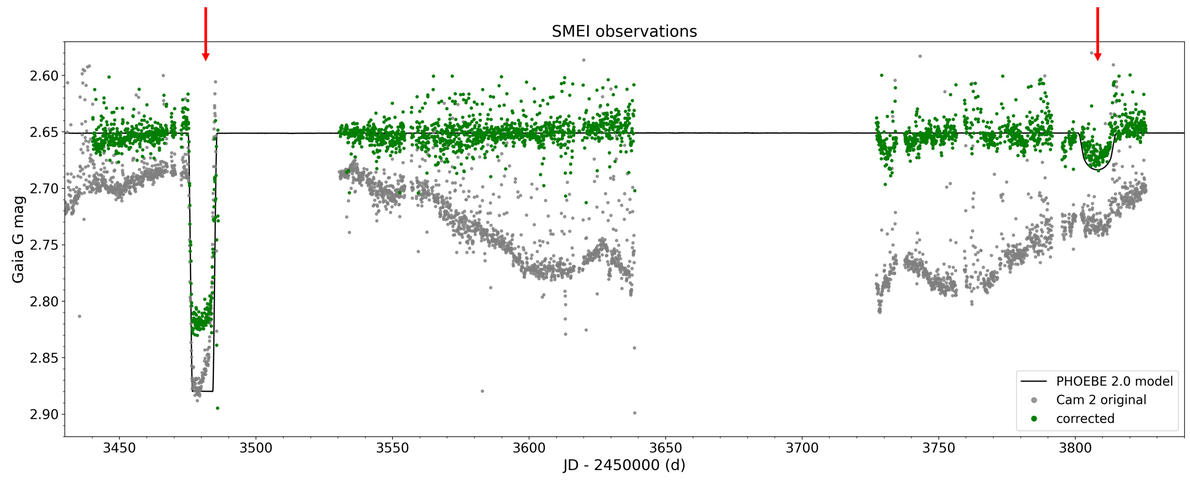
Light blue: PSD of the dense section. Note daily aliases. Red: high-amplitude beating modes. Blue: Residual PSD after removing the beating modes. Here ν_{max} closer to 20 μHz?

The SMEI data for γ Persei

- SMEI was an instrument with three cameras scanning the sky to track Coronal Mass Ejections on the Coriolis satellite. They had to remove the bright stars from the images, which resulted in a byproduct of quasi-continuous (but limited precision) photometry between 2003-2011.
- We calibrated the photometry to approximate Gaia G-band brightnesses.
- We corrected for the slow and fast systematics by determining the common annual variations outside the main eclipse.

The 2005 eclipse happened too close to the Sun - this is the first clear observation of it:

Secondary eclipses were never observed before. This dip matches our models:

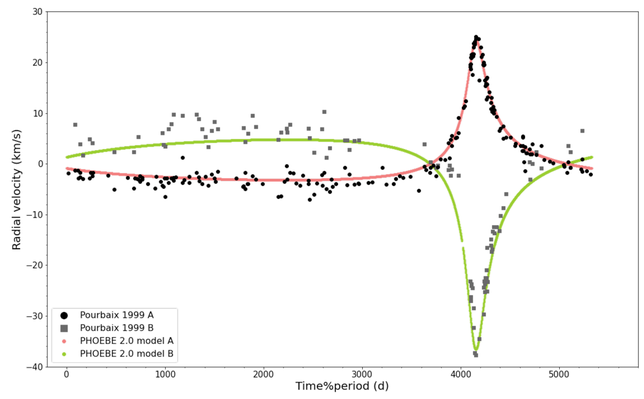


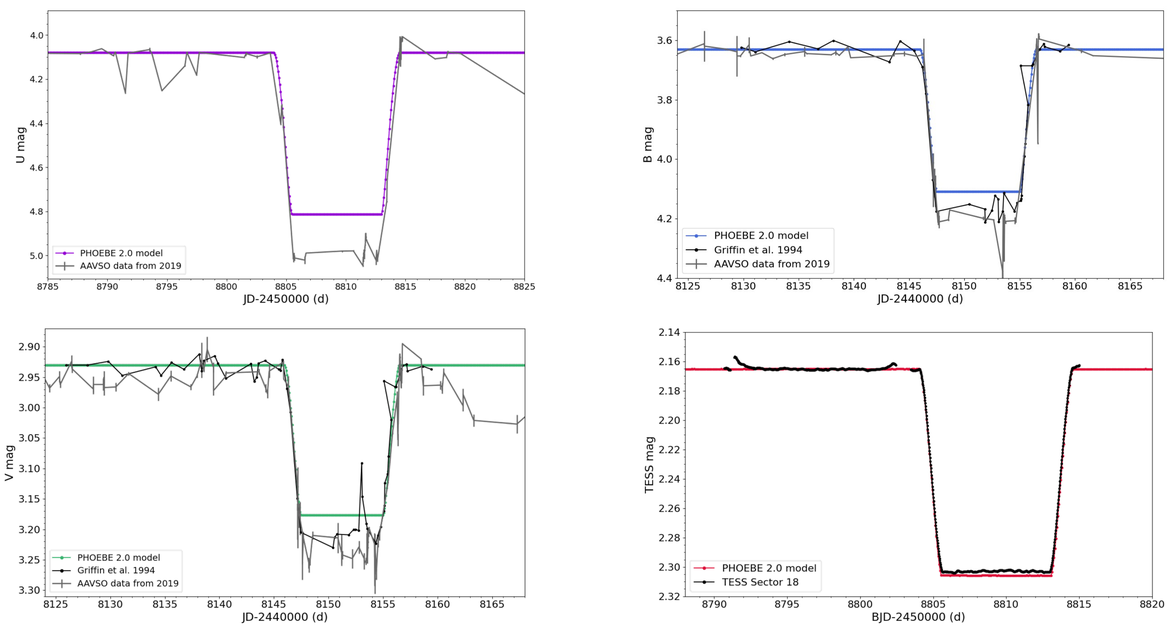
We detected the 2005 primary eclipse, and detected a secondary eclipse of the system for the first time, based on our PHOEBE models.

PHOEBE 2.0 models for γ Persei

- We calculated binary models for the system with the PHOEBE 2.0 code. For this, we used physical parameters published by Diamant et al. (2023).
- We used historic RV data for the orbit (Pourbaix, 1999). For the eclipses, we used the TESS light curve, plus observations from 1990 (Griffin et al. 1994) and 2019 (AAVSO).
- We identified the location of the secondary eclipse based on these models.

We adjusted some of the parameters to fit the RV data and the eclipses better. In this model, **the mass of the primary and secondary are 3.3 M_{Sun} and 2.2 M_{Sun}.**





The models are fitted to the TESS eclipse curve. While the length and geometry of the model eclipse, the depth don't fit perfectly in every passband, so further improvements are needed. **TESS will observe γ Per again in S85-86**, hopefully giving us better seismic constraints for the system.

References and acknowledgements

Diamant, S.J.M., 2023, A&A, 674, A162
Griffin, R.F. et al. 1994, IAPPP, 57, 31
Pourbaix, D., 1999, A&A, 348, 127

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