PTFO 8-8695: Two Stars, Two Signals, No Planet

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PTFO 8-8695 (CVSO 30) is a star in the 7-10 million year old Orion-OB1a cluster that shows brightness dips that resemble planetary transits[1]. Although strong evidence against the planet hypothesis for this system has been presented[2,3], the possibility remains debated in the literature[4,5,6]. To obtain further clues, we inspected data from the NASA TESS and the ESA Gaia missions. The Gaia data suggest that PTFO 8-8695 is a binary: the photometric data show it to be over-luminous with respect to members of its kinematic group, and the astrometric data are inconsistent with a single star. The TESS light curve shows two different photometric periods. The variability is dominated by a sinusoidal signal with a period of 11.98 hr, probably caused by stellar rotation. Also present is a 10.76 hr signal consisting of a not-quite sinusoid interrupted by hour-long dips, the type of signal previously interpreted as planetary transits. The phase of the dips is nearly 180° away from the phase of the originally reported dips. This makes the dips difficult to explain as planetary transits. Instead, we believe that PTFO 8-8695 is a pair of young and rapidly rotating M dwarfs, one of which shows the same "transient-dip" behavior that has been seen in at least 5 other cases (Figure 1). The origin of these transient dips is still unknown but likely involves circumstellar material[7,8,9]. Combined with recent counter-arguments[10,11] against the planetary nature of CI Tau b and V830 Tau b, the rejection of the planetary hypothesis for PTFO 8-8695b suggests that the number of known hot Jupiters younger than 100 Myr is approximately[12] zero.

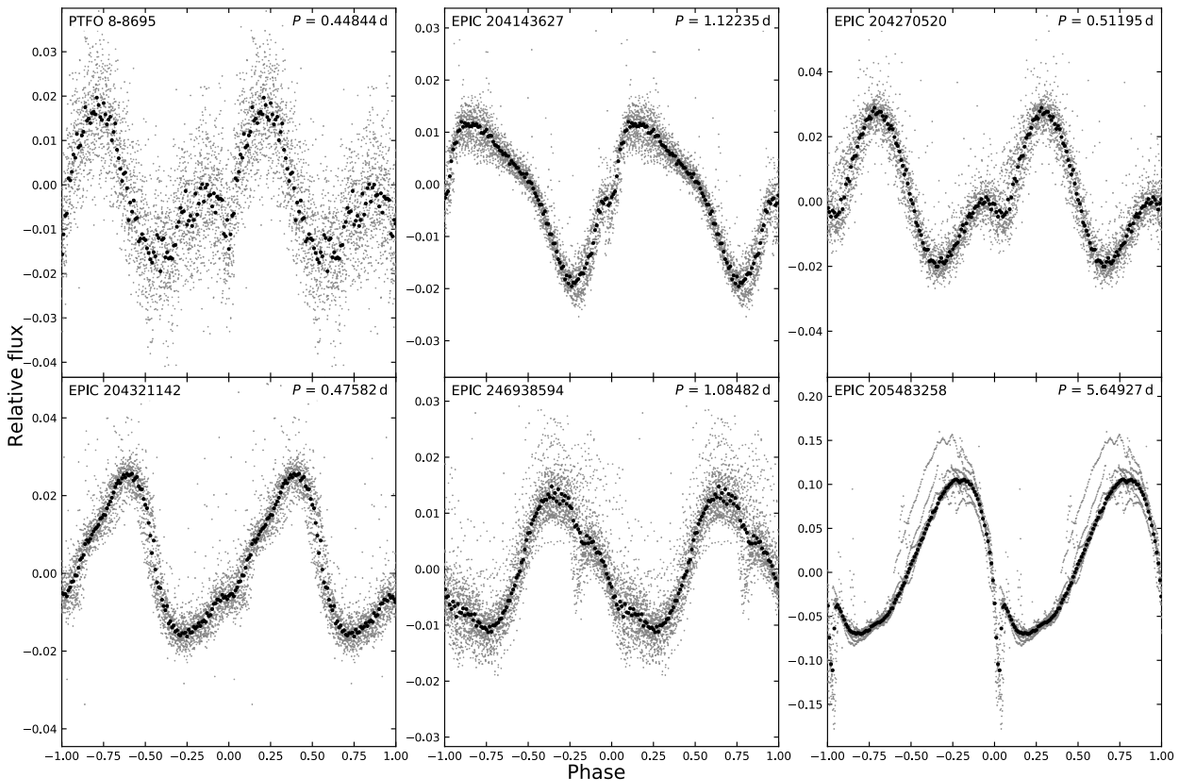

Figure 1. PTFO 8-8695 and its brethren. Top left is the TESS light curve of PTFO 8-8695 phase-folded at 10.76 hours, after subtracting the dominant 11.98 hour signal from the other star in the system. The other five panels show K2 light curves of 5-100 Myr old M dwarfs that show similar variability.

References & footnotes. [1]van Eyken+12. [2]Yu+15. [3]Onitsuka+17. [4]Ciardi+15. [5]Johns-Krull+16. [6]Tanimoto+20. [7]Stauffer+17. [8]Rebull+18. [9]Zhan+19. [10]Donati+20. [11]Damasso+20. [12]Rizzuto+20 recently found a 17 Myr old 0.9R_{Jup} planet with a 7 day orbital period; its mass will reveal whether it is the first clear counter-example.