Referee Report

Reviewer's Comments:

The authors present a number of new and high-quality transit observations of the hot Jupiter WASP-4b observed by TESS. After comparing the predicted mid-transit times (obtained only considering the pre-existing transits in the literature) with the measured values from the TESS light curves, the authors conclude that the TESS transits occur ~ 82 seconds earlier than predicted. They examine different possibilities and find that the 2 most favored scenarios to explain this deviation are orbital decay and apsidal precession. However, the authors caution that more observations are needed to confirm these results. Also, they redetermine various parameters of the system, finding them in general agreement with literature values.

In general, the manuscript is scientifically accurate and the results presented in it certainly will be of interest to other investigators in the field. Then, I consider this paper worthy of being published after the concerns described below be addressed.

Below are my comments, beginning with the major points. I recommend the authors take them into consideration when revising their manuscript.

-- Major points:

1) In section 3.1, the authors claim "..We included data from peer-reviewed literature for which the analysis was based on observations of a single, complete transit,...". However, the transits listed in Table 2 corresponding to the epochs E=-827 (ttra= 2454697.79817; Winn et al. 2009), E=-804 (ttra= 2454728.57767; Hoyer et al. 2013), E=-537 (ttra= 2455085.88418; Dragomir et al. 2011), E=-208 (ttra= 2455526.16356; Ranjan et al. 2014) are incomplete light curves, and those from the epochs E=-795 (2454740.62125; Hoyer et al. 2013), E=-251 (2455468.61943; Hoyer et al. 2013) and E=21 (2455832.61815; Hoyer et al. 2013) present scarcity of after ingress/before egress data-points. On one hand, given that several partial light curves have been included in their study, the use of the word "complete" to indicate the characteristics of the transits in their sample, must be avoided.
On the other hand, at least two other transits included in their sample show visible anomalies, probably produced by the pass of the planet in front of one or several cold spots during transit (E=-561, ttra=2455053.76774 and E=-526, ttra=2455100.60595, both from Sanchis-Ojeda et al. 2011). Different studies have proven that mid transit-times measured from partial light curves (Sada et al. 2012, Barros et al. 2013, Nikolov et al. 2015, Mancini et al. 2018) or light curves with anomalies due to the presence of spots (Oshagh et al. 2013, Mazeh et al. 2015, Ioannidis et al. 2016), usually present larger uncertainties and untrustable values. Taking in consideration the conclusions of these previous works, it is possible that the exclusion of incomplete/with anomalies transits might affect the outcome of their analysis and conclusions, particularly with respect to orbital decay and apsidal precession. Then, in order to warrant confident results, I would like to see the same analysis but without including partial transits or with visible spot-crossing events on them.

2) As mentioned in 1), another possible interpretation for explaining the deviation from a linear ephemeris of the TESS mid-transit times could be the presence of anomalies in the light curves due to stellar activity. It has been well established that WASP-4 is an active star with a rotation period (P) in between 20-40 days (P ~ 22 days and P ~ 34 days were determined by Sanchis-Ojeda et al. 2011 and Hoyer et al. 2013, respectively), which is expected for a main-sequence G7 star. Given that the TESS mid-transits span around 30 days, wouldn't it be possible that these measurements be affected by the existence of unseen stellar spots? Regarding this point, I would like to

see an extra paragraph in the Section "Interpretation" with a discussion about this scenario.

-- Minor points:

0. TITLE:

i) As it is, the title implies a very strong asseveration. It would be more appropriate "Possible Early Arrival of WASP-4b for the TESS Mission" or something similar.

1. INTRODUCTION:

i) Please, include here a reference for TESS.

2. NEW TRANSITS AND SYSTEM PARAMETERS:

Section 2.1:

i) It could be informative to provide a reference for the "Deep Space Network".

ii) barycentric Julian date --> Barycentric Julian Date

iii) For the casual reader, it would be important to briefly specify what "Threshold Crossing Events" means, and what the flags "Reaction Wheel Desaturation Event" and "Manual Exclude" represent. Footnotes including this information would be appropriate. Also, could the authors describe what a "Presearch Data Conditioning" lightcurve is?

iv) It might be worthwhile to mention what "ramp-like systematic effects" are and also include a reference.

v) It would be important to include in this section an explanation of how photometric data-point errors are estimated.

Section 2.2:

i) Could the authors explicitly indicate, in the first paragraph, the number of transits observed by TESS finally used to create the phase-folded light curve? Furthermore, the manuscript would be more readable if the main text refers first to Figure 1 instead of Figure 2.

ii) The authors say that the phase-folded lightcurve was fitted by using the implementation of Kreidberg (2015) of the analytic model of Mandel & Agol (2002). Is this referring to the BATMAN code? If it is so, It would be good to mention the code's name in the text. Also, I would appreciate if, in the main text, the authors clarify from which source are the values used as initial photometric parameters (planet to star radius ratio, orbital distance to stellar radius ratio, inclination, etc). On the other hand, for highlighting the results obtained with TESS data, it would be important to visualize all the transit parameters derived from section 2.2 in an independent table. Furthermore, to see the agreement between the transit parameters reported in previous studies and those resulting from this work, it would be useful to present together the values obtained in both cases.

iii) In the caption of Figure 2, it would be important to specify which is the bin size used to determine the yellow points. Furthermore, in Figure 2, the photometric error of the unbinned data-points should be included.

iv) To estimate transit times for each individual lightcurve, did the authors use the same code as for the phase-folded light curve? In this case, how were

the mid-transit times' uncertainties determined?

v) Is χ^2=9.2 the reduced chi-square? If it is so, It should be clarified by using a different symbol or by adding a sub-index, for example. Please, fix this in the rest of the manuscript when necessary.

vi) χ^2 = 16 {plus minus} 5.7 --> χ^2 = 9.2 {plus minus} 5.7

vii) The note at the end of Table 2 explains what the parameter sigmat0 represents, but it's not clear which is its relation with the mid-transit times' measurements presented in the same table.

Section 2.3:

i) The authors should include the references for each of the mentioned catalogs and also for the Yonsei Yale isochrones.

ii) How did the authors estimate the errors of the stellar and planet parameters?

3. TIMING ANALYSIS

Section 3.1:

i) The sentence "..Since those data points carry significant weight in the analysis, we checked that the timestamps in their data represent mid-exposure times, that the barycentric correction was performed correctly, and that the time system of the final results was BJD(TDB).." is confusing, because seems to imply that these checks were only performed on the Huitson et al. mid-transit times and not in all the literature mid-transit times. It would be recommendable to clarify this point.

ii) Could the authors specify what is the meaning of each of the variables in Equation (1)?

Section 3.2:

i) How did you fit the mid times of the preTESS measurements? Did you use a weighted least-square fit?

ii) Figure 3:
I would recommend changing the "title" indicated in bold font in the caption, by a more explicit sentence about what is shown in the plot. To give an example, a possibility could be "Observed minus predicted mid-transit times".
Also: ii-1) In the legends of both panels, could the authors specify which is the bin size of the TESS light curves? (Please, fix this in all the manuscript).
ii-2) "The red band shows the average deviation of the TESS transits,..." --> "The red band shows the average deviation of the TESS transits {plus minus}1σ,..."

iii) It would be important to introduce references for equations (4) and (5). Also, for the casual reader, It might be informative to give a brief explanation of what sidereal and anomalistic periods are.

iv) Figure 4: In the caption, could the authors explicitly indicate what the plot shows in each of its panels (top and bottom)?

v) Similar to i) How did you fit the mid-transit times and occultations shown in Figure 4?

vi) In the caption of Table 4, please be more explicit, "Best-fit model parameters" of what?

vii) Given that the mid-transit times values used in this work are taken from different authors with different methodologies to perform the fitting and detrending of the light curves, could the authors mention how this could affect their results?

4. INTERPRETATION

Section 4.1:

i) First line: The word "caused" is repeated twice.

ii) In the caption of Figure 5 should be indicated what open circles represent.

iii) The characteristic timescale value calculated in equation (13), is it computed by considering a theoretical dP/dt value or from the one estimated through the observations?

iv) The authors mention that there are about 20 Hot Jupiters for which the theoretical timescale is shorter, where are the timescale values obtained from? Are they estimated from equation (13)? If this is the case, how do the theoretical dP/dts are computed?

v) In the top panels of Figures 4 and 6, the orbital decay model evolution shows that at the beginning the O-C values increase until, at some point, they reach a maximum and after that, they start decreasing. What is the physical explanation for that behavior? If the orbital period is diminishing, wouldn't it be expected to see only a decreasing in the O-C values? Why the O-C values would increase at these first epochs?

Section 4.2:

i) It might be informative to explicitly include the equation (14) of Ragozzine & Wolf (2009) to see of which parameters is depending on.

ii) Similar to Figure 3, I would recommend changing the title indicated in bold font in Figure 6, by a more explicit sentence about what is shown in the plot. For eample "Different apsidal precession and orbital decay models for the O-C values" or something like that.

iii) Mb is indicated as the mass of the hypothetical planet WASP-4c, however, the Mb symbol is not present in equation (19).

iv) Why do the authors assume k2b = 0.6 for the Love number? Is this value randomly chosen?

v) Would it be possible to introduce a definition of the reduced mass presented in equation 21? Also, could the authors specify which values they used for L, Mc, and Rc and provide references?

Section Appendix:

i) "WASP-4 timing anomaly" --> "WASP-4b timing anomaly"

ii) In the caption of Figure 7: "with standard deviation (σpredicted)" --> "with standard deviation (σpre-TESS)"